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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 9

EXTRADITION *TO* GARRICK

ENCYCLOPÆDIA BRITANNICA, INC.

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EXTRADITION *TO* GARRICK, DAVID

EXTRADITION may be briefly described as the surrender of an alleged or convicted criminal by one state to another. More precisely, extradition may be defined as the process by which one state upon the request of another surrenders to the latter a person found within its jurisdiction for trial and punishment (including preventive measures) or, if he has been already convicted, only for punishment, on account of a crime punishable by the laws of the requesting state and committed outside the territory of the requested state. This purpose, direction and request by the receiving state differentiate extradition from other measures for the forcible removal of undesirable persons, such as banishment, expulsion and deportation.

Kinds of Extradition.—Extradition between independent nations not linked by any constitutional ties is designated as international extradition as distinguished from interstate extradition. The latter is the surrender of criminals between states that form part of a federal system of government without unitary administration of criminal justice, as in the United States of America (*see* art. 4, sec. 2 of the U.S. constitution). In some nations with a federal government, however, the apprehension and transfer of criminals from one constituent member to another for trial or punishment is regulated by federal legislation of an inclusive and streamlined type. Thus, Australia (Service and Execution of Process act) and Canada (criminal code) require for an interstate or interprovincial surrender, respectively, merely that a warrant for apprehension and conveyance, issued in one state or province, be endorsed for execution by a qualified officer of the state or province where the person sought is found. In Switzerland the unification of criminal justice has eliminated the former need for intercantonal extradition. Within the British Commonwealth the surrender of accused persons from one part of the dominions of the crown to another is similarly accomplished by a broadly applicable and simplified procedure, regulated either directly by the British Fugitive Offenders act of 1881 or by separate dominion legislation modeled after that act, such as the Canadian Fugitive Offenders act (originally enacted in 1882).

Character and History.—Extradition plays an important role in the international battle against crime. It owes its existence to the so-called principle of territoriality of criminal law, according to which a state will not apply its penal statutes to acts committed outside its own boundaries except where the protection of special national interests is at stake. In view of the solidarity of nations in the repression of criminality, however, a state, though refusing to impose direct penal sanctions to offenses committed abroad, is usually willing to co-operate otherwise in bringing the perpetrator to justice lest he go unpunished. Some writers on the law of nations, including the celebrated Grotius, have asserted that states have an international duty either to punish or to extradite, at least in cases of common crimes. The preponderance of modern theory and practice, however, recognizes that extradition and the conclusion of extradition treaties are merely matters of comity and that customary international law establishes no obligations for a state to grant extradition.

While instances of the surrender of criminals and even of the conclusion of general treaties on the subject are reported for antiquity as well as for the middle ages, extradition as a legal institution developed chiefly after the end of the 18th century. Originally, extradition was treated as a question of diplomatic expediency and a matter within the general police powers of the executive, but gradually it was surrounded with legal safeguards for the protection of the individual and was placed under the superintendence of the judiciary. Many nations have passed comprehensive legislation regulating the subject.

Extradition Acts.—The pioneer in this development was Belgium, which passed a general extradition law on Oct. 1, 1833. The law specified seven extraditable crimes and a number of conditions to be stipulated in treaties concluded in accordance with this statute. It was supplemented and in part superseded by legislation of 1874, which greatly enlarged the catalogue of extraditable offenses. The United States adopted a statute regulating international extradition in 1848. It had the purpose of setting at rest certain doubts as to whether extradition had become a subject of judicial cognizance and of clarifying the procedure to be followed. It refrained from establishing limitations on extradition but restricted its applicability to cases arising under extradition treaties. The Netherlands followed the Belgian example with an act of 1849, which was replaced in 1875 by further legislation.

In Great Britain passage of a general extradition law was recommended by a select committee of the house of commons in 1868. Its proposals prompted the Extradition act of 1870, which has

been amended many times. The statute was designated to facilitate the conclusion of extradition arrangements by the crown, to define extraditable offenses and to establish certain other limitations on surrender under such arrangements, as well as to establish proper procedure. The law was enacted for the United Kingdom as well as other dominions of the crown. It applied, for instance, in Australia, but Canada required separate dominion legislation (adopted in 1877) modeled after the British. Other nations also enacted extradition statutes. Legislation of this type was passed in Argentina (law no. 1612 of 1885), Switzerland (1892), Brazil (law no. 2416 of 1911, superseded by decree law no. 394 of 1938), France (1927) and Germany (1929). Italy regulated extradition in its code of criminal procedure.

Extradition Treaties.—In view of the ease and swiftness of modern transportation, many nations entered into extradition treaties with other countries, especially with close neighbours, to establish an over-all regulation of the mutual surrender of fugitive criminals. In some instances the enactment of general extradition laws, as well as the need for a formal international arrangement as prerequisite for extradition, has stimulated this development. The United Kingdom, for instance, which before enactment of the 1870 statute (mentioned above) had extradition treaties only with the United States, Denmark and France, later entered into more than 40 such arrangements. The experience of the United States was comparable. These treaties usually specify the extraditable offenses as well as other conditions for the surrender of persons accused or convicted of the commission of a crime. In most cases they establish an absolute duty to extradite, but in some instances extradition is left to the discretion of the requested state.

The relation in the various nations between the extradition treaties and the general extradition acts poses complex questions regarding the respective powers of the lawmaking and treaty-making departments under the governing constitutions. No uniform answer is possible. Furthermore, the law of the different countries varies greatly as to the legality of extraditions independent of an existing treaty. Thus, in the United States any extradition must fall under the provisions of a duly ratified and subsisting treaty, as least so long as congress has not legislated to the contrary. Similarly, in the United Kingdom, save for special parliamentary action, extradition can be granted only under an international arrangement concluded pursuant to the act of 1870. A similar situation is deemed to exist under the Belgian and Dutch laws, by virtue of their requirement of reciprocity coupled with their reference to treaties concluded pursuant to the act. On the other hand, the French extradition act applies, by its own terms, only in the absence of a treaty and to matters not regulated in the treaties, thus impliedly authorizing extradition in such cases.

The Federal Republic of Germany is satisfied with assurance of reciprocity without insisting on a formal treaty, except where the requesting country would be so limited. Switzerland also will extradite apart from a formal convention, provided that its government and the requesting state have exchanged declarations of reciprocity. Canada permits extradition, regardless of treaty, with respect to a catalogue of offenses upon proclamation by the governor general to that effect with regard to a particular nation. In general, the majority of countries grant extradition even in the absence of binding international obligations and do not base a right of asylum upon such lack.

Extradition Principles.—The conditions of or limitations on extradition are regulated by treaties and statutes and vary considerably from country to country. Nevertheless, in the course of time there has crystallized a core of extradition principles which are followed by many, though by no means all, nations.

Nonextradition of Nationals.—During the last 100 years most states have come to decline any obligation to surrender their own nationals and have even forbidden such extradition. In some countries this prohibition is elevated to a constitutional guaranty, as in Brazil (constitution of 1946, art. 141, sec. 33), West Germany (Bonn const., art. 16[2]) and the Netherlands (const., Art. 4), while in others it is anchored in extradition acts, as in Belgium, France and Switzerland. The Italian constitution permits extradition of nationals only if specifically agreed upon in international conventions.

Conversely, in Argentina, the United Kingdom and the United States no explicit rules against the surrender of citizens exist. In these countries nationals may be extradited, but only if the governing treaty either requires or authorizes such action. Thus the U.S. supreme court held in 1936 that a citizen could not be surrendered to France because the controlling treaty did not confer such power on the executive. Similarly, the supreme court of Argentina in 1956 barred extradition of a citizen to the United States under the treaty of 1896 because his personal circumstances rendered such surrender inconvenient (*Matter of Milazzo*, decision no. 18,607).

Double Criminality.—Another rule commonly found in statutes or treaties bars extradition unless the offense prompting the request is also punishable in the surrendering state, the principle of double criminality. It gained public attention in the Gerhart Eisler incident in 1949. The United States had convicted Eisler, a former German Communist, for knowingly making false statements in an application for an alien departure permit. He had fled on a Polish vessel, and while in the United Kingdom, was arrested on a warrant issued upon request by a U.S. official. The English magistrate freed him because the offense in question was not tantamount to the extraditable crime of perjury. The U.S. supreme court, in a case decided in 1933, had not felt bound by this principle in the absence of a specific treaty clause.

Nonextradition of Political Offenders.—A generally recognized extradition principle is the right of asylum for political offenders. First asserted by France, it was incorporated in the Belgian extradition law of 1833 and from there found its way into many constitutions, into most extradition laws and scores of extradition treaties. The characterization of an offense as "political" is subject to widely divergent statutory or judicial definitions. A common crime may be considered as political (so-called relative political offense), but the criteria that render it political are a matter of controversy. Connection with a political disturbance, political purpose or even a primarily political motive has been declared sufficient to justify the right to asylum. The Swiss supreme tribunal so held in favour of Yugoslavian pilots who had diverted their plane to Switzerland because of force and threats. On the same ground, extradition of purported war criminals has been refused. The Netherlands did so in the case of the German kaiser and a U.S. court of appeals in 1957 barred extradition to Yugoslavia of an individual charged with responsibility for the slaughter of thousands of victims.

Principle of Specialty.—Extradition treaties and acts usually specify that the surrender is on condition that the requesting state must not convict or punish the individual for any crime different from that for which he was extradited. This protection may be restricted to a limited period and subject to waiver by the extraditing state if its internal law so permits.

Temporary or Conditional Extradition.—Sometimes extradition is granted on condition of re-extradition to the surrendering state or is accorded subject to other limitations. Thus the supreme court of Argentina held in 1957 that the abolition of the death penalty in that country permitted extradition only on condition that no capital punishment would be imposed.

International Codification and Multilateral Treaties.—The committee of experts for the progressive codification of international law of the League of Nations (in 1926) and the International Law commission of the United Nations (in 1949) decided that extradition did not yet appear susceptible of codification or regulation by general convention. The Harvard Research on International Law, however, published a *Draft Convention on Extradition* (in 1935) to serve as basis for a common agreement. Several multilateral conventions on extradition, or certain aspects thereof, are in force among various American republics. They include three Pan-American conventions: (1) on extradition (Montevideo, 1933) binding 12 countries; (2) on private international law, art. 344–381 (Havana, 1928) binding 15 countries; and (3) on territorial asylum, art. 4 (Caracas, 1954), binding 6 countries. In addition, mention should be made of the Montevideo

treaty on international criminal law of 1889, operative in five South American republics and of the Caracas agreement on extradition of 1911, likewise in force in five South American countries. The Council of Europe prepared a European convention on extradition which was signed by 11 countries on Dec. 13, 1957.

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EXTRAPOLATION, in applied mathematics, the estimation of a value outside the observed or tabulated range of values. A graphical method often is used. *See* Interpolation and Extrapolation.

EXTRASENSORY PERCEPTION, commonly called ESP, the collective term for all the varieties of perception beyond the range of the known sensory processes. *See* Parapsychology.

EXTRATERRITORIALITY: *see* Exterritoriality.

EXTREMADURA (Estremadura), a region of western Spain, once economically important because if its rich winter pastures, comprising the provinces of Cáceres and Badajoz. Area 16,062 sq.mi.; pop. (1960) 1,378,777. It is to be distinguished from the Portuguese province of Estremadura, which occupies the central coastal region of Portugal and represents the zone conquered by Afonso Henriques from the Almohads in the 12th century. Historically, this name—popularly supposed to derive from Latin *terra extrema et dura*—was given during static periods of the Christian reconquest of the Iberian peninsula to whatever then happened to be the zones bordering on Moorish territory. Thus in the 10th and 11th centuries the border approximated to the line of the Duero or Douro river from Soria in the east to the Atlantic coast near Coimbra. Then, during the reign of Alfonso VI of León and Castile, the name Extremadura was transferred (*c.* 1086) to a newly conquered region to the south, which included Salamanca, Segovia and Ávila. This, at first, was described as "Extremadura beyond the Duero" to distinguish it from the older region of the same name. León, following its southern expansion between 1157 and 1230, also had a province called Extremadura which stretched southward from Ciudad Rodrigo to beyond Badajoz. In the 12th and early 13th centuries, therefore, both León and Castile possessed Extremaduran provinces administered as separate entities by each kingdom. Later in the reign of Ferdinand III of Castile and León this separate administration was abandoned and, from the later middle ages, the term was applied to a region only slightly larger than the combined area of the two modern provinces. *See* also Spain; Estremadura.

(P. E. R.)

EXTREME UNCTION. According to Roman Catholic and Eastern Orthodox teaching, the priestly rite of anointing the sick with oil is a sacrament of the New Law, instituted by Christ, suggested by Mark (vi, 13) and recommended by the apostle James (v, 14–17). According to both churches, the purpose of the anointing and the accompanying prayer is the forgiveness of sins, if they be present, and the cure of the sick person, if this be expedient for the good of his soul. During the 9th-century Carolingian reform, priests of the west were repeatedly exhorted to see to it that no sick person departed this life without first being reconciled, anointed and granted the Eucharist by way of viaticum; *i.e.*, food for the journey. In this way, the anointing of the sick became one of the last rites of the church, and in this context unction came to be regarded as a rite of the dying and a preparation for death. Accordingly, the anointing was usually postponed until death was imminent and the dying Christian was *in extremis;* hence the name "extreme" unction. Today, danger of death is still regarded in the west as a necessary condition for anointing, although the danger need not be imminent or even proximate. Anglicans, except for Anglo-Catholics, generally do not anoint the sick; the rite was deleted from the Book of Common Prayer after the first edition of 1549. However, the rite of anointing the sick with oil, or an alternative rite of imposing the hand, has been restored to the revised Book of Common Prayer as used by Episcopalians in the United States.

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EYBESCHÜTZ, JONATHAN (1690–1764), German rabbi and Cabalist, was born in Cracow. After serving as rabbi of Eibenschitz, Moravia, and of Metz, Ger., he became in 1750 chief rabbi of the German triple community of Altona, Hamburg and Wandsbeck. A man of erudition and personality, Eybeschütz became notorious because of a curious controversy concerning the amulets (for the aid of women in childbirth) which he was suspected of issuing. These amulets contained many sacred names of angels and Cabalistic formulas, which, according to Jacob Emden, included belief in Sabbatai Zebi (*q.v.*) as the Messiah. Eybeschütz was accused of heresy, and the ensuing controversy divided the rabbis of Germany and Poland into two contending parties. Though there is insufficient evidence against Eybeschütz, Emden may be credited with having crushed the lingering belief in Sabbatai current even in some orthodox circles. The controversy went on for years, however, and it weakened the authority of the rabbis.

See Gershen Scholem, *Major Trends in Jewish Mysticism* (1946); Mortimer Cohen, *Jacob Emden, Man of Controversy* (1937). (J. B. A.)

EYCK, VAN, the name of a family of Flemish painters in whose works the rise and mature development of art in Flanders are represented. An inscription on the frame of the Ghent altarpiece indicates that the work was begun by Hubert, and completed by his brother Jan. Since the discovery of this inscription in 1824, many art historians have tried to determine which part of the altarpiece could be ascribed either to Jan or to Hubert. Similar attempts have been made to discriminate between their two hands in Eyckish paintings not signed by Jan, as well as in the book of hours *Les Très Belles Heures de Jean de France, duc de Berry* (1911). Four records which could be applied to Hubert were discovered in the archives of Ghent, but they mention him only as "Meester Luberecht," "Meester Hubrechts," "Meester Hubrechte de scildere" and "Lubrecht van Heyke." On the basis of the inscription and the records already mentioned, together with some stylistic discrepancies within the Eyckish works, some art historians (mainly W. H. J. Weale, 1908; F. Winkler, 1921 and 1924; M. Dvořák, 1925; C. de Tolnay, 1938 and 1939; E. Panofsky, 1935, 1938 and 1953) have tried to reconstruct Hubert's production. Others (mainly E. Renders, 1933 and 1935; H. Beenken, 1935; M. J. Friedländer, 1937; J. Lavalleye, 1939; M. W. Brockwell, 1954) do not think it possible to make a distinction between two genial artists in the Eyckish group of paintings; some of them (especially E. Renders) even deny the very existence of Hubert. It must be remembered that the only evidence of Hubert being Jan's brother as well as a great artist lies in the inscription mentioned above; also that the physical and microchemical examination of the Ghent altarpiece at the Brussels laboratory in 1951 has shown that this inscription is not original, at least in its present state, and that, as regards painting technique, there is no evidence of a co-operation of two distinct personalities; furthermore, no literary source before Lucas de Heere (1565) mentions the name of Hubert, while many greatly praise Jan's art. Consequently nothing definite is known about Hubert's life and, except for the inscription on the Ghent altarpiece, there is no painting signed by him, while Jan's biographical data are numerous and well documented and several paintings are signed and dated by him. All this has to be kept in mind while reading the following notes.

1. Hubert (Huybrecht) van Eyck (?1366–1426) was the older of the two brothers. The date of his birth and the records of his progress are unknown. Hubert was probably born about 1366, at Maeseyck, and grew up under the protection of a Benedictine convent. He became a painter, wandered to Flanders and there

for the first time gained a name. At Ghent, where he settled, he painted pictures for the corporation, whose chief magistrates honoured him with a state visit in 1424. His principal masterpiece, the "Worship of the Lamb," at St. Bavon in Ghent, commissioned by Judocus Vijdt, lord of Pamele, is the noblest creation of the Flemish school, one upon which Hubert is said to have laboured until he died, leaving it to be completed by his brother. This great composition is almost unique as an illustration of contemporary feeling for Christian art. It represents, on numerous panels, Christ on the judgment seat, with the Virgin and St. John the Baptist at His sides, hearing the songs of the angels. He is contemplated by Adam and Eve and, beneath Him, the Lamb is shedding His blood in the presence of angels, apostles, prophets, martyrs, knights and hermits. On the outer sides of the panels are the Virgin and the angel annunciate, the sibyls and prophets who foretold the coming of the Lord, and the donors in prayer at the feet of the Baptist and Evangelist. After this great work was finished it was placed, in 1432, on an altar in St. Bavon of Ghent, with an inscription on the framework describing Hubert as *maior quo nemo repertus* ("greater than whom nobody is found"). Jan van Eyck probably wished to guard against an error which ill-informed posterity showed itself but too prone to foster, the error that he alone had composed and carried out an altarpiece executed jointly by Hubert and himself. His contemporaries may be credited with full knowledge of the truth in this respect, and the facts were equally well known to the duke of Burgundy and the chiefs of the corporation of Bruges, who visited the painter's house in state in 1432, and the members of the chamber of rhetoric at Ghent, who reproduced the Agnus Dei as a *tableau vivant* in 1458.

The solemn grandeur of church art in the 15th century never found, out of Italy, a nobler example than this altarpiece. The representation of Christ as the judge, between the Virgin and St. John, affords a fine display of realistic truth, combined with pure drawing, gorgeous colour and a happy union of earnestness and simplicity with the deepest religious feeling. Hubert died on Sept. 18, 1426, and is supposed to have been buried in the chapel on the altar of which his masterpiece was placed. According to a tradition as old as the 16th century, his arm was preserved as a relic in a casket above the portal of St. Bavon of Ghent.

2. JAN VAN EYCK (?1385–1441). The date of his birth is not more accurately known than that of his elder brother. But numerous details about his life are known to us through account books of his employers. About 1422, Jan became painter and *varlet de chambre* to John of Bavaria, count of Holland; he was commissioned to decorate his palace at The Hague (1422–24). In May 1425, Jan left Holland (John of Bavaria had died in 1424) and was appointed painter and *varlet de chambre* to Philip the Good, duke of Burgundy, at a salary of 100 livres per annum. From then until his death Jan van Eyck remained in Philip's service. He was frequently employed in missions of trust, and appears for a time to have been in ceaseless motion, receiving extra pay for secret services at Leiden, drawing his salary at Bruges, yet settled at Lille. In 1428 he joined the embassy sent by Philip the Good to Lisbon to beg the hand of Isabella of Portugal. His portrait of the bride fixed the duke's choice. After his return he settled definitely at Bruges, where he married some time before 1434. His wife bore him at least two daughters, one of them known in after years as a nun in the convent of Maeseyck, and at whose christening the duke was sponsor. Jan's death in 1441 at Bruges is authentically recorded. He was buried in St. Donat, which was at the time the cathedral of Bruges.

Numerous altarpieces and portraits now give proof of Van Eyck's extensive practice. As works of art and models of conscientious labour they are all worthy of the name they bear. The panels of the Ghent altarpiece were completed in 1432. They show that Jan was quite able to continue the work of his elder brother. His own experience had been increased by travel, and he had seen the finest varieties of landscape in Portugal and the Spanish provinces. This enabled him to transfer to his pictures the scenery of lands more sunny than those of Flanders. Much of the success which attended his efforts to complete the altarpiece of Ghent may be ascribed to the cleverness with which he reproduced the varied

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"THE MARRIAGE OF GIOVANNI (?) ARNOLFINI AND GIOVANNA CENAMI (?)" BY JAN VAN EYCK. IN THE NATIONAL GALLERY, LONDON

aspect of changing scenery, reminiscent here of the orange groves of Cintra, there of the bluffs and crags of his native valley. In all these backgrounds, though lacking the scientific rules of perspective, there are such delicate perceptions of gradations in tone, such atmosphere, yet such minuteness and perfection of finish, that our admiration never flags. Nor is the colour less brilliant or the touch less firm than in Hubert's panels.

Jan excels in two splendid likenesses of Judocus Vijdt and his wife, Elisabeth Borluut. The same vigorous style and coloured key of harmony characterizes the small "Virgin and Child" of 1433 at the National gallery, Melbourne, Austr., formerly at Ince hall, and the "Madonna," probably of about the same date, at the Louvre, Paris, executed for Rolin, chancellor of Burgundy. Contemporary with these, the male portraits in the National gallery, London, the "Portrait of a Young Man" (1432) and the "Man in a Turban" (1433), show no relaxation of power; but later creations display no further progress, unless we accept as progress a more searching delicacy of finish, counterbalanced by an excessive softness of rounding in flesh contours. An unfaltering minuteness of hand and great tenderness of treatment may be found, combined with angularity of drapery and some awkwardness of attitude in the full-length portrait couple ("The Marriage of Giovanni [?] Arnolfini and Giovanna Cenami [?]"; 1434), at the National gallery, London, in which a rare insight into the detail of animal nature is revealed in a study of a terrier dog. (*See* PORTRAIT PAINTING.) A small triptych with the "Madonna Enthroned With St. Catherine, St. Michael and a Donor" at Dresden, equally soft and minute, is notable for the mastery with which an architectural background is put in. The bold and energetic striving of earlier days, the strong bright tone, are not equaled by the soft blending and tender tints of the later ones. Sometimes a crude ruddiness in flesh appears to be a growing defect, an instance of which is the picture in the museum of Bruges, in which Canon van der Paelen is represented kneeling before the Virgin under protection of St. George (1434). First to last Van Eyck retains his ability in portraiture. Fine specimens are two male liknesses in the gallery of Vienna: "The Goldsmith Jan de Leeuw" (1436) and "Cardinal Niccolò Albergati," and a female, the master's wife, in the gallery of Bruges (1439). Two more pictures have been signed and dated by Jan: "St. Barbara," uncompleted (1437), and "The Virgin by a Fountain" (1439), both in the museum of Antwerp. Others have been ascribed to him on stylistic evidence: "The Annunciation," formerly in the Hermitage at Leningrad, now at the National gallery, Washington; a "Madonna and Child With Two Female Saints and a Carthusian Donor" (in co-operation with Petrus Christus?), formerly in the Rothschild collection, Paris, now in the Frick collection, New York; the "Portrait of Balwin de Lannoy" at Berlin and the "Portrait of a Goldsmith" at Cibiu, Rum. The following works of an earlier date are generally ascribed to Hubert, though some critics believe them to be by Jan: "The Crucifixion" and "The Last Judgment," two wings of an altarpiece in the Metropolitan museum in New York; the "Three Maries at the Sepulchre," in the D. G. van Beuningen collection at the Boymans museum in Rotterdam; the "Virgin" in the nave of a Gothic church at Berlin; two pictures of St. Francis, one in the Johnson collection at Philadelphia, the other in the museum at Turin.

Petrus Christus, who copied some of Jan's works and imitated his style in a somewhat weaker manner, is supposed to have been taught by him. But if the personal influence of the Van Eycks was small, that of their works was immense, and it is not too much to say that their example, taken in conjunction with that of Rogier

van der Weyden, determined the current and practice of painting throughout the whole of Europe north of the Alps for nearly a century.

A last word must be said about the legend, which has been alive since G. Vasari's *Vite* (1550), that Jan or Hubert van Eyck invented oil painting. This cannot be entirely true, for it was already mentioned in technical books of the middle ages and was also occasionally used by artists. However, as all Flemish panel paintings since the Van Eycks have an oil medium, one can admit that they improved the pictorial characteristics of this medium to such an extent that the former tempera could be forsaken. This new painting technique corresponded in time with the arising of the school of Flemish Primitives and could therefore account to a certain extent for its sudden development.

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EYE, market town and municipal borough in Eye parliamentary division of East Suffolk, Eng., 89 mi. N.E. of London. Pop. (1961) 1,583. Eye (A.S. "island") is surrounded by a network of tributaries of the Waveney. Brewing is the principal industry. The church of SS. Peter and Paul (Perpendicular flintwork) was formerly attached to a Benedictine monastery. Fragments of a Norman castle crown an earthwork already existing in 1066. Remains of a Roman villa and cemetery have been found. William the Conqueror gave the lordship of Eye to Robert Malet, a Norman, who built the castle and monastery, the first alien monastery to be subordinate to the abbot of Bernay in Normandy. In 1206 King John granted the townsmen a charter; later charters were granted by Elizabeth I and William III.

EYE, HUMAN. The eye is an end organ that in reacting to light conveys to the brain a sensation of vision (*q.v.*).

This article is divided into three main parts with the following headings: *Anatomy and Physiology of the Eye; Diseases of the Eye;* and *Surgery of the Eye.*

ANATOMY AND PHYSIOLOGY OF THE EYE

Methods of Study.—The essentials of ocular anatomy were learned during the 18th and 19th centuries by gross observation and, toward the end of this period, by the use of the compound microscope. In the 20th century the development of new techniques allowed study of finer details than previously, and by the mid-1960s investigation of the cellular anatomy of the eye had been superseded by intracellular analysis down to the molecular level.

Some of the methods of study are employed in the living eye—for the eye is accessible, by means of optical devices, to close scrutiny at high magnification. These methods avoid the pitfalls encountered by postmortem changes or chemical fixation. The devices include the gonioscope, invented by A. Trantas in 1901, and a slit lamp introduced by Allvar Gullstrand in 1916. Both allow detailed study of the front portions of the eye (anterior chamber, cornea, iris and lens), the vitreous body and even the retina.

Circulation in the eye has been investigated by various injection and digestion techniques and autoradiography (*see* NUCLEAR INSTRUMENTS: *Photographic Methods*). Special optical methods have been introduced to increase the degree of resolution both in living and water-fixed specimens. These methods include the use of monochromatic light; ultraviolet microscopy; and phase-contrast microscopy, originated by Frits Zernike in 1934. The last-named method has allowed undisturbed living-state examinations of transparent structures of the eye such as the vitreous body and retina. Electron microscopy, which utilizes beams of electrons rather than light, has permitted magnifications of eye structures having molecular dimensions. X-ray diffraction, histochemistry and absorption spectrophotometry have also contributed to ultramicroscopic knowledge of the eye. (*See* ANATOMY, MICROSCOPIC; HISTOLOGY: *Histological Methods;* MICROSCOPE.)

Plan and Mechanisms of the Eye.—In all vertebrates, including man, the eye is built according to the plan of a simple camera (fig. 1). It is essentially a spherical sac with opaque walls and a transparent front, the cornea. The eye is filled with transparent media. The most anterior inner space, immediately behind the cornea, is the anterior chamber; next is the ring-shaped posterior chamber, which is separated from the anterior chamber by a pigmented membrane, the iris. Both chambers are filled with aqueous humour. Behind the anterior structures is the spacious vitreal cavity, filled with the gelatinous vitreous humour; this, the largest portion of the eye, is called the vitreous body.

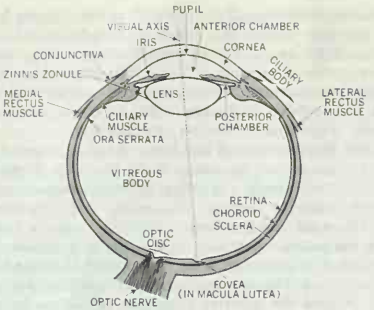
At the centre of the iris is a circular opening, the pupil. Immediately behind the pupil is the crystalline lens, a virtually transparent, elastic body of biconvex shape. It is suspended by a number of delicate tendinous threads, the suspensory ligament, or Zinn's zonule. The zonule in turn is attached to the epithelium (covering tissue) of the ciliary body. When the ciliary muscle relaxes the zonule fibres are placed under tension, which exerts a pull on the equator of the lens and tends to flatten the lens. When the ciliary muscle contracts the zonule is less taut and the lens surfaces increase in curvature. Changes of lens shape enable the eye to accommodate visually to near and distant objects.

The lens consists of a great many fibres arranged in sheets like the layers of an onion and enclosed in a clear, elastic membrane, the capsule. The core is firmer than the rind, whose relative softness permits the lens to change shape under slight force. The perfectly smooth surfaces of the lens are curved, the posterior surface more so than the anterior. With the aid of a slit lamp, various zones can be seen in the lens; alternation in growth rate and disease processes will produce changes in the transparency, appearance, and size of these zones. The lens as a whole becomes harder and less transparent with age.

Dioptrics of the Eye.—When the eye is considered as a dioptrical (light-refracting) apparatus it may, as noted above, be compared with a camera. The photographic lens is represented by the refracting media, the cornea and the lens; the photosensitive screen corresponds to the retina, the innermost of the coats, or tunics, of the eye. Rays of light coming from the exterior are distributed in the eye according to the laws of geometrical optics. First they are collected and refracted by the cornea; they then proceed to the lens, where additional refraction takes place. Most refraction is done by the cornea in terrestrial vertebrates and by the lens alone in aquatic animals (because the outside water and the intraocular media have the same index of refraction). The aqueous and vitreous humours do not influence refraction. Accommodation of the lens (*see* above) focuses the refracted rays of light on the retina, to form a real image that is much smaller than the object being viewed and is symmetrically inverted.

Coats of the Eyeball.—The outer shell of the eyeball is made up of three coats: the fibrous tunic, the uveal tunic and the retina. The outermost is the tough fibrous tunic, composed of variously arranged connective tissue fibres. The larger, posterior segment of this tunic, called the sclera, is opaque; the smaller, anterior segment fitted into the sclera is the transparent cornea. The curvature of the latter is much sharper than that of the sclera. The thickness varies in different regions of the fibrous tunic.

The Sclera.—The sclera is surrounded by the capsule of Tenon, which contains fluid-filled spaces. The inner surface of the sclera has a brownish colour due to pigment cells. The scleral fibres are collagenous and elastic, and are arranged to minimize the effects of changes in intraocular pressure and external forces. The nerve supply of the sclera is derived from the ciliary nerves; the few blood vessels are branches of the anterior and posterior ciliaries. The anterior portion of the sclera close to the anterior chamber is encircled by Schlemm's canal, which is in direct contact with the



FROM CHARLES H. BEST AND NORMAN B. TAYLOR, "THE PHYSIOLOGICAL BASIS OF MEDICAL PRACTICE"

FIG. 1.—HORIZONTAL SECTION OF THE RIGHT EYE

deeper layers of the trabecular tissue of the angle of the anterior chamber. Fluid from the anterior chamber can drain through the trabecular meshwork into Schlemm's canal and then leave the canal via venous tributaries.

The Cornea.—This is the clear, smooth, transparent coat that is anterior to and continuous with the opaque sclera. The transition zone between the cornea and sclera, called the limbus, is a semitransparent zone which also blends with the conjunctiva, the membrane that covers the undersurface of the eyelids as well as the anterior portions of the sclera. The cornea is not vascular but the limbus is well supplied with blood and lymphatic vessels. Corneal nerves are derived from the first division (ophthalmic) of the fifth cranial nerve and come to the cornea through the ciliary nerves.

The cornea has five layers. From outermost to innermost they are: the epithelium; the anterior lamina, or Bowman's membrane; the stroma, or substantia propria; the posterior lamina, or Descemet's membrane; and the endothelium. The stroma, made up of fibrous connective tissue, is by far the thickest layer. The regular arrangement of the stromal fibres is essential to maintain the normal corneal transparency. Each of the corneal fibres consists of fibrils that are relatively uniform and comparatively thin in contrast with the variability of the size of the scleral fibrils. Most corneal fibrils are collagenous in nature and, unlike those of the sclera, each lies in a thick mucoid ground substance.

Choroid Membrane.—The next coat of the eye, lying beneath the fibrous tunic, is the uveal tunic, so called because of its similarity to a grape (Lat. *uva*). Its thinner and larger posterior segment is the choroid membrane, which contains numerous minute blood vessels and chromatophores (pigment cells). The function of the choroid is to supply the photosensitive rods and cones of the retina with nutritive blood and to form a dark lining on the inside of the eyeball.

Between the choroid and sclera is the suprachoroidal space. Here the two coats are connected only by delicate fibres; for this reason the choroid is easily detached from the sclera. The inner surface of the choroid is indistinctly separated from the outer portion of the retina by a membrane partly derived from each. This composite structure, called the lamina basalis or Bruch's membrane, lies between the pigmented epithelium of the retina and the capillary layer of the choroid; when the retina is detached, the retinal layer remains adherent to the choroid.

Ciliary Body.—Toward the front end of the eyeball the uveal tunic is thickened into a special structure called the ciliary body. This is a series of minute, radially arranged, ridgelike processes containing smooth muscle fibres and blood vessels. The inner surface of the ciliary body is lined with two pigmented epithelial layers which secrete the aqueous humour; they represent forward continuations of the retina. Some of the muscle fibres are arranged more or less radially, and others are circular; their function is to relax the suspensory ligament of the lens and thus to increase the lens' refractive power. Ciliary muscle also influences the drainage of aqueous humour from the anterior chamber by altering the size and shape of Schlemm's canal and the meshwork of tissue lying in the angle of the anterior chamber in front of the canal.

Iris.—The most anterior portion of the uveal tunic is the iris, the pigmented diaphragm or curtain whose contractions regulate the amount of light entering the eye through the pupil. The colour of the iris—a person's eye colour—varies among individuals from dark brown to light blue or green, depending on the number and distribution of pigment cells.

The iris contains two minute sets of smooth muscle fibres: the circular, or sphincter, fibres surrounding the pupillary margin and the radiating, or dilator, fibres running from the circumference inward. The two sets are involuntary, are antagonistic in function, and are regulated by different nerves: the sphincter by the oculomotor, or third cranial, nerve, and the dilator by cervical sympathetic nerve fibres. When strong light stimulates the retina and activates the nerve pathway of vision, the sphincter fibres contract, reducing the pupillary aperture and thus the amount of light entering the eye; when the impinging light lessens, the dilator fibres contract, widening the pupil and thus admitting more light.

The anterior layer of the iris is a continuation of the endothelial layer of the cornea. The vessels of the iris continue forward from the vessel layer of ciliary body and choroid. The sphincter and dilator muscles represent extensions of the pigmented epithelium of the ciliary body and retina. The ciliary epithelium continues forward as the pigmented epithelium of the iris.

The Retina.—The innermost coat of the eye, the retina, lines most of the large posterior cavity, the vitreal chamber. The anterior limit of the retina is serrated and is therefore called ora serrata, or serrated margin; beyond it only a microscopic epithelial vestige continues on the inner side of the ciliary body and the iris as far as the pupillary margin. The retina is an extremely delicate tissue and is only a fraction of a millimetre thick. Its inner layers contain thin-walled blood vessels that carry blood from the central artery to the central vein.

Retinal Layers and Cells.—The retina is the actual organ within which the stimulation by physical light takes place and where the sensation of vision is initiated; the remainder of the eyeball is merely a supporting shell that regulates the nutrition and serves as a dioptrical apparatus. In its early embryonic development the retina is a thin outpocketing of the brain around which the eye forms. In microscopic sections vertical to its surface ten layers customarily may be distinguished (fig. 2):

1. Closest to the choroid and farthest from the vitreous is the single-layered pigment epithelium, which is a transformed outer sheet of the secondary optic vesicle, or cup, of the embryo.

2. Layer of rods and cones (consisting of outer segment 2a and inner segment 2b), formed of the rodlike outer parts of the photoreceptors or visual cells, the rod-and-cone cells, within which the first steps in the physiological process of light reception take place.

3. Outer limiting membrane, a thin line formed by the supporting radial fibres of Müller.

4. Outer nuclear layer consisting of the bodies of the rod-and-cone cells.

5. Outer plexiform layer made up of the terminal fibres of the rod-and-cone cells and of the dendrites of cells that form the sixth layer.

6. Inner nuclear layer containing the bodies of the horizontal cells, bipolar cells and amacrine cells.

7. Inner plexiform layer consisting of the processes of both the preceding cells and of the ganglion cells.

8. Ganglion cell layer.

9. Layer of the optic nerve fibres or axons of the ganglion cells.

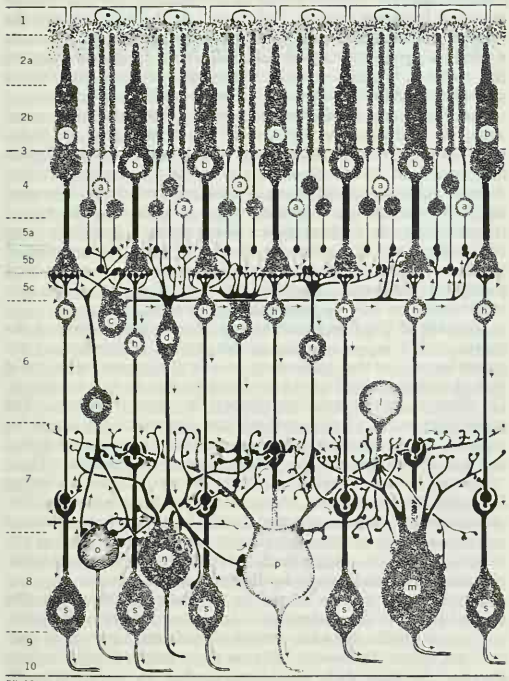
10. Inner limiting membrane formed by the joining of the inner ends of the supporting radial fibres of Müller.

The retinal cells directly involved in the visual process are (fig. 2): photoreceptors, which are represented by the rod (*a*) and cone (*b*) cells; horizontal cells (*c*); four or five varieties of bipolars: mop (*d*), brush (*e*), flat-topped (*f*), midget (*h*) and cen-

trifugal (*i*) varieties; at least five varieties of ganglion cells: parasol (*m*), shrub (*n*), small diffuse (*o*), garland (*p*) and midget ganglion (*s*); and several varieties of so-called amacrine cells (*l*). These cells are called neurons because they initiate or conduct nervous information. They are put together in an intricate pattern that is of fundamental importance for the visual functions. Each of these neurons is related to another by contact; the points of contact or attachment are called synapses. At synapses, nervous information is permitted by intricate mechanisms to pass in one direction only, from cell to cell.

Functional Interpretation of the Retinal Structures.—Each variety of retinal neuron has its particular synaptical relationship to other varieties. The significance of the relationships, apparently, is the creation of multiple channels through which the excitations generated in the photoreceptors may be modified in various ways. Light coming from without is refracted in the dioptrical apparatus (cornea, lens) and distributed over the retina according to the laws of geometrical optics. The rays finally pass through almost the entire thickness of the retina without causing any change in the dynamical status of its nervous elements. Only in the rod-and-cone layer (2) does the light meet the photosensitive chemical substances that act as mediators by initiating the nervous impulses.

Specifically, it is in the outer limbs of the rods and cones proper (which in the aggregate form the layer 2a) that the first step in the process of photoreception takes place. It is believed that the rods function principally in weak light, such as exists during twilight; they mediate the so-called scotopic vision that responds to weak stimuli but is not capable of distinguishing colours. The cones in turn function in bright light and respond specifically to certain wave lengths of the spectrum (*i.e.*, to colours) and, besides, serve the perception of much finer details (acuity). Accordingly, the retina is a composite organ capable of performing two different functions under various conditions of stimulation (duplicity theory, retina duplex).



BY COURTESY OF STEPHEN L. POLYAK

FIG. 2.— ARRANGEMENT OF THE VARIETIES OF NERVE CELLS AND SYNAPTICAL RELATIONSHIPS IN THE HUMAN AND SIMIAN RETINA. (*See* TEXT)

Visual Acuity and Regional Differentiation of the Retina.—The structure of the retina varies considerably in its different regions. The most important region is the one around the visual axis (fig. 1). In fresh specimens the point where the visual axis meets the retina shows a yellow colouring—the yellow spot, or macula lutea. Here the retina is much thicker because of the greater number of cells, except that in its centre the central area is much thinner since most of the inner layers (5–9 in fig. 2) are displaced in a lateral direction to form an excavation—the central pit or fovea (fig. 1). The layer of photoreceptors in the fovea, however, is exceptionally thick (fig. 3). This thickening is caused by a lengthening of the cones, which are present here without rods. This area measures approximately 0.5 mm. ($\frac{1}{50}$ in.) across. There are no blood vessels here to obstruct the passage of light rays to the central cones; it is therefore called the avascular central area.

Conversely, the central cones are thinner in diameter than in any other region, being reduced in the centre to 1 micron ($\frac{1}{25,000}$ in.). Viewed from the surface, the central cones show a solid mosaic of minute hexagonal fields corresponding to the individual cones and arranged in intercrossing rows.

Not far from the central fovea is the optic papilla or disk (fig. 1), the locality where all axis cylinders of the ganglion cells, or optic nerve fibres, assemble before they leave the eyeball and form the optic nerve. Since there are no rods and cones here, the optic papilla is not sensitive to light and is referred to as the blind spot in the field of vision. From the centre of the fovea, where it is most refined, the structure of the retina gradually becomes cruder toward the periphery, especially close to the serrated margin, or ora serrata. This agrees with the decrease of the acuity in the periphery of the field of vision. Other details, *e.g.*, the connections of many more rods and cones with each bipolar cell and of many more bipolar cells with each ganglion cell than found in the central region of the retina, indicate a mechanism of convergence and summation by which the retinal periphery close to the ora serrata is made more sensitive to weak visual stimuli than the axial region.

Vitreous Body.—Behind the lens and in front of the retina lies the transparent, semisolid gel called the vitreous body. It occupies two-thirds of the volume of the globe. It is firmly attached in only two areas: anteriorly to the ciliary epithelium and posteriorly to the optic disk. The gel is composed of a collagenlike protein, vitrein.

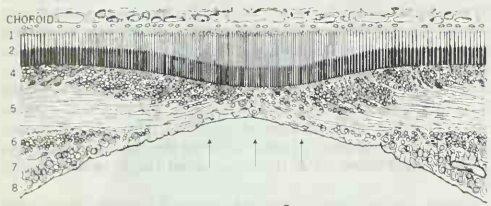
Optic Nerve.—The optic nerve extends from the eye to the chiasm, on the ventral surface of the brain. It originates in the ganglion cells of the retina and varies in length, in adults, from 35 to 55 mm. ($1\frac{2}{5}$ to $2\frac{1}{5}$ in.). The intraocular portion, lying within the coats of the eye, is only 1 mm. ($\frac{1}{25}$ in.) long. The orbital portion of the nerve has considerable slack to allow for rotation of the eyeball. In addition to the visual fibres and those responsible for the pupil reactions, three other types of optic-nerve fibres have been identified. Each optic nerve contains almost one million fibres.

Accessory Structures of the Eye.—The eyeball is lodged in the bony socket of the skull together with other parts pertaining to it: seven extrinsic muscles, blood vessels, nerves, the lacrimal gland and the orbital fat. It is protected externally by the fascia, mucous conjunctiva, skin, lashes and the brow. The tears secreted by the lacrimal gland (fig. 4) moisten and wash the exposed parts, thus keeping the cornea clean and transparent. The surplus tears are carried through the two short lacrimal canals into the lacrimal sac, and from it through the nasal or nasolacrimal duct to the nasal cavity. (S. L. Pk.; W. K. N.; I. H. L.)

DISEASES OF THE EYE

This section deals principally with common and typical diseases of the human eye and also discusses injuries and malignant tumours. Diseases of the eye, which will be discussed first, may be classified according to the part or region primarily affected, namely: (1) the eyelids; (2) lacrimal apparatus; (3) conjunctiva;

(4) cornea; (5) sclera; (6) iris, ciliary body and choroid; (7) retina; (8) crystalline lens; (9) vitreous body; (10) the eyeball as a whole; (11) the orbit; (12) the optic nerve and the visual pathway; and (13) the eye muscles, their nerves and nerve centres. Related information appears in the articles BLINDNESS: *Causes of Blindness;* COLOUR BLINDNESS; NIGHT BLINDNESS; AMBLYOPIA; ASTHENOPIA; MALNUTRITION.



BY PERMISSION, FROM S. L. POLYAK, "THE RETINA"; © 1941 BY THE UNIVERSITY OF CHICAGO

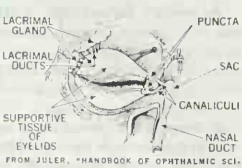
FIG. 3.—CROSS SECTION THROUGH DEEPEST PART OF THE HUMAN FOVEA SHOWING ATTENUATED, ELONGATED, AND MORE NUMEROUS CONES IN THE CENTRE, INCREASING IN THICKNESS AND BECOMING LESS NUMEROUS TOWARD PERIPHERY

The numbers of layers are the same as in Fig. 2. Rod-and-cone, or photoreceptor, layer (2) has a few rods at both ends; inner layers (6–8) are practically absent in fovea! floor, permitting rays of light (indicated by arrows) to reach photoreceptor layer unhindered

Diseases of the Eyelids.—The eyelids are movable curtains or shields that protect the eyeball from mechanical injury and help keep the eye chamber moist; a moist condition is essential for the normal functioning of the cornea and conjunctiva. The lids are closed through the action of a circular muscle, the orbicularis, and are opened by an arrowhead-shaped muscle, the levator of the upper lid. Normally the lids are in close apposition with the eyeball, closing and opening the eye and keeping it covered during sleep. This normal position is the result of the harmonious action of the lid muscles and of the elasticity and strength of the other supporting structures of the lids. Abnormal overaction (spasm) of the circular lid muscle may cause a turning in of the lid border (entropion), causing the eyelashes to rub against the eyeball. Injuries or infections affecting the eyelids may terminate in scars that pull the lids away from the eyeball and may partly or completely evert them (ectropion). The effect of age on the supporting structures of the eyelids may lead to turning out of the lower eyelid. The fine wrinkles of the skin of the eyelid that distinguish mature individuals from the very young are caused by a gradual weakening of the elastic elements of the skin. Skin diseases may bring on this weakening at an early age.

A fairly common abnormality of the position of the upper lid is congenital or acquired drooping, or ptosis, due to weakness or lack of innervation of the lid-raising muscle If this is pronounced to the point of covering the pupil, it calls for surgical repair to improve vision. Drooping of lesser degree is primarily a matter of appearance.

Normal lid closure is dependent on the normal innervation of the circular muscle by the facial nerve, the seventh cranial nerve. Paralysis of this nerve makes lid closure impossible, whether by voluntary or involuntary (*e.g.*, during sleep) nerve routes; inability to close the lids exposes the cornea to the danger of drying out and becoming ulcerated. Protective measures may have to be taken to keep the cornea moist, particularly during sleep. (*See* also NERVE: *Cranial Nerves: Facial Nerve.*)



FROM JULER, "HANDBOOK OF OPHTHALMIC SCIENCE AND PRACTICE" (MURRY)

FIG. 4.—LACRIMAL APPARATUS OF THE EYE

The lid borders are kept lubricated by the oily secretion of the lid glands. This barrier of grease keeps the normal amount of tears from spilling over onto the cheek. The lid glands may become infected by bacteria from the air or from the adjacent skin or conjunctiva. The acute purulent form of this infection, called hordeolum, or sty, is a common eye disease and is effectively treated by local (topical) application of suitable antibiotic or other antiinfective agents.

Another common but less acute lid disease is the chalazion, a circumscribed swelling in the depth of the lid caused by obstructions within a lid gland. Some of these swellings persist and require surgical removal to restore normal appearance and function of the lid. Chalazia often clear up through a natural process of absorption.

The lid borders may become the site of a chronic inflammation (blepharitis) caused by microorganisms that find the local conditions (skin joining a mucous membrane) particularly suitable for their metabolism and continued growth. Scales or flakes of secretions cling to the congested or ulcerated lid borders and to the eyelashes. Most forms of blepharitis can be brought under control with antibiotics.

Diseases of the Lacrimal Apparatus.—The exterior surface of the eye, that is, the cornea and the conjunctiva overlying the anterior sclera, are normally covered by a thin layer of fluid that is provided and continuously replenished by the lacrimal, or tear, gland. The rates of tear production, tear evaporation from the surface of the eye globe and tear elimination from the eye through the action of the lacrimal passages are normally so well balanced that the eye is kept moist without any overflowing of tears or any subjective sensation of moisture. This normal balance may be disturbed in the sense of too little or too much moisture. The latter is by far the more common and the less serious condition. It may be caused by obstruction of the lacrimal passages; such obstructions often can be traced to a disorder within the nose. Abnormal position of the lower lid or deficient action of its musculature may interfere with the pumping mechanism within the tear passages. A mild abnormal overflow of tears (epiphora) is common in elderly people with overly relaxed lower lids. Most states of deficient muscle action or abnormal lid position can be corrected by minor surgical procedures. If the duct between the tear sac and the nose is closed off completely, the sac becomes a blind alley and, unavoidably, infected. Such infections endanger the cornea and must be eradicated by an operation that creates a new communication between the tear sac and the nose.

Insufficient tear production is a more serious and much more annoying condition; the dryness of the eye may give rise to intense discomfort culminating in the sensation that a sharp foreign body is present. The lack of tears is part of a systemic endocrine disorder occurring characteristically, but not exclusively, in women 40 to 60 years of age. Artificial tears instilled into the eye at frequent intervals, surgical closure of the channels that drain away the small amount of moisture or, in extreme cases, implantation of the duct of a salivary gland into the conjunctival sac are the local therapeutic measures. Rectification or amelioration of the systemic condition may be attempted by hormone therapy.

Diseases of the Conjunctiva.—A considerable portion of the conjunctiva is exposed to the outside world. This exposure accounts largely for the common occurrence of conjunctivitis (*q.v.*); that is, inflammations of the conjunctiva due to (1) infections, (2) allergies or (3) irritating physical or chemical agents. The typical symptoms of conjunctivitis are congestion (as shown by redness) of the affected membrane, tearing (secretion of tears) and a discharge that may be watery, mucous or purulent. These symptoms are accompanied by mild to moderate burning, stinging or foreign body sensations. Accumulation of the conjunctival discharge during sleep causes the eyelids to be stuck together on awakening. Pain or visual impairment are not normal parts of the clinical picture of conjunctivitis; if present, they suggest complications that usually mean involvement of the cornea.

Conjunctivitis can be caused by several physical agents, the chief of which is ultraviolet light. Its source may be a sun lamp, welding arc or the sun when sunlight is reflected by snow at high altitudes (snow blindness). The resultant conjunctivitis is characterized by only slight discharge, marked hypersensitivity to light and, fortunately, short duration. The vision is actually not disturbed, but the sensitivity to light may be so intense that the

affected person is unable to keep his eyes open.

A mild allergic conjunctivitis accompanies most forms of hay fever. The discomfort due to the allergic state of the upper respiratory tract is usually very much greater than the ocular discomfort, which rarely exceeds a mild itching sensation. Allergies of the conjunctiva and eyelids frequently occur after prolonged topical use of drugs in the treatment of other eye diseases. The symptoms of drug allergy, or drug sensitivity, include itching, redness and swelling of the affected tissues; they usually abate promptly upon withdrawal of the offending drug.

"Spring conjunctivitis" (or vernal conjunctivitis) is usually classified among the allergic conjunctivitides, although its etiology is not definitely established. It is a chronic conjunctivitis with characteristic exacerbations during spring; that is, at the beginning of warm weather. It occurs in children or youths between the ages of 5 and 15 years and causes marked thickening of the conjunctiva associated with intense itching. Topical application of steroids has been highly beneficial in alleviating the itching.

The conjunctiva, because of its exposed position, comes into contact with microorganisms more often than any other mucous membrane. The advent of highly effective antibiotics and other anti-infective agents has changed the incidence, course and outcome of many forms of conjunctivitis. Some of the more severe forms such as gonorrheal ophthalmia have been practically wiped out, both in the adult and in the newborn (*see* also VENEREAL DISEASES: *Gonorrhea: Gonococcal Ophthalmia Neonatorum*). Mild bacterial conjunctivitis is still common and probably will continue to be common, even though it is easily and effectively treated with topical antibiotics. The term "pinkeye" is used popularly to refer to mild, short-lasting but very contagious forms of conjunctivitis irrespective of their etiology.

Several types of conjunctivitis caused by viruses began to come to the fore about 1940 because the viruses were resistant to the anti-infective drugs then in use. A type of viral conjunctivitis now known as epidemic keratoconjunctivitis assumed serious dimensions during World War II. By its alarming spread in industrial populations, particularly in shipyards—hence its popular name of "shipyard conjunctivitis"—the disease caused serious losses in production. Because of its high contagiousness, it still occasionally gives rise to small epidemics. The conjunctivitis may last as long as two to three months, but the patient usually makes a complete recovery.

Mankind has been plagued by a severe chronic infectious conjunctivitis called trachoma (*q.v.*), which, in the endemic form, once affected large populations and caused serious visual impairment by scarring the cornea. Through the sustained efforts of international and national health organizations, trachoma has become restricted to smaller and smaller sections of the earth. In the U.S. the disease has been practically wiped out except for several of the Indian reservations. It has been proved to be caused by a virus that is susceptible to some antibiotics.

"Swimming pool conjunctivitis" is caused by a virus that has its usual habitat in the male or female genitourinary tract, where it causes no symptoms or pathologic changes. Infection of the conjunctiva may occur in any person who uses an infected pool; it occurs more frequently, however, in an infant whose eyes have become infected as it passes through the birth canal of an infected mother. In either case the conjunctivitis is characterized by bilaterality, copious discharge and prompt response to sulfonamides.

Many systemic diseases of the skin and mucous membranes, particularly the acute infectious childhood diseases such as diphtheria and measles, cause conjunctivitis of greatly varying severity.

A noninflammatory disease of the conjunctiva quite common in dry regions is the condition called pterygium, which is caused by shrinkage of the portion of the conjunctiva most exposed to dust and wind. This shrinkage causes the conjunctiva to be drawn onto the cornea. In extreme cases the vision becomes impaired by the opaque irregular tissue that invades the cornea. In the milder cases the patient is most concerned about the abnormal appearance of the eye. Minor operations can usually restore normal or almost-normal appearance and prevent recurrences.

Diseases of the Cornea.—The normal cornea functions as the front lens of the optical system of the eye and, at the same time, as the front wall of the eyeball. The perfect regularity in the arrangement of its elements accounts for the transparency of the cornea as well as for the smoothness of its surfaces. After a corneal disease has run its course the natural process of repair (which is scar tissue formation) rarely succeeds in restoring the cornea to its normal condition. The optical irregularities due to corneal scars may lend themselves to correction by spectacle lenses, contact lenses or corneal surgery.

Many times in the history of ophthalmology the human cornea has been described as being prone to disease. This proneness is due partly to its exposed portion, partly to its lack of blood vessels and partly to the fact that minimal tissue changes in the cornea may cause profound disturbances of vision, whereas the same changes would cause no perceptible or detectable symptoms in many other tissues or organs. Many diseases of the cornea can be corrected by corneal transplantation operations (see *Surgery of the Eye: Cornea* below).

The large number of disease entities among the common corneal affections can be classified according to (1) the route by which the cornea became involved; *i.e.*, ectogenous (from the outside) or endogenous (from within the body); (2) the nature of the disease, *i.e.*, infectious, allergic, metabolic, circulatory or degenerative. Four typical corneal diseases will be mentioned here.

Corneal Ulcer.—First of all there is the corneal ulcer that is caused by ectogenous infection. In most instances the microorganisms gain access to the corneal tissue through a minute scratch in the surface layer. The object that inflicted the scratch may also be the carrier of the bacterial invader. The microorganisms destroy the surrounding tissue and, thereby, give rise to an ulcer. The course of corneal ulcers depends upon the virulence of the bacterial invader, on the one hand, and on the efficacy of the anti-infective treatment, on the other. Most corneal ulcers respond well to treatment and heal within two or three weeks, leaving behind a scar that corresponds in size and depth to the amount of tissue destroyed by the bacterial invader. If untreated or if the treatment is ineffective, the ulcer enlarges in width and depth. Spread in depth is particularly serious since it may lead to perforation of the cornea with loss of the aqueous humour and establishment of contact between cornea and iris. The iris usually plugs the perforation so that the eye may regain its normal size and shape; this correction is made at the price, however, of permanent adhesions of the iris to the cornea that may lead to further complications. The ulcer usually heals after the perforation has occurred. Infection of the interior of the eye rarely occurs, probably because the microorganisms would have to travel against the current of the aqueous.

Infection With Fever Blister Virus.—A second common corneal disease is infection with the virus of herpes simplex (the virus of the common fever blister). Many individuals harbour the virus in their conjunctival sacs. The exact mechanism whereby the virus gains a foothold in the cornea is not known. The first manifestation of the disease (dendritic keratitis) is the development of a minute, gray figure on the corneal surface, accompanied by marked irritation and tearing of the eye. The gray figure, whose shape resembles a branching tree, represents the corneal cells that have become affected by the virus. The course of the disease varies; in individuals who possess a high degree of immunity to the virus, the opacity clears within a few days with minimal scarring. In other individuals the virus may invade more and more of the surface area and even the deeper layers. The progressive cases must be recognized promptly and treated with agents that either kill the virus or interfere with its life cycle.

Interstitial Keratitis.—The third principal type of corneal disease is the interstitial keratitis due to congenital syphilis. The term interstitial implies that the inflammation (the keratitis) is located within the substance of the cornea, in contradistinction to the corneal ulceration described above. The age at which the symptoms of interstitial keratitis appear varies from 1 to 18 years; usually, however, the disease appears between the ages of 5 to 8

years. The onset of the corneal disease may be the first gross sign of syphilitic infection. The eye becomes markedly inflamed, with bluish-red congestion around the diffusely hazy cornea. The associated symptoms of hypersensitivity to light, tearing and cloudiness of vision may be very severe. The disease may last from one to several months; the second eye usually becomes involved in a similar manner. Antisyphilitic treatment during the acute corneal inflammation is not strikingly effective, either in mitigating the symptoms and shortening the course of the disease in the first eye or in preventing the disease in the second eye. Antisyphilitic treatment of the mother during pregnancy is strikingly effective in preventing interstitial keratitis in the child. Prenatal examinations and care of the expectant mother have made interstitial keratitis almost extinct.

Degenerative Conditions.—The fourth principal group of corneal diseases comprises degenerative conditions. The study of degenerative diseases has revealed only deterioration and involution of the structural elements of the affected tissues, without revealing the apparent cause of the degeneration or showing how the degeneration can be repaired. Corneal diseases of the degenerative type are quite common. The symptoms are gradual clouding of the cornea and corresponding clouding of vision without pain, discomfort or irritation. The shape and size of the elements causing the corneal opacity may vary from dots to nodules and from lines to streaks or lattices, but the over-all effects are very similar. Most of the degenerative conditions take a slow, progressive course and are not demonstrably influenced by living conditions, occupation, climate or concurrent illnesses. For many of these conditions a hereditary background has been established.

Diseases of the Sclera.—Diseases of the sclera are rarer than diseases of the cornea. Scleritis (inflammation of the sclera) is closely related to inflammation of joints, muscles or tendons and is, therefore, an expression of a systemic rather than a local disease. The cortical steroids (*i.e.*, those produced by the cortex of the adrenal glands) are beneficial in mitigating and shortening the course of scleritis.

Diseases of the Iris, Ciliary Body and Choroid.—The iris, ciliary body and choroid make up the middle (uveal) layer of the eyeball wall. The iris plays the part of the diaphragm in the optical system of the eye, controlling the size of the pupil by the accurately balanced action of two muscles. The ciliary body functions in the production of the aqueous humour and in the focusing of the eye from distant to near objects. The choroid is rich in blood vessels of different sizes and serves primarily to supply nourishment to the overlying retina.

The most common diseases of the iris, ciliary body and choroid are endogenous inflammations caused by microorganisms that reach the uveal tissue through the blood stream. A number of well-known systemic infectious diseases regularly and typically involve parts of the uvea, causing acute or chronic inflammatory eye lesions. These usually take the same course and usually are treated as part of the underlying systemic disease.

Acute iritis is a truly dramatic event in terms of pain, congestion of the eye, exudation into the anterior chamber and almost complete blockage of vision. Under proper treatment all these symptoms may disappear almost as rapidly as they came. Acute iritis often accompanies acute or chronic arthritis.

In chronic uveitis the congestion, irritative symptoms and pain are slight; the vision is clouded in proportion to the exudation that has flowed into the anterior and vitreous chambers. Choroiditis may spread to the overlying retina and thereby cause a blind spot in the field of vision. Chronic uveitis occurs in association with systemic infections such as relapsing fever, undulant fever, sarcoidosis, certain forms of tuberculosis and syphilis. Fairly often, however, chronic uveitis occurs in individuals in whom there is no detectable active systemic illness. In these cases one has to assume that the systemic disorder is too slight to be identified by the present means of diagnosis.

Uveitis is treated by trying to bring the underlying systemic disease under control. Prudent use of corticosteroids has, in many instances, mitigated the course of the uveitis and brought about some cures.

Diseases of the Retina.—The innermost and most delicate layer of the eyeball wall is the retina. It contains the cells that are specifically equipped to transform light into the nerve impulses that are transmitted by a number of connecting links to the portion of the brain concerned with visual sensations.

Most of the common retinal diseases are local manifestations of systemic diseases of the blood vessel system; *e.g.*, arteriosclerosis, hypertensive cardiovascular and kidney diseases, diabetes, toxemia of pregnancy and many rarer varieties of inflammatory, allergic or degenerative vascular diseases. Since the retina and particularly its blood vessels can be observed and examined directly with the ophthalmoscope, the physician often uses the condition of the retina as a guide in the diagnosis and treatment of vascular diseases.

The retinal disease of most concern to physicians in the U.S. once was retrolental fibroplasia, which occurred in premature newborns who were given oxygen in high concentrations during the first few weeks of life to improve their chances of survival. The immature vascular system of the retina reacts adversely to a high concentration of oxygen by going into a state of spastic constriction that impairs the food supply to the retina instead of improving it. Careful adjustment of the oxygen concentration in the incubators of premature babies has made it possible to reach a compromise between the oxygen demands of all body tissues.

A number of retinal affections can only be classified as degenerations. One such condition is the primary, so-called pigmentary, degeneration (retinitis pigmentosa), which is characterized by gradual progressive impairment of peripheral and night vision. The rate of progression varies within wide limits so that some patients retain useful vision up to 40 or 50 years of age. In the more rapid progressive cases the loss of peripheral and night vision may cause serious psychological, social and educational problems during childhood and adolescence. The hereditary background of the disease has been established in many instances. Other forms of hereditary degenerative retinal disease affect primarily the central vision, upon which depends the ability to recognize fine patterns, including the ability to read and write. There is no known effective treatment for any of the hereditary retinal degenerations.

As mentioned in the discussion of diseases of the choroid, inflammations of the choroid may spread to the retina and cause loss or destruction of some retinal tissue. Partial destruction without much scarring may leave a hole or break in the retina which may cause a detachment or separation (partial or complete) of the retina from the choroid. Detachment may also occur when the vitreous shrinks and pulls on the retina. Retinal detachment has proved highly amenable to surgical procedures that aim at closure of the retinal break or elimination of vitreous pull.

Diseases of the Crystalline Lens.—As the name indicates, the crystalline lens is part of the optical system of the eye. The muscle of accommodation, which is located in the ciliary body, changes the thickness of the lens and the curvature of its surfaces; this mechanism gives the human eye its adjustable focus. The lens is suspended by fine fibres behind the iris and in front of the vitreous and receives its supply of nutritive substances from the surrounding aqueous humour. No blood vessels or nerves supply any part of the lens. It grows throughout life, the younger layers being deposited around and on top of the older, more condensed and more central portions. The gradual increase in size of this hard centre, or nucleus, is one of the causes of the gradual loss in elasticity and corresponding impairment of near vision that is characteristic of middle-aged man and causes him to use reading glasses. This need of reading glasses should not be considered an abnormal or disease process.

The typical manifestation of disease or abnormality of the lens is the change from normal transparency to abnormal opacity. The opacities vary in size, shape, location and rate of growth. Some opacities remain confined to the peripheral rim of the lens and go entirely unnoticed since they do not affect vision. Other opacities may be located close to the visual axis of the eye and thereby cause a very considerable visual disturbance. The magnitude of this disturbance depends markedly on lighting conditions. In

the ophthalmologist's office, where vision is tested by projecting letters on a screen in a dark or semidark room, lens opacities tend to disturb vision much less than out-of-doors, where, because of the multiple sources of incidental light, light is scattered over the entire retina with the result that objects are seen as blurs. Since indoor sources of light usually are restricted in number, most patients with lens opacities see better indoors.

Strictly speaking, the term cataract applies to all forms of definite lens opacities. The term is generally used, however, only for lens opacities that impair vision and are progressive. The cause of cataract is, in principle, a metabolic, systemic or local disorder that impairs the food supply to the lens so that abnormal (*i.e.*, opaque) tissue forms in the lens. Many types of experimental cataracts have been produced in laboratory animals by diets deficient in one or several essential ingredients or by diets that include metabolic poisons. In humans, cataracts have been observed as an accompaniment of metabolic diseases originating in the parathyroid gland or in the pancreas. The most common form of cataract in man is senile cataract, which occurs as a part of the normal aging process.

A congenital form of cataract occurs in man as a strictly hereditary condition. Other congenital forms are caused by certain infectious diseases of the mother, such as German measles during the first three months of pregnancy or toxoplasmosis during any part of the pregnancy.

The progressive forms of cataract finally reach a point where they may produce plainly visible gray spots or sectors in the pupil or a grayness in the entire pupil. If all other parts of the eye remain normal, even the complete opacification of the lens does not make the eye completely blind. The affected person still sees light and colour and is able to locate light sources.

A few forms of cataract can be treated by conservative means. Most progressive cataracts, however, call for surgical removal of the entire crystalline lens when the visual disturbance caused by the cataract becomes a professional or social handicap to the patient. Surgical removal of cataract is one of the most successful operations in human surgery. (See *Surgery of the Eye: Lens* below.)

Diseases of the Vitreous.—The vitreous body is a transparent, colourless, jellylike substance almost entirely devoid of living cells. It fills the posterior two-thirds of the eyeball and reflects the state of health of its surroundings more than its own. The typical manifestation of abnormality is loss of its normal transparency; this is usually partial and only rarely complete. Partial opacity in the form of black threads or dots of all possible shapes and constellations, which the affected person projects into the outside world and sees as interferences with actual objects, is probably the most common reason for consulting an eye physician. In most instances the significance of these "floaters" is far less than the annoyance caused by them. They are usually produced by a mild inflammation of the tissues surrounding the vitreous; although such opacities are minimal they may disturb and alarm the patient because they are magnified by the optical system of the eye and also because they move with all ocular movements. Examination by the eye physician reveals, in most instances, the benign and transient nature of the condition. Vitreous opacities that increase in number and density may indicate a serious disease of the ciliary body, choroid or retina.

The vitreous has practically no regenerative ability. When its normal structure is disturbed by an inflammation in its surrounding membranes, the normal jellylike structure is lost and replaced by clear, watery fluid. To some extent this process of liquefaction takes place in the normal eye as a part of aging.

Diseases of the Eyeball as a Whole.—The aqueous humour, which is produced by the ciliary body, carries food to the nonvascular structures of the eye, the lens and the cornea. The aqueous flows in a steady stream from the ciliary body through the pupil into the anterior chamber and leaves the eye through a microscopic channel (Schlemm's canal) in the so-called chamber angle at the junction of the sclera and cornea. The rate of aqueous formation and elimination determines the intraocular pressure, which maintains the length and width of the eyeball. Intraocular pressure is measured with a tonometer, an instrument that indents the eyeball wall in direct proportion to its own weight and in inverse proportion to the intraocular pressure. The normal intraocular pressure ranges from 12 to 22 mm. of mercury. Necessary and beneficial as this pressure is for the normal functioning of the eye, an abnormal elevation of the pressure seriously endangers most parts of the eye.

The diseases characterized by abnormally high intraocular pressure are comprised under the term "the glaucomas." In these diseases the rate of aqueous production is normal but the rate of aqueous elimination is diminished by obstacles that interfere with the passage of aqueous. In chronic iridocyclitis the pupil may become closed by exudates that bind the pupillary border to the crystalline lens. This results in "a bottleneck" behind the iris and a rise in intraocular pressure. The crystalline lens, during cataract formation, may swell to such an extent that it presses the iris against the cornea and closes off the entrance to the chamber angle. The result, again, is a rise in intraocular pressure. Glaucomas that follow in the wake of other eye diseases are called secondary glaucomas to distinguish them from the so-called primary glaucomas, in which the rise in pressure is the first demonstrable manifestation of any abnormal, pathologic process. The primary glaucomas occur in different forms and at different ages. The rise in pressure may be associated with definite, almost unmistakable, subjective symptoms; *e.g.*, episodic blurring of vision, colour fringes around lights and mild to severe pain in and behind the eye. The symptoms of this so-called angle-closure glaucoma are so definite that most patients seek and receive treatment before irreversible visual damage has been done.

Unfortunately, there exists in man an insidious, entirely painless chronic form of glaucoma that often becomes far advanced before the patient is aware of the disease. The sustained, abnormally high pressure interferes with the blood supply to the nerve fibres of the retina at the point of their exit from the eyeball. After a certain period of deficient blood supply, a nerve fibre dies, depriving a portion of the retina of its connection with the brain and thereby making it blind. The portions of the retina first affected are intermediate zones in the visual field; that is, points which are closer to the point of clear central vision than to the peripheral rim of the field. If the abnormal elevation of intraocular pressure persists, the glaucomatous damage slowly spreads to other and finally to all portions of the field.

One fortunate feature about chronic glaucoma in man is that the disease usually does not start in both eyes at the same time. Thus the affected person may notice a difference between his two eyes that leads him to the eye physician. Many cases of chronic glaucoma are diagnosed in the course of routine eye examination before the patient is aware of the presence of a serious eye disease. For this reason private, state and national health organizations have conducted specific "screenings" of large sections of the population for chronic glaucoma.

The treatment of glaucoma may be medical or surgical. A number of drugs, if applied topically to the eye in the form of eye drops or ointments, have the distinctive property of lowering the intraocular pressure. Other drugs lower the intraocular pressure when taken internally. Surgery for glaucoma seeks to eliminate "bottlenecks" within the eye or to create new outlets for the aqueous. The best possible result of any form of treatment for chronic glaucoma is normalization of the intraocular pressure and, thereby, prevention of further visual loss. In angle-closure glaucoma surgical procedures may improve the visual acuity of the affected eye; in very early cases of angle-closure glaucoma a tiny surgical "buttonhole" in the iris may cure the disease.

Another pathological entity that affects the eyeball as a whole is degenerative myopia. Small to moderate degrees of myopia (nearsightedness), hyperopia (farsightedness) or astigmatism (*q.v.*) do not represent diseases but are merely physiological variations of the dimensions of the eyeball (*see* also AMETROPIA). A distinctly different entity is degenerative myopia, in which choroid and retina undergo a type of deterioration as a result of abnormal stretching or growth of the eyeball. This deterioration can be so crippling to the patient's vision that the eye surgeon

may resort to prophylactic surgical shortening of the eyeball. (*See* also VISION: *Optical Defects of the Eye.*)

Diseases of the Orbit.—In ophthalmology the term "orbit" applies to the two pyramid-shaped spaces in the skull that house the eyeballs and most of their auxiliary structures, such as muscles, blood vessels and nerves.

A common form of orbital disease is protrusion of both eyeballs (exophthalmos or proptosis), which is caused by an endocrine disorder (exophthalmic goitre, or Graves' disease) due to overfunction of the thyroid gland (*see* THYROID GLAND, DISEASES OF). In addition to systemic treatment of the endocrine disorder, topical treatment may be necessary to protect the unduly exposed eyeball. Protrusion of only one eye may be a sign of an orbital tumour; this condition, because of the conspicuousness of the protrusion, usually is recognized early and consequently is treated early.

Diseases of the Optic Nerve and Visual Pathways.—The optic nerve is made up of the nerve fibres of the retina; it makes its exit from the eyeball nasal to the posterior pole of the globe, leaves the orbit at its apex and then enters the cranium, where it at first lies under the frontal lobe of the brain. Farther back, in the so-called chiasma, the optic nerve meets and exchanges fibres with the optic nerve from the opposite eye; at this point a new arrangement of nerve fibres is reached, the fibres from the right halves of the two retinas traveling together in the right hemisphere of the brain and the fibres from the left halves traveling together in the left hemisphere. The term "visual pathway" is applied to the fibres that connect the visual centres in the brain.

The diseases of the optic nerve and visual pathway are inflammatory, neoplastic or circulatory. Microorganisms and viruses with specific affinities for nerve tissue may attack the optic nerve and cause blind spots within the field of one eye. Lesions of the visual pathway above the chiasma characteristically cause blindness of corresponding portions of both visual fields (homonymous, or equilateral, hemianopsia). A lesion impinging upon the visual pathway in the right half of the brain makes the left halves of the visual fields of both eyes blind (left-sided hemianopsia).

Visual disturbances resulting from intracranial lesions often are helpful in that they give clues regarding the nature and exact location of such lesions.

Diseases of the Extraocular Muscles, Their Nerves and Their Central Control Apparatus.—The normal binocularity of man requires a motor apparatus of precise harmonious action. This apparatus consists of six individual muscles for each eye and a number of co-ordinating nerve centres.

Normal ocular motility is a faculty acquired in early childhood. During the first year of life the baby actually "learns" to control its own eye muscles. Obstacles to the learning process may develop in four principal forms: (1) marked degrees of farsightedness or nearsightedness in both eyes; (2) marked differences between the two eyes, either in their refractive state or their structural development; (3) uneven development or strength of ocular muscles; and (4) uneven development of the control centres in the brain. The over-all effect of any of these factors is faulty ocular motility in the sense that one eye is directed at the object of attention or interest (the "fixing" eye) while the other eye deviates inward, outward, upward or downward. The term squint (*q.v.*), or strabismus, is applied to this condition, with qualifying adjectives (convergent, divergent or vertical) designating the direction of the deviation. An important further qualification is whether it is always the same eye that deviates or whether the child spontaneously shifts or "alternates" from one eye to the other. It is also important to determine whether the deviation is constant or intermittent.

Strabismus in small children is more than just a matter of appearance. A persistent strabismus means that the child is not acquiring the normal functional relationship between the two eyes. It may also mean that the deviating eye, since it is not used properly, is falling further and further behind in its visual development. A persistent strabismus of the same eye may also be an indication of a serious disease other than strabismus. The inevitable conclusion is that persistent strabismus in a baby or small child calls for prompt examination and treatment by an eye physician.

A different and considerably milder disturbance of ocular motility is characterized by normal parallelism, or "straightness," of the eyes most of the time, interrupted by turning in or turning out of one eye only under unusual circumstances such as physical or mental fatigue or systemic illness. In these cases of intermittent strabismus a state of muscular imbalance can be held in check by the control apparatus in the central nervous system as long as the latter is in prime condition. If it becomes weakened by any of the factors mentioned above, the state of muscular imbalance comes to the fore.

Intermittent strabismus is related to so-called latent strabismus, which is the muscular imbalance that appears when one eye is covered by a patch in order to temporarily suspend the individual's interest in normal co-operation of the two eyes; the same result can be achieved by making objects appear dissimilar to the two eyes. Such tests are used by the eye specialists to disclose conditions of muscular imbalance held in check with effort and with an expenditure of energy that causes the sensation of eyestrain. These anomalies of ocular motility are called -phorias with the prefixes exo-, eso-, hyper- or hypo- indicating the direction in which one eye deviates if the action of the control apparatus is temporarily suspended.

Finally, there is the paralytic type of disturbance of ocular motility that may involve one or several muscles. The characteristic features of muscle paralysis are double vision and limitation of movement in the direction of principal action of the paralyzed muscle. The double vision is, at first, most annoying and confusing, particularly because the affected person may find it very difficult to distinguish between the real and the false image. The site of the disturbance is usually in the central nervous system. In the process of determining the cause of the disease the ophthalmologist often has to solicit the help of the neurologist and the internist. (*See* also DIPLOPIA.)

Another phenomenon concerning ocular motility is nystagmus; it may be described as involuntary, rhythmic oscillations of both eyes. Looking casually at the countryside while riding on a train or in an automobile normally brings on such a nystagmus in a horizontal direction. A similar phenomenon in the up-and-down direction may be observed in people riding on elevators with partly open doors through which various objects appear and disappear in rapid succession.

A persistent nystagmus that is not elicited by rapidly moving objects is an abnormal condition. A congenital form (present at birth or noticed within a few months after birth) is usually a sign of faulty development of the central portion of the retina. In most instances this means diminished vision but not blindness.

Nystagmus acquired later in life is a symptom of a nervous disorder affecting various parts of the central nervous system. The vestibular apparatus that is man's most important aid in maintaining physical equilibrium is usually involved in the nervous disorders that cause nystagmus.

In the treatment of disorders of ocular motility, three principal approaches are utilized: (1) In the treatment of strabismus, particularly in small children, every effort is made to build up the vision of the weaker eye, if there is one; this is done by systematic exercises and by temporary occlusion (patching) of the stronger eye. (2) Through systematic orthoptic exercises the central control apparatus is stimulated and trained to perform tasks of carefully graded and slowly increasing difficulty. (3) Marked states of muscular imbalance (*i.e.*, grossly uneven distribution of muscular strength) are corrected by operations on the eye muscles.

Injuries of the Eye.—The exposed position and great delicacy and vulnerability of the human eye account for a major portion of the injuries that result in serious, permanent visual impairment. The eye is exposed principally because the eyelids do not and cannot provide complete protection; exposure is increased since most persons, out of necessity or habit, place their heads and eyes fairly close to their work. Injuries emphasize the extreme delicacy and vulnerability of the eye. A tiny sliver of steel is capable of making an eye completely and irreparably blind if it strikes the eye with enough momentum to penetrate the anterior wall, the iris, the lens

and the vitreous and finally lodges in the retina. Permanent visual impairment is almost inevitable if the crystalline lens, the vitreous body or the retina are involved in an injury.

The ophthalmologist distinguishes between perforating (penetrating) injuries and nonpenetrating (superficial) injuries. Perforation, strictly speaking, means that an object forces its way through all the layers of the eyeball into one of the chambers of the eye. This entails, in addition to the direct injury to the cut or bruised tissue, the danger of an intraocular infection and of retention of an intraocular foreign body. The subjective symptoms of a perforating injury may be very slight at first; a tiny perforation in the anterior sclera, for example, can be easily overlooked. Examination of an injured eye by an eye physician without delay is therefore imperative particularly when the circumstances of an accident suggest the possibility of a perforation of the globe by the tips of sharp instruments or tools or by a particle coming off a tool. The management of perforating injury consists of three principal steps: (1) the search for and removal of intraocular foreign bodies; (2) surgical closure of the entrance wound; and (3) anti-infective measures.

The most tragic sequel of a perforating injury is involvement of the second (that is, the uninjured) eye. This fortunately very rare complication has been observed in cases in which the original injury was very severe and the recovery delayed by a persistent inflammation of the iris and ciliary body. Through a process that probably involves the formation of antibodies to products of the tissue destruction in the injured eye, an inflammatory reaction is elicited in the other eye and persists or recurs for a number of years. The final outcome may be blindness or near-blindness. This disease, known as sympathetic ophthalmia, can be mitigated by the local and systemic use of steroids. The early removal of hopelessly injured eyes has greatly reduced the incidence of sympathetic ophthalmia.

In millions of eye injuries the inflicting agent, fortunately, does not possess enough momentum to penetrate the eyeball wall. Small foreign bodies usually lodge in the superficial layers of the cornea or conjunctiva, where they are easily removed by the physician. If objects with sharp edges brush across the eye they may abrade the cornea and thereby cause, for 12 to 24 hours, rather painful exposure of corneal nerves. With proper treatment such corneal abrasions heal promptly without causing permanent visual impairment. An entirely different situation prevails if corrosive chemicals such as lye or strong acids splash into the eye. These agents are capable of destroying (*i.e.*, actually killing) the cells in the superficial layers of the cornea and conjunctiva. The result may be severe scarring of the cornea and permanent loss of conjunctiva to the point where motion of the eyeball is restricted. First aid administered immediately by a bystander in the form of copious irrigation of the conjunctival sac with any neutral fluid available (*e.g.*, fresh water from a faucet) may contribute more toward a favourable outcome of the injury than the most expert but subsequent treatment by an eye physician.

Still another type of eye injury is the contusion, which usually is caused when a blunt object strikes the eyelids and underlying eyeball with considerable force. As a result of the impact the eyeball is indented, intraocular fluid is displaced and the membranes that make up the eyeball wall are stretched. Because of their limited distensibility membranes may rupture when stretched; thus a contusion may become a perforation although in a somewhat different sense than by penetration with a sharp object. The impact that produces a contusion is not always severe enough to rupture the globe; and many "contused" eyes recover their normal appearance and most of their normal function.

During the first week after a blunt injury the effects upon the eyeball may be overshadowed by bleeding into the lids, a condition known as "black eye." Because of its conspicuousness the black eye may attract more attention than the usually more serious damage to the eyeball. The black eye clears up without treatment while the contused eyeball may require intensive medical or even surgical treatment.

Malignant Tumours of the Eye.—Two principal types of cancer arise from ocular tissue. They are the retinoblastoma (glioma of the retina), which originates in the retina of infants or very young children, and the malignant melanoma that originates in the uvea of middle-aged persons. Their causes are not known, but heredity is unquestionably a strong factor in retinoblastoma. Early detection and radical removal of the tumour, including the entire eye in many instances, is standard treatment for malignant melanoma. The retinoblastoma may, from the beginning, appear as multiple tumours affecting both eyes. Treatment, which depends on the portions of the retina involved, may include a combination of X-rays and cancer-killing chemicals. (P. C. K.)

SURGERY OF THE EYE

Modern developments in general and local anesthesia, drugs, instruments and techniques have made eye surgery a far safer, more effective and less painful procedure than it once was.

Eyelids.—Drooping, or ptosis, of the upper eyelids may be a hereditary defect or may result from an injury. Ptosis is corrected by shortening the levator muscle that raises the upper eyelid, provided the muscle is not completely paralyzed. A piece of the levator muscle is removed and the remaining muscle is sutured farther downward under the skin of the eyelid.

In paralytic ptosis a strip of skin, muscle or wire is used to form a sling from the upper eyelid to the frontalis muscle above the eyebrow. This permits the patient to open his eyelid by raising his eyebrow.

In mild cases of ectropion (outward turning of the eyelids), passing a cautery through the tarsus (the connective tissue framework of the eyelid) from the conjunctival surface brings the eyelid into position. In severe cases, the eyelid is shortened by removing skin and tarsus.

In mild entropion (inward turning of tarsus and eyelid), a cautery applied through the skin may correct the condition. In severe cases more extensive surgery is required.

Tear Apparatus.—Tearing, usually caused by some obstruction to the tear duct and most commonly seen in infants in whom the lower end of the duct in the nose has failed to open, is often cured by passing a probe through the stricture. Pus in the lacrimal sac is drained by incising the local abscess. If the lower part of the duct is blocked the sac may be carried into the nose, producing a new drainage channel.

Eye Muscle.—The six external eye muscles (two oblique muscles and four straight, or recti, muscles) rotate the eye in various directions. Cross-eyes result from defective medial recti muscles, which draw the eyes nasally. When glasses and eye exercises fail to correct this condition, the medial recti muscles may be freed and reattached farther back on the eyeball; this operation is combined in some cases with shortening of the lateral recti muscles, which pull the eyes outward.

In exotropia, which results from muscle defects that pull the eyes outward, the majority of cases require freeing one or both lateral recti (fig. 5 [A]) and reattaching these muscles farther back on the eyeball (fig. 5 [B]). If the eyes are not straightened sufficiently, the medial recti muscles may be shortened.

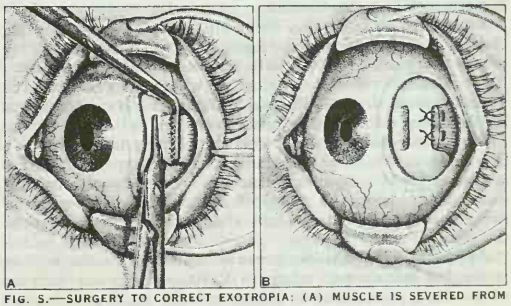


FIG. 5.—SURGERY TO CORRECT EXOTROPIA: (A) MUSCLE IS SEVERED FROM ITS NORMAL INSERTION AND (B) SUTURED FARTHER BACK ON THE EYEBALL

Spasm of an inferior oblique muscle produces upward, inward turning of the eye, which is corrected by severing the muscle or by receding the muscle on the eyeball. (*See* also SQUINT.)

Cornea.—Scarring or clouding, whether caused by disease or injury, may involve all or part of the cornea. In the surgical correction, the opaque cornea may be tattooed (for cosmetic purposes) or it may be partially or completely removed; in the removal procedure the opaque cornea is replaced with a clear cornea from a donor's eye. This is accomplished by removing the opaque tissue with a tubular cutting instrument, the trephine (fig. 6 [A]). A similar disc is cut from the transparent cornea of a donor's eye, transplanted to the patient's eye and sewn in place (fig. 6 [B]). (*See* also TRANSPLANTS, TISSUE AND ORGAN.)

Glaucoma.—This disease usually is caused by obstruction to the normal outflow of fluid from the eye. Surgery becomes necessary when drugs fail to lower the eye pressure and especially when the visual fields contract. Operations creating artificial channels for the fluid outflow comprise iridencleisis, in which a piece of the iris is drawn up into a wound made in the sclera; and iridocorneosclerectomy, wherein pieces of the iris, cornea and sclera are clipped away, allowing the fluids to escape under the conjunctiva.

In surgical treatment of congenital glaucoma, in which there is faulty development of the tissues in the angle between the cornea and iris, the tissues are cut with a knife to permit fluid outflow in this area. When it becomes necessary to decrease the fluid production in glaucomatous eyes, parts of the ciliary body are destroyed chemically or by heat.

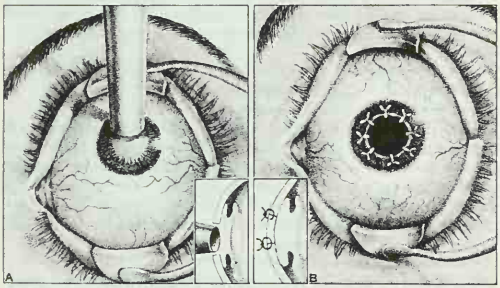


FIG. 6.—REMOVAL OF OPAQUE CORNEA: (A) TREPHINE CUTS OPAQUE DISC FROM THE CORNEA. THIS DISC IS REPLACED BY A SIMILAR DISC OF CLEAR CORNEA FROM A DONOR'S EYE AND (B) SUTURED IN PLACE

Lens.—The lens is surgically removed when it has become opaque through disease or injury. An incision is made close to or in the cornea and the iris is cut; the lens is then grasped and gently pulled out of the wound, which then is closed with suture. An enzyme may be injected to weaken the fibres that hold the lens in place, making removal easier.

Retina.—The retina may become partially or completely detached following injury or disease of the eye. Detachments are usually accompanied by tears (lacerations), which must be carefully sealed off by diathermy punctures or light coagulation. The eyeball is often shortened by folding or excising a strip of sclera, the fold being maintained by sutures.

Tumours.—Some small tumours on or within the eyeball may be excised or destroyed with radium or light rays. Diathermy applied to the sclera over a tumour has resulted in cures in some cases. Such tumours as glioma of infants (retinoblastoma) and sarcoma of the choroid of adults usually necessitate removal of the eye. (CD. BS.)

Artificial Eyes.—Artificial eyes are known to have been made in the 9th century B.C., when the Egyptians removed the eyes of the dead, poured wax or plaster into the orbits and inserted precious stones. In the 5th century B.C. Roman priests who practised surgery began to make artificial eyes for living patients. Glass eyes were first made in Venice in 1579, and important contributions to this art by French surgeons in the 17th and 19th centuries resulted in the artificial eye as it is known today. In the beginning of the 18th century the manufacture of glass eyes was centred almost exclusively in Germany and Austria.

Originally, artificial eyes were made as oval shells, which were not only ill-fitting but also uncomfortable to wear. In 1898 an eye was developed that was in effect a two-layered shell with space between the layers. Today the earlier type is used almost exclusively over deformed eyes or in evisceration cases, where the contents of the eye have been removed and the outer portion (sclera) left intact. The two-layered eye is used in cases of enucleation (removal of the entire eye).

Prior to 1939 artificial eyes were made from glass materials imported from Germany. Just before World War II the government-controlled guild of German eyemakers established restrictions on shipments of glass and raised prices to a very high level. As a result, U.S. manufacturers developed a glass comparable with the German product. In addition, a program sponsored by several commercial firms and the medical departments of the U.S. army and navy resulted in development of a plastic eye that would not break or crack.

After World War II several surgeons developed implants that could be inserted into the orbit after enucleation; motility was imparted to the artificial eye through direct transmission, magnetic attraction or by leverage action. The result is an artificial eye that moves to a degree in conjunction with the good eye.

See also references under "Eye, Human" in the Index.

(S. W. R.)

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EYEGLASSES, or spectacles, are optical devices intended to aid vision. Roger Bacon in 1268 recorded the earliest comment on the optical use of lenses, but magnifying glasses inserted in frames were used by the Chinese for reading as early as the 10th century. Marco Polo noted this custom also in the court of Kublai Khan (1270). Eyeglasses made their first European appearance in Italy, their introduction being attributed to Alessandro di Spina of Florence. The first portrait to show eyeglasses is that of Hugh of Provence by Tommaso da Modena, done at Treviso in 1352. Domenico Ghirlandajo in 1480 painted St. Jerome at a desk from which dangled eyeglasses, and from this detail St. Jerome became the patron saint of the spectacle makers' guild. At first only convex lenses were used for the aid of presbyopia (old-sight) and hyperopia (old-sight in young people). A concave lens for myopia is first evident in the portrait of Pope Leo X, painted by Raphael in 1517.

Originally lenses were made of transparent quartz and beryl (of which aquamarine is a variety), but increased demand led to the adoption of optical glass, for which Venice and then Nürnberg were the chief centres. The availability of glass lenses not only aided ocular efficiency but led to the invention of the microscope (1590) and of the telescope (1608). In 1784 Benjamin Franklin invented bifocals, dividing his lenses for distant and near vision, the split parts being held together by the frame. Cemented bifocals were invented in 1884, and the fused and one-piece types followed in 1908 and 1910, respectively. Trifocals and new designs in bifocals were later introduced, including the Franklin bifocal revived in one-piece form, to satisfy more adequately diverse optical problems and occupational needs. When the corrections for the

two eyes vary significantly, there occurs in the reading field a disturbing prismatic effect that can be nullified by a compensating prism in the bifocal area or by dissimilar bifocal segments.

In 1827 Sir George Airy, a British astronomer, made the first attempt to correct astigmatism (his own) by a suitable cylindrical lens. Astigmatism was considered a curiosity until its prevalence was firmly established by F. C. Donders, whose classic work (1864) created scientific clinical refraction and stimulated further improvement in both the subjective and objective determination of the glasses needed. Donders also popularized the adding of prisms to facilitate the muscular adjustments in binocular vision.

In 1804 William Wollaston of London found that the peripheral aberrations noted in "flat" lenses were almost entirely eliminated when the corrections were ground in appropriate convexo-concave forms. The virtues of these meniscus lenses were extended later to cylindrical corrections by incorporating the cylinder in a toric curve. Since the previously standardized toric surface proved inadequate when the spherical component was strongly plus, an extra series of "corrected curve" lenses was introduced in 1930. The proper toric form increases the effective field of view, but occasionally a person who requires a weak minus correction notes disturbing reflections, particularly in artificial light.

The varieties of fine optical glass essential for high-grade ophthalmic lenses resulted from a century of costly research. Ernst Abbe and Otto Schott in 1885 demonstrated that the incorporation of sundry new elements into the glass melt led to many desirable variations in refractive index and dispersive power. Optical glass for ophthalmic lenses is first rolled into plate glass form. The bulk of spectacle lenses are made from clear crown glass of refractive index 1.523. However, in high myopic corrections a cosmetic improvement is effected if the lenses are made of dense flint glass (refractive index 1.69) and coated with a film of magnesium fluoride to nullify the surface reflections. Flint glass or barium crown, which has less dispersive power, is used in fused bifocals. The power of a lens was expressed by its focal length in inches until Monoyer of France introduced in 1872 the diopter unit. A lens of one diopter (1 D.) brings parallel rays to a focus at one metre; as the dioptric power increases, the principal focal length decreases proportionately. Prisms were measured originally by their refractive angle in degrees, but this was changed to the prism-diopter at the suggestion of Charles F. Prentice of New York (1890). A prism that causes a deflection of one centimetre at a distance of one metre is one prism-diopter (1 $\triangle$).

Visual discomfort and fatigue are commonly associated with errors of refraction or of oculomotor balance. Occasionally the disturbance is caused by inequality of the retinal images (aniseikonia), which is remediable by lenses that equalize the retinal image without alterlng the effective optical power.

Decreasing use of shading headgear promoted the popularity of sunglasses. Any sunglass that transmits more than 30% of light does not adequately prevent dazzling. Constant wearing of tinted glasses may adversely affect normal adaptation, night vision and indoor working acuity. (J. E. Ln.)

Contact Lenses.—Contact lenses are lenses worn on the eyeball. They can be made to correct all visual conditions correctible by regular eyeglasses. The first contact lenses to be used as refractive devices were made by A. E. Fick in 1887. The early lenses were made of glass, but after 1938 plastic, usually methylmethacrylate, was used. From 1938 to 1950 most lenses were made by taking impressions of the eye and forming the lens on this mold. Such lenses covered most of the eye, and a fluid was used under them. After 1950 smaller lenses were used which cover only the cornea (front surface of the eye) and float on a layer of tears. It is not necessary to make an impression of the eye, as the curvature of the cornea can be measured by optical instruments. Such lenses, only 7 to 11 mm. in diameter and 0.1 to 1 mm. in thickness, usually can be worn all day without removal. Contact lenses are invisible, and they give a wider field of vision than eyeglasses do. Since they are not easily broken they can be worn while participating in active sports. Further, some visual conditions which cannot be corrected by regular glasses can be corrected by contact lenses. Contact lenses can be coloured for use as sun lenses; they also have been used by actors to change the colour of the eyes. In 1958 bifocal contact lenses were developed.

Contact lenses cost more than regular eyeglasses do, and many persons experience difficulty in learning to wear them.

See also Lens: *Spectacle Lenses.* (E. E. Tn.)

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(J. E. Ln.; E. E. Tn.)

EYEISH, a North American Indian tribe of the Caddo confederacy, also called the Aas, Aays, Aes, Aix, Haish, Yayecha and other names, that lived on the Eyeish or Ayish creek, between the Neches and Sabine rivers in northeastern Texas. By the beginning of the 20th century the tribe was virtually extinct. Twenty families of the "Ays" were reported in 1779 and 300 "Ahijitos" in 1785. There were only 20 living members of the tribe in 1805, according to John Sibley, Indian agent for Orleans territory, but in 1828, 160 families living between the Colorado and Brazos rivers were reported.

Luis Moscoso de Alvarado, who had succeeded Hernando de Soto after the Spanish explorer's death in 1542, visited the Eyeish in that year, and late in the 17th century the French explored the tribe's country, associates of René Robert Cavelier, sieur de la Salle, noting the tribe in 1686–87. In 1716 Spaniards founded the Franciscan mission of Nuestra Señora de los Dolores de los Ais near the Sabine river. The mission was abandoned three years later and the Indians destroyed its property. Re-established in 1721, it was again abandoned in 1773.

The Eyeish tribe, near both French and Spanish posts, suffered from the new diseases brought by the white people. The Eyeish who survived the ravages of war and disease during the 19th century were settled with other Caddoans on the Wichita reservation in Oklahoma, where their combined population in the 1960s was about 670.

See F. W. Hodge (ed.), *Handbook of American Indians North of Mexico* (1959).

EYEMOUTH, a small burgh of Berwick, Scot., lies at the mouth of the Eye, 9 mi. N.N.W. of Berwick-upon-Tweed. Pop. (1961) 2,161. Eyemouth was a port during the reign of Alexander II (1214–49). There is a safe harbour and a modern fishing fleet, the main occupation being seine-net fishing, with some boatbuilding and allied trades. Tweed- and knitwear-finishing processes are also carried on. The town is a popular summer resort and the rugged coast, which was once a haunt of smugglers, provides fine cliff scenery including St. Abb's Head, 3 mi. N.W. Coldingham, a picturesque village 3½ mi. W.N.W. of Eyemouth, is noted for its Benedictine priory, founded by King Edgar in 1098. The remains are now incorporated in the parish church.

(J. C. Mu.)

EYRE, EDWARD JOHN (1815–1901), British explorer and colonial governor, remembered especially for his suppression of a Negro uprising in Jamaica (1865), was born at Hornsea, Yorkshire, on Aug. 5, 1815. He emigrated to New South Wales in 1832 and farmed sheep, becoming a pioneer "overlander" driving stock from Sydney to South Australia. He explored the central deserts of South Australia, where Lake Eyre bears his name; his most famous voyage was in 1840–41, when almost alone he made an expedition round the Great Australian Bight which proved the possibility of land communication between South and Western Australia. As early as 1836 Eyre was appointed a magistrate and protector of aborigines, with whom he maintained good relations. He returned to England in 1845 and was appointed in 1846 lieutenant governor of New Zealand, where he served under Sir George Grey. After governing St. Vincent and the Leeward Islands in turn, he was appointed acting governor of Jamaica in 1861 and governor in 1864. In Oct. 1865 he suppressed a Negro uprising there with an efficient severity which earned him the warm gratitude of the local Europeans, but raised a storm in England: there were over 400 executions, and it was claimed that some of them had been illegal. The Whig government, after an inquiry, both thanked Eyre for putting the uprising down and blamed him

for taking excessive reprisals; in July 1866 he was recalled. Several unofficial attempts to try him failed, and he was acquitted in a civil case brought against him by a Jamaican. Eyre was finally granted the usual colonial governor's pension in 1874. He died near Tavistock on Nov. 30, 1901. (M. R. D. F.)

EYRE, LAKE, a great playa or salt pan covering an area of 3,430 sq.mi. in South Australia, is the central feature of an interior drainage basin of about 471,000 sq.mi. The floor, in places nearly 40 ft. below sea level, is normally a vast crust of salt, which can support a truck, over brine-saturated gypseous clay. In 1950, however, Cooper creek and the Warburton river were in high flood, and the lake filled until 1953. It is named after the explorer E. J. Eyre, who discovered it in 1840. (O. H. K. S.)

See *Lake Eyre: The Great Flooding of 1949–50,* Royal Geog. Soc. of Australasia, South Australia Branch (1955).

EYSTEIN (EYSTEIN ERLENDSSON) (d. 1188), one of the foremost ecclesiastical leaders of medieval Norway, came of an aristocratic family of Trondheim. On the death of Jon Birgisson, first archbishop of Nidaros, in 1157, King Ingi the Hunchback nominated Eystein to succeed him. Eystein received the pallium from Pope Alexander III four years later and returned to Norway in 1161. By that time King Ingi was dead and Norway was divided in a struggle for succession between Haakon II Broad-Shoulders and Erling, who claimed the throne for his infant son Magnus. Haakon was defeated and killed in 1162. The archbishop was meanwhile consolidating the position of the church. The cathedral of Nidaros, in which he took a special interest, was being built and there was need to increase the ecclesiastical revenues. Eystein reformed the system under which ecclesiastical dues were paid, demanding pure silver instead of debased coinage, and was thus led to hard bargaining with Erling. Each side gave the other generous concessions, though Eystein was the more astute. The power of the church was increased and the position of the infant king, whose claims to the throne were questionable, was temporarily secured. It was agreed that Magnus should receive the sanction of the church, and in 1163, at the age of seven, he was crowned, as Magnus IV, by the archbishop in the presence of the papal legate Stephanus of Orvieto. This was the first time the ceremony of coronation had been performed in Norway.

Eystein stood for the universal power of the church and in some ways resembled Thomas Becket. His policy came clearly to light in his dealing with Iceland (part of his province), where he tried unsuccessfully to compel chieftains to hand over churches they owned.

When the upstart Sverre from the Faeroes, asserting claims to the throne, had driven Magnus from Norway (1180), Eystein, who had sponsored the latter's cause, fled to England and formally excommunicated Sverre. He returned to Norway, however, in 1183 and made peace with Sverre.

Eystein was also remembered as the author of a lawbook, now lost, called *Guldfjaer* ("Golden-Quill") perhaps because of its illuminations; and of part, at least, of a work on the passion and miracles of St. Olaf.

See T. B. Willson, *History of the Church and State in Norway From the Tenth to the Sixteenth Century* (1903); E. Bull, *Det norske folks liv og historie,* vol. ii (1931). (G. T.-P.)

EZEKIEL, BOOK OF (in the Douai version of the Bible, EZECHIEL; in the Hebrew Bible, YEHEZQEL), a book of the Old Testament. In the English Bible Ezekiel is placed between Lamentations and Daniel. In the Hebrew Bible it is one of the four books of the Latter Prophets; *i.e.,* Isaiah, Jeremiah, Ezekiel and the Twelve (Minor Prophets). It is one of the three Major Prophets, the others being Isaiah and Jeremiah. The Hebrew text of Ezekiel is frequently corrupted, and the versions, particularly the Septuagint, often provide important witness of the original reading. Two fragments of the text of Ezek. iv, 16–v, 1 were found among the Dead sea scrolls in Qumran Cave I, and fragments of two manuscripts of Ezekiel were reported from Cave IV.

Outline.—The Book of Ezekiel may be outlined as follows:

i–xxiv:	prophecies against Judah and Jerusalem
i–iii:	Ezekiel's call and commission
iv–v:	symbolic action oracles: siege of Jerusalem and exile
vi:	against the mountains of Israel
vii:	against the land of Judah
viii–xi:	Temple abominations and departure of the Glory of the Lord
xii:	symbolic action oracles: baggage for exile and food eaten in fear
xiii:	against false prophets and prophetesses
xiv, 1–11:	against idolaters
xiv, 12–23:	the righteous man saves only himself
xv–xvii:	allegories of the vine branch, the unfaithful wife and the two eagles
xviii:	individual responsibility
xix:	allegories of the lioness and vine
xx:	apostasy and restoration
xxi:	swords of the Lord and Nebuchadrezzar
xxii:	the bloody city
xxiii:	allegory of the two wives of the Lord
xxiv:	allegory of the pot; death of Ezekiel's wife
xxv–xxxii:	prophecies against foreign nations
xxv:	against Ammon, Moab, Edom, Philistia
xxvi–xxviii, 1–19:	against Tyre
xxviii, 20–26:	against Sidon
xxix–xxxii:	against Egypt
xxxiii–xxxix:	prophecies of restoration
xxxiii, 1–20:	responsibility of the prophet; individual responsibility
xxxiii, 21–22 (*cf.* iii, 24–27; xxiv, 26–27):	Ezekiel's dumbness
xxxiii, 23–33:	reaction of Ezekiel's hearers
xxxiv:	against the shepherds of Israel
xxxv:	against Mt. Seir
xxxvi:	restoration on the mountains of Israel
xxxvii:	vision of the valley of dry bones; oracle of the two sticks
xxxviii–xxxix:	Gog of Magog
xl–xlviii:	vision of the restored Temple and land
xl–xliii; xlvi, 19–24:	arrangements and measurements of the temple area
xliv:	regulations for the priesthood
xlv; xlvi, 1–18:	the sacred allotment; regulations for the prince, offerings and festivals
xlvii, 1–12:	the river from the temple
xlvii, 13–xlviii, 35:	allotment of the land

Themes.—It is due to the editor (*see* below) that the over-all orientation of the book is toward the restoration of the united monarchy under the messianic king of the line of David (xxix, 21; xxxiv, 23; xxxvii, 24–28). The exiles from both Judah and Israel will return to Palestine (xi, 17–19; xxxvii, 15–23; xlvii, 13–xlviii, 35), leaving none in the Diaspora (xxxiv, 12; xxxix, 28). In the imminent new age a new covenant will be made with the restored house of Israel, to whom the Lord will give a new spirit and a new heart (xi, 19; xvi, 59–63; xxxiv, 25–31). The restoration will be an act of grace, for the sake of the Lord's name (xx, 44; xxxvi, 22–23; xxxix, 7). Gog of Magog and his hordes who will come against the restored land will be defeated by the Lord (ch. xxxviii–xxxix). A new allotment of the land will be made, with the tribes north and south of a sacred portion set aside for the Zadokite priests, Levites and the city of Jerusalem, and with the lands of the "prince" on each side of the sacred portion (xlvii, 15; xlviii, 35).

Judging from phraseology and parallels, it may be to the editor that the discourses on responsibility in ch. xiv, xviii, xxxiii belong, coming from the same school of thought as Jer. xxxi, 29 ff., although most scholars reckon this to be the high point of Ezekiel's thought. In deliberate contrast with the normative view of corporate responsibility, each man will be held responsible for his own sin alone and be judged exclusively in the light of his present goodness or sin. The author is meeting the complaint that "the way of the Lord is not just," and gives an important answer to the problem of the goodness and omnipotence of God.

Literary History.—There is a wide variety of opinion regarding the unity and date of the Book of Ezekiel. According to the book itself, the prophet's career extended from 592 to 570, but one scholar (James Smith) places him in the 7th century at the time of Manasseh and another (N. Messel) after the time of Nehemiah,

around 400 B.C. Most, however, accept the general chronology of the book.

J. Herrmann recognized in the book editorial work by Ezekiel himself and later expansions. G. Hölscher focused modern attention on the main problems of the composition, concluding from a study of literary characteristics that Ezekiel was a poet and prophet of doom, and that a 5th-century redactor was responsible for most of the book, only about 170 verses belonging to Ezekiel. W. A. Irwin concluded that more than 80% of the book is spurious, consisting of commentary and commentary on commentary written over several centuries, and he sought to isolate the original poems of Ezekiel.

Several scholars have followed in various ways the suggestion of V. Herntrich that Ezekiel prophesied in Palestine and that the Babylonian setting comes from a redactor; many recognize at least some Palestinian ministry of Ezekiel. There is little disposition to accept C. C. Torrey's view that the book comes from a writer who lived *c.* 200 B.C. and who presents a fictitious Ezekiel imagined to have lived at the time of Manasseh, while the Babylonian setting is the result of still later editing. The authenticity of ch. xl–xlviii has often been questioned, and there is a general opinion that the chapters are composite in authorship. There are also scholars who maintain the substantial authenticity of the book.

Oft-repeated typical words and phrases give a strong impression of literary unity to the book: "Then they will know that I am the Lord" (more than 50 times), "As I live, says the Lord God" (13 times), "my sabbaths" (12 times), "countries" (24 times), "idols" (Hebrew *gillulim;* about 40 times), "walking in my statutes" (11 times), etc. A large share of the repeated phraseology seems to belong to the redactor or editor of the book. Its relative literary homogeneity mitigates against the theory of many editors and authors, suggesting that a single editor is responsible for the present form; ideology and literary relationships point to a possible 5th-century date for him.

Life and Teachings of Ezekiel.—Ezekiel, who was probably a member of the Zadokite family of priests, was carried into exile in 597. His home was at Tel-abib near the canal Chebar, known to have been in the vicinity of Babylon, Nippur and Erech. His call came in July 592 in a vision of the throne-chariot of the Lord, and he ate a scroll written on both sides with the Lord's message of woe, lamentation and mourning (i; ii, 8–iii, 3). He may actually have returned to Jerusalem in Sept. 591 (viii, 1–3; *cf.* iii, 14), where he witnessed the abominations in the Temple, and while he prophesied there Pelatiah dropped dead (xi, 1–13). He saw the departure of the throne-chariot of the Lord from the Temple, foreshadowing the destruction (x; xi, 22–25). He may have been in Jerusalem at the beginning of the siege in Jan. 588, for he knew of it on the day it occurred (xxiv, 1, 2), but he was in Babylonia when the city fell (*cf.* xxxiii, 21–22). He used the occasion of his wife's death for a symbolic action oracle (xxiv, 15–24). He prophesied until April 585 (xxxii, 17), and then he is not heard from until April 572 (xl, 1). His latest oracle is dated April 570 (xxix, 17).

These two periods of prophesying, separated by 13 years, represent variant emphases in his message. His earlier oracles to the Jews in Palestine were pronouncements of the Lord's judgment on a sinful nation for its apostasy. Judah was more guilty than Israel had been (ch. xvi, xxiii), and Jerusalem would fall to Nebuchadrezzar and its inhabitants would be killed or exiled (ch. iv; v; vii; xii, 1–20; xxiv, 15–24). To dramatize his message he used symbolic actions and effective allegories. The false prophets uttered delusions and misled the people (ch. xiii). Judah trusted in foreign gods and foreign alliances (xvi, 16–19), and Jerusalem was a city of blood, full of injustice (viii, 8; ix, 9–10). Pagan rites abounded in the Temple courts (ch. viii–x). The Lord's judgment was also on the pagan nations, particularly Egypt and Tyre, which would fall at the hands of Nebuchadrezzar (ch. xxvi–xxxii).

After the fall of Jerusalem and the period of silence, now addressing himself more pointedly to the exiles, Ezekiel sought to direct the hopes for restoration. His theme changed from judgment to promise, although many scholars find both themes present throughout his career. Like flesh and life coming to dead bones, the house of Israel would revive (ch. xxxvii). In contrast with those hoping for national restoration under a Davidic king, Ezekiel envisaged a theocratic community centred around the Temple and its cultus (ch. xl ff.). With priestly meticulousness he presented in vision form the arrangements and measurements of the Temple area. Foreigners were to be prohibited from entering the sacred courts or serving as ministers (xliv, 6–9). Because of their pollution by contact with paganism at the local sanctuaries, the Levites were to be demoted to be ministers in the outer court, and only the priests of the family of Zadok were to be granted full priestly status. It is uncertain how much of the legislation in ch. xlv and xlvi goes back to Ezekiel, but that the prophet legislated for the prospective community is most probable. His vision of the New Jerusalem is climaxed in the beautiful vignette of the stream of life issuing from the Temple (xlvii, 1–12).

The Temple was never rebuilt according to Ezekiel's specifications, and the legislation in the book remained an "ideal" code. While it may be inaccurate to call Ezekiel "the father of Judaism," his influence and that of the book which bears his name were very great in subsequent centuries when Israel was rebuilding her life again in Palestine.

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(H. G. MA.)

EZION-GEBER, seaport of Solomon and the later kings of Judah, now Tell al Kheleifeh 3 mi. N.W. of Aqaba, at the extreme northern end of the Gulf of Aqaba. The boundary between Israel and Jordan crosses the site. About 2 mi. S.E. of Kheleifeh are the remains of Roman Aelana (biblical Elath; now probably buried under the sand). In the Bible Ezion-geber is mentioned beside Elath or in its immediate vicinity (Deut. ii, 8; I Kings ix, 26). The site of Ezion-geber was independently found by Fritz Frank and Nelson Glueck, who excavated it for three seasons (1938–40). Glueck proved that the site had been occupied by a fortified settlement surrounded by strong walls from the 10th to the 4th century B.C. It was almost certainly founded about 950 B.C. by Solomon, who used it both as a port for his trade with Ophir (*q.v.*) and as a copper refinery. Large-scale refinery installations show its industrial importance.

See Nelson Glueck, *The Other Side of the Jordan* (1940), *Rivers in the Desert* (1959).
(W. F. A.)

EZRA (Greek ESDRAS), a Babylonian Jew, in the 4th or 5th century B.C., led a caravan of Jews to Palestine, where he promoted the establishment of an exclusive, legalistic type of religion that became dominant in later Judaism. The history of his reforms is given in the Old Testament books of Ezra and Nehemiah and in I Esdras (*see* also EZRA AND NEHEMIAH, BOOKS OF; ESDRAS, FIRST BOOK OF).

Ezra is called a priest (Ezra vii, 11–12), and Josephus, in the *Antiquities,* following I Esd. ix, 40, calls him chief priest, reflecting the tradition that supplied Ezra with a genealogy linking him to the pre-exilic high priests, back to Aaron (Ezra vii, 1–5). He is also called a scribe (Ezra vii, 11–12), which may mean that he was an official secretary of Jewish affairs in the Persian court; but, because of Ezra's concern for the Law, the title is usually understood in the later sense of one who is especially concerned with the preservation and propagation of Jewish religious law. It is said (Ezra vii, 7–8) that he began his work in the seventh year of King Artaxerxes, but since the Bible does not specify which Artaxerxes, the date of Ezra's journey to Judea is uncertain. Either 458 B.C. or 398 B.C. is defensible (*see* EZRA AND NEHEMIAH, BOOKS OF).

The Ezra story is now included in the Chronicler's history of Israel (Chronicles-Ezra-Nehemiah), where a considerable part of the Ezra narrative has been transposed to the Book of Nehemiah

as the result of a copyist's mistake. Because the Ezra story shows some of the distinctive language and ideas of the Chronicler, there are some, notably C. C. Torrey, who mistrust its historicity and even doubt the existence of Ezra, regarding him as a fictional creation of the Chronicler, as the personification of the Chronicler's interests or as a symbol embodying legalistic, priestly Judaism. There is, however, an increasing tendency to regard the Ezra story as essentially historical.

On his arrival at Jerusalem Ezra read the Law to the people and instructed them in its meaning. When he had won its acceptance by the community he accomplished important reforms in accordance with it (Ezra x, 3). Chief among these was the purging of the community of all non-Jewish elements by prohibition of mixed marriages and the banishment of all persons who were even partially of non-Jewish stock.

Nehemiah rather than Ezra was lauded in early lists of Jewish worthies (Ecclus. xlix, 13 and II Macc. i and ii), but as Jewish religion developed along the exclusive, legalistic lines favoured in Ezra's reforms, Ezra's stature increased mightily until he was regarded as a second Moses who restored the Jewish Law, the founder of modern Judaism.

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EZRA, THIRD BOOK OF, is one of the two apocryphal Ezra books of the Bible. The title III Esdras has been used for the so-called Greek Ezra (I Esdras) in Latin Bibles since Jerome, in the English Great Bible (1539) and in the Anglican Book of Common Prayer, art. vi. *See* Esdras, First Book of.

EZRA, FOURTH BOOK OF, commonly known as the Ezra Apocalypse, is one of the two apocryphal Ezra books of the Bible. It is appended to the Vulgate Bible as IV Esdras. In the English Bible it is the second of the apocryphal books and is numbered II Esdras. *See* Esdras, Second Book of.

EZRA AND NEHEMIAH, BOOKS OF, two books of the Old Testament, ranking among the Hagiographa, or Writings. Along with the Books of Chronicles, Ezra and Nehemiah once formed a history of Israel from Adam to the 4th century B.C., written about 350 B.C. by an anonymous "Chronicler." Its purpose seems to have been to trace the origin of the Temple and to show the antiquity and authenticity of its cultus and of the formal, legalistic type of religion that dominated later Judaism. Most of this history is written in the distinctive language and style of the Chronicler, and it is permeated with his religious ideas. Later Jewish scholars severed the Books of Chronicles, which were largely dependent upon earlier biblical books, from the postexilic history of the Persian period which did not duplicate material already in the Bible. The unique material was then called "Ezra," and talmudic tradition regarded the reformer Ezra as its author. At least as late as Melito of Sardis (A.D. 170) Ezra-Nehemiah formed one book called Ezra. In the Codex Vaticanus of the Greek Bible and in I Esdras the narrative proceeds directly from Ezra into the Book of Nehemiah without indicating a break (*see* Esdras, First Book of). Division into two books is first mentioned by Origen (3rd century A.D.), and the actual separation is encountered first in the Vulgate version, where the Book of Nehemiah appears as II Esdras. A separate Book of Nehemiah was not found in the Hebrew Bible until the Bomberg edition (A.D. 1525). (For a table outlining the Ezra literature, *see* Esdras, Second Book of.)

Scholars have differed considerably in their opinions regarding the character of the books of Ezra and Nehemiah and their historical value. Some (*e.g.*, C. C. Torrey) have regarded the Chronicler as a novelist who freely composed his story for apologetic purposes, with little or no use of documentary sources. Such records as are quoted are believed to be forgeries, and the Chronicler's work is regarded as fiction with no value as history. Others consider the Chronicler to have been an editor rather than an author. His use of earlier biblical writings can be demonstrated in the Books of Chronicles, and works no longer preserved are cited in Ezra-Nehemiah (*e.g.*, Neh. vii, 5; xii, 23). It may be assumed, where the Chronicler's sources have disappeared, that he used the same editorial techniques of copying and rewriting, omission and supplementation, that can be observed where his biblical sources are still available to serve as a check. Undisputed is his use of the personal memoir of Nehemiah as a source (*see* below). Less clear is the nature of his Ezra source, since the Chronicler's own characteristics are most conspicuous in the Ezra story. The Chronicler's liking for lists, clearly indicated also in the Books of Chronicles, is demonstrated also in Ezra-Nehemiah. He presents not only inventories of animals and gifts to the temple but also genealogies, lists of leaders in civil projects, census reports and lists of temple ministrants, designated by class. The lists are often such as may have been preserved as temple records.

Among the Chronicler's sources in Ezra is a collection of what purport to be official documents issued during the reigns of several Persian kings, written in Aramaic, one of the official languages of the Persian empire (Ezra iv, 7–vi, 18). These documents, reflecting the continual harassment of the Jews who were attempting to restore their city, have been called the Chronicler's forgeries, but they are probably an earlier assemblage of records which the Chronicler used to account for the delay in rebuilding the Temple (Ezra iv, 23–24). He misunderstood his source, in part, for Ezra iv, 11–16 is concerned with the building of the city wall rather than the Temple. The royal commission granted to Ezra (Ezra vii, 12–26) is also written in the Aramaic language.

The text of Ezra-Nehemiah is not in its original order. Its faulty Persian chronology may have been correct in the Chronicler's Aramaic source, but because he was more concerned with the history of the Temple than with accurate chronology, the Chronicler arbitrarily shifted the text of Ezra iv, 6–23 (Artaxerxes) from its original place after Ezra v, 1–vi, 18 (Darius, who was in fact a predecessor of Artaxerxes) to its present location. This permitted his narrative to flow without interruption from the completion of the Temple and its dedication (Ezra vi, 15–18) to the reinstitution of cultic services, as preliminary to the story of Ezra (Ezra vii, 1–x, 44). A later editor transposed three chapters of the Ezra story (Neh. vii, 73b–x, 39) from its position after Ezra viii, 36 to its present place in the Book of Nehemiah. Such dislocation may have been due to faulty transmission of the text by a copyist confused by the close resemblance of Ezra ii, 68–iii, 1 to Neh. vii, 70–viii, 1a. The correct original order is still maintained in I Esdras and in Josephus' narrative. The original order of the Ezra story was thus Ezra vii–viii; Neh. viii–x; Ezra ix–x. At an early date a pagan story was interpolated into the Book of Ezra to show how Zerubbabel won the right to rebuild Jerusalem. It is preserved in I Esd. iii, 1–v, 6 and in Josephus' *Antiquities* but not in the Hebrew Bible.

Book of Ezra.—Evidence for the original union of the Book of Ezra with the Books of Chronicles is found in the duplication of II Chron. xxxvi, 22–23 at the beginning of the book (Ezra i, 1–3a). In the I Esdras translation of the Book of Ezra the duplicated material begins with II Chron. xxxv, 1. The Book of Ezra has two parts: (1) postexilic history prior to Ezra (Ezra i–vi), consisting largely of the Aramaic documents (*see* above); and (2) the Ezra story (vii–x), of which part has been transposed to the Book of Nehemiah (Neh. vii, 73b–x).

The former part includes an account of the decree of Cyrus and the return of Jews from Babylonia to Judea during his reign (Ezra i–ii) and the record of Jewish attempts to rebuild Jerusalem and its Temple despite the opposition of neighbouring peoples and Persian officials (Ezra iii–vi). The story of Ezra the "priest" and "scribe" (Ezra vii, 11–12) records Ezra's journey to Palestine in the time of Artaxerxes with a royal commission to institute Jewish law there (Ezra vii–viii); the account of the reading of the Law in Jerusalem and its acceptance by the people, who then pledge to support the Temple (now found in Neh. vii, 73b–x, 39); and the purging of the Jewish community of all non-Hebrew persons after the Jews promised to keep separate from the "people of the land" (Ezra ix–x).

Because of the difficulty of identifying the Artaxerxes of Ezra vii, 7, the date of Ezra is not fixed. The Bible places him in Jerusalem before Nehemiah, presumably under Artaxerxes I (458

B.C.; this Artaxerxes reigned 464–423 B.C.). Since Nehemiah, when he arrived in Jerusalem in 445 B.C. (Neh. ii, 1), found no evidence of Ezra or his reforms but rather a social, economic and religious situation as bad as or even worse than that which Ezra encountered, and since neither Ezra nor Nehemiah mentions the other, it is unlikely that they were contemporaries in Jerusalem. The references that seem to indicate that they were (Neh. viii, 9; xii, 36) are later additions to the text. Ezra probably came to Palestine in 398 B.C. under Artaxerxes II (reigned 404 to 358 B.C.). By arbitrarily emending Ezra vii, 7 to the 37th rather than the 7th year, some would place the arrival of Ezra in Jerusalem in 428 B.C., while Nehemiah was absent from Jerusalem.

Since the Chronicler's language, style and ideas are encountered through the Ezra story, a genuine Ezra narrative, apart from the Chronicler's contribution, cannot be isolated. Some have regarded the portion of narrative written in the first person (Ezra vii, 27–28; viii, 1–34; *cf.* ix, 1–15) as an autobiographical nucleus; but others have called it a literary device of no significance, and there remains great diversity among scholars as to the extent of the genuine Ezra story. Judged by substance rather than style, the Ezra narrative seems to include Ezra vii, 11–x, 44 and Neh. vii, 73b–ix, 5.

Book of Nehemiah.—The only undisputed source for Jewish history between 520 and 175 B.C. is Nehemiah's memoir (Neh. i, 1–vii, 73a; xi, 1–2; xii, 27–43; xiii, 4–31), written not long after 432 B.C. (*cf.* Neh. v, 14; Artaxerxes I ascended the throne in 464). It is an accurate historical record preserved by the Chronicler with but little reworking or interpolation. As a memorial record it was perhaps intended to be placed before God in the temple where it would stir remembrance of Nehemiah's good works and assure a "name" for him who was probably a eunuch and who could not obtain it through descendants (Isa. lvi, 3–5). It is likely that the Nehemiah memoir circulated separately as late as about 180 B.C. (Ecclus. xlix, 13) and when II Macc. ii, 13 was written, probably between 100 B.C. and A.D. 70. Although I Esdras contains Neh. vii, 73–viii, 12 (I Esd. ix, 37–55) it does not have the Nehemiah story, and Josephus, who depends upon I Esdras, presents the Nehemiah memoir in a form somewhat different from that in the Bible. He gives the substance of Neh. i–vi; alludes to Neh. vii, 4 and, with no reference to Neh. ix–x, proceeds directly to Neh. xi, 1; xii, 27; and xiii, 10 ff.

The Book of Nehemiah includes (1) an account of how Nehemiah, a royal official in Susa, learned of the distress of Jerusalem and obtained a royal commission to rebuild the city (Neh. i, 1–ii, 10); (2) a record of the rebuilding of the wall of Jerusalem despite opposition by Samaritans, Ammonites and Arabs (Neh. ii, 11–iv, 23; vi, 1, 15; vii, 1) and of attempts to entrap and assassinate Nehemiah (Neh. vi, 1–14, 17–19); (3) a description of the repopulation of Jerusalem (Neh. vii, 2–73a; xi, 1–24) and the dedication of the city wall (Neh. xii, 27–43); (4) an account of the social and religious reforms instituted by Nehemiah, including the prohibition of usury leading to the enslavement of Hebrews (Neh. v, 1–13), the reinstitution and organization of temple services that had been neglected (Neh. vii, 1; xii, 44–47; xiii, 4–14, 30–31), Sabbath reforms (Neh. xiii, 15–22) and the purging of Jerusalem of all non-Hebrew persons (Neh. xiii, 1–3, 23–30). In Neh. v, 14–19 Nehemiah asserts the policies of his administration which reflected his generosity and self-sacrifice.

After 12 years as administrator in Jerusalem (Neh. v, 14), Nehemiah returned to his king in the 32nd year of Artaxerxes I (433–432 B.C.; Neh. xiii, 6). According to Neh. xiii, 6–7 something later induced him to return to Jerusalem for an indeterminate period. The reforms described in Neh. xiii are presumably those of his second administration. C. C. Torrey believed that Nehemiah's work was concluded with the completion of the city walls and that Neh. xiii is the Chronicler's fiction, utterly worthless as history. While Neh. xiii, 1–3 is certainly the Chronicler's work and his hand is observable elsewhere in Neh. xiii, which is concerned with such subjects as greatly appealed to the Chronicler, the vivid forcefulness of the chapter is in keeping with the activity of Nehemiah recorded in his memoir and it is probable that the kernel of Neh. xiii, 4–31 is part of Nehemiah's memoir—a description of his solving of problems that had arisen during his absence from Jerusalem. *See* also BIBLE.

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EZZELINO DA ROMANO (1194–1259), Ghibelline lord of Verona, Vicenza and Padua, was born on April 25, 1194, of a German family from Franconia that had been enfeoffed by the emperor Conrad II early in the 11th century with lands in northeastern Italy including the castle of Romano near Vicenza. A ruthless leader, feared and hated for his coldly deliberate cruelty, Ezzelino was prominent for nearly 40 years in the wars and factions of his native region and was also the first Italian despot to seize and hold authority successfully for any length of time (from 1236 to 1259).

His career began in 1226 when he became Ghibelline *podestà* of Verona, but four years later he lost the city. The fight went on uncertainly for several years until in 1236–37, acting in the name and with the help of the emperor Frederick II (*q.v.*), Ezzelino resumed control of Verona and took Vicenza and Padua as well. In Nov. 1237 he fought on the imperial side at Cortenuova; in 1238 he married Frederick's natural daughter, Selvaggia; and in 1239 he was appointed imperial vicar of the march of Treviso. Ezzelino thus built up his despotism less from within than by alliance with the emperor against their common enemies; and it was this more than loyalty that bound him to the Hohenstaufen dynasty. With little care for formal offices like that of *podestà*, Ezzelino sought and won actual power and independence, so that when Frederick II died in 1250 his position was not immediately affected. In spite of his ferocity, however, his rule was under constant challenge from hostile neighbours and the papacy. In 1254 he was excommunicated, and shortly after a crusade was proclaimed against him. Then, in 1259, he quarreled with the other Ghibelline leaders, Oberto Pelavicino and Buoso da Dovara. He was wounded and captured in battle at Cassano on Sept. 27, 1259, and died four days later, refusing both medical aid and peace with the church. He left no issue.

Ezzelino was commemorated as a tyrant in Dante's *Inferno* and in a tragic drama, the *Ecerinis*, written in the Latin manner by the early Paduan humanist Albertino Mussato.

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F THIS letter corresponds to the sixth letter of the Greek, Etruscan, and Latin alphabets, known to the Greeks as digamma. The sound represented by the letter in Greek was a labial semivowel similar to English *w*. This sound had disappeared early from the Ionic and Attic Greek dialects, so that the Ionic alphabet, which eventually came into general use in Greece, contained no digamma. It was retained, however, for some time in many local dialects and alphabets, including that from which the Etruscan (and through it the Latin alphabet) was derived.

The form of the letter in Greek was , , or , none of which forms occur in the Semitic alphabets. Its origin in the Greek alphabet has been a matter of dispute, some maintaining

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	1200 B.C.	
CRETAN	1100-900	
THERAEAN	700-600	
ARCHAIC LATIN	700-500	
ATTIC	600	
CORINTHIAN	600	
CHALCIDIAN	600	
IONIC	403	
ROMAN COLONIAL	PRECLASSICAL AND CLASSICAL TIMES	
URBAN ROMAN		
FALISCAN		
OSCAN		
UMBRIAN		
CLASSICAL LATIN AND ONWARD		

THE DEVELOPMENT OF THE LETTER "F" FROM THE PHOENICIAN THROUGH THE CLASSICAL LATIN TO THE PRESENT FORM

that it descends from Semitic *vau* , others, far less convincingly, maintaining that it was merely differentiated from the preceding letter by the omission of a horizontal stroke. In either case it is probable that the Greeks were not the innovators, since a form of the letter () occurs in the Lydian alphabet. The letter was probably contained in an Asianic alphabet from which the Greek, Lydian and Etruscan were derived.

In some very early Latin inscriptions F was used in combination with *h* to represent the unvoiced labial spirant (English *f*), as in the word **FHEFHAKED** "he made." The *h* was soon dropped, and the sound represented by the letter F alone. It was not required in Latin to represent the bilabial semivowel (*w*), for the Latins had taken the letter V to represent both this sound and the corresponding vowel (*u*). F has represented the unvoiced labial spirant ever since.

In the Faliscan alphabet the letter had the curious form , and in Latin there was a form corresponding to the form of the preceding letter. Latin cursive of the 5th century A.D. employed a lengthened form , and the letter was generally extended below the line in uncial writing, .

In Irish writing of the 7th century the form was , and the Carolingian with further rounding of the top . From this developed the modern minuscule *f*. (*See* also ALPHABET.)

In music, F is the name of the sixth note of the musical alphabet, otherwise the fourth note of the scale of C. It also gives its name to the bass clef, whose distinguishing sign denotes the F line. Further, it serves as an abbreviation for *forte* (*f*) and *fortissimo* (*ff*).

In chemistry, F is the symbol for fluorine.

For a discussion of phonetic correspondences involving the letter *f* in Indo-European languages, *see* GERMANIC LANGUAGES.

(J. W. P.)

FABER, a family of German lead-pencil manufacturers. The business was founded in 1761 by Kaspar Faber (d. 1784) near Nürnberg and remained in the Faber family until 1903. The founder's great-grandson JOHANN LOTHAR VON FABER (1817–1896) established branches of the company in New York city, Paris, London and Berlin, and agencies elsewhere in Europe. Johann contracted for exclusive control of all graphite from the east Siberian mines. He also branched out into the manufacture of water colours and oil paints, inks, slates and slate pencils and drawing instruments. His factory became a model of efficiency for German and Austrian manufacturers. The German emperor gave him a patent of nobility and appointed him councilor of state.

EBERHARD FABER (1822–1879), another great-grandson of the founder, in 1848 went to the United States and in 1849 established a business in his own name and built the first U.S. pencil factory in 1861. (J. R. Lt.)

FABER, FREDERICK WILLIAM (1814–1863), British hymn writer and theologian, was born on June 28, 1814, at Calverley, Yorkshire. Educated at Harrow and at Balliol college, Oxford, he was elected fellow of University college in 1837. Meanwhile he had given up Calvinistic views, and had become an enthusiastic follower of John Henry Newman. In 1843 he became rector of Elton in Huntingdonshire, but after a prolonged mental struggle joined the Roman Catholic communion in Nov. 1845. He founded a religious community at Birmingham, called Wilfridians, which was ultimately merged in the Oratory of St. Philip Neri, with Newman as superior. In 1849 a branch of the Oratory was established in London and over this Faber presided till his death on Sept. 26, 1863.

It is mainly as a hymn writer that Faber is remembered, some of his most popular hymns being "Hark! Hark, My Soul" and "My God, How Wonderful Thou Art." His other works include *Lives of Modern Saints* (1847 *et seq.*); *The Blessed Sacrament* (1855); *The Creator and the Creature* (1858); *Growth of Holiness* (1854); *Spiritual Conferences* (1859); *The Foot of the Cross*, eight volumes (1853–60); and *Notes on Doctrinal Subjects*, two volumes (1866).

See J. E. Bowden, *Life and Letters of Fr. Faber* (1869; 2nd ed., 1888), and *A Brief Sketch of the Early Life of the Late F. W. Faber, D.D.*, by his brother F. A. Faber (1869).

FABERGÉ, PETER CARL (KARL GUSTAVOVICH FABERGÉ) (1846–1920), Russian goldsmith whose work, comparable to that of Benvenuti Cellini, ranks with the finest of all ages. Fabergé was born of Huguenot descent at St. Petersburg in 1846 and was educated in Dresden, Italy, France and England. Inheriting his father's establishment in 1870, he made a bold change from the exclusive design and manufacture of jewelry to the creation of objects of fantasy.

The workshop soon became famous for exquisite masterpieces: flowers, figure groups, animals and the celebrated imperial Easter eggs, which became the delight of Russian and other royalty throughout Europe and Asia. Alexander III commissioned the first of the eggs for his tsarina in 1884. The Fabergé studios in St. Petersburg and Moscow employed artists and skilled craftsmen who achieved wonders of imaginative, elfin delicacy until the Revolution of 1917 ended the world of Fabergé. He died in exile in 1920. (M. C. Rs.)

FABERT, ABRAHAM DE (1599–1662), marshal of France, was born at Metz on Oct. 11, 1599. His grandfather, Mangin Fabert, had been made director of the ducal printing and had been ennobled by Charles III of Lorraine. His father Abraham had served Henry IV of France, who had reconfirmed the family's letters patent of nobility. The duc d'Epernon (J. L. de Nogart de La Valette) gave a commission in the French service to the young Abraham, who was a friend of his son Louis, the warlike Cardinal de La Valette. Conspicuous courage at the sieges of the Huguenot towns made him "sergeant-major" of a regiment (1627). He helped to combat the army's prejudice against work with the artillery and engineers; and his "singular dexterity" in handling the attacks in sieges made him well-known to Louis XIII and to the Cardinal de Richelieu, while his conduct in the battle of Veillane (1630) in the Alps and in La Valette's retreat from Mainz to Metz (1635) showed equal prowess on the field of battle. At 40 he was colonel of La Valette's regiment in Italy. From 1642 until his death he was governor of Sedan, though Cardinal Mazarin sent him out as lieutenant to Du Plessis-Praslin (*see* CHOISEUL, CESAR, DUC DE) in the expeditions to Catalonia and Tuscany (1644–46). During the Fronde, Sedan was a key point; Fabert was made a marquis (1650) and a lieutenant general (1651). It was at Sedan (1651–52) that he equipped the small force which finally brought Mazarin back to power in France. In 1654 Mazarin sent him to reduce the rebel base at Stenay, with the promise of a marshal's baton. After his coronation at Reims the young Louis XIV, with the French guards, joined Fabert, and Stenay fell in four weeks. Fabert was marshal of France in June 1658. He twice refused the Order of the Holy Ghost (*Saint Esprit*) (1653 and 1661) on grounds of having insufficient noble qualifications. He was a man of fine character, and in advance of his age; but the 18th century extolled him mainly because he did not come from the feudal nobility. He died at Sedan on May 17, 1662. (I. D. E.)

FABIAN, SAINT (d. 250), pope and martyr, was pope from 236 till he was martyred during the persecution under Decius on Jan. 20, 250. He was buried in the catacomb of St. Calixtus, and later was moved to S. Sebastian's, where his tomb was found in 1915. He is said to have divided Rome into seven districts assigned to the seven deacons, and to have founded several churches in France. The tradition that he appointed notaries to register the deeds of the martyrs reflects the increasing precision of the records of the Roman Church beginning in his time. His feast is celebrated on Jan. 20. (E. R. Hy.)

FABIAN SOCIETY, a socialist society founded in 1883–84 by a small group in London who aimed at "reconstructing society in accordance with the highest moral possibilities." The name is derived from the Roman general Fabius Cunctator, whose elusive tactics in avoiding pitched battles secured his ultimate victory over stronger forces. The early members included George Bernard Shaw, Sidney Webb, Annie Besant (*qq.v.*), Edward Pease and Graham Wallas. Shaw and Webb, joined later by Webb's wife Beatrice, were the outstanding leaders for many years. In 1889, the society published *Fabian Essays in Socialism*, edited by Shaw; and since then it has sold in large numbers. It was reinforced in 1952 by *New Fabian Essays*, edited by R. H. S. Crossman. The Fabians preferred John Stuart Mill and Stanley Jevons to Karl Marx; they put their faith in evolutionary socialism rather than revolution; and they considered that the utilitarian aim of the greatest happiness of the greatest number could be secured only by extensive action by the state in the economic field. They regarded the state as a social machine to be captured and used for the promotion of social welfare, not as an instrument of class domination to be overthrown.

At first, the Fabians attempted to permeate the Liberal and Conservative parties with socialist ideas, but later they helped to organize the separate Labour representation committee, which became the Labour party in 1906. The society is affiliated with the Labour party.

The rules of the society state that it consists of socialists: "It therefore aims at the establishment of a society in which equality of opportunity will be assured and the economic power and privileges of individuals and classes abolished through the collective ownership and democratic control of the economic resources of the community. It seeks to secure these ends by the methods of political democracy." However, all publications appear under the names of the individual authors who are alone responsible for the views expressed, and the rules require that research carried out by the society shall be free and objective. The society has thus attracted the intelligentsia of the Labour movement and provided it with the opportunity for expression and criticism.

The national membership reached a peak in 1946 with 5,089 members. Thereafter it declined sharply until 1956, but after that it rose gently again. The importance of the society has always been much greater than its size might suggest. Generally, nearly half the number of Labour members of parliament in the house of commons and a majority of the party leaders are Fabians; and in addition to the national society there are more than 80 local Fabian societies.

The principal activities of the society consist in the furtherance of socialism and the education of the public on socialist lines by means of meetings, lectures, discussion groups, conferences and summer schools; carrying out research into political, economic and social problems; and publishing books, pamphlets and periodicals. In 1931, the New Fabian Research bureau was established as an independent body. The bureau and the society amalgamated in 1938 to form a new and revitalized Fabian society. Since then research has formed an important part of the society's work, and many research pamphlets have been published.

In the first 20 or 30 years of its existence, much of the attention of the society was devoted to general arguments against capitalism and in favour of socialism. The tone was severely rational, practical and empirical. During this early period the society also stressed the importance of local government as a means of promoting collective ownership. The horizons have gradually widened, and Fabians have become as much interested in the social services as in the nationalization of industry. In 1940, the colonial bureau was established and thereafter produced a continuous stream of Fabian discussion and writing on colonial questions. The Fabian International bureau was started in 1941, as an integral part of the society, to cater to the growing concern of Fabians with foreign policy and the great issues of war and peace.

Many practical reforms can be traced in part to the work of Fabians; but much of the impact of Fabianism has been through the gradual permeation of Fabian ideas among teachers, civil serv-

ants, politicians, trade-union officials and others in influential positions. The work of the society tended to become more specialized in dealing with such subjects as economic planning, social security, consumers' councils, leasehold enfranchisement, monetary policy and housing; but leaders of the society also encouraged it to deal with the problems of man in society in order to discover how far people aspire toward equality, a classless society and a widely dispersed power of self-government. In approaching this problem, emphasis was less on doctrine than on sociological and psychological investigation.

See also SOCIALISM; SOCIALISM: PRINCIPLES AND OUTLOOK.

See E. R. Pease, *History of the Fabian Society*, rev. (1925); G. D. H. Cole, *The Fabian Society, Past and Present*, pamphlet, rev. (1946) and *British Working Class Politics, 1832–1914* (1941). (W. A. RN.)

FABIOLA, SAINT (d. *c.* A.D. 399), Christian noblewoman of Rome, credited with founding the first public hospital in western Europe, was a member of the great Fabian family. After her conversion to Christianity she worked closely with Jerome, like other women of her class who had accepted the new religion. Her immense wealth and energy she dedicated to the church with the intention of atoning for transgression against a church law in marrying a second time while her first husband, whom she had divorced, was alive. On the death of her second husband she began her career of charity. She not only founded the first general public hospital in the western part of the Roman empire, but, acting as physician and nurse, cared for the sick herself. According to Jerome no patient was so sick that she refused to nurse him. With Pammachius she also founded a hospice for pilgrims at Ostia and gave generously to other religious foundations throughout Italy and the Mediterranean islands. A woman of learning who knew Hebrew and Greek as well as Latin, she studied the Scriptures under the guidance of Jerome, whom she followed to Bethlehem. There, at her request, he wrote a treatise on the priesthood of Aaron and the priestly dress. Jerome's treatise on the 42 stopping places of the Israelites in the wilderness was also written for her, though she did not live to see it finished.

When disturbances in the eastern empire made a sojourn there precarious, Fabiola returned to Rome and died in her native city about A.D. 399. The Romans, remembering the solicitude she had displayed for them, attended her funeral in great numbers as a mark of the veneration in which they held her. Her feast day is Dec. 27.

See M. Adelaide Nutting and Lavinia Dock, *A History of Nursing* (1907); W. Smith (comp.), *Dictionary of Christian Biography* (1880).

FABIUS, the name of one of the oldest and most distinguished patrician families of Rome. Its members claimed descent from Hercules and a daughter of the Arcadian Evander. It was one of the two *gentes* ("clans") exclusively charged with the management of the ancient festival in Rome of the Lupercalia. The most important members of the family are the following:

QUINTUS FABIUS AMBUSTUS was one of three Fabii sent as ambassadors to the Gauls when they were besieging Clusium in 391 B.C. When they took part in a skirmish the Gauls demanded their surrender, but the Romans by way of reply elected them tribunes with consular power (*see* TRIBUNE) in the following year. The sequel was the march of the Gauls upon Rome, the battle of the Allia river and the capture of the city.

QUINTUS FABIUS MAXIMUS, surnamed RULLIANUS or RULLUS, master of the horse in the second Samnite War to Lucius Papirius Cursor, by whom according to Livy he was indicted for having fought the Samnites contrary to orders, in spite of the fact that he gained a victory (325 B.C.): he was saved from the capital penalty only by his father's appeal to the people (*provocatio ad populum*). In 315, when dictator, he was defeated by the Samnites at Lautulae. In 310 he defeated the Etruscans at Lake Vadimo. In 295, consul for the fifth time, he defeated at the great battle of Sentinum the combined forces of the Etruscans, Umbrians, Samnites and Gauls. As censor (304) he is said to have limited the freedmen and landless citizens to the four city tribes. Not all the details of his life as related by Livy can, however, be accepted.

QUINTUS FABIUS MAXIMUS, surnamed CUNCTATOR ("the delayer," from his delaying tactics in the war against Hannibal), grandson or great-grandson of the preceding. He served his first consulship in Liguria (233 B.C.), was censor (230) and consul for the second time (228). Either he, or more probably Marcus Fabius Buteo, who was *princeps senatus*, was sent in 218 to Carthage to demand satisfaction for the attack on Saguntum. After the disaster of Lake Trasimene, Fabius was elected dictator in 217 and began his strategy of attrition. Maneuvering among the hills where Hannibal's cavalry was useless, he cut off his supplies, harassed him incessantly and did everything except engage battle. His steady adherence to his plan caused dissatisfaction at Rome and a quarrel with Minucius Rufus, his master of the horse. The people then divided the command between Minucius and Fabius. True to his strategy of exhaustion, Fabius allowed Hannibal to ravage Campania, and he was even tricked into letting him slip back safely to Apulia. After the end of his dictatorship the Romans turned again to a strategy of annihilation, but this led to the disaster of Cannae (216). Fabian strategy was needed again; he was elected consul for a third and fourth time, for 215 and 214, when he operated in Campania. In his fifth consulship (209) he retook Tarentum, which Hannibal had held for three years. He strenuously opposed Scipio's plan to invade Africa, but in vain. He died in 203, having been both pontiff and augur. His strategy had given Rome time to recover; in the words of Ennius, *unus homo nobis cunctando restituit rem* ("one man by delaying restored our fortunes").

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QUINTUS FABIUS PICTOR, one of the first Roman prose historians, fought against the Gauls in 225 B.C. and was sent on a mission to the oracle at Delphi in 216 after Cannae. His *History*, now lost, which dealt with the history of Rome from the earliest times, was written in Greek, partly in order to justify Roman policy to the Greeks.

The fragments are published by F. Jacoby, *Fragmente der griechischen Historiker*, iii C, no. 809 (1958). For recent discussion and bibliography *see* A. Momigliano, "Linee per una valutazione di Fabio Pittore" in *Atti dell' Accademia Nazionale dei Lincei*, ccclvii, *Rendiconti*, pp. 310 ff. (1960).

QUINTUS FABIUS VIBULANUS, or one of his brothers Caeso and Marcus, held a consulship each year from 485 to 479. In the last year, when Caeso helped the plebeians, there was a reaction against the family; the Fabii thereupon are said to have migrated from Rome and settled on the banks of the Cremera river (mod. Fosso di Valchetta), a few miles north of Rome. For two years they held their position against the inhabitants of Veii, until they were surprised and annihilated (477). The essence of this story may well represent a historical episode, though it is not necessary to believe that 300 Fabii perished in the disaster and only one survived. This alleged sole survivor was Quintus, son of Marcus; he became consul in 467, 465 and 459 and a member of the second decemvirate (*see* DECEMVIRI) in 450. (H. H. Sd.)

FABLE, in its original, widest sense, a fictitious story or statement of any description (from the Latin *fabula*, "a thing said"). In the narrower, modern sense, with which this article is concerned, the term is synonymous with apologue and denotes a short narrative in prose or verse designed to convey a moral or a useful lesson. The characters are most often animals, but inanimate objects, human beings or gods may also appear. It has affinities with the parable (*q.v.*), but the latter normally deals with humans in a situation that might naturally occur and is usually on a higher ethical plane; fables, on the other hand, commonly depict a fantastic situation (*e.g.*, a mouse helping a lion) and teach a more worldly wisdom. Fables also have affinities with proverbs (*q.v.*), which are often virtually condensed fables, and many common proverbial phrases (*e.g.*, sour grapes, a dog in the manger, a wolf in sheep's clothing, to cry "Wolf!," never count your chickens before they are hatched) summarize well-known fables. The moral—"the soul of the fable," according to La Fontaine—may be stated separately at the beginning or end, or it may be implicit in the narrative.

The presence of a consciously derived moral serves to differen-

tiate the fable from many related forms, such as myths, legends, folk tales and the medieval French *fabliaux*. Myths are primarily explanatory stories devised to account for natural phenomena or the nature of divine beings or to give reasons for ritual customs whose real origin has been lost; legends contain a core of historical fact around which mythical elements have collected; folk or fairy tales, like the *fabliaux*, are usually told simply for entertainment and are innocent of moral. (*See* FABLIAU; FOLKLORE.)

Classical and Early Oriental Fables.—There are two main streams of fable—the Greek and the oriental. It is impossible to determine priority; undoubtedly there was mutual influence from very early times, for there were indirect contacts between Greece and India by trade routes long before the time of Alexander the Great. In the form in which they are now known the Greek fables are older, but this may be merely due to the accidents of transmission.

Although fablelike stories are to be found on Egyptian papyri, the earliest existing fable proper is perhaps that of the hawk and the nightingale in the *Works and Days* of Hesiod (*q.v.*; *c.* 8th century B.C.); somewhat later are the allusions to fables in the works of Archilochus and Solon. By the middle of the 5th century B.C. fables had become connected with the name of Aesop (*q.v.*), a semihistorical, semimythical character who is said by Herodotus to have been a deformed Phrygian slave living in the mid-6th century B.C. Once the tradition of Aesop as a composer of fables about animals started, all fables tended to be fathered on him. He is given an honoured place in Plato's *Republic*, Socrates is supposed to have versified some of the fables while in prison awaiting death, and there are allusions to him or his fables in the writings of Aristophanes, Aristotle, Sophocles, Xenophon and others. The *Fables of Aesop* as they are now known, however, are mainly derived from late medieval compilations. William Caxton's edition of 1484, for example, apparently comes via the French from Heinrich Steinhöwel's collection of *c.* 1480, which (in Latin with German translation) consists in part of the versions of Romulus (10th century) and Avianus (4th century); these in their turn go back to the collection in Greek verse of Babrius (*q.v.*) of the 2nd or 3rd century A.D. or that in Latin verse of Phaedrus (*q.v.*) dating from about A.D. 40, and behind these lies the lost work of Demetrius Phalereus of the 4th century B.C.

In the east the fable was early used as a vehicle of Buddhist instruction: some of the Jatakas (*q.v.*), or birth stories of the Buddha, which relate his experiences in previous animal incarnations, resemble Greek fables and are used to point a moral. These may date back to the 5th century B.C., though the written records are much later. The most important compilation is the *Panchatantra*, a Sanskrit collection of beast fables in five prose books with interspersed gnomic stanzas summing up the moral. The original is lost, but it has been transmitted (via a lost Pahlavi version) as the mid-8th-century Arabic *Kalilah wa Dimna*, or *Fables of Bidpai*. Kalilah and Dimna are two jackals, counselors to the lion king, and the work is a frame story containing numerous fables designed to teach political wisdom or cunning. From the Arabic, this was translated into many languages; perhaps the most influential version was that by John of Capua (*c.* 1270), the *Directorium Vitae Humanae*, translated from the Hebrew; this was the chief means by which oriental fables became current in Europe. The four-book *Hitopadesa*, circulating mostly in Bengal, is a virtually independent medieval treatment of the *Panchatantra* material. (*See* also BIDPAI, FABLES OF; SANSKRIT LITERATURE; *Fables and Narratives*.)

The main difference between the fables of Aesop and those of Bidpai is that in Aesop animals act as animals, whereas in the oriental stories they act as men in animal form and little regard is paid to their supposed animal characteristics.

Other ancient fables include some found in the *Book of Ahikar*, an Aramaic papyrus attributed to the 5th century B.C. (*see* AHIKAR, WISDOM OF); the fable of the trees in Judg. ix, 8–15; some 30 in the Talmud; and the story of the Town and Country Mouse and that of the Weasel as told by Horace.

Medieval and Modern Literature.—As the supremacy of Latin declined the fable took on a new life in the modern languages. The oldest and most famous of the many "Ysopets," or versions of Aesop, is that of Marie de France (*q.v.*) of the late 12th century; hers was based on an English original and consists of 103 fables, of which about a third are unknown in any previous form. In English, there is the fable of the fox in *The Owl and the Nightingale* (late 12th century), the episode of the belling of the cat in *Piers Plowman*, the mock-heroic *Nun's Priest's Tale* of Chaucer, and fables by John Lydgate (early 15th century). Many medieval preachers made use of fables as *exempla*, or illustrative anecdotes, and collections of these were published. The finest of early fabulists in Britain is the Scot Robert Henryson (*q.v.*), whose *Morall Fabillis of Esope* (late 15th century) includes some for which no original is known. Henryson's work is re-creation rather than translation; his mixture of pathos and humour, his vivid presentation of homely detail and the racy vigour of his verse make these some of the best fables ever told. Later, fables are found in the works of various 16th-century humanists, such as Clément Marot, François Rabelais, Gilles Corrozet, Guillaume Haudent and Hans Sachs.

Some of the medieval tales can be ultimately traced to the great beast epic, Reynard the Fox (*q.v.*), which probably appeared first in Latin as a parody of the chivalric epic and exists in many versions, notably the French *Roman de Renart* and the German *Reinhart Fuchs*. These beast epics differ from fables proper in that the moral recedes into the background; they are actually long connected narratives with fable material used as episodes, the whole being mainly a satire on the upper classes and clergy. A modern form of beast epic is Joel Chandler Harris' *Uncle Remus* (1880), in which many of the episodes derive from beast tales brought to the United States from Africa by Negro slaves. (*See* also FRENCH LITERATURE: *Fabliaux; Roman de Renart*.)

The greatest of later fabulists is Jean de la Fontaine (*q.v.*), whose *Fables choisies* in 12 books appeared between 1668 and 1694. The first books are mainly adaptations of Aesop, via Phaedrus, but the later ones contain, in addition, versions of oriental fables. La Fontaine may have known the Latin collection *Speculum Sapientiae Indorum Veterum* (1666), but his eastern tales are mainly from *Le Livre des lumières* (1644), an abridged translation of a Persian form of Bidpai. La Fontaine is a fine poet with a Chaucerian quality of unpretentiousness, pervasive humour and sympathy with the creatures about which he writes. He described his fables as "a comedy in a hundred acts" and "a picture in which each one of us may find his own portrait"; "I use the Animals to teach Mankind." He had many successors in the 18th century, though none of comparable genius: in France the most distinguished is Jean Pierre de Florian, in Spain Tomás de Iriarte, in Italy L. Pignotti, G. C. Passeroni and A. Giorgi-Bertola, all of the late 18th century, and "L. Clasio" (L. Fiacchi) in the early 19th. In England, a notable collection was that of Sir Roger L'Estrange (*q.v.*), containing some 500 fables in prose, often with a political slant, which began to appear in 1692. John Gay's *Fables* (1727–38) have some charm, but Johnson's complaint that from some of them "it will be difficult to extract any moral principle" is just. Of other English 18th-century poets, Matthew Prior wrote a few fables, Christopher Smart 19, William Cowper 9; Swift tells a fable of a spider and a bee in *The Battle of the Books* (published with *A Tale of a Tub*, 1704); and a notable extended fable is *The Fable of the Bees* (1714), a political allegory by Bernard de Mandeville (*q.v.*). Many occasional fables were produced in pamphlet form as political satires, and there are numerous collections such as *Fables for the Female Sex* (1744) and *Fables for Youth* (1777).

The *Fabeln* (1759) of Gotthold Ephraim Lessing (*q.v.*), with his important introductory monograph, represent a protest against what he felt to be the overliterary type introduced by the imitators of La Fontaine. His ideal fable is that of Aesop, and he rejects all later elaborations and refinements from Phaedrus onward as perversions; he is unwilling for the fable to be used, as his contemporary Christian Gellert (*q.v.*) had used it, as a vehicle for lively railings against women and the follies of the day. Lessing's own fables are marked by his humanitarianism and common sense, but he is not a poet as La Fontaine was, and he lacks

his humour and lightness of touch.

These qualities are, however, found in the greatest of 19th-century fabulists, the Russian Ivan Krylov (*q.v.*). He began with some distinctively individual and Russian versions of La Fontaine and Aesop, but practically all the later fables are his own. He used the form as a means of protest against the rigid police rule and censorship and presents both universal types and a realistic gallery of the Russians of his day with the peasant as his hero. (*See* also RUSSIAN LITERATURE: *Old Russian Literature (988–1703)*.

The fable continued as a literary form: Rudyard Kipling's *Jungle Book* (1894) and *Just So Stories* (1902) are analogous to the fable in some ways; the dialect *Favole romanesche* (1900) of Trilussa (C. A. Salustri) are true fables, as are James Thurber's *Fables for Our Time* (1940); George Orwell's *Animal Farm* (1945), though subtitled "a fairy story," is a kind of extended fable; and fresh currency has been given to the fable through the medium of the cartoon film, notably by Walt Disney (*q.v.*).

See also references under "Fable" in the Index volume.

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FABLIAU, the name now given to about 150 medieval French narrative poems written (with two exceptions: *Richeut* and *Baillet*) in octosyllabic rhymed couplets. The word was formed in Old French from the noun *fable;* the form of its suffix associates it with northern and northeastern France. It is only one of several variants (*fablel, flabel,* etc.) used by medieval writers and has been generally adopted by modern scholars and critics since the 18th century.

The genre was not clearly defined in the middle ages. Sixty or so fabliaux were so called by their authors, but on the one hand the name was used for poems which are clearly something different, *e.g.*, animal fables or allegories, and on the other hand a variety of terms, *conte, dit, fable,* etc., were applied to fabliaux as now defined. The fabliaux certainly had affinities with a number of contemporary genres; on the classification of some there is still room for disagreement. Most of these tales are relatively short; there are extremes of less than 20 and more than 1,300 lines, but the typical length is between 200 and 400 lines. A fabliau is essentially a narrative, often written with a fair amount of vivid detail and realist observation, to entertain and to arouse laughter. The basis of some is an extremely simple situation which could have been mirrored in real life, as in the case of the boatman who rescues a man from drowning but unfortunately puts out his eye with his boat hook, or in many cases of the eternal triangle. Other stories have a less prosaic setting, as in the tale of St. Peter winning at dice all the souls in hell from the jongleur who has been left in charge of them. Others again are based on mere puns, *e.g., Estula,* which is either a name or the phrase "Are you there?" Some of the merriment provoked by many fabliaux depends on situations and adventures which are either indecorous or frankly obscene. About three-quarters of the fabliaux could be described as erotic, using this word in its broadest sense. Many of the frequently recurring characters, the rustic, the jealous husband, the wanton wife, the naughty priest and the successful or unsuccessful lover, are obvious types, but some fabliaux are more ambitious in their presentation, *Le Boucher d'Abbeville* and *Constant du Hamel* for example.

In the majority of cases the humour and amusement for the original hearers and the interest for the modern reader lie deeper than the reaction to the plot, the situation, the characters or the words. These stories, sometimes even the coarsest of them, contain a substantial element of burlesque, or parody or mockery; they make fun of priests, bourgeois and rustics in circumstances which depend for their appreciation on a knowledge of courtly love and courtly manners and on a scorn for those of baser metal who try to ape their betters or who are fundamentally incapable of rising to any such heights. The characters mocked are never the nobles and the stories themselves are not simply anticourtly.

If this is accepted, the once widely held opinion that the fabliaux are the literature of the bourgeois and the common people collapses. It was already difficult to defend in view of the literary company in which the fabliaux were placed in the manuscripts which have preserved them. Also, if they are thus closely linked with courtly society, they must have originated after the courtly romances, and there is no need to search for remote origins and to postulate the existence of many lost fabliaux before the earliest extant one, *Richeut* (*c.* 1175), and this in any event is far from typical, being rather a study of manners than a compact narrative. Of the wide range of subject matter more or less rigorously adapted to the tone and taste of the new genre some can be paralleled in other times and countries. Some have classical affinities, *e.g.*, the Widow of Ephesus, others resemble oriental apologues. Similarities with the French fable may be more than coincidental. The presence in both fable (*q.v.*) and fabliau of a moral or a moralizing epilogue is especially interesting.

The main period of fabliau production is the 13th century, with extensions to the last quarter of the 12th and the first half of the 14th. The manuscripts which preserve them were all written in the 13th and 14th centuries.

The names of 21 authors of fabliaux, responsible between them for 50 tales, are known. The most celebrated are the professionals Jehan Bodel, Rutebeuf (*qq.v.*) and Jean de Condé, and there are talented amateurs such as Henri d'Andeli and Philippe de Remi Beaumanoir (*q.v.*).

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FABRE, FERDINAND (1827–1898), French novelist who may be said to have founded the French regional novel with his studies of country life that seem to spring from the very soil of the Cévennes, was born at Bédarieux, Hérault, June 9, 1827. Brought up by his uncle, a country curé, he was sent to the seminary of St. Pons but, having no vocation, he began to write poems and went to Paris, where his *Feuilles de lierre* (1853) attracted attention. Illness sent him back to the country, where he wrote *Les Courbezon* (1862), describing the life of a country priest in the Cévennes. Of a score of similar novels—including *Julien Savignac* and *Mdlle de Malavielle* (1863); *Le Chevrier* and *Scènes de la vie rustique* (1868); *Barnabé* (1874); *Mon oncle Célestin* (1881); and *Lucifer* (1884)—the masterpiece is *L'Abbé Tigrane* (1873), which tells the story of an ambitious priest, who intrigues his way to a cardinalate, with such dispassionate realism that it was attacked both by the church and by anticlericals. Fabre was appointed keeper of the Bibliothèque Mazarine in 1883 and died in Paris, Feb. 11, 1898. (R. DL.)

FABRE, JEAN HENRI (1823–1915), French entomologist noted for his beautifully written essays on insect natural history, was born at St. Léons in Aveyron on Dec. 21, 1823. He taught successively at Carpentras, at the college of Ajaccio, Corsica, and in 1852 at the *lycée* of Avignon. Meanwhile he had taken his doctor's degree in Paris, devoting himself to the study of the life history, habits and instincts of insects, his sole occupation after his retirement to Sérignan in 1871.

All his work was based on direct observation. Although the ways of all insects interested him, his attention was given chiefly to the Hymenoptera, Coleoptera and Orthoptera, as well as to spiders. Of the first, the wasps, with their skill in stinging their prey in the region of the nervous ganglia so as to paralyze it and preserve it living as food for their young, seemed to Fabre to show an intelligence irreconcilable with the theory of fixed habits. Other researches led him to oppose the theory of evolution. His observations and deductions concerning the relation between the animal and the human mind, and between entomology and agriculture, are

detailed in *Annales des sciences naturelles* (1855–58) and in the 10 volumes of *Souvenirs entomologiques* (1879–1907; Eng. trans. by De Mattos, 1912 *et seq.*), which was crowned by the Institute of France. He was a member of many academies and scientific societies.

Fabre died at Sérignan, Provence, on Oct. 11, 1915.

See A. Fabre, *Jean-Henri Fabre* (Eng. trans., 1921); C. V. Legros, *Fabre, Poet of Science* (Eng. trans., 1913); and P. F. Bicknell, *The Human Side of Fabre* (1923).

FABRE D'ÉGLANTINE, PHILIPPE FRANÇOIS NAZAIRE (1750–1794), French dramatist and a prominent figure in the Revolution, was born at Carcassonne in July 1750, the son of a draper. He added to his surname Fabre the appellation "d'Églantine," claiming without justification that he had won a golden eglantine in a literary competition organized by the academy of floral games at Toulouse. After publishing a poem, *L'Étude de la nature* (1783), dedicated to Buffon, he wrote a large number of comedies, the most celebrated being *Le Philinte de Molière* (1790), a self-styled sequel to Molière's *Le Misanthrope*, showing Philinte as a politically dangerous aristocrat and Alceste as a virtuous republican. Fabre's best-known work is the famous song, "Il pleut, il pleut, bergère." He was an energetic revolutionary, a close associate of Danton and Camille Desmoulins, a deputy in the National Convention and a member of the committee of public safety. He voted for the execution of Louis XVI, supporting his opinion with quotations from Rousseau. In spite of his meagre astronomical competence, he was *rapporteur* of the committee which drew up the republican calendar and was personally responsible for some of the nomenclature. Arrested on a charge of forgery in connection with the Compagnie des Indes, he was sentenced to death and guillotined on April 6, 1794. Opinion about his innocence has remained divided, but modern judgment denies it.

Bibliography.—His *Oeuvres [dramatiques] choisies* were edited by C. Nodier and P. Lepeintre (1824). His *Oeuvres politiques* were edited by C. Vellay (1914). *See* also C. Lenient, *La Comédie en France au XVIIIe siècle* (1888); H. d'Alméras, *Fabre d'Églantine* (1905); A. Mathiez, *Un Procès de corruption sous la Terreur. L'Affaire de la Compagnie des Indes* (1920); J. M. Thompson, *Leaders of the French Revolution* (1929); L. Jacob, *Fabre d'Églantine* (1946). (Rt. S.)

FABRIANO, GENTILE DA: *see* Gentile da Fabriano.

FABRICIUS, GAIUS (surnamed Luscinus) (3rd century B.C.), Roman general during the war with Pyrrhus, king of Epirus (*q.v.*), renowned for his incorruptibility. He settled in Rome from Aletrium in Latium. In *c.* 285 B.C. he negotiated with the people of Tarentum. In 282, when consul, he saved Thurii from the Lucanians and Bruttians. After the defeat of the Romans by Pyrrhus at Heraclea (280) he was sent to treat for the ransom and exchange of prisoners. His incorruptibility so impressed Pyrrhus that the king released the prisoners without ransom. In 278 Fabricius, again consul, negotiated terms with Pyrrhus, who left for Sicily. Fabricius afterward gained a series of victories over Samnites, Lucanians and Bruttians. He is said to have died poor and, like Manius Curius Dentatus, was regarded as an example of the early Roman virtues. (H. H. Sd.)

FABRICIUS, JOHANN ALBERT (1668–1736), German classical scholar and the greatest of 18th-century bibliographers, was born on Nov. 11, 1668, at Leipzig. In 1689, after two years at the University of Leipzig, he graduated as master of philosophy and published anonymously his *Decas decadum, Sive plagiariorum et pseudonymorum centuria*, a survey of 100 writers accused of plagiarism or literary mystification; the year before he had published, also anonymously, his *Scriptorum recentiorum decas*, a criticism of ten contemporary scholars. In 1694 he became librarian in Hamburg to J. F. Mayer, an antipietist theologian, and from 1699 until his death on April 30, 1736, he taught at the gymnasium there as professor of ethics and rhetoric.

Though he produced editions of Dio Cassius (completed by his son-in-law, H. S. Reimar, 1750–52) and Sextus Empiricus (1718) and a collection of biblical apocrypha, Fabricius is remembered primarily as a bibliographer. He began by compiling a *Bibliotheca Latina* (1697; revised by J. A. Ernesti, 1773–74), of which the first three books discuss the principal classical authors from Plautus to Jordanes. Brief biographies are followed by notes on extant and lost works, editions and translations. The fourth book deals with early Christian writings, minor historians and treatises on language, rhetoric, law and medicine. But Fabricius' masterpiece is his *Bibliotheca Graeca* (1705–28; revised by G. C. Harles, 1790–1812), which extends from pre-Homeric times to 1453. Individual authors receive fuller treatment than in the Latin work. There are, for example, accounts of the Homeric *scholia* and Homer's ancient and Byzantine critics and imitators. Each volume contains in its appendixes some works there printed for the first time; these include the grammar of Dionysius Thrax, Porphyry's life of Plotinus and speeches by Libanius. He also produced a *Bibliotheca antiquaria* (1713), which surveys writings on Hebrew, classical and Christian antiquities, the *Centifolium Lutheranum* (1728–30), an account of 200 writers on the Reformation, and finally the *Bibliotheca Latina mediae et infimae aetatis* (1734–36; supplementary volume by C. Schottgen, 1746, ed. by J. D. Mansi, 1754), which provided a foundation for the new study of medieval Latin. Few men have done more to bring order into the world of learning.

See H. S. Reimar, *De vita et scriptis J. A. Fabricii commentarius* (1737); J. E. Sandys, *History of Classical Scholarship*, vol. iii (1908). (R. R. Bo.)

FABRICIUS, JOHANN CHRISTIAN (1745–1808), Danish entomologist and economist, whose scientific reputation rested upon the system of insect classification that he founded, based upon the structure of the organs of the mouth instead of the wings. He was born at Tondern, Jan. 7, 1745. He studied at Altona and Copenhagen and at Uppsala under Linnaeus. In 1769 he lectured on political economy and in 1775 was appointed professor of natural history, economy and finance at Kiel. But it is as an entomologist that his memory survives. Fabricius died March 3, 1808.

FABRICIUS AB AQUAPENDENTE, HIERONYMUS (Geronimo or Girolamo Fabrizio or Fabrici) (1537–1619), Italian anatomist and embryologist, one of the founders of modern embryology, studied at Padua, where he succeeded his master, Gabriel Fallopius, as teacher of anatomy and surgery, on the latter's death in 1562. Fabricius' studies of the effect of ligatures and the valves in the veins influenced the discoveries of his famous pupil, William Harvey. Fabricius was greatest as a teacher; he failed to follow his own discoveries to their logical conclusion. He died at Padua on May 21, 1619.

Fabricius' collected works were published at Leipzig in 1687 as *Opera omnia Anatomica et Physiologica*, but the Leiden edition, published by Albinus in 1738, is more complete.

FABRITIUS, CAREL (1624?–1654), Dutch painter whose few surviving works reveal an artist of great power. The date and place of his birth are unknown. From a description of Delft dated 1667, stating that he was killed in an explosion at Delft on Oct. 12, 1654, at about 30 years of age, it is inferred that he was born about 1624. He was a pupil of Rembrandt and appears as a serious and cultivated artist in the conversation on art of Rembrandt's pupils as reported by S. D. van Hoogstraten. In 1652 he entered the painters' guild in Delft.

He was a master of the first rank, an independent spirit who did not lose his own individuality while studying under the great Rembrandt. He seems to have first established a reputation in painting mural decorations with views of architecture in perspective. But of these works nothing remains.

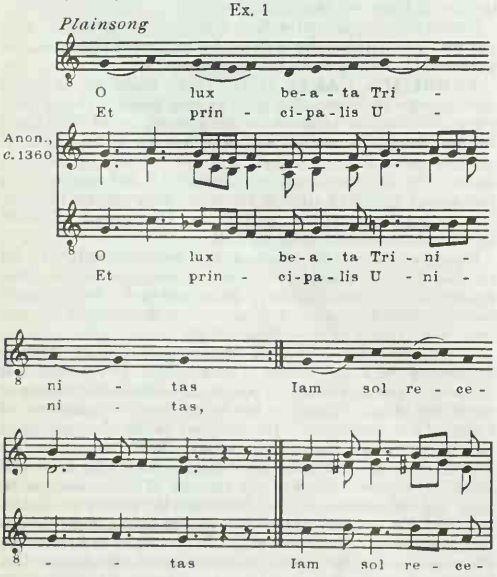
The earliest extant work is the half-length portrait of Abraham de Notte in the Rijks museum at Amsterdam. Dated 1640, it is the work of a mature artist. A portrait of a man in the museum at Rotterdam was attributed to Rembrandt until the signature of Fabritius was discovered. The National gallery, London, has a splendid half-length portrait of a soldier. In the same collection is the picture of "A Musical Instrument Dealer With a View of Delft." The museum at Schwerin contains "The Sentinel," dated 1654, and the Ferdinandeum at Innsbruck the picture of "Tobias and His Wife." In the Mauritshuis at The Hague is the famous "Goldfinch," signed and dated 1654. In distinction to Rembrandt, whose figures emerge modeled by the action of light from a dark background, the figures of Fabritius are silhouetted against a light

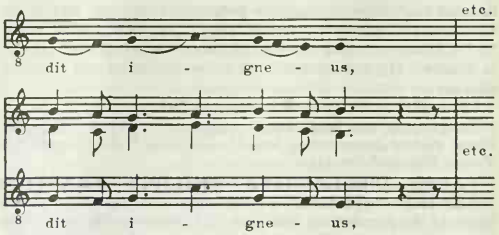
background, a scheme which was adopted and developed by Fabritius' pupil, Jan Vermeer.

FABRIZI, NICOLA (1804–1885), Italian patriot of the Risorgimento, was born at Modena on April 4, 1804. He took part in the Modena insurrection of 1831 and attempted to succour Ancona, but was arrested at sea and taken to Venice. Freed in 1832, he went to Marseilles, where he joined Giuseppe Mazzini (*q.v.*), with whom, in 1834, he launched the ill-fated Savoy expedition. Taking refuge in Spain, Fabrizi fought against the Carlists. At the end of the Carlist war he established a centre of conspiracy at Malta, tried to dissuade Mazzini from favouring the plans of the Bandiera brothers, but helped Francesco Crispi to organize the Sicilian revolution of 1848. He took part in the defense of Venice and of San Pancrazio in Rome. On the fall of Rome (June 1849) he returned to Malta. In 1859 he worked with Crispi to prepare the Sicilian revolution and sent arms and stores to the island. On June 2, 1860, while Garibaldi was sailing from Genoa toward Marsala, Fabrizi landed at Pozzallo. After severe fighting, he joined Garibaldi at Palermo. Under the Garibaldian dictatorship he was appointed governor of Messina and minister of war. Returning to Malta after the Neapolitan plebiscite, which he had vainly tried to postpone, he was recalled to help Enrico Cialdini to suppress brigandage. On his way to Sicily in 1862, to induce Garibaldi to give up the march on Rome, he was arrested at Naples by A. Ferrero La Marmora. During the war of 1866 he became Garibaldi's chief of staff; in 1867 he fought at Mentana. In the Italian parliament he sought to promote agreement between the chiefs of the left and, from 1878, worked to secure Crispi's return to power. He died on March 31, 1885.

FABURDEN was a musical term used in the 15th and 16th centuries for a method of improvising in two or three parts upon a plainsong. It occurs in England *c.* 1430 in a letter recommending a singer who is said to be "of connyng sufficiante . . . te synge a tribull til faburdun." At about the same time the term *fauxbourdon* appeared on the continent in compositions by G. Dufay and others. While the origins of the term—English or French—remain in dispute, there seems no doubt that the origins of the practice were English. There are many English pieces of the 14th century that use the parallel movement characteristic of faburden. Most are free compositions but a few are based on plainsong, as in the following example:

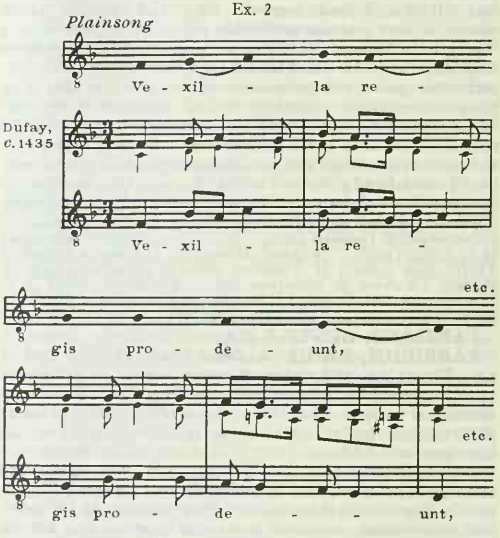
Ex. 1





It will be seen that at this stage the parts could move either in parallel fifths or parallel sixths. In the 15th-century form of this technique the upper parts moved in parallel fourths following the melodic line of the plainsong, while the lowest part, the faburden, sang an octave below the treble (a fifth below the middle part) at the beginning and end of each phrase and occasionally at other points, and elsewhere sang a series of sixths below the treble (thirds below the middle part):

Ex. 2



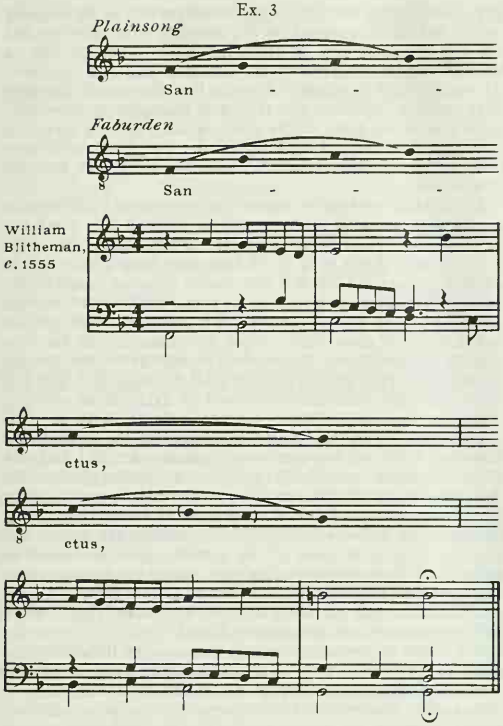
It was customary on the continent to write down only the outer parts of the *fauxbourdon*, as in this case, the middle part being sung at sight in fourths below the treble.

From about 1460 English composers used the faburden not only for simple polyphonic treatment of such chants as hymns, processional psalms and litanies but also as the basis for the composition of these and other liturgical forms in more elaborate ways. The faburdens of the *Magnificat* tones, for example, were paraphrased and extended by ornamentation to serve as the tenor of large-scale settings for four or more voices. Similarly, in the 16th century, settings for organ of hymns and the *Te Deum* were often composed by writing contrapuntal figuration on the faburden, which could be put in any part of the texture (*see* Ex. 3).

Such treatments of the faburden as a separate entity were a specifically English development.

In Italy and Spain a different method, called *falsobordone*, was adopted; it consisted of applying chordal polyphony for four or more voices to simple chants. Examples of this, which consisted essentially of chords in root position over a functional bass, may be found in the work of Tomás de Victoria, L. G. Viadana and many other church composers of the 16th and early 17th centuries. Though some printed sets of *falsibordoni* were rather elaborate, the simpler style continued in use. It is well exemplified in the

Ex. 3



Improperia ("Reproaches" for Good Friday) by Palestrina and Victoria. (F. L. Ha.)

FABYAN, ROBERT (d. 1513), English chronicler, author of *The newe Cronycles of Englande and of Fraunce*. He lived in London, was a member of the Drapers' company and served as sheriff (1493–94) and alderman (1497–1502). He died on Feb. 28, 1513. Fabyan's chronicle, ending with the reign of Richard III, was first published by Richard Pynson in 1516. The second edition was printed by William Rastell in 1533 with continuations to 1509; a third edition appeared in 1542 and a fourth, with further additions, in 1559. The only modern edition is that of Sir Henry Ellis (1811), which has an informative introduction.

Fabyan's merits are little more than those of an industrious compiler. His principal service lies in having published information which through Edward Hall and Raphael Holinshed (*qq.v.*) has become the common property of later historians.

See C. L. Kingsford, *Chronicles of London*, pp. xxvi-xxxii (1905) and *English Historical Literature in the Fifteenth Century*, pp. 103–106 (1913). (N. D.)

FACCIOLATI, JACOPO (1682–1769), Italian philologist, was born at Torriglia, near Padua, on Jan. 4, 1682. As professor of logic and regent of the schools, Facciolati was for 45 years the outstanding teacher of the seminary of Padua. He died at Padua on Aug. 26, 1769. His magnum opus is the *Totius Latinitatis Lexicon* (4 vol., 1771; rev. ed. by De Vit, 1858–87). In the compilation of this work the chief burden seems to have been borne by Facciolati's pupil Egidio Forcellini. It has been said that the whole body of Latinity, if it were to perish, might be restored from this lexicon. In 1808 a volume containing nine of Facciolati's *Epistles* was issued at Padua.

FACE, a term anatomically denoting the front part of the head, which, in the higher animals with backbones (vertebrates), houses the sense organs of vision and smell as well as the mouth and jaws.

During evolution from prehuman, apelike forms to modern man (*Homo sapiens*), the face became smaller in relation to the over-all size of the head. While brain and brain case (cranium) nearly doubled in volume, the jaws became shorter and the teeth simpler in form and smaller in size. In consequence the face receded beneath the forehead. Thus modern man exhibits an essentially vertical profile, in marked contrast to the protruding snout or facial muzzle of the gorilla, the chimpanzee and, to a lesser extent, such extinct forms of early man as Java and Peking man. The recession of the tooth-bearing portion of the jaws beneath the forehead left two distinctively human features: a prominent, projecting nose and a clearly defined chin.

The reduction in size of the face is usually attributed to the development of intelligence, which made possible the making and use of tools and weapons that, in turn, eliminated any advantage from the possession of large, tusklike teeth; and also to the acquiring of erect posture, which favoured forms with smaller, less protruding faces, since in these forms the head is more easily balanced on the vertical spine.

The facial features characteristic of the major physical groupings of mankind (Caucasoid, Mongoloid, Negroid) resulted from the same evolutionary processes responsible for creating racial differences generally within the species.

Typically, the Caucasoid face is long, with width ranging from narrow to medium broad; the nose is prominent, the bridge high; the lips are thin; facial hair in the male is abundant; and the contour of the profile ranges from straight to convex. The Mongoloid face tends to be moderately long and very broad, with prominent cheekbones and a wide jaw; the nose is moderately wide, the bridge low; the inner corner of the eye is covered by a skin fold (epicanthus); facial hair is sparse; the contour of the profile tends to be flat and straight. The Negroid face tends to be short and narrow; the nose broad, the bridge low; the lips are thick; facial hair is sparse; and the jaws protrude, creating a forward- and upward-slanting profile.

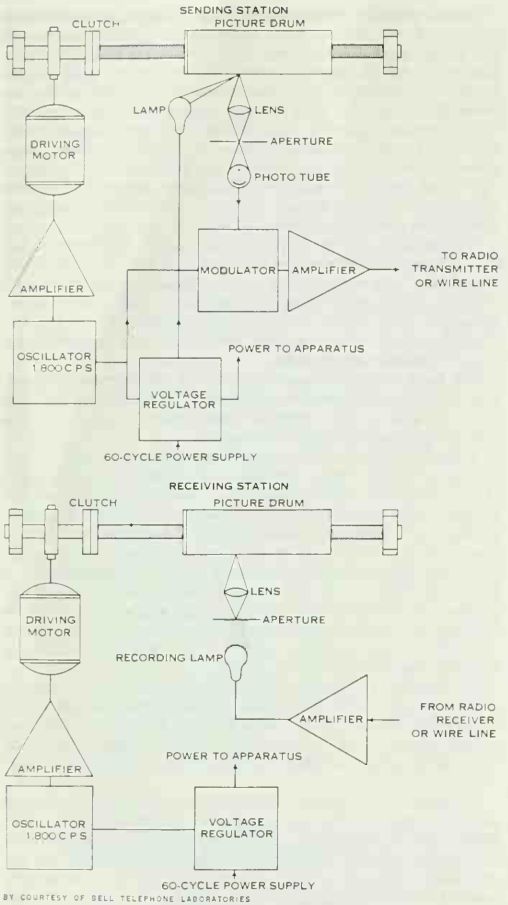
Facial traits are not exclusive to any one grouping; for example, some Caucasians have wider noses than some Negroes. In evolutionary advancement, each major grouping possesses "primitive" as well as "advanced" traits. Thus the protruding jaws of the Negro are a "primitive" trait, the thick everted lips an "advanced" trait.

In individual development, face and brain case follow different patterns of growth. The brain and brain case attain 90% of adult size by the age of six years, while the face grows more slowly in concurrence with the enlargement of the nasal passages and the eruption of both sets of teeth. Viewed in profile, the face at birth is less than one-fifth the size of the brain case; by adulthood it has increased to nearly one-half. Facial dimensions increase most in depth, next in height (length) and least in width. The more sturdy appearance of the male face, as compared with the delicate features of the female face, is produced by the greater development of facial musculature and the enlargement of the facial sinuses in adolescence.

A research technique widely adopted after 1931, consisting of the use of serial X-ray pictures of the living subject, permits a more exact investigation of facial growth changes than was possible with earlier caliper measurements. With this technique, measurements of different facial dimensions can be taken directly from the X-ray film and compared at several stages of development. Data bearing on facial growth in man have been gathered also through investigations of bone growth in animals. In such studies normal growth may be interfered with surgically, or dyes may be injected to stain the living bone to show areas and extent of growth. Corrective measures used in facial deformities are dealt with in Head and Neck, Surgery of; Plastic Surgery.

See also Physiognomy; Skull; Races of Mankind. (M. J. Br.)

FACSIMILE TRANSMISSION, the electrical transmission of pictures, maps and other printed matter, dates from the work of Alexander Bain, who outlined the principles in a British patent in 1843. Arthur Korn in Germany and Edouard Belin in France were outstanding European contributors, while in the



BY COURTESY OF BELL TELEPHONE LABORATORIES

FIG. 1.—TELEPHOTOGRAPH OR FACSIMILE TRANSMISSION SYSTEM

United States major advances were made by Maurice Artzt, Austin G. Cooley, John V. L. Hogan, Pierre Mertz, Raleigh J. Wise, Charles J. Young and many others.

Many different equipment designs have been proposed, but practically all are based on the scanning of the original copy, one elemental area at a time, and representing the shade or tone of each area by a specified amount of electric current; this current then is used at the receiver to reproduce an image of the elemental area in the proper relative position and the correct shade of gray. The original is scanned by optical means, but recording may be accomplished by exposure of light-sensitive film, by electrothermal methods, by electrolytic action or through the use of carbon paper.

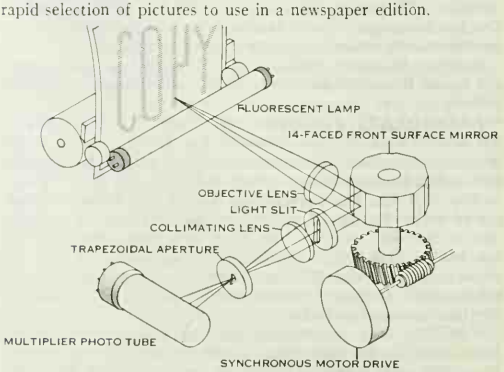
Fig. 1 is a block diagram of a telephotograph system typical of those used for transmission of news photographs. The original photograph is placed on the sending picture drum and unexposed photographic film on the receiving drum. Both drums are rotated at a very constant speed controlled by oscillators, and their rotation is synchronized or phased; that is, the edges of the film pass the recording position at the same time the edges of the original photo pass the scanning position. The lens and aperture combined with the rotational and axial movement of the sending drum dissect the picture into small elemental areas which are scanned one at a time. The photo tube converts the varying amounts of reflected light into corresponding electrical signals which are sent to the receiving station and there converted by the recording lamp, aperture and lens into a spot of light of proper intensity. Thus the film on the receiving drum is exposed, one elemental area at a time, until the whole picture is recorded. For wire line transmission a sending filter and delay equalizer give the signal the optimum wave form while a receiving filter blocks some of the incoming unwanted noise to reduce distortion in the signal. For transmission over radio circuits, frequency-modulation (FM) techniques are used (*see* RADIO).

A significant advance in transmitting photographs and detailed graphic data was achieved by employing Polaroid film, which can be developed without the use of darkroom equipment. The scanning method is shown in fig. 2. A fluorescent lamp illuminates the original picture, and the lens and mirror focus an image of the original on the aperture plate. As the mirror rotates, one elemental area after another of one scanning line is presented to the aperture and then to the photo tube. When one complete line has been scanned, the next face of the mirror is in position to start scanning the next line, the original copy having advanced by the height of a line. The same technique can be used for facsimile recording.

Another form of continuous scanner is shown in fig. 3. This is an exploded view; in reality, the image of the original, the coarse spiral, slit and fine spiral are as close as practical. An image of the original is focused (fig. 3[A]) on a scanning plane where the intersections of the transparent slit and five transparent turns of the fine spiral form five apertures as shown in fig. 3(B). However, the coarse scanning disk, containing one transparent spiral, is actually in front of the scanning plane, as shown in fig. 3(C), and the image reaches only one of the five apertures. The use of the fine spiral instead of a single-turn spiral improves scanning detail and minimizes a defect known as "jitter" which tends to make straight lines appear jagged.

In addition to photographic facsimile recorders, there is a large group of direct recorders, so named because a visible copy is produced during the recording process without need for subsequent photographic developing. Electrothermal, electrolytic or pigment transfer methods are usually used. The electrothermal process consists in the burning away of a white surface of a special recording paper, exposing a black subsurface, as current is passed through the paper. This type of facsimile recorder is used for transmission of telegrams, railroad ticket reservations and weather charts.

Electrolytic recorders depend upon chemical change as current is passed through an electrolyte impregnated in the recording paper. This change may utilize the metal of the electrode or may use chemicals entirely within the electrolyte. A helix wire wrapped around a drum in front of the paper and a straightedge behind the paper provide a traveling intersection of electrodes as the drum revolves. This type of recorder is often used as a monitor, enabling newspaper editors at their desks to view photos that are being received simultaneously in the darkrooms and to make a rapid selection of pictures to use in a newspaper edition.



BY COURTESY OF TIMES FACSIMILE CORP

FIG. 2.—FACSIMILE SCANNER OF THE ROTARY-MIRROR TYPE

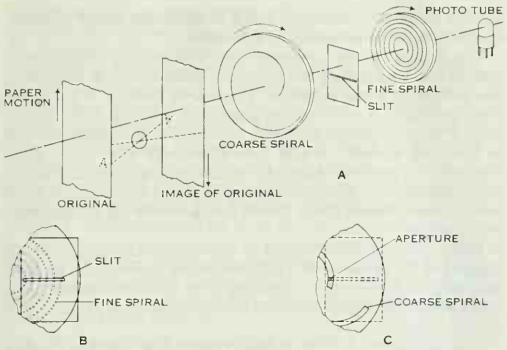


FIG. 3.—CONTINUOUS-FEED SCANNER SHOWING (A) EXPLODED VIEW; (B) DETAIL OF SLIT AND FINE SPIRAL WITH COARSE SPIRAL REMOVED; (C) DETAIL OF APERTURE FORMED BY INTERSECTION OF COARSE SPIRAL AND SLIT

Carbon-paper recorders may be thought of as utilizing pigment transfer. Until the middle 1940s such recorders were extremely difficult to adjust and recording speed was slow. However, an improved system was developed using three recording heads mounted on a continuous belt.* Carbon paper and ordinary paper feed from rolls, and marking takes place when the recording stylus applies pressure to the carbon paper.

Facsimile machines have been made which transmit a letter-size page in a fraction of a second. The operating speed for most facsimile equipment, however, is limited by the electrical characteristics of the circuit used for transmission. In most cases this is equivalent in signal-carrying capacity to a voice circuit but is specially designed to transmit a signal with minimum distortion. A typical picture machine operating over such a circuit might have the following characteristics: 96 scanning lines per inch, a rectangular elemental scanning area $\frac{1}{96} \times \frac{1}{128}$ in., 90 scanning lines per minute, copy size $8\frac{1}{2} \times 7$ in., transmission time about $7\frac{1}{2}$ min.

(H. F. B.)

FACTA, LUIGI (1861–1930), Italian statesman, the last prime minister before Mussolini's era, was born at Pinerolo in Piedmont on Sept. 16, 1861. After studying law at the University of Turin, he became a journalist. Taking up politics under Giovanni Giolitti's guidance, he was elected deputy in 1891. From Nov. 1903 to March 1905 he served in the second Giolitti cabinet as undersecretary of state, first for justice, then for the interior. He was minister of finance in Luigi Luzzatti's cabinet (March 1910–March 1911) and in Giolitti's fourth cabinet (March 1911–March 1914).

Having been minister of justice under V. E. Orlando (Jan.–June 1919), Facta became prime minister on Feb. 25, 1922. Defeated in parliament on July 19, he reformed his government on Aug. 1 because no other statesman wanted power in the critical situation created by industrial unrest, Communist agitation and the mounting wave of fascism. On Oct. 28 he proclaimed a state of siege and ordered the army to defend the constitutional government, but the king, Victor Emmanuel III, refused to sign the necessary decree. Facta resigned and on Oct. 30 Mussolini assumed power. Facta was made senator in Sept. 1924. He died in Rome on Nov. 5, 1930.

FACTOR, a business organization rendering specialized financial, credit, collection and bookkeeping services to manufacturers and distributors of merchandise. Prior to the beginning of the 20th century the word "factor" in Europe and in the United States designated a type of general business agent, but the term has since been used primarily to describe the relatively small but very important group of commercial and financial organizations centred in New York city whose business is known as factoring. The agent who formerly carried out all the functions of the old-fashioned factor no longer exists. His closest modern counterpart is the commission merchant, commercial representative or broker (*q.v.*), but it should be noted that they do not perform all the services that the original factor rendered, nor do they hold themselves out to the business world as factors. Although there is little resemblance between the manner in which factoring is conducted today and the activities of the factor in former years, an important link with the past nevertheless exists.

History.—The time when the word factor was first used is not known, but there are references to factors in William Caxton's *Lyf of Charles The Grete* (1485) and in Shakespeare. In Scotland an estate agent is sometimes referred to as a factor, the solitary survival of one of the original meanings of the word. The London agents with whom the Pilgrims contracted for the sale of the furs, fish and timber they expected to ship from the new world to England were referred to in the agreement as "agents and factors." The original factor was an agent who occupied a position of considerable trust and confidence, performing in part the broad functions of a merchant dealing with goods in his own name rather than merely obeying specific instructions of a principal, as would be the case with an ordinary agent or broker. His services were of particular value in foreign trade, where communications were slow and the assistance of a reliable agent in foreign ports was essential to the success of any commercial undertaking. For this reason, factors became important in the great period of colonial exploration and development.

It was the function of factors, whether located in Europe or in the colonies, to warehouse and to sell the commodities or manufactured articles consigned to them, to account to their principals for the proceeds, to guarantee the credit of purchasers and, when requested, to make cash advances to their principals before the actual sale of the goods. Court decisions defining the rights and obligations of factors were codified in the factors' acts that were enacted in England and in the United States in the early part of the 19th century.

Although these statutes have not been repealed, they are of little practical significance and are resorted to only occasionally in litigation involving pawnbrokers or other persons who, in the course of business, come into the possession of property belonging to others. These factors' acts must not be confused with the modern factors' lien statutes enacted in the United States, which are referred to later on.

Prior to the beginning of the 20th century, when Europe was providing most of the textile requirements of the United States, factors contributed greatly to the commerce between the two continents. The U.S. factors were in a position not only to provide storage and marketing facilities for the foreign exporters but merchandising advice as to styling and other requirements of the domestic market. By the turn of the century, however, the picture changed radically. Aided by preferential tariffs, textile manufacturers in the United States gradually increased in number and soon were supplying the major portion of domestic requirements. As a result, imports from Europe dwindled and the U.S. factors found themselves with a rapidly decreasing number of foreign employers. The traditional warehousing and selling functions of the factor had little value for the U.S. manufacturer because domestic merchandise could be readily stored at the mills until sold and shipped.

The U.S. manufacturer, catering to a market that was familiar to him, found it more economical to provide his own merchandising and selling organizations, so the factor was no longer needed for his primary function of selling. It was at this point that the operations of the old-fashioned factor in the United States changed and the modern factor emerged. The factors realized that to survive they had to concentrate on those services that filled a need in the U.S. economy. These needs were finance and credit: finance to assist the expansion of the textile industry, and a credit service that would enable the mills to distribute their products to every segment of the U.S. economy. By making their large financial resources available to growing textile organizations, they became in a sense bankers for this important industry, and their highly efficient and resourceful credit departments took over the task of providing the credit supervision that was needed to enlarge the domestic market.

One other change occurred at that time, and that was in the relationship between the parties. Theretofore the relationship had been one of principal and agent, but now the factor became an independent commercial organization supplying financial and credit services on a contractual basis to other business concerns, which he referred to as "clients." He entered the 20th century with the ancient and honourable title of factor but without many of his predecessor's distinguishing features: he no longer handled merchandise, he no longer sold and he was no longer an agent.

The Modern Factor.—A few banks outside of New York city operate factoring departments, but except for these banks and a limited number of small organizations, the factoring companies are to be found in New York. The factors are located in that city because it has always been, and continues to be, the important selling and styling centre for the textile industry. When the factors were performing a selling function, it was natural that they be located in close association with textile buyers and sellers; and even when they no longer acted as salesmen and were specializing in credit services, it was advantageous for them to be located where buying orders originated.

The old-fashioned type of factor in Europe gradually became of decreasing economic significance because of the fact that his various functions of warehousing, selling and financing were diverted in the course of time to commercial banks who took over the financing of foreign imports and of domestic sales, and to commission houses and selling agents who specialized in the distribution and sale of goods. In the 1960s steps were taken by U.S. interests to establish factoring in England.

Although the major number of factoring clients are in the textile field, factors are also used extensively by the shoe, furniture, hardware and other industries, and the trade areas in which factors operate have increased annually. In general, the type of business that can be factored is any manufacturer, converter, jobber or any other distributor whose sales are made on short credit terms to customers whose credit can be examined and determined. As indicated above, the concerns with which the factors enter into contractual arrangements are referred to as "clients," and the concerns to which the clients sell their merchandise are referred to as "customers." Although the factors are concentrated in New York, their clients are scattered throughout the United States, and there are also many manufacturers in Europe and elsewhere who use the services of factors for their sales to customers in the United States.

Practically all of the factors' customers are in North America, and it is only in unusual situations that a factor is asked to pass on the credit of customers in Europe who may be buying from a manufacturer in the United States. The customers range in size from the largest business corporations to the smallest retail store, and the average factor will have many thousands of customers throughout the United States with each of which it maintains a running ledger account.

Modern factoring has expanded rapidly. In 1935 the volume of business transacted through factoring concerns in the United States was $726,000,000; by 1945 the volume had increased to $1,565,000,000; and by the 1960s it was in excess of $5,000,000,000.

Guarantee of Credit.—One of the factor's unique services is that it acts as the credit department for the manufacturer. The manufacturer's salesmen continue to solicit orders, but each order is referred to the factor's credit department. On all sales which the factor approves for credit, it assumes the entire risk of loss if the invoice is not paid at maturity because of the customer's insolvency, but not if the invoice is unpaid for any other reason; *e.g.*, if the customer refuses to pay because of defective merchandise. The factor assumes the credit risk by literally purchasing the manufacturer's accounts receivable on what is known as a "without recourse" basis; *i.e.*, after purchasing the receivable, the factor has no recourse to the manufacturer in the event the customer becomes insolvent. The principal value of the factor's credit service lies in the greater risks that the factor is able to take by reason of its extensive resources, the highly specialized skill and proficiency of its credit department and the comprehensive financial information which it alone can afford to obtain currently from its thousands of customers.

The factors' credit personnel are divided into departments, each of which specializes in a particular industry and in some cases in subdivisions of an industry. In view of the size of its operations and the fact that the customers with which it deals are not limited to a particular industry, the factor can spread the risk of loss over a much broader base than could any single client. The factor is capable, therefore, of making credit determinations more expeditiously and more efficiently and is in a position to extend far more liberal credit than is the case with the average business concern.

Many manufacturers find that the use of factoring, and the transfer to the factor of all credit functions, improves its relationship with its customers by enabling it to avoid the embarrassing detail of having to establish, and in some cases restrict, the credit limits of its customers.

Collection Services.—An unusual feature of a factoring arrangement is that although all invoices are issued by the manufacturer in his own name, they are made payable not to the manufacturer but to the factor. This is accomplished by a printed notice that appears on the face of the invoice directing the customer to pay the invoice to the factor. This arrangement does not exist because of any legal requirement but solely for a practical business consideration, for in order to extend proper credit to the customers of the manufacturer it is essential that the factor maintain a complete record of the transactions between the manufacturer and the customer; in other words, the factor must maintain the customer's ledger and post to it all sales and payments as they occur. To do this, the factor receives from the manufacturer a copy of the invoice sent to the customer, and receives directly from the customer the remittance in payment of the invoice. The factor is thus in a position to know at all times exactly how much the customer owes and whether he is delinquent or not. On the basis of this paying record and of the financial information in its files, the factor's credit department is able to arrive at a reasonable conclusion regarding the credit responsibility of the customer.

It is when the customer becomes delinquent in his payment that the collection service of the factor becomes of particular significance. It is essential that payments be made, but at the same time the factor must enforce collections without antagonizing the customer or jeopardizing the good will which has been established between the manufacturer and the customer. Because of the special credit skills and the detailed information which the factor has employed in extending the credit initially, it is not obliged to be arbitrary if customers, for valid reasons prevailing in their trade, are unable to meet their obligations promptly as they mature, and the factor's financial strength permits it to grant indulgence where necessary. Furthermore, because of the factor's prestige and influence in the trade, customers will make special efforts to pay invoices owing to a factor in order to maintain a good credit rating. The manufacturer who is factored is thus relieved not only of collection costs but of collection problems, and can devote his time to the production and merchandising aspects of his business.

Financial Services.—Depending upon the length of the selling terms that a manufacturer is willing to grant to his customers, a substantial amount of his assets are tied up in unpaid accounts receivable. Under a factoring arrangement the factor cashes these accounts receivable as soon as the goods are shipped to the customer, and the manufacturer has immediately available from the factor the selling price of his goods without having to wait until the invoice comes due.

The factor makes this money available not as a loan on the security of the accounts receivable but in the form of an actual purchase of the receivables, which the factor acquires at a discount at a rate of 6% per annum, computed, in effect, from the date of sale to the maturity of the invoice. However, if the manufacturer does not choose to draw the available funds, the discounted amounts are credited to his account in the form of a "credit balance" which he can draw later at his convenience. The factor credits interest on such balances at the same rate at which the

invoices were discounted, namely 6%, so that the credit interest will offset the discount earned if the balance is not drawn before the maturity of the invoice.

In addition to the cash which the factor makes available upon the shipment of merchandise, it also provides further funds if the manufacturer requires them in his operations. These funds are referred to as "overadvances." The principal use for these overadvances is to enable the manufacturer to build up inventory in anticipation of a selling season, and they are either secured or unsecured, depending on the period of time during which they are to remain outstanding and the financial responsibility of the client involved. If the advances are to be secured by a lien on inventory in the possession of the manufacturer, the lien is usually effected through use of the factor's lien statute, which is referred to below. The factor also makes money available to the manufacturer for the acquisition of new machinery and equipment, the erection of plant facilities and other business purposes. These funds usually take the form of term loans, and if security is required the loans are collateralized by a chattel mortgage on machinery and equipment or by a real estate mortgage on land and buildings. Great flexibility is allowed by the factor in the repayment schedule for term loans, and the amounts to be repaid each year are fixed in proportion to the ability of the manufacturer to pay as a result of increased production and profits. The factor's overadvances and term loans are granted in anticipation of a continuing volume of sales that will be collected in the future by the factor, and it is from these sales that the overadvances and loans are paid off in accordance with a prearranged schedule.

It is to be noted that overadvances and term loans are made by a factor only to a client and only as part of, and incidental to, a continuing factoring contract between them.

Factor's Compensation.—The factor receives payment for his services in two ways. The first is by a commission or fee that is computed on the face amount of all invoices of the manufacturer that are handled by the factor. This commission is not in any way a charge for the use of money but is solely compensation for the factor's credit, bookkeeping and collection services. The amount of the commission normally ranges from $\frac{3}{4}$ of 1% to 2%, but the exact charge for any particular manufacturer is controlled by several considerations: the credit standing of the manufacturer's customers; the length of the terms of sale on which the merchandise is sold; the number of invoices that are issued by the manufacturer; and the annual sales volume of the manufacturer.

The second source of the factor's income is the discount and interest charge in purchasing accounts receivable and in making overadvances. It should be noted that not all manufacturers dealing with a factor make use of the factor's financial service, and if the manufacturer does not draw funds against his sales or if he does not obtain overadvances or loans from the factor, he does not have to pay interest.

Those manufacturers who do use the factor's money are charged interest in the form of the discount of their accounts receivable and simple interest on such loans as they may ask of the factor. For both the discount and the loans, the factor's basic rate has traditionally been 6%, although in periods of abnormally high money costs a surcharge is sometimes added.

Factor's Lien Statutes.—The factor's lien statutes exist only in the United States and in Puerto Rico and were enacted to enable a manufacturer to use his merchandise inventory as collateral for loans obtained from a factor. At common law, it was difficult for a manufacturer to mortgage his inventory because, unlike land or machinery, inventory was held by the courts to be of such a shifting and transitory nature as not to be adaptable to the rigid requirements of the existing mortgage statutes.

Since some manufacturers did not qualify for unsecured loans from their factors, and because existing laws made it almost impossible for them to use their inventory as collateral for such loans, the Factor's Lien statute was passed in 1911 in the state of New York to make it legally possible for manufacturers to grant a lien in the nature of a floating charge on their inventories to secure loans received from a factor. Following the pattern established by mortgage laws, the statute required that a notice be filed in a local recording office giving the names of the parties and stating to the public that a lien exists on inventory belonging to the manufacturer. The lien attaches not only to the inventory but also to the proceeds of sale if the inventory is disposed of. The statute proved so beneficial that many other states in the United States and Puerto Rico have enacted it as uniform legislation. Although it is called the Factor's Lien statute, it is so worded that its provisions are available to the widest possible class of lenders, including banks or any other party lending money on the security of inventory.

Factoring is to be distinguished from accounts-receivable financing, a form of commercial loan transaction in which the finance company neither guarantees the collection of the receivables nor makes collections directly from the customers. The money that is made available is in the form of loans against accounts receivable, which are pledged to the finance company as collateral, and the sole compensation it receives is interest on such loans.

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(J. S. FE.)

FACTORS OF PRODUCTION. This is a term used by economists to denote the economic resources, both human and other, which, if properly utilized, will bring about a flow or output of goods and services. Simply stated, factors of production are the "inputs" necessary to obtain an "output." However, not all the "inputs" that must be applied are to be regarded as factors in the economic sense. Some of these inputs in a normal situation are "free." Although atmospheric air, for example, or a substitute for it, must be at hand to enable production to go on, it is not counted among the factors since it is available in most circumstances in practically unlimited quantities. But if it has to be piped into a deep mine, or under water, it would then have to be treated like the other "economic resources." Incidentally, from the standpoint of the whole economy, a cost is involved in using a resource if, as a result of this particular use, the production of something else which depends upon the same kind of resource is hampered. Thus, if the input is scarce in relation to the need for it, it is regarded as a factor of production. The needed inputs may be scarce, and so constitute productive factors, either because they represent something which cannot be produced, like land (in the strictly economic sense), or because although their supply could be enlarged, like factories, to do so would be costly in terms of resources.

The productive factors are commonly classified into three groups: land, labour and capital. The first represents resources whose supply is low in relation to demand and cannot be increased as the result of production. The income derived from the ownership of this factor is known as economic rent. The factor of labour represents all those productive resources that can be applied only at the cost of human effort. The wage or salary is the form of payment for the use of this factor. And the effort which the economist regards as qualifying may be either manual or mental, although in earlier periods, and apparently under communism, manual labour alone was considered a productive factor. The final category, capital, is a more complex one. In the simplest sense, it refers to all the "produced" instruments of production —the factories, their equipment, their stocks of raw materials and finished goods, houses, trade facilities, and so on. The owners of capital receive their income in various possible forms; profits and interest are the usual ones.

It is generally assumed that the level of an economy's output depends directly, and indeed simply, upon the amount of its productive factors in use. It is also supposed that in some degree one kind of factor can be substituted for another in production. The study of the level of factor employment, of the specific direc-

tion of their employment and of the rewards received for their use constitutes the greater part of economics. *See* also ECONOMIC PRODUCTIVITY; ECONOMICS. (L. Ts.)

FACTORY DESIGN: *see* INDUSTRIAL ARCHITECTURE.

FACTORY INSPECTION: *see* HEALTH AND SAFETY LAWS.

FACTORY MANAGEMENT: *see* PRODUCTION MANAGEMENT.

FADEEV (real surname BULYGA), **ALEKSANDR ALEKSANDROVICH** (1901–1956), Soviet novelist who wrote in a clear realistic manner and was strongly influenced by Tolstoi. He was born at Kimry on Dec. 24, 1901. His early youth was passed in eastern Siberia, where he fought on the Red side in the civil war of 1918–22. This became the setting of his first novel, *Razgrom* (1927; Eng. trans. *The Nineteen*, 1929). Siberia is also the setting of his long unfinished novel *Posledni iz Udege* ("The Last of the Udege"; 1929–41). His best-known novel is *Molodaya gvardiya* ("The Young Guard"; 1946, rev. 1951) describing Russian partisan activity behind the German lines in World War II. He took a prominent part in literary politics, becoming secretary (1939) and president (1953) of the Union of Soviet Writers. During the period of ideological tightening up beginning in 1946 he co-operated with the political leader A. A. Zhdanov in imposing stricter discipline on Soviet writers. In his last years he became an alcoholic and he committed suicide at Peredelkino on May 13, 1956.

(R. F. HI.)

FAENZA (anc. FAVENTIA) a city of Ravenna province, region of Emilia-Romagna, northern Italy, lies on the Lamone river 49 km. (30 mi.) S.E. of Bologna by road. Pop. (1957 est.) 49,834 (commune). Faenza is on the railway from Bologna to Rimini. The town still preserves traces of the Roman rectangular plan that divided it into four quarters surrounded by walls dating from 1456. In the centre of the town is the Cathedral of S. Pietro begun in 1474 by Giuliano da Majano; it has an incomplete façade, but contains the magnificent tomb of S. Savino with reliefs by Benedetto da Majano. Nearby is a bronze ornamented fountain (1621) by D. Paganelli. The arcades of the Palazzo del Comune date from the 15th century and those of the Palazzo del Podestà from the 18th century. The art gallery (1805) contains sculptures, the best works of Faenza's painters and fine specimens of majolica, a variety of which, faïence, takes its name from the town (*see* POTTERY AND PORCELAIN: *European Pottery*.) The International Museum of Ceramics, founded in 1908, was completely rebuilt after World War II; it contains examples of ceramics of every age and origin. Industries include artistic handicrafts (ceramics, gold and wrought copper) and export of fruit and wine.

Faventia was a Roman town in the 2nd century B.C. on the Via Aemilia, but excavations show it to have had a much earlier origin. After the fall of the Western Roman empire, the town was subjected to many barbarian attacks. Desiderius ceded it in 757 to the papal states; at the beginning of the 12th century it was a commune and in 1240 it stood an eight-month siege by Frederick II. In 1313 the Manfredi took it and retained possession until 1501, when the town was taken by Cesare Borgia. It remained part of the papal states (except for the brief domination of Napoleon, 1797–1814) until it was annexed to the kingdom of Sardinia in 1859, passing to the Italian kingdom in 1861. (G. M. Z.)

FAEROE ISLANDS (FAROE ISLANDS, Danish FÆRØERNE, Faeroese FØROYAR), a group of islands in the North Atlantic ocean that form a self-governing community within the kingdom of Denmark. They are situated between Iceland and Shetland, about 200 mi. N.W. of the latter, between latitude 62° 24′ and 61° 26′ N. and longitude 6° 15′ and 7° 41′ W. The total area of the group is 540 sq.mi., and there are 17 inhabited islands. The principal ones are Stromo, Ostero, Vaago, Sudero, Sando and Bordo. Pop. (1960) 34,596. Capital, Thorshavn, on Stromo; pop. (1955) 6,014.

Physical Features.—The islands were formed by submarine outpourings of basalt in Tertiary times, with thin, intercalated, reddish tuff. The layers of basalt are from 30 ft. to 100 ft. thick, those of tuff about 3 ft. thick. Upon the basalt rests the so-called coal formation, 35–50 ft. thick; the lower part is mainly fire clays and sandstone and the upper part is weathered clay with thin layers of shale and brown coal. The latter occurs especially on Sudero. Above this, over most of the surface, are beds of dolerite, 15–20 ft. thick. All these beds of basalt, tuff and dolerite lie practically horizontally. Probably during the glacial period the whole surface was covered by ice sheets, and the relief is mainly the result of the action of slight ice pressure upon the horizontal beds, with a peneplain surface at about 1,000 ft. The rocky ground of the islands is covered by a thin layer of moraine or peat soil, the latter being used for heating. The islands are high and rugged, with perpendicular cliffs and flat summits separated by narrow ravines. The coasts are indented, with deep-cut cliffs known as *gjogvs* opened out along dikes or joints. The narrow passages between the islands are made dangerous by very strong tidal currents. The greatest height is Slaettaratindur (2,894 ft.) in Ostero. There are several lakes where trout are abundant; the largest is Lake Sorvaag in Vaago, which discharges into the sea by a sheer fall of about 160 ft.

The climate is oceanic, with mild but stormy winters and cool summers. Rainfall is heavy (*c.* 60 in. a year), the maximum occurring in autumn and winter, and there are about 280 rainy days a year. The sky is generally overcast, and fogs are frequent. There are seldom long periods of frost, and because of the warm North Atlantic drift (terminal section of the Gulf stream) the harbours are rarely icebound. At midsummer the sun is above the horizon for about 19¾ hours.

There are no indigenous land mammals. Rats and mice have come with ships, and the polar hare is imported. Toads and reptiles are also missing. Numerous sea birds, including the guillemot, puffin and eider duck, nest in the cliffs. Because of the strong westerly winds and frequent gales the islands are naturally treeless, but hardy conifers, maple and mountain ash have been planted in a sheltered hollow behind Thorshavn.

History.—The oldest map mentioning the Faroes by name is the Hereford map (1280) where they are called Farei, perhaps a Celtic word akin to *fearand* ("area"), perhaps a Scandinavian word akin to *faar* ("sheep"). Dicuil, the Irish geographer, writing in about 825, said that Irish hermits had lived there for 100 years. The present population is descended from 9th-century Norse settlers. Olaf I Tryggvessön, king of Norway, introduced Christianity about 1000 and gave the islands to the Faeroese Sigmund Brresterson, but he was killed by the islanders who clung to their independence. The remains of a Gothic cathedral, begun but never completed by Bishop Erlend (1269–1308), are at Kirkjubo. In 1035, however, the islands became a Norwegian feoff, and they were associated with Denmark in the 14th century, when Norway and Denmark were united. In 1814, when Norway was separated from Denmark, the Danish king retained the islands. The name of Magnus Heineson, a native of Stromo, who cleared the seas of English adventurers in the 16th century, is still celebrated in many songs and stories. So also is the period of Sigmund Bresterson, in the *Faereyinga Saga* and in popular songs and legends. This early native literature became the starting point of modern Faeroese nationalism. The folklorist Ulricus Hammershaimb formed in the 19th century a written Faeroese language, and in the 20th century Joannes Patursson made his farm an intellectual and national centre. In 1906 he formed the Sjalvstyrisflokkur, or Home Rule party. After 1912 the use of Faeroese in schools and churches was to some extent authorized. In 1938 the local language became the single language of instruction, if the teacher wished it. The Sambandsparti was formed to maintain ties with Denmark, in opposition to the Sjalvstyrisflokkur. There was also a Social Democratic party. The old Faeroese *lagting* (a combined jury and parliament), abolished during the absolutism, was restored in 1852 as an *amtsraad* (county council).

When the Germans invaded Denmark in 1940 Great Britain took over control of the islands until Sept. 1945. Thirty-nine fishing vessels were sunk and 131 fishermen and seamen lost their lives. The Faeroese contribution of fish to Britain's food supplies was of great value.

After the war Denmark proposed to give the islands a greater measure of self-government, but at a plebiscite in 1946 only 5,490 voted for the government proposal as against 5,656 for an inde-

pendent republic, which was demanded by the new Home Rule party, the Fólkaflokkur. Election for the *lagting* displayed, in the same year, an opposite result, leaving the Fólkaflokkur as a minority (5,383 votes as against 7,470 votes cast for the other parties). In 1947 negotiations were renewed in Copenhagen, and as a result the islands were given self-government, their own flag and their own unit of currency, the krona (1 krona = 1 Danish krone). A decline in the prices of fish in 1952 caused economic troubles. The Sjovinnu bank suspended its payments, and the Danish government had to make loans and subscribe new shares in the bank in order to overcome the crisis.

Social Conditions and Administration.—The Faeroese constitute a separate nationality and have preserved numerous ancient manners and customs. Faeroese, akin to Icelandic rather than to Danish, is the main teaching language (*see* above). Besides elementary schools there are five secondary schools, including a grammar school in Thorshavn. There are also a navigation school, technical schools and a high school. Most islanders are Lutherans, belonging to the Danish national church. The population rose from 5,200 in 1801 to 15,230 in 1901 and later more than doubled.

Matters of self-government are: electoral rules, municipal institutions, sanitation, schools, social services, trade laws and taxation. Self-government is exercised through the *landsstyre* (executive) and the *lagting*, which has 27 members. All men and women over 21 may vote.

The Danish government is represented by the *rigsombudsmand* (commissioner). The islands elect two representatives to the Danish *folketing* (parliament).

Agriculture, Fisheries and Industries.—The ground around the farms was formerly used for hay, potatoes, turnips and barley crops, but less than 4% of the total area was ever under cultivation. With the sudden increase in importance of the fisheries, agriculture was abandoned. In deserted gardens clumps of angelica, a source of vitamins, still grow. Vegetables will grow, berry fruits will flourish and even strawberries will ripen late in the summer. The uncultivated area offers good pasture where sheep graze in summer and winter. The wool is exported or used by a small home industry in spinning and knitting. Two modern textile mills have been built. There are cows, but they give little milk because of their coarse feed. The puffin is caught for food, and the feathers of the eider duck are collected. About 300,000 sea birds are caught annually on the cliffs. Fishing, however, has become the main trade of the islands. The cod fishery is especially important, dried or frozen fish being exported in large quantities to Spain, Denmark, the United Kingdom and Italy. The swim bladders are made into gelatin and the cod liver into liver oil. Salted herrings are also exported. The whaling industry became important toward the close of the 19th century but is no longer of significance.

The islands have regular communication by ship with Denmark (Copenhagen), Iceland and in summer with the Shetland Islands. During and after World War II Faeroese roads were improved. Hydroelectric power stations were constructed after the war and coal is mined in Sudero.

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FAESI, ROBERT (1883–), Swiss poet, dramatist, short-story writer and literary critic, was born at Zürich on April 10, 1883, and was professor of German literature at the university there, 1922–53. His poems in the collections *Aus der Brandung* (1917) and *Der brennende Busch* (1928), and his tragedy *Opferspiel* (1925), with the same subject as Rodin's sculpture of "The Burghers of Calais" (1896), are products of World War I and postwar expressionism, not without social significance. His *Füsilier Wipf* (1917; enlarged and revised, 1938), the story of a private soldier of World War I, became popular as a film. The *Zürcher Idylle* (1908, rev. ed., 1950) and the epic saga *Stadt der Väter, Stadt der Freiheit, Stadt des Friedens* (3 vol., 1941–52) deal with Zürich life stories during the 18th century, including the French Revolution. In 1949 he wrote the libretto for Willy Burkhard's opera, *Die schwarze Spinne* (based on Gotthelf's tale). His novel *Alles Korn meinet Weizen* (1961) is set in World War II. He also wrote important studies on Paul Ernst (1913), R. M. Rilke (1919), C. F. Meyer (1925), Carl Spitteler (1913), on whom he wrote the article in the *Encyclopædia Britannica*, G. Keller (1942) and Thomas Mann (1955), with whom his correspondence was published in 1962. (O. OB.)

FÁFNIR is the name of the dragon in the Norse version of Nibelung legend. Fáfnir turned into a dragon after killing his father, Hreidmar, and after seizing the Nibelungs' hoard of gold. He lay on this until the hero Siegfried (*q.v.*) slew him, so that gold came to be called "the dragon's bed" by Norse poets. *See* also NIBELUNGENLIED. (G. T.-P.)

FAGACEAE, the beech family, contains more than 800 species, including giant trees such as beech, oak and chestnut (*qq.v.*) and prostrate shrubs. They are broad-leafed plants with deciduous or evergreen, alternate, simple leaves which are lobed, toothed or entire. The wind-pollinated flowers are inconspicuous, borne singly or in groups, the male usually in catkins, the female in small clusters.

The fruit is a nut, borne singly in a cup as in the oak (an acorn) or several in burlike bracts as in the chestnut and beech.

(C. H. MR.)

FAGGING, in the English public schools, is the compulsory performance by junior boys of prescribed menial services for senior boys. The etymology of the word is obscure, but it is clearly connected with "fag" for weariness, hence drudgery. Like many other public-school features popularly supposed to be of immemorial antiquity, fagging is in fact of quite late development. The custom developed rapidly after about 1785 and was in general recognized by the school authorities, and sometimes regulated by them. Probably, as A. F. Leach suggests, its growth was occasioned by the development of organized games and the introduction of extra meals.

By the mid-19th century fagging was customary in most of the great public schools. An illustration of how fagging worked at Rugby is to be found in T. Hughes' *Tom Brown's School Days* (1857). For details of its operation in the public schools generally, the best source is the report of the Clarendon commission (1864), where the returns to the commissioners' queries no. 29 and 30 and the (indexed) minutes of evidence and recommendations give full particulars of the heavy tax upon young boys' time involved by fagging, and lurid (perhaps not altogether reliable) details of the alleged "oppressive, degrading and brutal" abuses of the system. By the second half of the 20th century fagging had either been abolished or reformed beyond recognition.

(W. E. T.)

FAGOTTO: *see* BASSOON.

FAGUET, ÉMILE (1847–1916), French critic, literary historian and moralist, author of many influential critical works revealing a wide range of interests, was born on Dec. 17, 1847, at La Roche-sur-Yon. He was educated at Poitiers and at the École Normale in Paris, presented his doctoral thesis in 1883, was appointed to a chair at the Sorbonne in 1890, succeeded Jules Lemaitre as dramatic critic of the *Journal des Débats* in 1896 and was elected a member of the Académie Française in 1900. In 1902 he founded the *Revue Latine* and he remained the editor and principal contributor until 1908. He contributed extensively to the *Revue des Deux Mondes*, the *Revue de Paris*, the *Revue des Cours et Conférences*, the *Revue Encyclopédique*, the *Revue Hebdomadaire*, the *Revue des Revues* and *Le Correspondant* and published many monographs and volumes of essays.

He was an intelligent, vigorous, argumentative and provocative critic with an essentially traditionalist approach. At his best when analyzing ideas, and in particular the ideas of individuals, he was relatively unconcerned with purely aesthetic values or with general tendencies common to a whole period, and he rarely attempted to mark the stages of a writer's development. He had

many prejudices, his dramatic criticism lacked the freshness of Francisque Sarcey's and Lemaitre's, and he was too deficient in sensibility to be a good judge of poetry and too much of an impressionist to insist on rigorous precision or encourage systematic research. But, even outside academic circles, his influence was considerable and he deserves a high place among critics if only for his remarkable *Politiques et moralistes du dix-neuvième siècle*, 3 vol. (1891–1900). He died in Paris on June 6, 1916.

(J. G. Ck.)

FAHRENHEIT, GABRIEL DANIEL (1686–1736), German physicist who made important improvements in the construction of thermometers and introduced the thermometric scale known by his name (*see* THERMOMETRY). He was born at Danzig on May 14, 1686. For the most part he lived in England and Holland, devoting himself to the study of physics and making a living, apparently, by the manufacture of meteorological instruments. He also invented an improved form of hygrometer, a description of which, together with accounts of various observations and experiments made by him, was published in the *Philosophical Transactions* (1724). He died in Holland on Sept. 16, 1736.

FA-HSIEN (fl. A.D. 399–414), Chinese Buddhist monk and traveler in central Asia, India and Ceylon, whose record of his journeys and studies is valuable evidence for the history of Buddhism and its strength in central Asia and northern India before its eclipse by Islam and the resurgence of Hinduism. Born at Shansi during the 4th century A.D., Fa-hsien set out from China, traveled westward through Turkistan and, about A.D. 402, crossed the Hindu Kush into India. There, in the then central Buddhist realm, he stayed for ten years, visiting Afghanistan and the Ganges valley, conversing with Buddhist monks and scholars and copying Buddhist texts. From India he sailed to Ceylon, where he continued transcribing sacred texts that were unknown in China. About A.D. 414 he returned via Java to Nanking where he translated these texts (listed in P. C. Bagchi, *Le Canon bouddhique en Chine*, 1927) from Sanskrit into Chinese.

Translations of his narrative include S. Beal, *Travels of Fah-Hian and Sung-Yun* (1869); J. Legge, *Fa-hsien, a Record of Buddhistic Kingdoms* (1886); H. A. Giles, *The Travels of Fa-hsien* (399–414 A.D.) (1923). (R. L. Hl.)

FAIAL (formerly FAYAL), a Portuguese island forming part of the Azores archipelago. Pop. (1960) 23,280; area, 66 sq.mi.; volcanic activity in 1957–58 increased the area by 1 sq.mi. Faial (*i.e.*, "the beech wood," named from the former abundance of the *Myrica faya* or Canary Islands wax myrtle, which its discoverers mistook for beech trees) has an excellent harbour at Horta (pop. 7,489). Cedros (2,289) and Feteira (1,916) are the other chief towns. The women of Faial manufacture fine lace from the agave thread, execute carvings in snow-white fig-tree pith and carry on fine basketmaking. A small valley, Flamengos, recalls the Flemish settlers, who were completely absorbed by the Portuguese within a few generations, leaving no trace of influence in the physical appearance, customs or language of the population. (J. Ao.)

FAIDHERBE, LOUIS LÉON CÉSAR (1818–1889), French army officer and colonial administrator, chiefly distinguished for his service in Senegal under the second empire, was born at Lille on June 3, 1818. His family could ill afford his education, and though he had won grants his performance at the École Polytechnique was disappointing. Entering the military engineers, he was commissioned in 1840, but showed little inclination for soldiering and fell into debt through gambling. In Algeria, however, from 1843 to 1846, he at last became interested in active service. Bored with a post at Belfort, he joined the colonial army, with captain's rank. Sent to Guadeloupe early in 1848, he showed too much enthusiasm for the abolition of slavery there, and his superiors had him recalled. Sent to Algeria again, he chose the post of Bou Saada, in the south, where he built a fort. His work now won commendation, and after further service in Kabylia he was made chevalier of the Legion of Honour.

After four months' leave in France, Faidherbe was posted to Senegal. Arriving at Gorée in Nov. 1852, he went on to St. Louis as subdirector of engineers. Delighted with this new country, he made himself an expert on its geography, languages and problems. Promoted battalion commander (July 1854), he saved Bakel from attack by Omar el-Hadj. Then late in 1854 he was made governor of Senegal—not without suspicion of having intrigued for the appointment.

Faidherbe's military undertakings were twofold. In the dry season, when troops could move freely, he relentlessly attacked the Moors, breaking their hold over the left bank of the Senegal river and imposing the treaty (1858) that was to open the route to the Sahara. In the wet season, he sent forces up the river against Omar el-Hadj, whose ambitions were thwarted by Faidherbe's relief of Médine (besieged from April to July 1857) and by the treaty of 1860. To have local support, at the same time, he began raising indigenous troops, the Tirailleurs Sénégalais. He moreover sponsored the exploration of the Falémé basin and of the country eastward as far as Ségou on the Niger. His internal policy, meanwhile, was to let the people manage their own affairs as far as possible, under benevolent French supervision. He divided the colony into three districts, subdivided into circles. At St. Louis, he founded a secular school, a public library, a museum and a newspaper, *Le Moniteur du Sénégal*. He also tried to save the colony's economy from total dependence on rubber by developing groundnut (peanut) cultivation, and it was he who established the Banque du Sénégal (1855).

Despite his care for the Senegalese, however, his great achievements were carried out in the authoritarian spirit of the French second empire (which made him colonel in 1858, general and commander of the Legion of Honour in 1863, though he later claimed to have been victimized by it); and his preoccupation with the "sand country" north and east of Senegal inaugurated a tradition that led France to neglect the rich Guinea coast. In 1861 Faidherbe asked to be recalled from Senegal, but after further service in Algeria he was governor of Senegal again from May 1863 to May 1865.

Indignantly refusing a Corsican appointment (Nov. 1865), Faidherbe was next made commandant of the subdivision of Bône (Constantine) and then of the "circle" of Batna in 1866. After the fall of the empire (Sept. 1870) he offered his services to Léon Gambetta and became general of division and commander of the army of the north in the Franco-German War. He took Ham in Picardy (Dec. 13, 1870), opened the indecisive battle of Pont Noyelles and captured Bapaume (Jan. 3, 1871). After the war he was appointed grand officer of the Legion of Honour. Elected deputy to the national assembly for the *département* of Somme in July 1871, he soon resigned, but later stood for the senate, being finally elected in 1879. He was made grand chancellor of the Legion of Honour in 1880. In 1884 he was elected to the Académie des Inscriptions et Belles-Lettres. He wrote on archaeology, history and philology and remained interested in Africa until his death in Paris on Sept. 29, 1889.

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FAÏENCE, a term applied generally to all kinds of glazed pottery, but properly the French word for the *porzellana di Faenza*, a fine kind of glazed and painted earthenware made in Faenza, Italy. *See* POTTERY AND PORCELAIN: *European Pottery; see* also references under "Faïence" in the Index volume.

FAIN, AGATHON JEAN FRANÇOIS (1778–1837), French historian, was secretary and archivist to the *cabinet particulier* of Napoleon I from 1806 to 1815. He was born at Paris on Jan. 11, 1778. At the time of his appointment to the emperor's cabinet he had been working since 1795 in various state archives. Napoleon created him a baron in 1809 and in 1813 made him his private secretary. This office, lost at the first Bourbon Restoration, was resumed during the Hundred Days, after which Fain retired into private life. He was recalled in 1830 by Louis Philippe, who appointed him first secretary of the cabinet and, on occasion, administrator of the civil list. He was also, from 1834 until his death at Paris on Sept. 16, 1837, the deputy for Montargis, Loiret.

Fain employed his years of retirement in publishing his reminiscences of Napoleon's reign. These works have remained important sources for the history of the first empire in France; the most

notable are *Manuscrit de 1814, contenant l'histoire des six derniers mois du règne de Napoléon* (1823); *Manuscrit de 1813, contenant le précis des événements de cette année pour servir à l'histoire de l'empereur Napoléon*, 2 vol. (1824); *Manuscrit de 1812*, 2 vol. (1827); and *Manuscrit de l'an III (1794–1795)* (1828). Fain's *Mémoires* were published posthumously in 1908.

FAIR: *see* EXHIBITIONS AND FAIRS.

FAIRBAIRN, ANDREW MARTIN (1838–1912), British Congregational theologian, an advocate of theological liberalism, was born at Inverkeithing, Fife, on Nov. 4, 1838. He was educated at Edinburgh and Berlin and at the Evangelical Union Theological academy in Glasgow; entering the Congregational ministry, he held pastorates at Bathgate, West Lothian and Aberdeen. From 1877 to 1886 he was principal of Airedale college, Bradford, a post which he gave up to become the first principal of Mansfield college, Oxford. In 1883 he was chairman of the Congregational Union of England and Wales. He resigned his position at Mansfield college in 1909 and died in London, Feb. 9, 1912.

Among his more important works are *Studies in the Philosophy of Religion and History* (1876), *Philosophy of the Christian Religion* (1902) and *Studies in Religion and Theology* (1909).

See W. B. Selbie, *Life of Andrew Martin Fairbairn* (1914).

FAIRBAIRN, SIR WILLIAM (1789–1874), British engineer who in 1845 collaborated with Robert Stephenson in the design of the famous early railway bridges over the Menai strait, Wales, and over the river Conway, and who made the tests that led to the adoption of the tubular design for bridges. Fairbairn was born at Kelso, Roxburghshire, on Feb. 19, 1789. Although for a time he ran a yard to build iron ships in Millwall, London, most of his working life was spent in Manchester, with James Lillie as partner from 1817 to 1832.

In 1844 Fairbairn introduced the Lancashire boiler with twin flues. He pioneered the use of wrought iron as a material for the hulls of ships and for bridges, and introduced it in preference to cast iron for mill shafting and for beams for buildings. From 1834 Fairbairn scientifically investigated the strength of iron, the relative merits of hot and cold blast, and how to abate smoke; with Eaton Hodgkinson he studied the strength of iron beams and columns. For Lord Kelvin he determined (1851) the melting points of many substances under great pressure. He conducted or guided experimental work for several government committees and was consulted on many and varied works both in Great Britain and abroad.

Fairbairn was president of the Institution of Mechanical Engineers in 1854, and of the British association in 1861. He received a gold medal from the Royal society in 1860 and was made a baronet in 1869. He died at Moor Park, Surrey, on Aug. 18, 1874. His youngest brother, Sir Peter (1799–1861), founded in Leeds an establishment to make textile machinery and machine tools, and was knighted in 1858.

See *The Life of Sir William Fairbairn*, partly written by himself, edited and completed by William Pole (1877). (S. B. HN.)

FAIRBANKS, CHARLES WARREN (1852–1918), U.S. politician, vice-president under Theodore Roosevelt (1905–09), was born on a farm near Unionville Center, Ohio, on May 11, 1852. He graduated from Ohio Wesleyan university, Delaware, O., in 1872, studied law in Cleveland and began practice in Indianapolis, Ind. He was the chief power in the Republican party in that state from 1896 until his death. He was temporary chairman and keynote speaker of the convention which nominated William McKinley in 1896, and was U.S. senator from Indiana, 1897–1905. Because he was a conservative and represented a doubtful state, he was the political choice as running mate to Theodore Roosevelt in 1904. In 1912 Fairbanks supported William Howard Taft instead of Roosevelt. He was again his party's nominee for vice-president on the unsuccessful ticket of 1916 headed by Charles Evans Hughes.

Fairbanks died June 4, 1918.

FAIRBANKS, DOUGLAS (1883–1939), motion-picture actor and producer, best known for his portrayals of ebullient and athletic heroes, was born in Denver, Colo., May 23, 1883. After college study he began a stage career, eventually becoming a leading man in New York (1906). Within a few years he turned to motion pictures, and in 1917 was head of his own producing company. Among his many popularly successful pictures were *The Mark of Zorro* (1920), *The Three Musketeers* (1921), *Robin Hood* (1922), *The Black Pirate* (1926) and *The Iron Mask* (1929). He was married to Mary Pickford (*q.v.*) in 1920 and divorced by her in 1935. With Miss Pickford, Charlie Chaplin and others, he was a founder of the United Artists corporation. Fairbanks died in Santa Monica, Calif., Dec. 12, 1939.

His son, DOUGLAS (ELTON) FAIRBANKS (1909–), also a film star, served with distinction in World War II and later became a television producer in England. (M. S. BY.)

FAIRBANKS, THADDEUS (1796–1886), U.S. inventor who devised a platform scale that became widely used for a broad range of weighing purposes, was born at Brimfield, Mass., on Jan. 17, 1796. After the family moved to St. Johnsbury, Vt., in 1815 he helped his father operate a saw- and gristmill and a wagon construction business. Beginning in 1823, he and his brother Erastus (1792–1864) manufactured stoves and plows. On April 19, 1826, he was issued a patent for a plow with a cast-iron moldboard. He secured a patent on his platform scale on June 13, 1831, and subsequently obtained 31 other patents for improvements on it. He also developed a method for constructing refrigerators, devised cooking and heating stoves, patented a machine for dressing hemp and flax and invented a hot-water heater. He died at St. Johnsbury on April 12, 1886. (C. T. F.)

FAIRBANKS, the principal city of the interior of Alaska, U.S., is a mining and transportation centre located 250 mi. up the Tanana river from its confluence with the Yukon. A gold strike in 1902 brought stampeders to the vicinity; in 1906 the population may temporarily have reached 8,000. That year gold production surpassed $9,000,000. Expensive dredges soon became necessary to reach the gold-bearing gravels; a number were still operating in the second half of the 20th century.

The Richardson highway from Fairbanks to the coast at Valdez was completed in 1923. In the same year the Alaska railroad was completed from Anchorage. In the 1920s Fairbanks became a centre for Alaska's famed "bush pilots." During World War II construction of the Alaska highway linked Fairbanks with the major North American highways. Ladd and Eielson air force bases were built nearby.

The meeting of the mining frontier and the air age at Fairbanks is symbolized by sturdy log cabins nestling beside multistory steel buildings. The University of Alaska (founded 1917) at College, 3 mi. N.W. of Fairbanks, is noted both for its mining course and for its advanced geophysical institute. For comparative population figures *see* table in ALASKA: *Population*. (J. E. CL.)

FAIRCHILD, DAVID GRANDISON (1869–1954), U.S. agricultural explorer who supervised the introduction of many useful plants into the United States, was born on April 7, 1869, at Lansing, Mich. In 1888 he graduated from Kansas State Agricultural college, Manhattan, and, after some graduate work at the University of Iowa, Iowa City, and at Rutgers university, he joined the section of plant pathology of the United States department of agriculture in Washington, D.C., in 1889. From 1893 to 1896 he studied in Italy, Germany and Java. He helped W. T. Swingle organize the section of plant introduction (then the section of foreign seed and plant introduction) of the department of agriculture in 1897–98. Fairchild served the section as agricultural explorer (1898–1903), as administrator in charge (1903–28) and, after retirement, as collaborator (1928–54). During his administration many thousands of kinds of plants were introduced into the country. In 1905 he married Marian, daughter of Alexander Graham Bell. Fairchild was the author of several books, including *Exploring for Plants* (1930), an account of the Allison Vincent Armour expeditions for the United States department of agriculture; the autobiographical *The World Was My Garden* (1938); and *The World Grows Round My Door* (1947), story of the Kampong, Fairchild's home in Coconut Grove, Fla. The Fairchild Tropical garden at Coconut Grove was named in his honour. Fairchild died in Coconut Grove on Aug. 6, 1954. (J. W. TT.)

FAIRFAX, EDWARD (*c.* 1575–1635), English poet, trans-

lator of Tasso and refiner of couplet verse, was born at Leeds, Yorkshire, *c.* 1575. His *Godfrey of Bulloigne or the Recoverie of Jerusalem* (1600), a translation of Tasso's *Gerusalemme Liberata,* achieved great fame, and was praised by John Dryden: "For *Spenser* and *Fairfax* both . . . saw much farther into the Beauties of our Numbers, than those who immediately followed them."

Although translating stanza by stanza, Fairfax freely altered poetic detail. His terminal couplets are often sonorous departures from the Italian, and from these especially Edmund Waller "deriv'd the Harmony of his Numbers."

> For in the secret of her troubled thought,
> A doubtful combat, love and honour fought;
> (*Godfrey,* vi, 70)

is a typically well-balanced couplet which Waller copied in *Instructions to a Painter* (1666). Fairfax also influenced Milton, whose tonal harmony he often anticipated:

> And counsellors of her old love, she made
> Those vallies dumb, that silence and that shade.
> (*Godfrey,* vi, 103)

Among Fairfax' other works were 12 eclogues, of which only 2 and most of a third have been found. The finest, "Hermes and Lycaon," is an apocalyptic singing match between worldly and spiritual lovers, and was published, with a curious account of the bewitching of the poet's daughters, in the Philobiblon society's *Miscellanies* (1858–59). Another eclogue appeared in *The Muses' Library* (1737). The complete manuscript of the eclogues still survived in 1789 and may exist unnoticed. Fairfax died in Jan. 1635. (C. G. B.)

FAIRFAX OF CAMERON, FERDINANDO FAIRFAX, 2ND BARON (1584–1648), English general, fought on the parliamentarian side in the Civil War, and was the father of Thomas, the 3rd baron and parliamentarian commander in chief (*see* FAIRFAX OF CAMERON, THOMAS FAIRFAX, 3rd Baron). Ferdinando was born in Yorkshire on March 29, 1584, the eldest son of Thomas, 1st Lord Fairfax (d. 1640), who is reported to have said of him: "I sent him into the Netherlands to train him up a soldier and he makes a tolerable country justice but is a mere coward at fighting." He commanded a foot regiment in the first Bishop's War (1639) but took no part in the campaign of 1640. He shared the resentment of other Yorkshire gentlemen over heavy demands for billeting and other services made upon them and became a moderate parliamentarian in the Civil War. He was member of parliament for Boroughbridge in seven parliaments and for Yorkshire in the Long parliament, and was member of the committee which presented the Grand Remonstrance to the king (Nov. 1640).

Appointed by parliament to command its forces in Yorkshire on Sept. 27, 1642, Ferdinando, after unsuccessfully blockading York, withdrew south to Selby in December. He moved to Leeds in March 1643 and was defeated by the earl of Newcastle on Adwalton moor near Bradford on June 30. In October he raised the siege of Hull. He won a battle at Selby on April 11, 1644, and took part in the siege of York. He is said to have fled from the battlefield of Marston Moor where he commanded in the centre, but later returned. Governor of York in July 1644, he took Pontefract in December, but resigned his command after the passing of the Self-Denying ordinance. Fairfax died in Yorkshire from an accident on March 14, 1648. Bulstrode Whitelocke wrote of him that he was "a gentleman of noble family, of a generous and courageous spirit, yet meek and civil and not given to insulting." With little training he proved himself a fair soldier and passed on his experience to his brilliant son and heir. (M. P. A.)

FAIRFAX OF CAMERON, THOMAS FAIRFAX, 3RD BARON (1612–1671), English general, commander in chief during the Civil War of the parliamentarian army and later of the Commonwealth army, was born at Denton, in Wharfedale, Yorkshire, on Jan. 17, 1612. He was the eldest son of Ferdinando, 2nd Baron Fairfax of Cameron (*q.v.*), whom he succeeded in 1648. Contemporaries universally acclaimed him as a sweet-tempered and mild-mannered man, reserved and somewhat inarticulate. John Milton wrote, with a little exaggeration, that "thy firm unshaken virtue ever brings victory home." He was an aggressive general of high personal courage and no mean skill. As a statesman he seems to have been influenced by those nearest to him. It is said that he had no finesse and little insight into character. He suffered from ill health which contributed to his withdrawal from public affairs at the age of 38.

Thomas Fairfax was largely brought up by his strong-minded grandfather, Thomas, 1st Baron Fairfax of Cameron, with whom he lived after his mother's death in 1619. He matriculated at St. John's college, Cambridge, in 1626 and fought in the Netherlands from 1629 to 1631. He married Anne Vere, a zealous Presbyterian, in 1637. It was said that she wore the trousers. At any rate she quarreled with his grandfather, and they moved to Nunappleton, which became their permanent home. In the first of the Bishops' Wars (1639) Fairfax raised a force of dragoons known as the Yorkshire Redcaps. He was afterward knighted and fought in the second campaign (1640). On June 3, 1642, he presented, on behalf of the Yorkshire gentry, a petition against the raising of troops to Charles I on Heyworth moor near York. It was thought that the king then tried to ride him down and he became a local hero. His father, a member of parliament, had participated in protests against the royal policy, so that Sir Thomas found himself on the parliamentarian side when the Civil War began (*see* CIVIL WAR, ENGLISH).

In Sept. 1642 Fairfax was appointed to command the parliamentarian cavalry in Yorkshire. He occupied Leeds in Jan. 1643 and forced the royalists to evacuate Wakefield, but he was defeated at Seaforth moor, east of Leeds, on April 2, and after a confused struggle he and his father were again beaten at Adwalton moor, southeast of Bradford, in June. He carried out a skilful withdrawal to Hull, where on Sept. 26 he met Oliver Cromwell for the first time. Together they fought and won the battle of Winceby in Lincolnshire. This reduced the royalist pressure in the northeast and later Hull was relieved. In Jan. 1644 Fairfax was ordered by parliament to relieve Nantwich, threatened by a royalist force from Ireland. He did so and returned to Yorkshire, where on April 11 he took part in a victory at Selby. Next he served in the siege of York. In July he showed great personal bravery in the battle of Marston Moor (*q.v.*). Although wounded, he rode over from the right wing to seek help from Cromwell on the left and together they converted what looked like a defeat into a victory. At the age of 33 he was appointed in Feb. 1645 to be captain-general of the New Model army and it was he, not Cromwell, as is often stated, who organized its formation and training.

The New Model army was first ordered to go to the relief of Taunton and then recalled to blockade Oxford. As soon as Fairfax was given a free hand he set out to pursue the king, who had left Oxford on May 5; and with Cromwell's aid he won the battle of Naseby (*q.v.*) on June 14, 1645. Here he showed immense courage and resolution. He followed up his victory by immediately leading his army into the southwest, where he won the battle of Langport (July 10) and occupied in succession Bridgwater, Sherborne, Bristol, Tiverton and Dartmouth. He defeated Sir Ralph Hopton in Cornwall in Feb. 1646 and Exeter surrendered in April—his second successful winter campaign. In May he besieged Oxford, which surrendered on June 20.

After the end of the first phase of the Civil War, Fairfax was reluctantly driven to side with his soldiers in the quarrel between parliament and the army. He did not approve of the seizure of the king's person on the army's behalf, and it was not until anarchy was threatened in London that he led his force into the capital to restore order (Aug. 6). He expressed conservative views and dissociated himself from any idea of imposing a political solution by force. He maintained discipline in the army and was firm with mutineers. When the second phase of the Civil War began in 1648 he quickly captured Maidstone in Kent from the royalists. At Colchester in Essex, however, two attempts to storm the town failed, and he had to starve it into surrender. It submitted on Aug. 26, and Fairfax aroused controversy when, with his council of war, he ordered the execution of two of the defending officers, Sir Charles Lucas and Sir George Lisle, in order to "satisfy military justice."

Fairfax disapproved of Colonel Pride's purge of parliament in

Dec. 1648 and refused to serve on the commission to try the king. At the trial his wife cried out that he would never sit among such commissioners and they should not have named him. He refused afterward to take an engagement that implied his approval of the king's execution and the establishment of a republic, but agreed eventually to be a member of the Commonwealth's council of state. He remained commander in chief until 1650, when he refused to lead an expedition against the Scots on the ground that this was an aggressive war. He resigned his commission and on June 22, 1650, retired to Nunappleton to write bad verses, translate psalms, grow roses and patronize historical research.

In 1657 his daughter Mary married George Villiers, 2nd duke of Buckingham, a royalist, and Fairfax visited London to plead with Cromwell, now lord protector, on his son-in-law's behalf. They seem to have quarreled. At the end of 1659 Fairfax announced his support for Gen. George Monck when the latter was moving from Scotland to London in order to support parliament against the army. Fairfax helped secure Yorkshire for Monck and he advised him in Feb. 1660 to readmit the Presbyterian members who had long been excluded from parliament. On April 25 he was chosen member of parliament for Yorkshire in the convention parliament. But Fairfax resented the hanging up of Cromwell's bones in 1661, and though approving of Charles II's restoration, he took no further part in public affairs. His wife died in 1665 and at this time he composed two "short memorials" defending his conduct during the Civil War. He died at Nunappleton on Nov. 12, 1671.

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FAIRFIELD, a town of Fairfield county, Conn., U.S., on Long Island sound, adjoining Bridgeport on the southwest. (For comparative population figures *see* table in CONNECTICUT: *Population.*)

Although known as a summer resort, industries include the manufacture of batteries, chemicals, drugs, roller bearings and automobile accessories. Fairfield university, officially Fairfield University of St. Robert Bellarmine (Roman Catholic), a college of liberal arts for men, was founded there in 1942.

The town was settled in 1639 by Roger Ludlow, who in 1637 had been one of a band which defeated the Pequot Indians in the vicinity. During the colonial period it was a place of importance, but later it was overshadowed by Bridgeport. On July 8, 1779, Fairfield was burned by the British and Hessians under Gov. William Tryon.

FAIRHAVEN, a town of Bristol county, Mass., U.S., on Buzzards bay, across the Acushnet river from New Bedford. (For comparative population figures *see* table in MASSACHUSETTS: *Population.*) The town is a summer resort and a residential suburb of New Bedford and has factories which manufacture tacks, machinery and commercial fishing equipment. Whaling, the principal industry in mid-19th century, was replaced by shellfishing, deep-sea fishing and the building of fishing vessels. Fairhaven was the home port of Captain Joshua Slocum, the first man to sail alone around the world (1895–98).

First settled in 1670, Fairhaven was separated from New Bedford and incorporated as a town in 1812. In 1778 British forces dismantled the small fort and set fire to the town, but were driven off by militia under Maj. Israel Fearing. The fort was rebuilt at once and renamed Ft. Phoenix. In the War of 1812 it was a strong defense point on the New England coast. (CA. M. C.)

FAIR ISLE, a rugged island between the Orkney and Shetland Islands northeast of the Scottish mainland in Shetland county. Area 3 sq.mi. It is composed of Old Red Sandstone and its highest point, Ward hill, reaches 400 ft. It has two lighthouses. Fewer than 100 crofters live on Fair Isle, many of whom still knit the multicoloured woolen garments which made the island famous; it is a matter of conjecture whether the islanders were taught this art by Spaniards wrecked there in an Armada galleon. To ornithologists Fair Isle rivals Heligoland in its importance as a bird-migration station, and since 1949 it has belonged to the Fair Isle Observatory trust.

FAIR LAWN, a borough of Bergen county, N.J., U.S., 10 mi. from the George Washington bridge to New York city. The borough is separated from Paterson, N.J., by the Passaic river. (For comparative population figures *see* table in NEW JERSEY: *Population.*)

The borough was incorporated in 1924, and in 1948 a council-manager form of government was established. In 1929 a model garden apartment community named Radburn was built under the auspices of the Rockefeller foundation. This community served as an example of desirable apartment planning; its pattern was adopted in modified form in many places. An industrial park covering 175 ac. is another example of community planning. The park contains several light industries whose buildings have been integrated into the community without depressing property values. Local manufactures include airplane parts, dyes and concrete products. (S. HE.)

FAIRMONT, a city of northern West Virginia, U.S., 65 mi. S. of Pittsburgh, Pa., at the confluence of the West Fork and Tygart Valley rivers, the head of navigation of the Monongahela river; seat of Marion county. (For comparative population figures *see* table in WEST VIRGINIA: *Population.*) First settled after the American Revolution, it was incorporated in 1820 as Middletown, and renamed Fairmont in 1843. After the arrival of the Baltimore and Ohio railroad in 1852 it became an important political, mercantile and bituminous-coal-mining centre. At nearby Monongah a coal-mine explosion took 359 lives in 1907. Since 1919 Fairmont has had a unique four-man bipartisan commission government. Fairmont State college was founded in 1867 as a state-supported college. Industrial products include glass containers, aluminum sheets, fluorescent lamps, paper boxes, mining machinery and coke. (GE. W. SM.)

FAIR OAKS, a station on a branch (formerly famous as the York River railway) of the Southern railway, 6 mi. E. of Richmond, Va. It is noted as the site of one of the battles of the American Civil War fought on May 31 and June 1, 1862, and alternatively known as the battle of Seven Pines. The Union forces (army of the Potomac) were under Gen. G. B. McClellan and the Confederate troops (army of northern Virginia) were commanded by Gen. J. E. Johnston, who was severely wounded on the first day. So far as the victory lay with either side, it was with the Union army, for the Confederates failed to achieve their purpose of destroying the almost isolated left wing of McClellan's army, and after the battle they withdrew into the lines of Richmond. The Union losses were 5,031 in killed, wounded and missing; those of the Confederates were 6,134.

FAIR TRADE LAWS, a term applied to laws that allow manufacturers of branded, trade-marked goods, or, in some instances, distributors of such products, to fix the actual or minimum resale prices of these branded goods by resellers. Such price controls are more widely effective in retail sales to consumers than at other levels of marketing. Only a few types of goods have come under such controls, the leading examples being drugs and pharmaceuticals, books, photographic supplies, liquors, miscellaneous household appliances and various specialty goods.

By the 1960s "fair trade laws" had been enacted at various times in 45 states of the United States. The laws are rooted in a long, controversial history that began in the 1880s and has been paralleled by similar developments in other parts of the world, especially in the highly industrialized western countries.

Origins.—The designation "fair trade law" became widespread in the United States following the adoption of the California Fair Trade law in 1931, and its amendment in 1933. The label probably was inherited from the American Fair Trade league, an association of manufacturers of branded goods organized in 1913, which attempted for some 20 years to obtain federal legislation sanctioning resale price maintenance contracts between manufacturers and their distributors. Prior to 1931 in the United States, and in other countries historically and currently, the recognized name for this important problem area was "resale price maintenance."

The Sherman Antitrust act of 1890 in the United States, with its prohibition of monopolies, early gave resale price maintenance a peculiar status. The U.S. courts, especially the supreme court,

erected barriers to effective enforcement by prohibiting or casting doubts upon the means of enforcement. In other countries, and especially in Great Britain, resale price maintenance came into wide use, enforced by trade associations and groups of trade associations. Before enactment of the 1931 California Fair Trade law, resale price maintenance in interstate commerce in the United States was limited to the mere suggestion of prices to dealers without effective power of enforcement or to sale through bona fide agents and on consignment. The crux of the whole matter from the point of view of those wishing such controls was inability to enforce prices on unwilling independent dealers who chose to sell below the suggested prices of manufacturers. Under these conditions, the controls covered only a small proportion of total consumers' goods.

In 1933 California amended its 1931 statute to make the contractual prices agreed upon between a manufacturer and contracting dealers binding upon all resellers. This so-called "nonsigners' clause" with its coercive authority over unwilling dealers gave the fair trade movement enormous momentum. Although resale price maintenance historically is not a depression phenomenon, its legislative sanction was influenced very greatly by the depressed markets of the 1930s. In a few years following the 1931 and 1933 California acts, identical or similar statutes were enacted by 44 other states. In the meantime, the legal doubts and barriers were removed or relieved by a favourable 1936 review by the U.S. supreme court in *Old Dearborn Distributing Co.* v. *Seagram Distillers Corp.*, 229 U.S. 183 and passage of the Miller-Tydings act in 1937, which removed the barriers in interstate commerce between states with fair trade laws.

Thus, when World War II began, resale price maintenance had become widely accepted legally in the United States, as it had also in several other countries. The coercive power of the nonsigners' clause, in fact, gave manufacturers more specific authority over pricing in the U.S. marketing channels than was true in most other parts of the world, but, as it turned out, this was only a temporary peak in the United States. In the postwar years the entire issue was reopened in the United States and elsewhere.

Decline.—In 1951, the U.S. supreme court raised serious doubts concerning the nonsigners' clause in *Schwegmann Bros.* v. *Calvert Distillers Corp.*, 341 U.S. 384. In 1952 congress passed the McGuire act in order to re-establish the position of the nonsigners' clause, and it was upheld by the U.S. supreme court in 1953. However, in subsequent years the fair trade laws of the states ran into increasing difficulties in state supreme courts. By the early 1960s fair trade was without firm legal sanction or was in jeopardy in 20 states (including Vermont, Texas and Missouri, where such laws had never been enacted) and the District of Columbia.

During the postwar years, resale price maintenance as a business practice and organized movement weakened even more perceptibly in some other countries. It was prohibited in both Canada and Sweden and serious doubts about it existed in France. Developments in Great Britain were most interesting in light of the long British record of collective enforcement going back to 1890 and the relatively favourable reports on the subject by governmental committees in 1920 and in 1930. During the earlier period, British courts and governmental committees interpreted the right of contract broadly to permit manufacturers to make resale price maintenance agreements among themselves and with their distributors, provided undue restraint of trade was not shown. In the absence of outright prohibitions of collusive agreements or cartels, as in the United States, collective enforcement became widespread. In 1949, a third governmental committee, following an extended investigation and much more comprehensive treatment than in the earlier reports, recommended strongly against collective sanctions and enforcement. It also took a strong position in favour of the right of independent enforcement by individual producers. In 1956 the Restrictive Trade Practices act prohibited the enforcement of resale prices by the collective withholding of supplies and related arrangements; it also strengthened the position of the individual supplier by giving him a right of recourse to the courts in enforcement against dealers who were not parties to the agreement.

Unresolved Problems.—A review of law, regulation and practice throughout the leading nations of the world in 1960 disclosed that the issues and forces involved under "fair trade" and "resale price maintenance" were far from being resolved. Actually, it seems unlikely that a stable equilibrium or solution can be achieved either in law or in business practice. The initial movement beginning in the 1880s reflected the impact of successful brand promotion by manufacturers upon relations in the distributive trades and the division of the market among competing brands. The very success of manufacturer brand promotion made for more active competition among retailers. The modern U.S. drugstore, for example, with its shelves loaded with national brands is in much keener, more direct competition with other similar stores than was true of the former "chemists" and "apothecaries" who did their own mixing and labeling. Resale price maintenance by manufacturers might have become fairly widespread and effective, however, if retailing had remained in the hands of armies of unorganized small, local independent dealers. Large-scale retailing, together with the growth of strong dealer organizations, sets up strong conflicting interests within retailing and in the marketing channels. In most fields in highly industrialized countries, the marketing channels are both complex and highly overlapping. Consequently the establishment and enforcement of a single price or even of a minimum price by manufacturers is a complicated and burdensome business in the absence of collective enforcement efforts, limitation of numbers of enterprises or governmental intervention. In a few instances, as in the sale of alcoholic beverages in some jurisdictions, resale price maintenance has become mandatory and is enforced by governmental agencies. The long-run rationale of "fair trade" or resale price maintenance points either away from the unique traditional antitrust approach in the United States or toward governmental regulation. The conflicting interests of consumers, retailers, wholesalers and producers are so diverse and well organized as to allow no point of stable equilibrium in the absence of private or public limitations on free access to the market. Effective resale price controls act as magnets to attract excessive capital and manpower into distributive activities. Hence such a program is not workable in the long run without means of restricting numbers of enterprises.

Unfortunately, in the play of the competing forces and pressures on markets, occasional important injuries to individual enterprises or classes of enterprises occur. Thus, manufacturers of well-known advertised brands may be injured if their products are featured as "leaders" or "loss leaders" or are used as "bait," insofar as distributors may be able to push the sale of other brands in higher regard with them. Small independent specialty dealers are unable to use "leaders" and "loss leaders" as effectively as are department stores and supermarkets. Sellers and the consuming public both are injured by deceptive price practices. It is generally agreed among impartial observers that resale price maintenance or "fair trade" is not a true solution to problems arising out of trade conflicts or unfair and deceptive practices. It is held that active enforcement of antitrust legislation and of laws curbing unfair and deceptive methods of competition provide adequate safeguards for all concerned—manufacturers, distributors and buyers. *See* also RESTRICTIVE TRADE PRACTICES.

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Canada: see numerous reports of The Restrictive Trade Practices Commission. (E. T. G.)

FAIRY, the name given to a wide range of supernormal beings, differing in type and character but allied in race, who were once believed to inhabit this world or a magical kingdom lying near or below it. Fairies were akin to men in many respects, but they were not human, nor were they pure spirits. Robert Kirk describes them in his *Secret Commonwealth* (1691) as "of a middle Nature betwixt Man and Angel." They were skilled in magic of all kinds, able to change their shape and size at will, make themselves invisible and delude and enchant human beings, with whose lives they frequently interfered for good or evil. They lived far longer than men but died at last and were usually supposed to perish utterly at death, having no souls.

Belief in fairies existed in many parts of the world and is still an important element in the living folklore of some countries. The modern tendency to prettify them in children's stories represents a degeneration of what was once a serious and somewhat sinister tradition. The fairies of the past were feared as dangerous and powerful beings, sometimes friendly to men but often cruel or mischievous. It was better not to speak of them by name, for this gave them power over the speaker. Euphemisms like "the gentle people" or "the good neighbours" were used instead. Similarly, it was unwise to wear green, their chosen colour, or to frequent places known to be haunted by them. Those who visited fairyland, voluntarily or otherwise, usually had cause to regret it. In some stories, the visitor returns with scattered wits or drained vitality and dies soon afterward; in others, he finds that many earthly years have elapsed during what seemed only a short absence, so that all his friends are dead, his home in other hands and his own name barely remembered as that of one who disappeared long ago. If he eats food while in the enchanted region, he may never escape from it at all.

Yet, notwithstanding these perils, the folk tales of many countries suggest a close association between the fairy and human worlds. Fairies were often resorted to for their healing powers, and in their turn they frequently sought the aid of human midwives. Male fairies sometimes took mortal wives, or a fairy woman might consent to marry a man. Unions of the latter type were usually subject to some compact, the breaking of which ended the marriage. An English example of this tradition occurs in the story of Wild Edric, the Shropshire rebel-hero of William I's reign, who married a fairy from the Forest of Clun. She agreed to remain with him as long as he never reproached her with her alien origin. When he did so, she returned at once to her own people. Another example is the well-known French tale of Mélusine (*q.v.*).

Stories of loans or gifts made to or by fairies are common in British folklore. The Fairy Cauldron in Frensham church, Surrey, was supposed to have been so borrowed at some remote date and never returned. The Fairy Flag at Dunvegan castle, Skye, was a gift made to an ancestor of the MacLeods. Thefts of fairy treasures are also recorded, one famous example being the glass vessel known as the Luck of Eden Hall (in the Victoria and Albert museum, London), which was said to have been snatched from a fairy feast by a dependent of the Musgrave family. A very similar German folk tale records the theft of the famous Oldenburg horn, which Count Otto of Oldenburg is said to have stolen from an elf maiden in the 10th century. At Aagerup in Sjaelland (Zealand), Den., a golden altar cup in the church was believed to have been the gift of a man who stole it from the trolls and, being hotly pursued by them, vowed he would present it to the church if he escaped their vengeance.

The fairies themselves were arrant thieves and were occasionally detected robbing stalls at fairs and markets by those who had the power to see them. One of their most dreaded habits was that of stealing human babies and substituting a child of their own, so that it might have the benefit of human milk. Such a changeling could be recognized at once by its odd appearance. This idea sometimes had disastrous consequences for cretinous or deformed infants, who were brutally ill-treated in the belief that such action would bring the fairy mother to the rescue and force her to restore the human child.

Other stories speak of noted musicians or dancers lured away to perform at fairy revels or of girls acting as servants in fairy homes, sometimes, as in the Cornish tale of "Cherry of Zennor," without realizing their employer's alien nature. The fairy godmother is a comparative latecomer to folk tales, although akin to the Fates and Norns of pagan antiquity. She first appears in the form we know today in the French fairy tales of the 17th century.

Fairies varied considerably in form and habit. Some were of normal human size and appearance; others were small, ranging in stature from that of a child of 12 to minute beings like the flower fairies of Devonshire, or the portunes mentioned by Gervase of Tilbury (fl. 1211), in his *Otia Imperialia,* who were only three inches high. The *Daoine Sidhe* of Ireland were as tall as men, or taller, lovely and terrible in appearance and splendid in their way of life. They were organized in clans, with their own kings, queens and armies, and lived in subterranean palaces reached through caves or through gates magically opening in green hillsides. They passed their time in hunting, riding in procession, feasting, dancing and occasional clan warfare. They had little to do with mankind, except that they sometimes took human wives or husbands. (*See* CELTIC MYTHOLOGY; IRISH LITERATURE: *Early Period.*)

The commonest English fairies were of a more homely type whose lives closely resembled those of men. They were agriculturists and cattle keepers, weavers of cloth and workers in wood and metal. It was they who borrowed, lent or stole goods, played tricks on their human neighbours, sometimes sought their help, and generally came most closely into contact with mankind in friendship, malice or mischief.

Other fairies were of a solitary nature, living alone in remote places, like the Irish leprechaun. Some, like the brownie (*q.v.*), the house boggart and the ghostlike banshee (*q.v.*), attached themselves to human families as helpers or forewarners of death. There were also nature fairies who haunted woods, moorlands and rivers, either singly or in bands. The Scandinavian trolls and the German wood women were of this class, as were the Scottish kelpies and glaistigs and English water spirits like Jenny Greenteeth and Peg Powler. (*See* also DWARF; ELF.)

Origins of Belief.—Various theories have been evolved to account for the widespread and persistent belief in fairies. One is that it derives from memories of neolithic peoples precariously surviving in isolated communities after conquest by more advanced races. Such aborigines, with their superior knowledge of the countryside and of native gods, might easily be credited with magical powers, and occasional intermarriages, kidnappings and thefts between the two races would not be improbable. The case for this theory is strongest in connection with fairies of normal, or only slightly smaller than normal, size.

Another suggestion is that the tradition springs from legends of dethroned pagan gods and nature spirits whose worship was suppressed by the coming of Christianity. Many folk tales associated fairies with the Devil, who frequently takes the place of the old gods when folklore becomes Christianized. They were consulted by witches, who were supposed to be Devil worshipers; they feared and disliked contact with Christian holy things or the mention of holy names. Some wood and water fairies seem to preserve popular memories of the fauns, dryads and nereids of ancient pagan belief. The *Daoine Sidhe* in Ireland and the *Twylwyth Teg* in Wales have strong affinities with the displaced gods of those countries and may well be derived from them.

A third theory connects fairies with the dead. They were frequently found in the vicinity of barrows. Fairyland was usually believed to be an underground region and had certain resemblances to the Kingdom of the Dead in folklore tradition. Time ran differently in both places and it was dangerous for human beings to eat food in either. The known dead were sometimes seen in fairyland or riding with the fairy host. Some fairies, like banshees or the Cauld Lad of Hilton, were scarcely distinguishable from ghosts. In "The Fairy Dwellings of Selena Moor," a Cornish folk tale, it is explicitly stated that the fairies are in fact the dead.

The whole question of origins is extremely complex. No single explanation fits all the ramifications of this ancient and lively belief, which probably derives in part from all the suggestions mentioned above and from a variety of traditions, coloured and amplified by the fears and memories of simple people and the

imagination of poets, from the makers of ballads, to the more sophisticated poets of later ages.

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FAISAL (FAISAL IBN 'ABD AL-'AZIZ IBN 'ABD AL-RAHMAN AL SA'UD) (*c.* 1906–), king of Saudi Arabia from 1964, is a son of King Ibn Saud and brother of his own immediate predecessor, the former King Saud (*q.v.*). After Ibn Saud (*q.v.*) conquered Hejaz (1925), Amir Faisal became foreign minister and viceroy of Hejaz. In 1934 he led a victorious campaign in the Yemen-Saudi War. He represented Saudi Arabia at the United Nations Conference of 1945 and later at the UN General Assembly. After Saud's accession (1953), Faisal was crown prince, foreign minister, and (from 1954) president of the Council of Ministers. In March 1958 King Saud granted Faisal as president of the council full powers to save the state from bankruptcy. He introduced budgetary responsibility and drastic economies which restored financial stability. Saud regretted having ceded executive power, and disputes arose over royal expenditures and key appointments. In December 1960 Saud accepted the resignations of Faisal and the council and appointed a new council under his own leadership. In 1962 Faisal returned to power, inaugurated a program of economic and social development and administrative reforms, and abolished slavery. During 1963 King Saud spent months abroad for medical treatment. In March 1964 all powers were transferred to Faisal as viceroy of the kingdom and subsequently King Saud was deposed. These actions resulted from decisions taken by the supreme Council of Religious Leaders, by leading members of the royal family, and by the Council of Ministers, on the grounds that the king's failing health and his serious dissensions with Faisal threatened civil strife and chaos. On Nov. 2, 1964, Faisal became king of Saudi Arabia. Saud formally abdicated in January 1965. The accession of Faisal opened the way to new political reforms. His government committed itself to Arab solidarity and neutralism. *See* also SAUDI ARABIA: *History*.

See H. St. J. B. Philby, *Arabian Jubilee* (1952); G. Rentz, "Saudi Arabia: the Islamic Island," *Journal of International Affairs*, vol. xix, pp. 77–86 (1965). Documents concerning the statute of the Council of Ministers (1958) and the transfer of powers from King Saud to Faisal (1964) are in *Middle East Journal*, vol. xii, pp. 320–323, and vol. xviii, pp. 351–354. (C. P. H.)

FAISAL I (FAISAL IBN HUSAIN) (1885–1933) was king of Iraq from 1921 to 1933. The third son of Husain ibn Ali, sherif of Mecca and senior member of the family of the Prophet, he was born at At Ta'if in the Hejaz on May 20, 1885. Educated locally, and habituated to desert life, he moved in 1891 with his father to exile in Constantinople where he studied, learned politics and western ways, and in 1905 married his first cousin, Hazima. In 1909 he returned to Mecca with his father. During 1911–13 he accompanied expeditions against dissidents in 'Asir and in 1913 returned to Constantinople as a member of the Turkish Parliament.

In Syria in 1915 he became aware of the ambitions of Arab secret societies, was horrified by Turkish anti-Arab severities, and joined enthusiastically his father's British-assisted "Arab revolt" in the Hejaz. He thereafter commanded Arab forces in an exhausting desert campaign, under the high command of Gen. Edmund (later Field Marshal Viscount) Allenby until the capture of Damascus on Oct. 1, 1918. He then tried, in face of French opposition, to consolidate an Arab state in Syria, and in March 1920 was himself proclaimed king, but he was expelled from Syria by the French in July. Supported, however, by the British mandatory for Iraq, he secured election to a second throne, in Baghdad (1921), and for his remaining 12 years identified himself completely with the building up, strengthening, and liberation of his kingdom. He lived to see Iraq's admission to the League of Nations (1932), only to die at Bern, Switz., on Sept. 8, 1933. Profoundly mourned, he was succeeded by his son Ghazi. *See* IRAQ: *History*.

See T. E. Lawrence, *Seven Pillars of Wisdom* (1935); Mrs. S. Erskine, *King Faisal of Iraq* (1933); S. H. Longrigg, *Iraq 1900 to 1950* (1953), *Syria and Lebanon under French Mandate* (1958). (S. H. Lo.)

FAITH, in Christian thought, classically defined by the Epistle to the Hebrews as "the assurance of things hoped for, the conviction of things not seen." Most of the definitions of faith in the history of Christian theology have been little more than variations upon this biblical formulation. Of the nearly 250 instances of the noun "faith" (Greek *pistis*) in the New Testament, more than half occur in the writings of the apostle Paul—in fact, two-thirds if the authorship of the Epistle to the Hebrews is ascribed to Paul. Pauline thought and usage have therefore had much to do with shaping Christian language about faith; they have likewise been most prominent in the theological controversies over the meaning of faith and over its connection with other themes of Christian doctrine and life.

The Bible and Tradition.—As it is used in the Bible, "faith" has a variety of meanings. In its Hebrew root it carries the connotation of trustworthiness, reliability and loyalty, as the use of the adjective "faithful" still suggests. Frequently in the Gospels and Epistles the idea of confidence or trust is suggested by the use of the noun "faith" and especially of the verb "to believe." Yet in the Christian believer this confidence is not merely a subjective state of mind but an assurance or a conviction, as the definition in Hebrews makes clear. Thus faith as trust is a trust in that which is eternally real; it is not faith in faith or a vague pollyanism. There is only a short distance from this understanding of the objectivity of faith to the definition of faith by Thomas Aquinas as "the act of the intellect assenting to a divine truth because of a movement of the will, which is in turn moved by the grace of God." In reaction to what he regarded as the excessively intellectualistic cast of this definition, Martin Luther stressed the primacy of the element of trust, without, however, denying that faith as trust attaches itself to that which it knows to be true. John Calvin called it "a firm and certain knowledge of God's benevolence toward us, founded upon the truth of the freely given promise in Christ, both revealed to our minds and sealed upon our hearts through the Holy Spirit," and Protestant orthodoxy eventually divided faith into knowledge, assent and trust. Occasionally in the New Testament and much more regularly in the language of tradition, "the faith" is a technical term for the objective content of the Christian revelation, the creed (from the Latin *credo*, "I believe"), or what the Epistle of Jude calls "the faith which was once for all delivered to the saints."

Faith as Objective and Subjective.—This distinction between the objective and the subjective does not, of course, appear in the New Testament; in fact, present-day usage is an almost complete reversal of what the terms meant in scholastic and early modern philosophy. A traditional way of phrasing the distinction has been to speak of faith as that which one believes (*fides quae creditur*) and as that by which one believes (*fides qua creditur*). The correlate of faith is divine revelation. Where revelation is understood principally as the disclosure of divine truth or of sacred doctrine, there faith comes to mean the acceptance, on authority, of what has been supernaturally disclosed. Where, by contrast, faith is defined in more existential terms as an encounter between God and man, there the element of trust predominates over the elements of knowledge and assent. It would be an oversimplification to designate these two definitions as, respectively, Roman Catholic and Protestant, for the mystical and Augustinian traditions in Eastern Orthodoxy or Roman Catholicism have also emphasized the existential aspects of faith. On the other hand, the objectivity of revelation and the dependence of faith upon authority belong to an understanding of faith that characterizes both Roman Catholicism and orthodox Protestantism, although Protestant theology identifies this authority with the Bible alone while Roman Catholicism includes the teaching church in its view of authority. Objective faith is "faith *that*" this or that is divine truth, historical fact and authoritative dogma; it is, in the words of the Vatican council of 1870, "a supernatural virtue by which we, with the aid and inspiration of the grace of God, believe that the things revealed by him are true, not because the intrinsic truth

of the revealed things has been perceived by the natural light of reason, but because of the authority of God himself who reveals them." Subjective faith is "faith *in*" God as he is encountered in Christ; it is, in the words of Jacques Maritain about St. John of the Cross, a "faith that is one with the charity which informs it and the gifts that illumine it, faith as it acts concretely in a holy soul—loving, wise and fruitful" (*The Degrees of Knowledge,* Eng. trans. by G. B. Phelan, 1959; by permission of Charles Scribner's Sons and Geoffrey Bles Ltd.).

Faith as a Christian Virtue.—The relation between faith, hope and charity has long engaged the attention of Christian theology. If the meaning of faith were confined to the definition cited earlier from the Epistle to the Hebrews, the distinction between faith and hope would be difficult to specify. The distinction, according to Augustine, is that faith—in the sense of "faith that"—extends to many things, both good and evil, as for example to the existence of demons, and to things past, present and future; "but hope," he continued, "deals only with good things, and only with those which lie in the future, and which pertain to the man who cherishes the hope." Although faith and hope are more difficult to separate than are faith and charity, it is the relation between the latter that has been the occasion for theological controversy. Peter Lombard, and with him much of the medieval tradition, spoke of faith in its fullness as a "faith formed by love," *fides caritate formata.* Objecting to this formula as a denial of justification by faith without works, Luther and Calvin asserted that it was faith alone that took hold of the righteousness of Christ and salvation, although love did follow of necessity. Differ though they do about the definition both of faith and of the church, Roman Catholic and Protestant teaching agree that faith, like hope and charity, requires the community of the church for its proper nourishment and expression. (*See* also CHARITY; HOPE.)

The Certainty of Faith.—In both popular parlance and philosophical writing, faith is frequently equated with uncertainty: "I am not certain whether such and such is true, but I believe that it is." Traditional Christian theology has also distinguished faith from knowledge on the grounds that knowledge is based upon evidence while faith is based upon divine authority. But this does not mean that faith is less certain than knowledge; on the contrary, faith is free of the uncertainty caused by the fluctuations of knowledge and ignorance. Beset though it is by subjective difficulties and even by doubts, it retains its objective certainty; *i.e.,* the certainty of its object, which is God. With the decline in the prestige of the traditional proofs for the existence of God and with the loss of the authority of the church in western culture, however, this understanding of the certainty of faith has been replaced in the thought of many Christians by other views: a theory of double truth (as in medieval Averroism), according to which something may be true religiously but false scientifically, or vice versa; or (as in F. Schleiermacher) by a definition of faith as "a feeling of utter dependence"; or (as in Paul Tillich) by a generalizing interpretation of faith as "ultimate concern." Christian existentialism and the spirit of the age have both contributed to these redefinitions, but at the same time biblical study has uncovered the creedal elements in the New Testament and has thus recovered the "given" and objective character of Christian faith as faith in the word of God.

The history of the English language suggests that the earliest use of the term "faith," whether as confidence or as assent or as the objective revelation, was the religious use; only later was the term transferred to secular and purely human relations. For such historical reasons, and for reasons that transcend the historical, Christian theology teaches the priority of the God-man relation, that is, of faith, as the source from which the relation between man and man proceeds.

See also references under "Faith" in the Index volume.

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FAITH HEALING, or "spiritual healing," is the systematic seeking of heightened effect from the divine to remedy bodily or mental disability, either alongside or in place of medical care. Widely accepted as a part of prayer by the devout in various religions, faith healing takes on dramatic form when it becomes the central feature of a sect such as Christian Science, of a shrine such as Lourdes in France or of a reformer such as the famed 18th-century Jewish mystic, Israel of Moldavia.

Among preliterate peoples some form of faith healing is widely found alongside medicinal use of herbs and poultices. Usually associated with exorcisms, charms and the services of the shaman or medicine man, such faith healing has at times been the basis for a primitive secret society. In these phenomena observers have seen hints of the two kinds of faith healing that have recurred, often in tension with each other, in the history of the great religions (especially Hinduism, Buddhism, Greek religion, Judaism and Christianity): (1) healing mediated by individuals or small groups claiming direct access to the divine and (2) healing mediated by authorized priests or sacred organizations performing cultic acts.

The history of faith healing in Christianity began with the astonishing personal ministries of Jesus and the apostles (some 40 healings are recorded of Jesus alone), followed by the concentration of healing authority in the official sacraments, chapels, relics and pilgrimages of the church—and a decline of interest after the 3rd century. Since then periodic revivals of interest in faith healing have been associated with the persons of reformers in the Waldensian, early Lutheran, Anabaptist, Quaker and Wesleyan traditions as well as with the lives and intercessory miracles of Roman Catholic and Eastern Orthodox saints.

In the 20th century official church interest has again expressed itself in such vehicles as Catholic novenas and pilgrimages and in Protestant healing services as well as in the formation of orders, fellowships, conferences and commissions of clergy and physicians to study faith healing. During the same period the apparent healing gifts of individuals have attracted wide attention: in England, the Methodist pastor and theologian Leslie Weatherhead and the spiritualist practitioner Harry Edwards; in South Africa Elsie Salmon, the wife of a Methodist minister; in America Oral Roberts, the mass-meeting evangelist of healing, Agnes Sanford, the wife of an Episcopal rector, and the Presbyterian layman and Sunday school teacher Edgar Cayce. Less orthodox, the leading practitioners of New Thought and what William James called the "mind cure movements" have published numberless tracts and periodicals exhorting their followers to beliefs that stress the immanence of God and the essential unreality of disease.

Psychological and medical theories vary as to how the observable features of religious acts and attitudes might arrest the course of a disease or drastically speed up a recovery—or, on the other hand, complicate a disease and retard recovery. Possible explanatory hypotheses have been drawn from studies of hypnosis and suggestion, from studies of side effects of psychotherapy, from studies of psychosomatic links in illness, from studies of parapsychological effects that appear to join individuals at unconscious levels and from studies of temperament types. However, relatively little controlled research has been achieved on the many unknown factors in faith healing.

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FAITHORNE, WILLIAM (*c.* 1616–1691), English engraver and portrait draftsman noted for his fine line engraving, was born in London. He was a pupil of the painter Robert Peake, Sr., and the engraver John Payne. During the Civil War he was captured, imprisoned and exiled. In Paris he became the protégé of the print collector Michel de Marolles and may have

worked in the studio of Philippe de Champaigne. He returned to London in 1650 to become a print seller, printer and engraver. In 1662 he published *The Art of Graving and Etching*. His early engraving style is derived from Claude Mellan; his middle period combines Mellan's line technique with delicate point work, and it was in this middle period that Faithorne raised English line engraving to a level on which it competed with the best French work. In 1658 Faithorne published his maps of London and he made also maps of Virginia and Maryland. Examples of his portrait drawings are in the Ashmolean museum, the Bodleian library and the British museum. He died on May 13, 1691, in London. One of his sons, WILLIAM (1656–1710), became a mezzotint engraver.

See Louis Alexander Fagan, *A Descriptive Catalogue of the Engraved Works of William Faithorne* (1888). (C. H. C. B.; H. Es.)

FAIZABAD (FAYZABAD), a town and capital of the minor province of Badakhshan in northeast Afghanistan, is situated on the right bank of the Kokcha river, 195 mi. N.N.E. of Kabul and 4,000 ft. above sea level. Pop. (1960 est.) 20,000. It is the chief commercial and administrative centre for northeast Afghanistan and the Pamir region (*see* PAMIRS). In winter the town is sometimes cut off from the rest of Afghanistan by deep snow but in summer it enjoys a sparkling climate and a picturesque setting, surrounded by snow-capped mountains, green valleys and fast-flowing streams and rivers. The town has a school and a small hospital. Wheat, rice, beans, oilseed and cotton are grown in the district and there are rice and flour mills in the town. The population is mainly Tadzhik (Tajik) but there are many Uzbeks in the surrounding villages. Faizabad is linked by a precipitous road to Khanabad and Kunduz to the west and thence to Mazar-i-Sharif and Kabul. It is the gateway to the Munjan valley with its lapis lazuli mines to the south and to Zebak and the high Wakhan corridor leading to China in the east. Faizabad was destroyed by Murad Beg of Kunduz in 1821 and the inhabitants removed to Kunduz, but after Badakhshan was annexed by Abdurrahman Khan (*q.v.*) the town recovered some of its former importance.

FAJANS, KASIMIR (1887–), Polish-U.S. physical chemist, discovered (1913), simultaneously with F. Soddy, the displacement rule governing radioactive transformations resulting from alpha- and beta-ray emissions. He was born in Warsaw on May 27, 1887. After studying at Leipzig, Heidelberg (Ph.D. 1909), Zürich and Manchester, he joined the faculty of the Technische Hochschule at Karlsruhe (1911–17). He rose from associate professor to director of the Institute of Physical Chemistry at Munich (1917–35). From 1936 Fajans served as professor at the University of Michigan, Ann Arbor. He became a naturalized U.S. citizen in 1942. Thermochemistry, theory of chemical forces, photochemistry and light absorption are areas in which he became an authority. With O. Göhring, he discovered uranium X_2. Author of *Radioactivity* and of *Refractometry in Physical Methods of Organic Chemistry* with N. Bauer (1945), he was coeditor of *Zeitschrift für Kristallographie* (1924–29) and associate editor of *Journal of Physical and Colloid Chemistry* (1948–49).

His honours included the Victor Meyer prize (Heidelberg, 1909) and the Liège medal (1948). (V. Bw.)

FAJARDO, a town on the eastern coast of Puerto Rico. Pop. (1960) 12,409. The port of Fajardo has freight and passenger services to the off-lying islands of Vieques and Culebra. Water transportation is also available for the Virgin Islands of St. Thomas and St. Croix. A modern highway connects the town with San Juan, the island capital. Fajardo is the centre of one of the largest sugar corporations on the island. To the south of the town is the U.S. naval air base Roosevelt Roads. (T. G. Ms.)

FAKHR AL-DIN: *see* RAZI, AL-.

FAKIR, a term generally used in Arabic-speaking countries for a mendicant dervish (*q.v.*), is the transliteration of an Arabic word meaning "needy person." It refers to man's spiritual need of God, who alone is self-sufficient (Koran xxxv, 15). Although of Muslim origin it has come to be applied in India to Hindus as well, largely replacing *goswami, sadhu, bhikshu (bhikkhu), bawa* and other designations. Fakirs are common to all creeds in India, and in theory they belong to a religious order, but Muslim orders do not profess celibacy and the Hindu and other orders do not enforce it. Fakirs are generally regarded as holy men who are possessed of miraculous powers such as walking on fire. They are not influential in urban areas since the spread of education and the Industrial Revolution, but in the villages and the interior they retain some hold over the people. Some religious orders are active in the political field as well, and there is an all-India organization of *sadhus*. The chief Hindu orders are the *sanyasis, goswamis, yogis* and *bairagis;* the Sikhs have *udasis, nirmalas* and *akalis* (very active and militant politically); among the Muslims, the Chishtis, Qadiris, Naqshbandis and Suhrawardis are prominent and are influenced by Sufism (*q.v.*). (A. A.-A. F.)

FALAISE, a market town of northwestern France in the *département* of Calvados, the gateway to "Norman Switzerland," lies on the right bank of the Ante river, 34 km. (21 mi.) S.E. of Caen by road. Pop. (1962) 5,977. The castle, the oldest fortress in Normandy, was formerly the seat of the dukes of Normandy and the birthplace of William the Conqueror. It stands on a high crag overlooking the town and consists of a square mass defended by towers and flanked by a small donjon and the lofty Talbot's tower added by the English in the 15th century. Near the castle, in the Place Guillaume le Conquérant, is an equestrian statue in bronze of William the Conqueror by Louis Rochet (1851). The three old churches of St. Gervais, Ste. Trinité and Notre-Dame de Guibray are characteristic of the Norman, Gothic and Renaissance styles. In 1417 Falaise succumbed to Henry V of England and was in English hands until recaptured by the French in 1450. Factories making Camembert cheese, kitchen appliances and picture postcards have replaced the age-old tanneries. The surrounding countryside is rich in 18th-century châteaux and has studs where race horses are bred. Occupied by the Germans in 1940, Falaise was severely damaged during the Allied invasion of Normandy in the summer of 1944, when it formed the northern edge of the Falaise-Argentan pocket. It has been admirably rebuilt. *See* WORLD WAR II: *Allied Reconquest of Western Europe.*

FALANGE, a Spanish political party (in full, Falange Española, "Spanish Phalanx") founded in 1933 by José Antonio Primo de Rivera. It recruited its strength from youthful sectors equally disillusioned with the reactionary right and the revolutionary left. The Falange joined forces (Feb. 1934) with a similar group, Juntas de Ofensiva Nacional-Sindicalista, and issued a manifesto of 26 points. This repudiated the republican constitution, party politics, capitalism, marxism and class war, proclaimed the necessity of a national-syndicalist state, and it insisted (point 26) that "Falange desires a new order of things, its methods are direct, ardent and aggressive. Life is a battle and must be lived in a spirit of sacrifice and service."

Some early adherents stressed the aggressive note and in the months before the civil war young Falangist gunmen met their Communist or Socialist counterparts on equal terms. Despite parades, proclamations and pistols, the Falange made little headway in its first three years. In the election of Feb. 1936 which brought the popular front to power, the Falange polled, in Madrid, only 5,000 votes out of a total right-wing vote of 180,000, and its only representative in the *Cortes*, José Antonio himself, was defeated. With the coming of the popular front, and the rapid division of the country into revolutionary and counter-revolutionary bands, the Falangists as direct-action advocates gained increasingly in power at the expense of the moderates of the Catholic centre party which the Falange reviled. José Antonio was against commitment to any "reactionary movement," but events overtook him: he was a prisoner of the republic when the military uprising took place (July 1936) and was executed on Nov. 20, 1936.

Gen. Francisco Franco (*q.v.*) found in the Falange a potential bureaucracy, political structure and even an embryonic social theory ready to hand. True, it had to be reconciled with Traditionalist and Monarchist elements within the nationalist movement, but this was effected by the decree of April 19, 1937, whereby these potentially rival factions were forcibly merged into one body with the cumbrous title of Falange Española Tradicionalista y de las Juntas de Ofensiva Nacional-Sindicalista (F.E.T. y J.O.N.S.).

General Franco became its absolute chief; his brother-in-law Ramón Serrano Suñer its chief spokesman.

Henceforth its high-flown maxims were subordinated to military and political necessity, and its energies were distributed and largely dissipated through a network of government departments covering every aspect of civil and social life. Paradoxically, membership of the Falange became indispensable for political advancement and progressively ceased to have any original Falangist significance. Twenty-five years after the foundation of the F.E.T. none of the revolutionary tenets of the Falangist program had been realized, and while many of its leaders were in positions of trust and high emolument, it had virtually no voice of authority in the government.

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FALASHAS are Ethiopians of Jewish faith, claiming to be descendants from Menelik I, the alleged son of King Solomon and the queen of Sheba. They probably represent a segment of the indigenous Agau population that was converted to Judaism. Since they know only the Old Testament and have no knowledge of the Mishnah or the Talmud, their conversion must have occurred at the turn of the Christian era. The Falashas had an independent province until the 17th century, when the emperor Susenyos expelled them from Semyen, the northern part of Ethiopia, their residence for many centuries. They now live mostly in the region north of Lake Tana, though others are scattered throughout the country. The Falashas once had their own chiefs, but in modern times the administrative chiefs of their villages are Ethiopians elected by the local government. Spiritual authority is in the hands of the priests and the elders. There are probably 15,000–20,000 Falashas, some living in separate villages, some together with the Ethiopian population. The Falasha men are ironsmiths and weavers; the women make pottery. They also till the ground, but since they have no land of their own they rent it from the Ethiopians. The language of Falasha literature, including the Old Testament, is Geez or Ancient Ethiopic, but their spoken languages are those of their neighbours—that is, Amharic or Tigrinya (*see* SEMITIC LANGUAGES: *Ethiopic;* ETHIOPIAN LITERATURE: *Falasha Literature*). They most probably have never known Hebrew, but they had a language of the Cushitic family spoken today only in dispersed communities.

The religious life of the Falashas—which constitutes their major difference from the rest of the Ethiopian population—revolves around the synagogue (*māsgid*), the service being performed by the resident priest (*Kāhen*) of the village, who is nominated by the community. Each important community has a high priest, and it is the priest or the high priest who performs the daily prayers, blesses the circumcised child and the newly married couple, slaughters the sacrificial animal and consecrates the Sabbath and festival offerings. The animal sacrifices are offered on an altar located in the compound of the synagogue. There are six different prayers during the day and four at night, besides particular prayers for the Sabbath and the festivals. The Falashas have weekly, lunar and annual festivals and fasts, but the day celebrated in the strictest manner is the Sabbath. A boy is circumcised on the eighth day after birth and, as is customary in Ethiopia, the girl, too, undergoes a comparable operation or "excision." The Falashas also have monks who live in a monastery or in huts enclosed by a small stone wall on the outskirts of the village. A monk renounces conjugal life and is not even supposed to have contact with his fellow Falashas.

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FALCÃO, CRISTÓVÃO (*c.* 1515–*c.* 1553), Portuguese poet whose most famous eclogue has achieved added interest by a dispute about its authorship, was born at Portalegre in the province of Alentejo, of a noble but impoverished family. The details of his life are uncertain but he is said to have fallen in love with a young heiress, Maria Brandão, to have married her, and to have been separated from her by hostile parents. Because of this he was imprisoned for about five years, but was later restored to royal favour and employed on a diplomatic mission in Rome. His love story is told in the *Carta de um preso* and the charming eclogue *Crisfal*. Falcão's poems have resemblances to those of Bernardim Ribeiro to whom some critics have ascribed *Crisfal*.

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FALCÓN, a state in northwestern Venezuela, on the Caribbean bordering the Gulf of Venezuela. Area 9,575 sq.mi.; pop. (1961) 340,450. It consists of coastal lowlands and spurs which are outliers of the Andes. The state has a tropical wet and dry climate but because of the strong influence of the trade winds it is the dry period that dominates. Much of the land is quite useless for farming but the rearing of goats is important. Petroleum has been exploited on a large scale in the state but its importance stems from pipelines, refineries, storage facilities and loading terminals rather than production. There are some small oil-bearing formations in the barren north near the Caribbean, but the Falcón area is a declining one and has never produced more than a fraction of the total Venezuelan oil output. There are salt works at Mitare and fishing is carried on along the coast, mainly along the Paraguaná peninsula (*q.v.*). In the interior, particularly around Churuguara, sugar, coffee, cacao and other tropical crops are grown, and cattle are raised. Coro, the state capital (pop. 44,757), is the leading commercial and distributing centre. The chief ports are La Vela, Puerto Cumarebo and Tucacas. (L. We.)

FALCON is the term applied generally to almost 60 species of hawks of the family Falconidae, diurnal birds of prey characterized by long, pointed wings and swift, powerful flight; it is applied in a restricted sense, as true falcons, to the genus *Falco,* which numbers over 35 species. Most characteristic is crow-size peregrine falcon (*Falco peregrinus*), with races throughout the world except in Antarctica; the North American form is often called the duck hawk. It has a blue-gray back and a black head and cheek patches, and is buffy below, barred with black except on the throat. Its fierce alertness in the large, dark eyes and its lofty bearing marked this species as a "bird of nobility," and when falconry (*q.v.*) was the sport of kings the peregrine was the most popular falcon. A trained bird when released normally climbs for altitude with swift wingbeats before "stooping" with closed wings on flying waterfowl or other birds. Striking with clenched talons, it kills by impact, for its power dive may attain 180 m.p.h.

The gyrfalcon (*F. rusticolus*), a circumpolar species two feet long, has in most races white plumage that serves as camouflage. The desert falcons occupy the dry inland areas of the several continents and are paler than the peregrines. The American prairie falcon (*F. mexicanus*) haunts the western canyons; the aplomado falcon (*F. femoralis*), the brushy prairies of Central and South America. The Indian luggar (*F. jugger*) likes open scrub country. The lanner (*F. biarmicus*) and saker (*F. cherrug*) of southern Eurasia are found in open plains and semidesert.

BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

DUCK HAWK (FALCO PEREGRINUS ANATUM), A SUBSPECIES OF PEREGRINE FALCON

In true falcons the female is the larger and bolder and is most sought by falconers. The nest is made in tree cavities or on natural ledges on cliffs. Generally four or five eggs are laid, usually

buffy-white, speckled and blotched with reddish-brown. Eggs are incubated from about 28 to 35 days, and the young are cared for in the nest for as long as 35 days. The hooked bill in *Falco* species is toothed and notched. The legs are covered by long plumes called "flags."

Smaller, less-spectacular members of the falcon family are the sparrow hawk and European kestrel (*see* KESTREL). The hobby (*F. subbuteo*) and merlin, or pigeon hawk (*F. columbarius*), greatly resemble peregrines in colour and pattern, but are only about one foot long. The bat falcon (*F. albigularis*) of tropical America is somewhat similar.

Smallest are the sparrow-size falconets of circumtropical distribution. The malay falconet (*Microhierax fringillarius*) nests in tree holes and preys on insects and small birds, which it catches on the wing. The laughing falcon (*Herpetotheres cachinnans*), the forest falcon (*Micrastur semitorquatus*) and caracaras (*Daptrius* and *Caracara* or *Polyborus*) of tropical America are the most aberrant members of the family.

See H. Kirke Swann, *A Monograph of the Birds of Prey* (1924); E. T. Gilliard, *Living Birds of the World* (1958). (W. J. BE.)

FALCONE, ANIELLO (1600–1665), Italian painter, was born in Naples. He studied under Ribera (Lo Spagnoletto), was influenced by Domenichino and later by the Dutch school. He decorated the cupola of a chapel in San Paolo del Padri Teatini at Naples. He painted a "Flight Into Egypt" in the sacristy of Naples cathedral (signed and dated 1641) and the frescoes in the sacristy of Gesù Nuovo, also at Naples. He was famous as a battle painter, two of his battle pieces being in the Naples museum and in the Prado, Madrid. His many pupils included Salvatore Rosa. Some engraved plates have been attributed to Falcone without sufficient evidence.

FALCONER, WILLIAM (1732–1769), British poet, sailor and lexicographer whose poem *The Shipwreck* achieved wide popularity, was born in Edinburgh, Feb. 8, 1732. A poor barber's son, he went to sea in 1746. His survival, at 18, of the wreck of the "Britannia" off Cape Colonna inspired *The Shipwreck* (1762; revised 1764 and 1769), a long, conventional poem, giving nonetheless a sailor's firsthand account of a storm at sea. On the advice of the duke of York, to whom he dedicated the poem, Falconer then joined the navy and sailed on the "Royal George." He became the purser of the "Glory" in 1763. He continued to write, attacking John Wilkes and Charles Churchill in *The Demagogue* (1765), and published his useful *Universal Dictionary of the Marine* in 1769. He had meanwhile rejected an offer of partnership by the publisher John Murray in favour of the purserships of the frigate "Aurora" bound for India. She sailed on Sept. 20, 1769, reached the Cape of Good Hope on Dec. 27 and was never heard of again.

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FALCONET, ÉTIENNE MAURICE (1716–1791), French sculptor and chief exponent of "Pompadour" artifice, yet capable of the sublime (as in his statue of Peter the Great), was born in Paris on Dec. 1, 1716. He was first apprenticed to a carpenter and later became a pupil of J. B. Lemoyne. In 1744 he was elected to the Academy of Fine Arts upon presentation of his statue of Milo of Crotona (Louvre). He was nominated director of sculpture at the Sèvres factory in 1757 through Madame de Pompadour's influence. He supplied numerous models to be executed in Sèvres biscuitware (*e.g.*, "Pendule des Trois Grâces," Wallace collection, London), which gave a character of delicate, mannered grace to a whole phase of his work. From 1766 until 1778 he was in Russia, summoned by Catherine the Great, and sculptured the impressive equestrian statue of Peter the Great at St. Petersburg. He died in Paris on Jan. 24, 1791.

His writings were collected under the title of *Oeuvres Littéraires* (6 vol., 1781–82; 3 vol., 1787). A series of letters he exchanged with Diderot concerning the statue of Marcus Aurelius on the capitol in Rome was published in 1958. (P. LN.)

FALCONIDAE, a family of birds of prey that includes the falcon, caracara and kestrel (*qq.v.*). Among them are the magnificent hunting hawks used for hundreds of years in the sport of falconry (*q.v.*).

FALCONRY is the art of employing falcons, other hawks, and sometimes eagles in hunting game, often termed hawking. Falconry (Fr. *fauconnerie*, from late Lat. *falco*, "falcon") is a very ancient pastime practised by man even before he learned to write. There is conclusive evidence of the practice of falconry in Assyria in the period of Sargon II (722–705 B.C.). By A.D. 875 the sport flourished in western Europe and the British Isles. Merchants, adventurers and crusaders from Europe and England became familiar with falconry in the orient and on their return home brought falcons and falconers with them; in the middle ages it became the pastime of the more privileged classes.

Hawks, owls and eagles are killers by instinct. With skill and patience, they may be trained by man to kill selected quarry, but none, except possibly some of the eagles, will retrieve game. Some, because of their "personality" and flight habits, are more desirable than others. The most popular has long been the peregrine falcon. It is not only found throughout the world but possesses all the desirable traits. It can stand the climatic changes of any country, it is strong and swift, both gentle and fierce as required, and wild-caught birds are readily "retrained" by man. Only two groups of hawks (about a dozen species) possess such characteristics—the true falcons or long-winged hawks and the accipiters or short-winged hawks. Among the latter are the goshawk and the European sparrow hawk. (*See* also FALCON; HAWK.)

Falconers have their own picturesque language. The male hawk, which is smaller than the female by one-third, is the tercel. Only the larger female hawk is properly called the falcon. An eyas is a hawk taken from the nest when fully fledged but as yet flightless. Wild-caught immature birds are "passagers" because they often are caught when migrating and adults are haggards. After capture and until ready to be trained eyases are "at hack." While being hacked the birds are fed regularly on freshly killed animals tied to a board or block, always in the same spot. As soon as they are captured, hawks are always provided with a bell and leg straps or jesses. Eyases are seldom used in India and Africa but commonly so in Europe and the United States.

The would-be falconer should decide upon the best type of hawk for his own locality and cover conditions. The long-winged hawks are used in open country, while the short-winged accipiters are better equipped to work hedgerows and woods. Another difference between the two groups of hawks being considered is their method of killing. Falcons kill their quarry in the air, cleanly and at the end of a powerful dive or stoop. They do not cling or "bind to" their prey. On the other hand, the goshawk may perch in a tree watching intently while man and dogs beat the cover. When game is flushed, the goshawk dashes fiercely in pursuit, "binds to" its victim piercing the vital organs with its massive talons, then carries it to the ground. Goshawks are used for hunting hares,

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HOODED FALCONS

rabbits and pheasants. The smaller accipiters are best for blackbirds, starlings and small game such as partridges and quail.

Once the type of hawk is decided upon, the falconer must make another choice: shall it be an eyas from the nest or a wild-trapped hawk? The novice should always train an eyas first.

Trapping a wild hawk requires patience and skill. One method is to hide in a blind near a bow net set over a wild hawk's kill. As the hawk returns to its kill the net is pulled with a cord, and if successful the falconer at once removes the bird, attaches the leg jesses and places a soft leather hood or rufter over its eyes.

ERIC HOSKING

HOODED PEREGRINE FALCON (FALCO PEREGRINUS PEREGRINUS)

Training begins by carrying the hawk on the heavily gloved fist several hours each day while talking to it gently and stroking its plumage with a feather. When the hawk is able to feed from the fist without the rufter it is ready to be broken to the hood and to people, dogs and the like. Then it is trained to feed from the lure, a padded weight with wings of a pigeon or another bird attached and to which food is tied. The lure is thrown at considerable distances and the hawk taught to fly to and grasp it. After this is mastered the bird is trained to kill for itself. Now it is ready for hunting. Eyases are trained in much the same way as wild-caught birds.

Modern Falconry.—With the advent of the shotgun and after the enclosure of the open lands and numerous social upheavals in the older countries the noble sport of falconry nearly died out. However a revival of interest occurred after World War II, and in the United States alone there are more than 1,500 enthusiasts who are either full- or part-time falconers or are interested in the art and literature of falconry. (F. B. C.)

Falconry survived in Europe largely through the enthusiasm of members of hawking clubs in various countries. In Great Britain the Falconers' Society of England was founded about 1770 but ceased in 1838 with the death of the then manager, Lord Berners. Because of the scarcity of herons (a main quarry of the club's peregrines in East Anglia) and also partly because of the plowing up of the heath land over which the falconers rode, the centre of English falconry moved to the Netherlands and in 1839 the Loo Hawking club, an Anglo-Dutch society under the patronage of King William II of the Netherlands, was formed; in the first eight years of its existence 1,500 herons were taken by its hawks. In 1853 the royal patronage was withdrawn and the Loo club came to an end. For the next ten years falconry was kept alive in England by a few amateurs and their professional falconers. Then, in 1864, the Old Hawking club of England was founded, mainly to hawk rooks on the Wiltshire downs. It was wound up in 1926 and the British Falconers' club was founded in 1927. In the second half of the 20th century the British Falconers' club had a membership of about 150 but only half of these were resident in the United Kingdom, of whom only about 30 kept and flew hawks. The virtual disappearance of the rabbit due to myxomatosis and the placing of many of the traditional quarries on the protected list both had a profound effect on the sport after World War II. All British birds of prey except the sparrow hawk became protected by law, and a licence was required from the home office before an intending falconer could take a young hawk for falconry. Falconry clubs exist in other European countries. The French Club de Champagne went out of existence in 1870 but French falconers are organized in the Association Nationale des Fauconniers et Autoursiers Français. In Germany, the Deutscher Falkenorden was founded in 1923 and is a thriving club. Austria has its club, and Italy the Circolo dei Falconieri d'Italia.

Falconry is still practised by the Arabs in Cyrenaica, and oil-rich sheikhs in Saudi Arabia and the Persian gulf still train their saker falcons to hunt bustard. In Indian and Pakistan Punjab and in the Northwest Frontier region of Pakistan falconers fly their falcons at duck and their goshawks at partridge. Much-prized Indian hawk bells are made at Lahore and Amritsar. A few falconers survive in Japan, flying their Japanese hawk eagles at hares and their goshawks at pheasants. (M. H. Wo.)

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FALERII: *see* CIVITA CASTELLANA.

FALGUIÈRE, JEAN ALEXANDRE JOSEPH (1831–1900), French sculptor, whose most significant works were his naturalistic female nudes, was born at Toulouse on Sept. 7, 1831. He won the Prix de Rome in 1859 and became a member of the Institute in 1882. His "Victor of the Cock-Fight" (1864) and "Tarcisus the Christian Boy-Martyr" (1867) are in the Luxembourg. Falguière's more important monuments are those to Admiral Courbet (1890) at Abbeville and the famous "Joan of Arc." His "Triumph of the Republic" (1881–86), a vast quadriga for the Arc de Triomphe, Paris, was perhaps more amazingly full of life than others of his works, all of which revealed this quality of vitality in superlative degree.

To these works should be added his monument to "General de La Fayette" (in Washington), and his statues of "Lamartine" (1876) and "St. Vincent de Paul" (1879). His "Balzac" was executed for the Société des Gens de Lettres on the rejection of that by Rodin. "Diana" and "Woman and Peacock" are examples of his sensual treatment of the human form which aroused accusations of vulgarity from his contemporaries. He died in Paris on April 19, 1900. Falguière was a painter as well as a sculptor, but somewhat inferior in merit.

FALIER, MARIN (*c.* 1285–1355), doge of Venice from 1354 to 1355, whose brief tenure of office was cut short by his execution for conspiracy, belonged to one of the oldest Venetian patrician families and was trained accordingly for the magistrature. Head of the Council of Ten in 1320 and again in 1327, bailiff of the Negropont (Euboea) in 1323 and later, and commander of a naval squadron in 1333, Marin Falier moreover governed Farra, Padua and Treviso in turn for Venice as *podestà*. During Venice's struggle with Genoa and Hungary for control of the Adriatic, he played a prominent part in the military operations at Zara and Capodistria, and in the negotiations with Genoa (1350) and with the king of Hungary (1351). When the dispute with Genoa degenerated into war (1352), Falier, in command of a squadron, occupied Tenedos; he vigorously defended Venetian rights in Dalmatia against the demands of the king of Hungary (1353); and not least he was the organizer of the league with the Italian lords against Giovanni Visconti, to whom the Genoese had submitted (1354). His election as doge on Sept. 11, 1354, took him unawares during his negotiations at Avignon with Pope Innocent VI to resolve the critical dispute with Genoa.

It was Falier's misfortune to have been elected doge for his energy and experienced statesmanship at a time when political jealousy was curbing the doge's initiative in matters of foreign policy. Further, naval defeat by Genoa at Portolongo (1354) at the beginning of his dogeship turned him from a policy of peace to one of war, contrary to the predominant feeling in the city. Against this background a conspiracy was formed to restore personal power, but the plot miscarried, and Doge Falier was executed after formal trial on April 17, 1355. The mysterious origin of the conspiracy has been largely distorted by later literature and should be ascribed not to some trifling insult offered by Michele Steno to Falier's wife or to some ill-conceived dream of power but more probably to the acute political tension arising from domestic financial and economic stress and to the grave situation in foreign affairs resulting from ill success in war. *See* also VENICE: *History*.

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FALISCI, an ancient people of southern Etruria, between the Tiber river and Mt. Cimini, a region bounded by the Etruscan territories of Volsinii on the north, Tarquinii on the west, Veii on the south and by the Umbrians and Sabines on the east. Falerii (mod. Civita Castellana in the province of Viterbo), north of Mt. Soracte (Soratte), was the Faliscan capital, but the exact territorial limits are not known. Fescennia, probably the place where the Fescennine verses (*q.v.*) originated, and Soracte are described as Faliscan towns by ancient authors, and inscriptions in Faliscan dialect have been found at the later Roman *Colonia Falerii* (modern Faleri or Falleri), Carbognano, Corchiano and Capena, as well as at Civita Castellana itself.

The Falisci differed from the Etruscans both in nationality and speech. Inscriptions reveal a speech close to Latin but written in an etruscanized alphabet. The most celebrated Faliscan inscription is written on a 4th-century B.C. cup in the Villa Giulia, Rome: *foied vino pipafo cra carefo* = Lat. *hodie vinum bibabo* (= classical *bibam*), *cras carebo,* "I shall drink wine today, tomorrow go without it."

Objects in early Faliscan graves are indistinguishable from early Etruscan objects and there are rich Villanovan (Early Iron Age) graves at Narce in the Treia valley about 5 mi. from Falerii. Culturally the Falisci belonged to the Etruscan sphere and from 437 B.C. onward joined with Veii in the Etruscan alliance against Rome, and in 293 fought with Etruscans in the general war against Rome. In the First Punic War the Falisci still defied Rome's power: Falerii therefore was razed in 241 B.C.

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FALKE, GUSTAV (1853–1916), German poet and novelist, whose poetry, much influenced by the folk song and by the romantic poets, is tender and feminine in mood and celebrates simple domestic pleasures. Falke was born at Lübeck on Jan. 11, 1853, and earned his living first as a bookseller and then as a teacher of music, until a pension from the Hamburg government allowed him (from 1903 onward) to devote all his time to writing. He died at Grossborstel near Hamburg on Feb. 8, 1916. His best-known verses are contained in *Mynheer der Tod* (1892), *Hohe Sommertage* (1902) and *Frohe Fracht* (1907). His novel *Der Mann im Nebel* (1899) is still read. His *Gesammelte Dichtungen* (5 vol.) appeared in 1912.

See H. Spiero, *Gustav Falke* (1928). (W. D. Wt.)

FALKENHAYN, ERICH VON (1861–1922), German military officer, minister of war and chief of the general staff before and during part of World War I, was born at Burg Belchau in West Prussia on Nov. 11, 1861, of an old officer family. On leaving the cadet school he joined the infantry. Unlike most German officers, he served outside Europe for some time, being an instructor to the Chinese army and also a member of the Prussian general staff in the international expedition of 1900 against the Boxers.

In July 1913 Falkenhayn became Prussian minister of war, an appointment commonly held by a member of the general staff. He was thus responsible for the armaments and equipment of the German army. In this he clashed with H. J. L. von Moltke, the chief of the general staff, whose recommendations on equipment he partly ignored. Moltke later held this to be the main cause of the army's failure in France in 1914.

On Sept. 14, 1914, Falkenhayn was appointed by the emperor, William II, as Moltke's successor. This was not publicly announced until the end of the year and Falkenhayn stayed on as minister of war until Jan. 1915. For the next two years he remained responsible for the general strategy of the war, while manpower, the economy and morale gradually declined, and difficulties with Germany's ally, Austria-Hungary, increased. In spite of local successes, especially against Russia, Falkenhayn could not stage a decisive victory either on the eastern or on the western front. In Aug. 1916, mainly because of the costly failure of the offensive against the French fortress of Verdun, he resigned and was succeeded by Hindenburg.

From 1916 to 1917 Falkenhayn led the German army against Rumania. Then he commanded the mainly Turkish forces in Palestine, where he failed to stay the British attacks and was succeeded in Feb. 1918 by Liman von Sanders. He died at the castle of Lindstet, near Potsdam, on April 8, 1922.

Falkenhayn was a favourite of the emperor and took an interest in politics and the affairs of the imperial court. Otherwise he was a typical member of the German officer class—a highly trained staff officer, of striking appearance, with a keen sense of duty and a capacity for hard work. Still, it seems that he could not rise to the great problems of policy and strategy facing a chief of general staff. *See* also references under "Falkenhayn, Erich von" in the Index volume.

See A. Alberti, *General Falkenhayn* (1924); H. von Zwehl, *Erich von Falkenhayn* (1926). (C. N. B.)

FALKIRK, a large and parliamentary burgh of Stirlingshire, Scot., 11 mi. S.E. of Stirling by road and about midway between Edinburgh and Glasgow. Pop. (1961) 38,043. Falkirk stands on high ground overlooking the fertile Carse of Falkirk. The Forth and Clyde canal passes through the north of the burgh and the Antonine wall runs through the southern end. The suburb of Camelon is the site of successive Roman forts. Grangemouth (*q.v.*), the port, lies 3 mi. N.E. The Gaelic name, Eaglais Bhreac (1166), the Latin Varia Capella (1166) and the English Faw Kirk (1298) all mean "speckled (or many-coloured) church." The place was mentioned by Simeon of Durham (early 12th century) as Egglesbreth.

The first church was built by Malcolm III (Canmore), but the present church is of the early 19th century. The town became a burgh of barony in 1600 and of regality in 1646 under the important Livingston family who had held the estate of Callendar (with its *caput* immediately southeast of Falkirk) since the mid-14th century. They were forfeited after the rebellion of 1715 and the regality was canceled. Control of the town fell eventually into the hands of the stentmasters (a body of men elected by the trades to levy a "stent" to be spent for the common good), who governed its finances until 1857. Falkirk is now under the control of a council with provost and bailies, and combines with Stirling and Grangemouth to return one member to parliament.

The long-important trysts or sales of cattle and sheep, known as the Great Mercat, were transferred to Falkirk from Crieff in about 1750, but only local markets are now held. The district is rich in coal, and fire clay is mined, though iron is no longer worked. Falkirk is the chief seat of the light-casting trade in Scotland; other industries include aluminum rolling, precast concrete, chemicals and hosiery manufacture. Brewing and bookbinding are also carried on.

Carron, 2 mi. N.N.W., is well known for the ironworks established in 1759 by John Roebuck for whom John Smeaton and James Watt (*qq.v.*) worked. The carronade, an old type short iron naval cannon, was first made there. (X.)

Battles of Falkirk.—These were two engagements, one fought in 1298, the other in 1746.

The battle of July 22, 1298, was fought between the forces of Edward I of England and those of the Scottish national party under the command of Sir William Wallace. The Scots had taken up a strong position on a hillside south of the town with an impassable marsh to their front, and were formed in four "schiltrouns" or dense circles of spearmen, with archers between the schiltrouns and a small body of mounted men in reserve. The English first line, under the earl marshal and the earls of Hereford and Lincoln, tried the morass in vain and then rode round its western side. The second line, commanded by the warlike bishop of Durham, Antony Bek, rounded the marsh to the east and then halted to await the arrival of the third line under the king. The bishop's undisciplined and impatient followers, telling him to go back to his

Mass and leave warfare to soldiers, charged the nearest schiltroun. The first line under the earls attacked on the other side but Wallace's "forest of spearmen" resolutely repulsed all attacks with heavy loss. The Scottish cavalry fled without striking a blow, except for a few leaders such as Sir John de Graham and Sir John Stewart who remained to die with the archers and spearmen. Seeing that his cavalry could make no headway, Edward brought up his Welsh archers, who from a safe distance wrought such havoc among the schiltrouns with arrows and stones that the mounted troops were at last able to break the weakened and disorganized Scottish ranks and complete their destruction. It was the first victory of the longbow in a major battle.

At the second battle of Falkirk, fought on Jan. 17, 1746, the Jacobites, under Prince Charles Edward, defeated the government troops under Gen. Henry Hawley. Hawley had formed the opinion that a Highland army could not withstand a charge of cavalry and allowed them to occupy the high ground to the west of Falkirk. The dragoons, attacking uphill against driving rain, broke under the controlled and heavy fire of the Highland right under Lord George Murray. Most of the infantry became involved in the rout and Hawley fell back to Edinburgh with heavy losses in men, guns and stores. (R. L. He.)

FALKLAND, LUCIUS CARY, 2nd Viscount (*c.* 1610–1643), English statesman, who attempted to exercise a moderating influence in the struggles that preceded the Civil War, is chiefly remembered through his friendship with Edward Hyde (afterward earl of Clarendon). The son of Sir Henry Cary (afterward 1st Viscount Falkland), lord deputy of Ireland from 1622 to 1629, Lucius Cary was born in Oxfordshire in 1609 or 1610 and was educated at Trinity college, Dublin. He inherited the manors of Great Tew and Burford in Oxfordshire from his grandfather in 1629 and succeeded his father as Viscount Falkland in 1633.

Falkland assembled round him at Great Tew many learned men. He was the friend of John Hales and William Chillingworth, was celebrated by Jonson, Suckling, Cowley and Waller in verse, and in prose by Hyde, who is eloquent in describing the virtues and genius of the "incomparable" Falkland, and draws a delightful picture of his society and hospitality. With Hales and Chillingworth Falkland sought to promote a liberal strand in the theology and church policy of his day, stressing the importance of what the rival parties held in common, and recommending a broad-based nonsacerdotal church establishment.

Falkland served as a volunteer under the earl of Essex in the campaign of 1639 in the Bishops' Wars. In 1640 he was returned for Newport, Isle of Wight, to the Short and Long parliaments, and took an active part on the side of the opposition. He spoke against the exaction of ship money on Dec. 7, 1640, denouncing the servile conduct of Lord Keeper Finch and the judges. Falkland supported the prosecution of the earl of Strafford and he voted for the third reading of the attainder. On the church question he deprecated clerical encroachment in secular matters, and attacked Archbishop William Laud for the promotion of ceremonies and for the repression of Puritans; on the other hand, though he denied that episcopacy existed *jure divino*, he was opposed to its abolition, fearing the establishment of the Presbyterian system, which in Scotland had proved tyrannical. In fact Falkland sought compromise, but a bill simply excluding the clergy from secular offices failed, and the Root and Branch bill, for the total abolition of episcopacy, was introduced in the house of commons on May 27, 1641. This measure Falkland opposed, as well as the second bill for excluding the bishops, introduced on Oct. 21. In the discussion on the Grand Remonstrance he took the part of the moderates under Hyde. He was now definitely ranged against the policy of the majority in the house of commons, and on Jan. 1, 1642, was persuaded by Hyde to accept the secretaryship of state, though, like Hyde himself, he had no decisive influence in the king's councils.

On June 15, 1642, Falkland signed the protestation against making war at York. On Sept. 5 he carried Charles's overtures for peace to the parliament, when he informed the leaders of the opposition that the king consented to a thorough reformation of religion. The secret correspondence connected with the Waller plot passed through his hands. He was present with the king at Edge Hill and at the siege of Gloucester. By this time the hopelessness of the situation had overwhelmed him and, according to his intimate friend, Hyde, he welcomed death on the battlefield as an escape from the catastrophe he foresaw as inevitable. Riding alone at a gap in a hedge commanded by the enemy's fire in the battle of Newbury (Sept. 20, 1643), he was immediately killed.

Falkland wrote a *Discourse of Infallibility* (1646); *A Letter . . . 30 Sept. 1642 Concerning the Late Conflict Before Worcester* (1642); and Poems (ed. by A. B. Grosart, 1871, in Fuller's Worthies Library) in which he shows himself a follower of Ben Jonson.

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(B. H. G. W.)

FALKLAND, a royal burgh and civil parish of Fife, Scot., at the northern base of the hill of East Lomond (1,471 ft.), 21 mi. N. of Edinburgh and 16 mi. S.E. of Perth by road. Pop. (1961) 1,032. The little town, with its cobbled streets and many old houses, has been connected with Scottish kings since the 12th century. The castle was replaced by Falkland palace which, from the 16th century, became a favourite seat of the Scottish court. It was finished in 1540 by James V who died there in 1542. Its east wing was partly destroyed by fire in 1654 while Cromwell's forces were in occupation; only the foundations remain of the north wing; the south wing was rebuilt by the 3rd marquess of Bute, who acquired the property in 1887. The gardens have been restored to their original royal plan and at Falkland is the only royal tennis court left in Scotland. In 1952 the National Trust for Scotland became deputy keeper of the palace.

Falkland became a royal burgh in 1458 and its charter, which dates from 1160, was renewed in 1595. It gives the title of viscount to the Devon family of Cary (granted in 1620). Richard Cameron (*q.v.*) the Covenanter was born at Falkland *c.* 1648 and his thatched house still stands. The chief industries are linen and linoleum.

FALKLAND ISLANDS, BATTLE OF THE, the British victory over the German East Asiatic cruiser squadron in World War I. When the British admiralty learned of the battle of Coronel (*q.v.*) on Nov. 1, 1914, prompt measures were taken to restore the Royal Navy's supremacy at sea and to remove the threat which the victorious German squadron, under Vice-Adm. Graf M. von Spee, would constitute to British sea-borne trade if it entered the Atlantic. Two battle cruisers, "Invincible" and "Inflexible," were ordered south from the British grand fleet, and on Nov. 11 they sailed from Devonport under Vice-Adm. Sir Frederick Doveton Sturdee for the Falkland Islands, the main British base and coaling station in the South Atlantic. Other ships joined Sturdee on the journey, and on Dec. 7 he reached Port Stanley with the battle cruisers, three County-class cruisers, two light cruisers and the armed merchantman "Macedonia." The battleship "Canopus" was already at Port Stanley as guard ship.

Sturdee ordered "Macedonia" to patrol outside the harbour, and the remainder of his fleet immediately began coaling. They were thus not in the best position to repel an attack when, at 8:30 A.M. next day, lookouts reported the approach of Graf von Spee's squadron, consisting of the armoured cruisers "Scharnhorst" and "Gneisenau" and the light cruisers "Nürnberg," "Leipzig" and "Dresden."

It is not known exactly why the German admiral decided to attack the Falkland Islands, but it is certain that no one aboard the German ships suspected the presence there of British battle cruisers. The German ships turned away, but by midday it was obvious that they were doomed. The day was fine, visibility excellent, the British ships were out of harbour and the gap between the two fleets was rapidly narrowing. At 1:20 P.M. in a gallant attempt to protect his light cruisers, Graf von Spee ordered "Scharnhorst" and "Gneisenau" to turn and accept battle. Sturdee, however, had foreseen this maneuver, and the light cruiser "Glasgow" and the County-class cruisers "Cornwall" and "Kent" were immediately detached to chase "Leipzig," "Dresden" and

"Nürnberg," while the battle cruisers engaged the German armoured cruisers.

The German gunnery was excellent and their ships fought with great gallantry, but against the 12-in. lyddite shells of the battle cruisers they had no protection. By 4 P.M. "Scharnhorst" was a battered hulk, her funnels gone, her guns out of action, afire fore and aft; at 4:17 P.M. she turned on her beam ends and sank, taking with her the German admiral and her entire ship's company. "Gneisenau" fought on against the two battle cruisers and the cruiser "Carnarvon" until all her guns were out of action. At 5:40 P.M. her captain gave orders to fire explosive charges in her hull and the ship sank shortly after 6 P.M. Of the crew, 187 were saved.

Of the German light cruisers, "Nürnberg" sank at 7:27 P.M. after a gallant action with the "Kent"; "Leipzig" sank shortly after 9 P.M. after a long action with both "Cornwall" and "Glasgow." "Dresden" escaped but was hunted down and finally brought to bay off Mas a Tierra on March 14, 1915. There were 7 survivors from "Nürnberg" and 18 from "Leipzig." British casualties amounted only to 10 killed and 15 wounded.

See B. Pitt, *Coronel and Falkland* (1960). (B. W. E. P.)

FALKLAND ISLANDS AND BRITISH ANTARCTIC TERRITORY. The Falkland Islands, a group of islands in the South Atlantic ocean, belonging to Great Britain, lie between latitudes 51° S. and 53° S. and longitudes 57° W. and 62° W., and about 250 mi. E. of the nearest point on the South American mainland. The two principal islands, East Falkland and West Falkland, are separated by the Falkland sound, a narrow strait running northeast to southwest and 25 mi. across at its widest point, the southern entrance. Round them lie about 200 smaller islands, of which about a dozen are inhabited. The total area is 6,188 sq.mi. Pop. (1962) 2,172. Capital, Stanley. (*See* below, *Falkland Islands Dependencies and British Antarctic Territory.*)

Physical Features.—The coast line is deeply indented and affords many secure and sheltered anchorages. In dull weather, which predominates, the general appearance of the islands is uninviting, but under bright sun the scenery takes on colour and beauty. East Falkland is almost bisected by the Choiseul and Brenton sounds. Its hilly northern part is traversed by the Wickham heights, a rugged range running from east to west with its highest point at Mt. Usborne (2,245 ft.). The remainder of the island is mainly low and undulating ground covered with coarse grasses, with small streams feeding the valleys but also with extensive bog and shallow tarns and much stony outcrop. Seen from the air, its appearance is bleak and inhospitable. At the northern extremity are two fine inlets, Berkeley sound and Port William. The early seat of government, Port Louis, lay at the head of the former but it was moved in about 1844 to its present site at Stanley, a landlocked harbour within Port William.

West Falkland enjoys a gentler climate. Its hillier part lies to the east of the island where the Hornby hills, running parallel to the Falkland sound, reach their highest at Mt. Adam (2,290 ft.).

The small town of Stanley is built along the southern slope of Port William inlet, overlooking the harbour, and on a fine day presents an attractive picture with its cluster of clapboard houses with their painted roofs and their porches gay with flowers. It is dominated at one end by the red brick Anglican cathedral and at the other by Government house.

With the exception of Lafonia (the southern part of East Falkland), which is Permocarboniferous, the islands consist of the older Paleozoic rocks, Lower Devonian or Upper Silurian, slightly metamorphosed and a good deal crumpled and distorted. In the low grounds are clay, slate and soft sandstone and on the ridges hard sandstone passing into white quartzite. There are no minerals of value. Many valleys in the islands are characterized by the presence of "stone runs" of varying length which upon examination are revealed as extensive accumulations of quartzite boulders, from 2 ft. to 20 ft. long and half as wide and with a depth corresponding to the quartzite ridges of the hills above. These blocks or boulders, angular in form and resting irregularly, though close packed, one upon another, give an unmistakable impression of a river of stone flowing down toward the sea.

The Falkland Islands correspond in latitude in the southern hemisphere with London in the northern, and the temperature is equable with an annual mean of 43° F. The climate is not unlike that of the Outer Hebrides though somewhat colder. Its most trying feature is a persistent wind that blows at an average strength of 15 knots throughout the year and often with great force. The average annual rainfall (27 in.) is rather more than that of London, but the hours of sunshine, though fitful, are much the same. The strong winds and tempestuous seas have accounted for more than 130 wrecks around the islands and the hazards of navigation have been enhanced by the lack of beacons. There is only one lighthouse, at Cape Pembroke, but automatic lights have been placed at a number of danger points.

There is no evidence of human occupation before the establishment of the first settlement at Port Louis, in 1764, by L. A. de Bougainville. The land fauna is scanty. A small wolf or wild dog —the *loup-renard* of De Bougainville—is extinct, having last been seen in 1875. There are introduced hares and rabbits and, on two of the islands, Patagonian foxes, which have become a menace to young lambs. The herds of cattle that ran wild after the departure of the first settlers and bred prolifically have almost died out, and sheep, which were first raised on East Falkland in 1835, provide the sole economy of the islands. The whole colony is divided into sheep farms varying in size from 3,600 ac. to 400,000 ac. These carry a total in excess of 600,000 head with an average production of about 5,000,000 lb. of wool annually. The mortality, especially among lambs, is very high. Hair seal (sea lion and elephant seal) abound but attempts to exploit them commercially in the 20th century have failed. The southern fur seal, which was almost exterminated by wholesale killing in the 19th century, is re-establishing itself as the result of close protection. There are a few species of land birds, some of which, including the white-rumped sandpiper of North America, the Paraguayan snipe and the military starling, are migratory. There is a great wealth of sea birds and the islands possess large colonies of penguins, petrels and albatross. The only insect pest is the bluebottle.

As the islands are connected with subantarctic South America by an elevated submarine plateau, the island flora much resembles that found on the mainland except that the trees, of which there are such dense forests in southern Patagonia, are wholly absent. Attempts at tree planting have not met with success. The greater part of the land is formed of peat which is in some places of considerable age and depth and, at the bottom of the beds, dense and bituminous. It differs in character from the peat of northern Europe, for the lower plants enter but little into its composition and it is formed almost entirely of the roots and stems of *Empetrum nigrum* variety *rubrum*, a kind of crowberry bearing the local name of diddle-dee; of *Myrtus nummularia*, a small creeping myrtle known as teaberry; and of sedges and sedgelike plants. It is in general use as fuel. Two vegetable products, balsam bog (*Azorella caespitosa*) and tussock grass (*Poa flabellata*), have long been objects of interest. The first is a boulder-shaped, bright green mass which when dead becomes gray and stony in appearance. When cut open it reveals an infinity of minute leaf buds and stems from which, at intervals, exudes an aromatic resin. The second is not unlike an African sword grass but has broader leaves and grows in tufts that rise about six to ten feet high. The leaves are cut and fed to dairy cattle and horses and, having a high protein content, make admirable fodder. With the introduction of sheep, which eat the heart of the plant, the tussock grass was threatened with extinction on the main islands. Where it survives it is fenced in. On many of the smaller islands, where it is prolific, cattle and horses are put out to winter and, as they feed only on the leaves, do the plant no harm.

History.—The Falklands were discovered by the English navigator John Davis (Davys) in the "Desire" in 1592 and two years later Sir Richard Hawkins sailed along their northern shore. In 1598 Sebald van Weerdt appears to have visited some of the northern islands of the group (probably the Jasons), which were for long named the Sebaldine Islands. The Falklands derive their present name from Capt. John Strong, who, in 1690, sailed down

the sound separating the eastern and western islands and called them after Lucius Carey, Viscount Falkland, then treasurer of the navy. Their existence had long been known to French mariners sailing out of St. Malo for the Río de la Plata who called them Les Îles Malouines, which the Spaniards on the mainland converted to Las Islas Malvinas.

Recorded history begins with the establishment by De Bougainville of a party of settlers on East Falkland in 1764. In the following year Capt. John Byron, who had been sent out on a survey expedition, claimed the islands for Great Britain and left a small party at Port Egmont on Saunders Island. In 1766 the French settlement was withdrawn under pressure from Spain, which later (1770) ejected the British party—an action that brought the two countries to the brink of war. Port Egmont was restored to Britain in 1771 but was voluntarily abandoned three years later. In 1829 the Republic of Buenos Aires, which claimed to have inherited the rights of Spain, sent Louis Vernet to develop a colony in its name; he made some progress but in 1831 was rash enough to seize three U.S. sealing vessels and this brought down a U.S. corvette, the "Lexington," which "laid waste the Settlement and proclaimed the islands free of all governance." In 1833 Great Britain, which had never renounced its claims to sovereignty, resumed official occupation. The colony was under the charge of successive naval officers engaged on hydrographic work until 1841 when a civil administration was set up at Port Louis and continued from that time. In 1914 the adjacent waters were the scene of the battle of the Falkland Islands (*q.v.*), and during World War II Stanley was an important naval base and radiotelegraphy station.

Claims are outstanding by Argentina to the Falkland Islands and their dependencies and to the antarctic continental shelf opposite Argentina, and by Chile to territories lying between longitudes 53° W. and 90° W., including the South Shetlands. The claims of the two countries overlap and are contested by Great Britain. Bases were set up by both claimants in the territories claimed. Great Britain sought the arbitration of the International Court of Justice, but the court refused arbitration in March 1947 because Argentina and Chile had rejected its competence to adjudicate. A truce between the three countries, agreeing not to move warships south of 60° S. latitude, was renewed from time to time, and the 12-nation agreement of Dec. 1959 on the peaceful use of the antarctic continent, involving a moratorium on territorial claims, served to relax tension.

Administration and Population.—The administration follows the normal crown colony pattern under a governor who is appointed by the crown and is himself advised by an executive council of four official and three unofficial members. The lawmaking body is the legislative council comprising five official and six unofficial members, of whom four are popularly elected. There is thus an unofficial majority. There is no public debt and the colony is self-supporting. The revenue is derived mainly from income tax and from duty levied on imports of malt, wine, spirits and tobacco and upon the exports of hides and skins, tallow and wool. In the case of wool the duty is assessed on the average price for the season's clip. The islands have no other resources and apart from meat, fish and vegetables are dependent on external supply. The biggest single landowner is the Falkland Islands company, which obtained a royal charter in 1851. This company is responsible for the shipment and delivery to the London market of the annual wool clip. It acts as general agent for the farms and owns a large retail store and workshops at Stanley.

About half the population live in Stanley and the remainder on the farms. Most are of British descent but there are some Scandinavian strains. Family allowances are paid by the government, provided there are two or more children, and there is a contributory old-age pension scheme for male workers. Education is the responsibility of the government, which maintains two schools in Stanley where attendance is obligatory between the ages of 5 and 14 and voluntary up to 16 years. There is a flourishing boarding school at Darwin on East Falkland and a smaller school on West Falkland. Elsewhere on the farms education is largely dependent on traveling teachers. There is a well-equipped hospital and dental surgery and, in addition, medical officers are stationed on East and West Falkland. The colony has an efficient radiotelegraphy station, which is its link with the outside world, and a substation at Fox Bay on West Falkland. All farms and outlying islands are provided with two-way radiotelephone sets that keep them in daily touch with Stanley. Physical communications with the mainland and with the farms are maintained by the company's steamer, supplemented in the latter case by privately owned cutters, by a small government motor vessel and by an internal air service operating float planes. This air service, with the number of natural harbours available and the close proximity of the farms to them, provides the ideal medium. It is extremely popular and along with the provision of radiotelephone sets has revolutionized life in the islands.

Falkland Islands Dependencies and British Antarctic Territory.—By an order in council effective from March 3, 1962, the separate colony of British Antarctic Territory was established, comprising part of the former territory of the Falkland Islands dependencies. The dependencies now consist of the islands lying between longitudes 20° W. and 50° W. and latitudes 50° S. and 60° S., and those between longitudes 50° W. and 80° W. and latitudes 58° S. and 60° S. These are principally South Georgia and the South Sandwich group.

British Antarctic Territory comprises all land and islands between longitudes 20° W. and 80° W. and south of latitude 60° S.: namely the South Orkney and South Shetland island groups, and the wedge-shaped sector of the antarctic continent from Palmer peninsula (including Graham Coast) to the south pole. It is administered by the Falkland Islands' governor acting as high commissioner.

The above territories, until 1962 all part of the Falkland Islands dependencies, were annexed to the British crown in 1908. The area of the colony is 2,039 sq.mi., and its population about 1,300 in summer and 93 (1962) in winter. The area of British Antarctic Territory is about 473,000 sq.mi., and its population 150 in summer and 90 in winter. South Georgia is the site of an important land-based whaling industry. A chain of meteorological and scientific bases is maintained on British Antarctic Territory, stretching from Signy Island in the South Orkneys to Stonington Island off the west coast of Palmer peninsula, and manned by the British Antarctic survey (formerly the Falkland Islands Dependencies survey). This organization has been responsible for the topographical and geological survey of the greater part of British Antarctica. A meteorological office at Stanley receives reports from the bases and issues a daily weather forecast of which wide use is made. A scientific bureau in London serves as a clearinghouse for the distribution of this material and the publication of reports. Revenue is derived mainly from income tax, customs duties and an export tax on whale oil, and is supplemented by a substantial grant from the U.K. Most of the revenue is spent on the maintenance of the scientific bases.

While the bases, generally, are icebound throughout the winter months, South Georgia remains open. The South Sandwich group and Deception Island in the South Shetlands are volcanic and there are hot springs at the latter. The scenery in Antarctica as a whole is magnificent on a fine day in the summer, and this is especially true of South Georgia.

The island is closely associated with the memory of the explorer Sir Ernest Shackleton, who is buried there, and of his heroic journey during 1915–16.

South Georgia and the South Sandwich Islands were discovered in 1775 by Capt. James Cook, the navigator, who took possession for the crown. His reports of the abundance of whales and seals in those waters led to the discovery of the antarctic continent by the whalers and sealers who followed in his wake, for some of the shipowners were interested in discovery for its own sake and encouraged their captains to push even farther afield. Outstanding among the latter were George Powell (South Orkneys, 1821–22), William Smith (South Shetlands, 1819), James Weddell, Edward Bransfield (antarctic mainland, 1820) and John Biscoe (Graham Land, 1832); these in turn led to the expeditions of A. de Gerlache (Belgian), Otto Nordenskjöld (Swedish), W. S. Bruce, (Scottish), J. B. Charcot (French), Shackleton (British) and W. Filchner

(German), the continuing work of the Discovery committee and the British Graham Land expedition, and so to the establishment of the Falkland Islands Dependencies survey in 1943.

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FALKNER, WILLIAM: *see* FAULKNER, WILLIAM.

FALL, ALBERT BACON (1861–1944), U.S. lawyer and politician, was born on Nov. 26, 1861, at Frankfort, Ky. He had little formal schooling but studied law and began to practise in 1889. After a lengthy political career in New Mexico he was elected to the U.S. senate in 1912. He served as a senator until 1921, when he became secretary of the interior. Following a senate investigation of his action in leasing to private oil interests certain tracts in the Teapot Dome reserve in Wyoming and other reserves in California, Fall was convicted of accepting a $100,000 bribe and served a year and a day in prison. He died in El Paso, Tex., Nov. 30, 1944. *See* also OIL RESERVES SCANDAL (U.S.).

FALLA, MANUEL DE (1876–1946), the most distinguished Spanish composer of the early 20th century, was born at Cádiz on Nov. 23, 1876, and took piano lessons from his mother, who encouraged his early musical ambitions. Later he went to Madrid to continue his piano studies and to study composition with Felipe Pedrell, who inspired him with his own enthusiasm for 16th-century Spanish church music, folk music and native opera. He had already written two *zarzuelas* (the distinctively Spanish type of operetta), though without recognition.

In 1905 Falla won two prizes, one for piano playing, which led to his teaching the piano in Madrid for two years, and the other for a national opera with *La vida breve,* which despite lyrical passages influenced by the works of Jules Massenet evoked a truly Andalusian background. Disappointingly, it was not performed until 1913. In 1907 Falla moved to Paris, where he associated with Claude Debussy (who had an intuitive sympathy for Andalusian music), Paul Dukas and Maurice Ravel (whose orchestration influenced his own), and there he published his first piano pieces and songs.

At the outbreak of World War I he returned to Madrid, where the success of *La vida breve* led to his being invited to write the music for a ballet, *El amor brujo* (Madrid, 1915), which aroused enthusiasm only after the original chamber scoring had been expanded. The work is remarkable for its distillation of Andalusian folk music, though, as in all his works, save occasionally for the purposes of allusion, there is no actual quotation of folk melodies. Falla followed this with a mime version of a folk tale, *El corregidor y la molinera* (Madrid, 1917), which had an immediate success and attracted the attention of Diaghilev, who persuaded him to reshape and rescore it for a ballet by Leonide Massine; under the title *El sombrero de tres picos* (*The Three-Cornered Hat;* London, 1919) its vitality and wit scored a triumph. *Noches en los jardines de España* (*Nights in the Gardens of Spain*), a suite of three impressions for piano and orchestra (the piano being treated not as a concerto instrument but as *primus inter pares*) (Madrid, 1916), was a poetic evocation in the most subtle instrumental colouring of Andalusian atmosphere, though by suggestion rather than by illustration. All these works established Falla internationally as the leading Spanish composer.

Having always been interested in *cante jondo,* the traditional folk song of southern Spain, the flavour of which he had captured in *La vida breve,* Falla retired to Granada, where in 1922 he organized a *cante jondo* festival and composed a puppet opera, *El retablo de Maese Pedro* (*Master Peter's Puppet Show*), based on an episode in *Don Quixote.* Like the subsequent *Harpsichord Concerto* (1926), containing echoes of a Corpus Christi procession and of Domenico Scarlatti, the *Retablo* shows Falla in a new idiom, much influenced by Igor Stravinsky; his style was now neoclassical instead of romantic. It was nonetheless quintessentially Spanish, but Castilian rather than Andalusian.

After 1926 he wrote little, living in semiretirement first in Mallorca and, from 1939, in Argentina, where he worked fitfully on a cantata, *L'Atlántida,* which was, however, left unfinished at his death and was completed by his pupil Ernesto Halffter. Contemplative and scholarly by nature and a perfectionist in his ideas, Falla sought to lead Spanish music out of facile and false "Hispanicisms," and in his own work achieved a fusion of poetry, asceticism and ardour that represents the spirit of Spain at its purest. He died at Alta Gracia, Arg., on Nov. 14, 1946.

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FALLACY, the term given generally to any mistaken statement used in argument; in logic, technically, any violation of the conditions of valid inference (Lat. *fallax,* "deceptive"). An argument may be fallacious in matter (*i.e.,* misstatement of facts), in wording (*i.e.,* wrong use of words) or in the process of inference. Fallacies have, therefore, been classified as material, verbal and logical (or formal). The two latter kinds are often included under the general description logical and in scholastic phraseology, following Aristotle, are called fallacies *in dictione* or *in voce,* as opposed to material fallacies *in re* or *extra dictionem.*

Material.—The classification widely adopted by modern logicians and based on that of Aristotle's *Organon* (*Sophistici elenchi*) is as follows. (1) *Fallacy of accident; i.e.,* confusing what is accidental with what is essential. (2) *Secundum quid; i.e.,* arguing erroneously from a general rule to a particular case, without proper regard to special circumstances which vitiate the application of the general rule; *e.g.,* if manhood suffrage be the law, arguing that a criminal or a lunatic must, therefore, have a vote; or the converse fallacy of arguing from a special case to a general rule. (3) *Irrelevant conclusion,* or *ignoratio elenchi,* wherein, instead of proving the fact in dispute, the arguer seeks to gain his point by diverting attention to some extraneous fact (as in the legal story of "No case. Abuse the plaintiff's attorney"). Under this head come the so-called *argumentum* (*a*) *ad hominem,* (*b*) *ad populum,* (*c*) *ad baculum,* (*d*) *ad verecundiam,* common in platform oratory, in which the speaker obscures the real issue by appealing to his audience on the grounds of (*a*) purely personal considerations, (*b*) popular sentiment, (*c*) fear, (*d*) conventional propriety. This fallacy has been illustrated by ethical or theological arguments wherein the fear of punishment is subtly substituted for abstract right as the sanction of moral obligation. (4) *Petitio principii* (begging the question) or *circulus in probando* (arguing in a circle), which consists in demonstrating a conclusion by means of premisses which presuppose that conclusion. Jeremy Bentham points out that this fallacy may lurk in a single word, especially in an epithet; *e.g.,* if a measure were condemned simply on the ground that it is alleged to be "un-English." (5) *Fallacy of the consequent,* arguing from a consequent to its condition; *e.g.,* if a man is a drunkard he becomes destitute; therefore, if he is destitute, he is a drunkard. (6) *Fallacy of false cause,* or *non sequitur* ("it does not follow"), bases a conclusion on an insufficient or erroneous reason. This is often confused with (7) *Post hoc ergo propter hoc* ("after this,

therefore, because of this"), wherein one thing is incorrectly assumed as the *cause* of another, as when the ancients attributed a public calamity to a meteorological phenomenon. (8) *Fallacy of many questions* (*plurium interrogationum*), wherein several questions are improperly grouped in the form of one, and a direct categorical answer is demanded; *e.g.*, if a prosecuting counsel asked the prisoner, "What time was it when you met this man?" with the intention of eliciting the tacit admission that such a meeting had taken place.

Verbal.—These fallacies are those in which a false conclusion is obtained by improper or ambiguous use of words. They are generally classified as follows. (1) *Equivocation* consists in employing the same word in two or more senses; *e.g.*, in a syllogism, the middle term being used in one sense in the major and another in the minor premiss, so that in fact there are four not three terms ("All fair things are honourable; This woman is fair; therefore this woman is honourable," the second "fair" being in reference to complexion). (2) *Amphibology* is the result of ambiguity of grammatical structure; *e.g.*, of the position of the adverb "only" in careless writings ("He only said that," in which sentence, as experience shows, the adverb has been intended to qualify any one of the other three words). (3) *Composition*, a species of (1) which results from the confused use of collective terms ("The angles of a triangle are less than two right angles" might refer to the angles separately or added together). (4) *Division*, the converse of the preceding, which consists in employing the middle term distributively in the minor and collectively in the major premiss. (5) *Accent*, which occurs only in speaking and consists of emphasizing the wrong word in a sentence ("He is a fairly good pianist," according to the emphasis on the words, may imply praise of a beginner's progress, or an expert's depreciation of a popular hero, or it may imply that the person in question is a deplorable violinist). (6) *Figure of speech*, misinterpretation of a form of expression or an inflection; *e.g.*, taking "desirable" to mean what can be desired (instead of what ought to be desired) because "visible" means what can be seen.

Logical.—The purely logical or formal fallacies consist in the violation of the formal rules of the syllogism (*q.v.*). They are: (1) fallacy of four terms (*quaternio terminorum*); (2) of undistributed middle; (3) of illicit process of the major or the minor term; (4) of negative premisses.

Of other classifications of fallacies in general the most famous are those of Francis Bacon and J. S. Mill. Bacon (*Novum organum*, Aph. i. 33, 38 *et seq.*) divided fallacies into four *idola* (idols; *i.e.*, false appearances), which summarize the various kinds of mistakes to which the human intellect is prone (*see* BACON, FRANCIS). With these should be compared the *offendicula* of Roger Bacon, explained in the *Opus maius*, pt. i. Mill discussed the subject in book v of his *Logic*, and Jeremy Bentham's *Book of Fallacies* (1824) contains valuable remarks.

See A. Sidgwick, *Fallacies* (1883); H. W. B. Joseph, *An Introduction to Logic*, 2nd ed. (1916).

FALLIÈRES, ARMAND (1841–1931), eighth president of the third French republic, was born on Nov. 6, 1841, at Mézin, Lot-et-Garonne, the son of a small holder. He studied law and became a barrister at Nérac, beginning his public career as town councilor there (1871). In Feb. 1876 he was sent by the Nérac constituency to the chamber of deputies, where he sat with the left and signed the protest of May 18, 1877, against the dissolution decreed by MacMahon. Returned to the new chamber, he held a minor office in Jules Ferry's cabinet (1880–81), next became minister of the interior under Charles Duclerc (1882–83) and then, on Jan. 29, 1883, prime minister. His short-lived government lasted only 21 days. It had to face the question of the expulsion of the pretenders to the throne of France; after the senate's rejection of his compromise proposal he resigned. He then became in succession minister of public education, of the interior, of justice, of education again and of justice again. In June 1890 he was elected senator by the Lot-et-Garonne *département*. He was president of the senate from March 1899 till Jan. 1906, when he stood for the presidency of the republic. Elected on Feb. 18, 1906, by 449 votes against 371 for Paul Doumer, he held office until Jan. 7, 1913, when he was succeeded by Raymond Poincaré. Fallières proved to be an excellent president, who often gave sound advice to the ministers, especially on foreign matters. He died at Loupillon, near Mézin, on June 22, 1931.

See J. Chastenet, *La France de M. Fallières* (1949) and *Histoire de la IIIe République*, vol. iv (1957). (J. C. DE C.)

FALLING STARS: *see* METEOR; METEORITES.

FALL LINE, in U.S. geology, a line marking the junction between the hard rocks of the Appalachians and the softer deposits of the coastal plain. The Pre-Cambrian and metamorphic rocks of the mountain mass form a continuous ledge parallel to the east coast, where they form a series of "falls" and rapids in the river courses all along this line. The relief of the land below the falls is very slight, and this low, level country, the tidewater region of Virginia, for example, rarely rises to a height of 200 ft., so that the rivers are navigable up to the falls, while the falls themselves are a valuable source of power. A line of cities may be traced upon the map whose position will thus be readily understood in relation to the economic importance of the fall line. They are Trenton on the Delaware, Philadelphia on the Schuylkill, Georgetown on the Potomac, Richmond on the James and Augusta on the Savannah. It will be understood that the softer and more recent rocks of the coastal plain have been more easily washed away. The harder rocks of the mountains, because of differential denudation, have been left standing high above them, and the trend of the edge of this great lenticular mass of ancient rock is roughly parallel to that of the Appalachian system. *See* also VIRGINIA: *Physical Geography*.

FALLMERAYER, JAKOB PHILIPP (1790–1861), German traveler and Byzantinist, who propounded the theory that the inhabitants of Greece are descended not from the ancient Greeks but from the Slavs and Albanians who later overran the country (*see* GREECE: *Byzantine History: The Early Byzantine Period*), was born of a peasant family at Tschötsch (now Scesse), near Bressanone, in the Tirol. He studied theology and classics at Salzburg, law at Landshut and modern Greek, Turkish and Persian while on garrison duty during the latter part of his five years' military service (1813–18). During 1818–30 he taught at Augsburg and at Landshut, and in 1827 he made his name with his first book, *Geschichte des Kaiserthums von Trapezunt*. After producing the first volume of *Geschichte der Halbinsel Morea* (1830; 2nd vol., 1836) in which he enunciated his ethnological theories, he set out on a series of lengthy journeys which took him all over Greece and the Levant, as well as round Europe. He acted as foreign correspondent for an Augsburg newspaper, and published a number of political, historical and critical pieces. In 1848 he became professor of history at Munich, but had to resign in 1849, when as a member of the national congress he accompanied the rump parliament to Stuttgart. The amnesty of 1850 permitted him to return to Munich, where he died on April 26, 1861.

Fallmerayer was one of the first to discuss the ethnological problems of the Byzantine empire, which are difficult to solve as the racial terminology of most Byzantine writers is far from precise. His extreme position on the Greek question, which caused much controversy among scholars, is now generally discarded, but the subject is still a living issue.

BIBLIOGRAPHY.—*Gesammelte Werke von J. P. Fallmerayer*, ed. by G. M. Thomas, 3 vol. (1861), contains political, critical and travel works only. Some of his historical works are collected under the title *Byzanz und das Abendland* (1943). *See* also the full list of his writings in H. Seidler, *J. P. Fallmerayers geistige Entwicklung* (1947). For criticism of his ethnological views *see* H. O. Eberl, *J. P. Fallmerayers Schriften in ihrer Bedeutung für die historische Erkenntnis des gräkoslavischen Kulturkreises* (1930).

FALLOPIUS, GABRIEL (GABRIELLO FALLOPIO or FALLOPIA) (1523–1562), Italian anatomist, was born at Modena, where he became a canon of the cathedral. He studied medicine at Ferrara and became teacher of anatomy in that city and later at Pisa and Padua, where he worked with Andreas Vesalius (*q.v.*). He died on Oct. 9, 1562.

Fallopius discovered or described the chorda tympani, the sphenoid sinus, the opening of the uterine tubes of the human female into the abdominal cavity, the trigeminal, auditory and glosso-

pharyngeal nerves. He named the ovarian tubes, the vagina, the placenta, the muscles of the forehead, occiput and tongue. He attacked the teaching of Galen. Only one treatise by Fallopius appeared during his lifetime, the *Observationes anatomicae* (1561).

FALLOUT. The phenomenon of deposition of radioactive materials on the earth from the atmosphere is known as radioactive fallout or, more commonly, fallout. Strictly speaking, fallout refers only to deposition during nonprecipitant weather, with such terms as rain-out and snow-out used to describe the deposition during precipitant weather. However, in the broader sense and when discussing long-time effects, fallout can include deposition during all types of weather.

This radioactivity in the atmosphere may arise from (1) natural causes; (2) atomic bomb or thermonuclear bomb explosions; and (3) induced radioactivities and fission products from atomic reactor operations.

Most of the natural radioactivity in the atmosphere is a result of cosmic rays and the gaseous diffusion of radon and thoron from natural uranium and thorium found in the earth's crust. The local concentrations of these gases in the atmosphere depend to a great extent on the concentrations of uranium and thorium in the earth, as well as on meteorological conditions. Cosmic rays produce, among other isotopes, radioactive forms of carbon and hydrogen. Radioactive carbon has a sufficiently long half life to be useful in the dating of archaeological objects. This interesting technique arises from the fact that the isotope is absorbed into a plant only during its growth and remains there after the death of the plant, slowly dissipating in the course of time. Knowledge of the initial amount, present amount and the half life of the isotope leads to the age of the object. Radioactive hydrogen is similarly used, but for the dating of much more recent objects.

Concerning the explosion of nuclear bombs which release radioactivity, there are three separate types of fallout: local, tropospheric and stratospheric. The local fallout is due to the deposition of the larger radioactive particles near the site of the explosion. This is quite intense but relatively short-lived. Tropospheric fallout occurs when the finer particles become trapped in the troposphere and are deposited at a later time and over a larger area—both factors being determined by the local meteorological conditions. In general tropospheric fallout occurs in the month following the explosion, and takes place in the general latitude of the explosion site. Stratospheric fallout, caused by extremely fine particles in the stratosphere, may continue years after the explosion and the distribution is nearly world-wide. Generally only very large bombs (*i.e.*, thermonuclear) produce stratospheric fallout.

While many different radioisotopes are formed during a nuclear explosion, only the long-lived isotopes are concerned in stratospheric fallout. Particularly involved are cesium-137 and strontium-90 which have 27- and 28-year half lives. The latter presents the greater hazard to humans since it is chemically similar to calcium and, in calcium deficient areas, it may replace the calcium in certain foods and ultimately become deposited in the body. The radioactive material in the stratosphere ultimately mixes with the troposphere where it then deposits out onto the earth through electrical attraction, gravity or by attachment to larger particles such as water droplets. Since the latter is the largest effect it is obvious that the rate of fallout will be larger during precipitant conditions where the droplets are not only coming down but scrubbing the atmosphere at the same time.

The final sources of the radioactivity which might be dispersed in the atmosphere are emanations from reactor operations. The normal radioactive products associated with reactors can be quite successfully controlled and contained; however, should a reactor accidentally explode, the net result would be little different from that of a small nuclear bomb explosion and would produce large local fallout but would not penetrate the stratosphere.

See also ATOMIC ENERGY; ISOTOPE; RADIATION: BIOLOGICAL EFFECTS. (E. C. G.)

FALLOUX, FRÉDÉRIC ALFRED PIERRE, COMTE DE (1811–1886), one of the leaders of the movement for the restoration of the Bourbon monarchy in 19th-century France, was born at Angers on May 7, 1811. As his hopes of state employment were dashed by the overthrow of Charles X in 1830, he spent his youth in travel over Europe, in historical studies and in charitable work. He won distinction as an advocate of the moderate Legitimist and Catholic parties and in 1846 was elected member of the chamber of deputies for Segré (Maine-et-Loire). In the chamber he was one of the ablest lieutenants of Pierre Antoine Berryer, whose policy was to bring about a restoration by parliamentary and constitutional means rather than by force. In Dec. 1848 he was appointed minister of education and public worship in Louis Napoleon's first government. The law known to history as the *loi Falloux* because he sponsored it (though it was not promulgated till 1850) greatly increased the influence of the Roman Catholic Church in French education. His term of office (which ended in Oct. 1849) ruined his health; and, excluded in any case from active politics by the second empire, which he opposed, he retired to his estate at Bourg d'Iré and became absorbed in agriculture. He was thus rather prematurely an elder statesman, but he continued to advise the Legitimist and Catholic parties. After 1870 he again played an important part in the negotiations for the restoration of the comte de Chambord, but insisted on a liberal monarchy and on the retention of the tricolour flag. He had been elected member of the Académie Française in 1856, more for his politics than for any literary brilliance. He left, however, an interesting autobiography, *Mémoires d'un royaliste* (1888; new ed., 3 vol., 1925–26). His other works include *Louis XVI* (1840), *Histoire de Saint Pie V*, 2 vol. (1844; 3rd ed., 1858), and *Madame Swetchine* (1860). He died at Angers on Jan. 6, 1886. (T. ZE.)

FALLOW. Fallow is land normally under cultivation that is allowed to be idle for a season (sometimes longer) with or without cultivation. In dry-land areas the term applies specifically to land that is clean cultivated for a season to store water or release plant food for a crop the next year. Fallowing is a standard practice in many dry-land areas where the annual rainfall is not sufficient to produce paying crops regularly unless supplemented by stored moisture. Where the surface litter is plowed under it is called "black fallow" or "bare fallow" and where crop residues are left on the surface it may be called "trashy fallow."

In humid or subhumid areas fallow may be land lying idle without cultivation, but more often it is land plowed during the summer to destroy weeds or to improve the next year's crop prospects. Although true fallow is land without a crop, there are modified forms such as "green manure fallow" where a growing crop, usually a legume, is turned under; "bastard fallow" where a fall-planted crop is pastured off or harvested in an immature state in the spring and the land then cultivated; and "green fallow," a term used in some countries to indicate an intertilled crop such as turnips or potatoes.

Fallow is not properly used to describe land cultivated for only part of a season after a mature crop has been harvested.

FALLOW DEER (*Dama dama*), a medium-sized representative of the family Cervidae, characterized by its palmated antlers, rather long tail (black above and white below) and a coat spotted with white in summer but uniformly coloured in winter. The shoulder height is about three feet. The species is semidomesticated in British parks and occurs wild in western Asia, north Africa, south Europe and Sardinia. In prehistoric times it occurred throughout northern and central Europe. Bucks and does live apart except during the pairing season, and the doe produces one or two and sometimes three fawns at a birth.

JOHN MARKHAM

MALE FALLOW DEER (DAMA DAMA)

The Persian fallow deer (*D. mesopotamica*) is larger and has a brighter coat, differing in some

details of colouring. An allied genus, the gigantic fossil deer commonly known as the Irish elk (*Megaceros giganteus*), had horns of the fallow-deer type. This deer inhabited Ireland, Great Britain, central and northern Europe and western Asia in Pleistocene and prehistoric times, and stood six feet high at the shoulder. The antlers were greatly palmated and of enormous size, fine specimens measuring 11 ft. between the tips. *See* also DEER.

FALL RIVER, a city of Bristol county in southeastern Massachusetts, U.S., on the east shore of Mount Hope bay at the mouth of the Taunton river, about 50 mi. S. of Boston. Atop a sharply rising granite ledge, the city faces west overlooking its large harbour. Pop. (1960) city, 99,942; standard metropolitan statistical area (Fall River city and Somerset, Swansea and Westport towns in Bristol county, Tiverton town in Newport county, Rhode Island), 138,156. (For comparative population figures *see* table in MASSACHUSETTS: *Population.*)

French and English legends on monuments and French language newspapers testify to the considerable number of residents who are of French-Canadian origin.

"Freeman's Purchase," or Freetown, including the present city of Fall River, was bought from the Indians by a group of settlers who came from Plymouth in 1656. In 1803 "Fallriver" was incorporated as a separate town. The name was changed to Troy a year later, but in 1834 it was changed back to Fall River, after the Quequechan (or Fall) river which flows through the city from Watuppa pond about 200 ft. above the city on its eastern edge. It was incorporated as a city in 1854.

Until the American Revolution, agricultural interests predominated, but the city developed some industry thereafter and by 1871 had established itself as the cotton textile centre of the nation. Despite a disastrous fire in 1843, Fall River's natural advantages —water power, a mild moist climate and a good sea harbour—provided a basis for continuing booms in the cotton industry, and attracted new residents throughout the 19th century. The population grew from 14,026 in 1860 to 104,863 in 1900.

Although the Fall River cotton millworkers lost two of three important strikes in 1870 and 1875, textile craft unions nevertheless obtained recognition. Cotton workers predominated in the United Textile Workers of America, formed in 1901, and Fall River was its backbone. One of the first big walkouts after the union's organization occurred in Fall River in 1904, when about 27,000 workers stayed out for six months in protest against a general wage cut. The outcome was important because Fall River wage rates generally governed the rest of the industry. The strike ended by state intervention, and the workers accepted a unique sliding scale arrangement which actually meant a reduction. The industry, and the city as a whole, were seriously affected by the depression of 1920–21, competition of southern cotton mills and the financial crash of 1929. The apparel and textile industries, however, continued in the second half of the 20th century to be the largest source of employment; the manufacture of rubber products is the next industry of importance.

Fall River was the scene of the celebrated unsolved mystery in which Lizzie Andrew Borden (1860–1927) was acquitted of the ax-murder of her wealthy father and stepmother Aug. 4, 1892.

(L. G. BA.)

FALMOUTH, a seaport, holiday resort and municipal borough in the Falmouth and Camborne parliamentary division of Cornwall, Eng., 36 mi. E.N.E. of Land's End and 11 mi. S. of Truro by road. Pop. (1961) 15,427. Falmouth stands on the west shore of Carrick roads, the largest of the estuaries which open on the south coast of Cornwall. Several rivers empty into the estuary, opening it to inland navigation by river steamer; the largest is the Fal, at the head of the estuary on the east shore; the Penryn river and creek join Falmouth with Penryn on the west, and the picturesque inlet of the Percuil (Porthcuel) river opens out from St. Mawes, near the entrance opposite Falmouth. Carrick roads forms one of the best refuges for shipping on the south coast, being accessible at all times by the largest vessels. The scenic wooded shores slope sharply up to about 250 ft. The entrance from Falmouth bay on the channel is about 1 mi. across between St. Anthony's point, with its lighthouse, and Zoze point, on the east, and Pendennis point, the promontory of Falmouth, on the west. Pendennis and St. Mawes castles are Tudor fortresses; the former is celebrated for its gallant defense in the Civil War, when Cornwall was a centre of the royalist cause, another memorial being the Restoration church of King Charles the Martyr, built about 1662. Situated on a peninsula, Falmouth faces the water on both sides, and the old part of the town, with narrow streets, overlooks the inner harbour, while the newer residential area with the hotels faces the bay. There is an extensive marine drive, a concert hall, three sheltered beaches and approximately 100 ac. of public walks and pleasure grounds. Among the chief buildings are the town hall and municipal buildings. Because of its especially fine yachting harbour, the Royal Cornwall Yacht club has its headquarters in Falmouth; the principal prize in the annual regatta, held in August, is a cup usually given by the prince of Wales as duke of Cornwall.

Falmouth (*Falemuth* in 1235) as a haven, port and mail-packet station, has had a place in the maritime history of Cornwall from early times. The site of the town, formerly known as Smithick and Pennycomequick, formed part of the manor of Arwenack held by the Killigrew family, the last of whom died in the 18th century. Arwenack house still stands. In 1652 the Commonwealth parliament granted a market to Smithick. This market was confirmed to Sir Peter Killigrew in 1660, together with two fairs and a ferry, which still runs, between Smithick and Flushing, on the opposite shore of Penryn creek. By the charter of incorporation granted in the following year the name was changed to Falmouth. In 1664 an act creating the borough a separate ecclesiastical parish empowered the mayor and aldermen to assess all buildings within the town for the support of the rector, whose rate (tax) later occasioned some ill feeling and by act of parliament (1896) it was taken over by the corporation and finally abolished. By the Redistribution act, 1885, the number of members returned to parliament by the united boroughs of Penryn and Falmouth was reduced from two to one. The municipal borough is under a mayor, four aldermen and 12 councillors, and has a separate commission of the peace.

With its sandy beaches and equable climate, Falmouth is a favoured resort all the year round. Engineering and ship repairing are undertaken, and there are oyster fisheries in Falmouth harbour and Helford river. The growing importance of the town as a ship-repairing centre was met by increased wharfage and the extension of dry-dock facilities to accommodate the world's largest oil tankers and other ships. The area of the tidal harbour within the docks is about 42 ac.

Across the bay to the east is the Roseland peninsula with the parishes of St. Anthony in Roseland and St. Just in Roseland. The church of St. Anthony has a Norman doorway, that of St. Just is Perpendicular and stands by a creek of Carrick roads with a picturesque wooded churchyard sloping down toward the water. Both villages are well known for their beauty. In 1956 part of the Trelissick estate on the estuary of the Fal was made over to the National Trust. It includes Trelissick house, which existed as a farm in the reign of Elizabeth I.

FALSE IMPRISONMENT: *see* ARREST.

FALSE PRETENSES: *see* FRAUD.

FALSETTO, a forced form of sound production employed to obtain notes above the natural range of the voice. *See* VOICE.

FALSTAFF, SIR JOHN: *see* OLDCASTLE, SIR JOHN; FASTOLF, SIR JOHN.

FAMA, in classical mythology the personification of popular rumour (Greek *Pheme; cf.* Homeric *Ossa*). Pheme is more a poetic personification than a deified abstraction, although Hesiod, in the *Works and Days,* characterizes her as a goddess of sorts, and there was an altar in her honour at Athens. In Hesiod she is an ill-doer, easily stirred up but impossible to quell. Aeschines distinguishes Popular Rumour (Pheme) from Slander (*Sykophantia*), disassociating the former from Malice (*Diabole*).

In Roman literature she is imaginatively conceived: Virgil describes her (in the *Aeneid,* book iv) as a swift, birdlike monster with as many eyes, lips, tongues and ears as feathers, traveling on the ground but with head in the clouds. According to Ovid, in the

Metamorphoses, she inhabits a reverberating mountaintop palace of brass with innumerable entrances and 1,000 openings.

See Pauly-Wissowa, *Real-Encyclopädie der classischen Altertumswissenschaft;* Daremberg-Saglio, *Dictionnaire des antiquités.*

(R. B. Ld.)

FAMAGUSTA (Anc. Gr. Ammochostos; *ammos,* "sand"; *choö,* "to block, silt"), the chief port of the Republic of Cyprus and administrative centre of Famagusta district, lies on the east coast in the bay formed between Cape Greco and Cape Elea, 39 mi. E. of Nicosia. Pop. (1960) 34,774.

Famagusta is said to have been founded as Arsinoë by Ptolemy II Philadelphus of Egypt (308–246 B.C.). Though its population was increased by refugees from neighbouring Salamis in A.D. 648, it was still only a village till the fall of Crusader Acre (1291) in Palestine when the Lusignan king offered it to the Christian refugees. It soon became one of the richest cities in Christendom. The Lusignan kings were crowned as kings of Jerusalem in St. Nicholas' cathedral, a magnificent Gothic building, now a mosque. In 1372 Genoa seized Famagusta and held it till 1472. It passed to Venice in 1489 when the last Lusignan ruler, Caterina Cornaro, was exiled. The Venetians made it the capital of Cyprus and remodeled the fortifications. The old walled and bastioned town, now only partly inhabited, contains some of the finest examples of medieval military architecture extant; some of its masonry was sold to build Port Said, Egy., about 1869. The walls are 50 ft. high and 27 ft. thick in places and there is a fosse round the landward walls. To the north of the well-preserved sea gate, rebuilt in 1496, stands the Othello tower, so called because one of the governors, Christoforo Moro, is said to be the hero of Shakespeare's *Othello.* In 1570–71 the town was taken by the Turks. The British occupied Cyprus from 1878 to 1960. They built extensive harbour installations at Famagusta which became a naval base in World War II.

The harbour is the only deep one in Cyprus and ships drawing up to 22 ft. 6 in. water can berth alongside its quay. Varosha, the modern town, is mostly to the south of Famagusta and 6 mi. N. is the suburb of Glossa with bathing beaches.

Footwear, clothes, metal products and transport equipment are manufactured. Famagusta is connected by road, telephone and telegraph with other towns in Cyprus and by telegraph and radiotelephone with other countries.

Famagusta district, area 764 sq.mi., had a population of 114,389 in 1960. Potatoes and oranges are grown in the area and exported.

(M. Ro.)

FAMILISTS, the name of an English sect of Dutch origin commonly called the Family of Love, the following of Hendrik Niclaes, a Dutch merchant, whose main activity was in Emden (1540–60). Niclaes never withdrew from the Catholic Church and was not attracted by Protestantism. His roots lay rather in medieval sectarianism. In his *Evangelium regni,* issued in England as *A joyful message of the kingdom,* he invited all "lovers of truth, of what Nation and religion soever they be, Christian, Jews, Mahomites or Turks and Heathen" to join in a great fellowship of peace, the Family of Love, eschewing all contention over dogma, seeking to be incorporated into the body of Christ and made god with God.

Niclaes gained many followers, among them the great publisher Christophe Plantin, who surreptitiously printed a number of Niclaes' works. The Catholic authorities at Emden awoke to the danger. Niclaes became a fugitive and died in Cologne in 1580. He appears to have made two visits to England, where his sect had the greatest following. Elizabeth I issued a proclamation against the Family of Love in 1580. James I believed it to have been the source of Puritanism. The sect did not survive the Restoration.

See J. Strype, *Annals of the Reformation,* vol. ii, pt. 1 (1708); J. H. Hessels, *Notes and Queries* (Oct., Nov. 1869). (R. H. Ba.)

FAMILY. Recognizable forms of family are found in every known society and appear to have arisen earlier in human prehistory than either church or state. The family is everywhere identifiable as a social group characterized by common residence, economic co-operation and reproduction. Included in the personnel which make it up are adults of both sexes, at least two of whom maintain a socially approved sexual relationship, and one or more offspring or adopted children.

The family is defined technically as a group of persons united by the ties of marriage, blood or adoption constituting a single household, interacting with each other in their respective social positions of husband and wife, mother and father, son and daughter, brother and sister, who share, create and maintain a common culture. The family group is often confused with the household because it constitutes a single household, but boarders, roomers, indeed any persons sharing a common residence may be included in a household. The family is also sometimes confused with a kindred because of the unity of blood lines, but a kindred may be divided into several households. Frequently the family is not differentiated from the marriage pair, but the essence of the family group is the parent-child relationship, which may be absent from many marriage pairs. In its institutional aspects the family is also frequently confused with the institution of marriage, the complex of customs regulating the sexual relations between the cohabiting pair of adults within the family group. Marriage defines the procedures for establishing and terminating the husband-wife relation, the reciprocal obligations and the accepted restrictions upon its personnel (*see* Marriage; Marriage, Primitive; Marriage, Law of).

Viewed abstractly, this most familiar of social institutions appears also to be the most stable, enduring and universal of cultural forms. It occurs more ubiquitously than church or state or any of the other persistent forms of relationship by which men have organized their activities. Viewed individually and concretely, however, each family is endangered by multiple threats of dissolution at every phase along its typical cycle of existence. The dependence of human beings almost exclusively upon their families for the satisfaction of certain of their most important wants makes the continued working of this social group a perennial concern.

For the sake of analysis, many anthropologists assert that the family functions to satisfy certain universal needs (as sexual satisfaction, procreation, economic survival, personal and cultural identification, child-rearing and education) that persist among all men in all times. The forms of relationship assumed by actual families, however, are not given in nature; they arise as artifacts of human ingenuity. Thus, world-wide surveys reveal the patterns of family life to be extremely variable.

In any particular time and place, the favoured form of the family is believed by such theorists to be that which has proven most workable in meeting the universal needs under the existing specific conditions. And in the career of any single family, its unique variation upon the traditional design of its society is the adaptation it has made to the conditions and crises confronting it. Moreover, to the extent that underlying needs are subject to change, for example, the need of the family to train children to perform a trade or craft, still further diversity and uncertainty of outcomes may be expected. The kinds of classifications and generalizations and predictions that can be made about the family, therefore, must always remain somewhat loose and controversial.

A major concern of many late 19th century scholars involved tracing the origins of the family and establishing an evolutionary sequence in the forms it took from prehistory to the present. The most advanced outcome of human progress was taken to be the form reached in western Europe during that period—a form, incidently, much altered in the relatively short time since. Notable controversies arose over the beginning form of the family—from a promiscuous horde, a polygamous patriarchy, a matriarchy, or a nuclear family of father, mother and children, with variations.

Although continuing among a few specialists, these controversies began to die down unresolved during World War I, along with theological interest in primitive origins and popular faith in the idea of progress. Investigations among living primitive peoples, moreover, had brought to light the immense range of variation existing in familial forms. The distribution of these customs around the globe could be accounted for better by specific histories of cultural invention and diffusion than by some supposedly biological process.

Celibacy, contraception, infidelity, illegitimacy, incest, infanticide, neglect and desertion are found among all peoples, as are also kinship systems, marriage, adoption, incest tabus and rules of morality. Only a wide range of capacities can be regarded as innate and universal, capacities which make participation in any concrete form of family behaviour possible for the unformed individual.

Despite the occurrence of what looks like family patterns among the lower species, it is recognized that there is no instinctual basis universally compelling animals, including human beings, to form families or to rear their young. The long period of dependency of the human infant has come to be regarded as a necessary condition of its uniquely extreme malleability. The characteristic patterns of behaviour it acquires are learned rather than instinctual; their identity depends upon the local version of human culture to which it is exposed. That each society appears to have instituted some kind of family to care for and instruct its young has never insured that this will be done without exception. Each society has devised distinctive myths to explain the origins and uphold the duties of families, but this does not justify the reading of some innate purpose into sexual complementariness and infant helplessness.

Classifications of Forms of Family Organization.—Certain analytical terms derived from ethnological studies are useful in classifying existent forms of family organization and in sketching a broad historical movement away from extended kin groups (combining several generations and degrees of relationship) toward the nuclear family as the most characteristic of mobile, industrial communities and societies.

In a survey of 250 representative human societies George Peter Murdock identified three distinct types of family organization. The first and most basic, the nuclear family, consists typically of a married man and woman with their offspring, although in exceptional cases one or more additional persons may reside with them. This is, of course, the type of family recognized to the exclusion of all others by modern western societies. Among the majority of the peoples of the world, however, nuclear families are found combined, like atoms in a molecule, into larger aggregates. Two composite forms which differ in the principles by which the constituted nuclear families are affiliated may be identified. An extended family consists of two or more nuclear families affiliated through an extension of the parent-child relationship by joining the nuclear family of a married adult to that of his parents. The patrilocal extended family is an example. It embraces, typically, an older man, his wife or wives, his unmarried children, his married sons and the wives and children of the latter. The second type of composite form is the polygamous family, which consists of two or more nuclear families affiliated by plural marriages, that is, by having one married parent in common. Under plural marriage, for instance, one man occupies the position of husband and father in two or more nuclear families and thereby unites them into a larger familial group. In the sample of societies surveyed by Murdock roughly a fourth had normally only the nuclear family form, somewhat more than a fourth had polygamous combinations and almost a half possessed some form of the extended family of three generations linked together under one head and in one household. (*See* also KINSHIP.)

Ralph Linton has classified families as consanguineal (related by blood) and conjugal (related by marriage) in type. Consanguineal families have been more prominent in the past and in peasant countries. Here the family is defined primarily in terms of blood relationship and descent, with family functions concentrated in the unit so constituted. Linton speaks of the consanguineal family as consisting of parents, children and grandchildren surrounded by a fringe of spouses, comparable to the extended family above. He contrasts it with the conjugal family, consisting of husband, wife and their offspring surrounded by a fringe of loosely attached and intermittently operative relatives. The nuclear family structure is identical with the conjugal family as to form, but this analytical observation is not to be confused with the matter of social recognition and emphasis; until recently the consanguineal obligations of the nuclear family have generally received prominence and precedence over the conjugal responsibilities.

The conjugal family is knit primarily by the marriage bond rather than by descent, but conjugal family practices tend to show some impress of the pattern of descent. If descent—of name and relationship, but usually also including appended attributes, such as ownership and residence—is traced through the father, the family is called patrilineal; if through the mother, which is less common, matrilineal; if through both, which is common in western countries but less common elsewhere, bilineal. Talcott Parsons sees the kinship structure of English-speaking peoples as an open, multilineal, conjugal system of interlocking nuclear families. The principle of the structural relations of these families is founded on the fact that, as a consequence of the incest tabu, an individual is always a member not of one but of two nuclear families, the family of orientation (parents and siblings) and the family of procreation (spouse and children). Moreover, he is the only common member of the two families.

In many societies distinction can be made between patrilocal and matrilocal families, according to whether the custom is for the wife to live with her husband's family or, less commonly, the husband to live with his wife's. This distinction is very meaningful for those societies where a family's occupation is agriculture and its settled residence is the land it farms, although migratory grazing and hunting tribes often exhibit the pattern when they travel in groups. Murdock points out that the spouse who does not have to shift his residence in marriage enjoys certain advantages over the other. He remains at home in familiar physical and social surroundings, and his family of procreation can maintain a close connection with his family of orientation. The other spouse, however, must break with the past in some measure and establish new social ties. Where marriages are exogamous with respect to the community, spouses of one sex find themselves living among comparative strangers to whom they must make new personal adjustments and upon whom they must depend for the support, protection and social satisfactions which they have previously received from relatives and old friends. They thus find themselves at a considerable psychological and social disadvantage in comparison with the sex which remains at home.

Distinctions like patriarchal and matriarchal continue to have meaning in all societies, with fathers far more commonly ruling their families. In industrialized countries, however, paternal authority tends to decline wherever the father's occupation removes him from his home and his wife and children much of the time, or where their employment away from home reduces their dependency upon him. Frequent and substantial changes of job and residence likewise reduce the control that can be exerted by relatives, while industrial changes that reward skill and learning rather than property ownership reduce the economic advantages of loyalty to the consanguineal family. Thus, with the spread of industrialization and urbanization, the further attrition of consanguineal family types may be expected. From the scientific standpoint, this trend can be adjudged neither progress nor retrogression, but numerous partisans uphold each view. Evidence from surveys of the degree of self-sufficiency of nuclear families in urban England by Michael Young and Elizabeth Bott and in metropolitan areas of the United States by Marvin Sussman and Eugene Litwak suggests that the trend stops short of complete independence of the nuclear family. A modified form of extended family co-operation persists in the form of parental subsidies and gifts to get started in marriage, and continuous mutual interchange of visits, money transfers, services and counsel for most of the stages of family development.

Between World War I and World War II, previous emphases by scholars upon biological and historical origins were replaced by attention to the dependence of the forms of institutions upon the functions they are intended to perform. This latter outlook led increasingly toward psychological and sociological interpretations of change in family forms. The transfer of production from homes to industrial and commercial institutions was pointed out as reducing the economic functions of the family to serving only as a consuming unit. The reduced differentiation of men's work from women's work in the home tended to transform marriage from

interdependence into companionship, especially among urban couples above the lowest income levels. Children ceased to be valued as economic assets in a family enterprise and became economic liabilities for some, whereas for others they were regarded as wanted "items of consumption," with each family deciding how many it could afford. Maintenance of health, protection from enemies, education of the young, religious and recreational functions likewise were transferred in large part to specialized institutions.

Family Stability.—Despite certain retransfers and the emergence of various new functions, as in hygiene and recreation, the net effect of these changes has been generally appraised as reducing the importance of families to their members, thereby posing an additional threat to family stability. On the other hand, certain functions have remained the recognized responsibility and offering of families; indeed, comparison might indicate that families show more attention than in the past to the giving and receiving of affection, and the care and enjoyment of children. Such transformations as these can no longer be usefully conceived as the natural unfolding of an independent entity; instead, the family is now seen as both a reaction to and an influence upon other institutions of the whole society.

Thus the family is studied and served professionally from the standpoint of each of its functions—as a biological unit, as a producing and consuming unit, as a unit of social organization, as a personality-forming agency and as a centre for the formation of religious and cultural values and personal and social identities.

The popular and conservative outlook tends to construe certain forms of family life in each culture and subculture as sacred, fixed, ideal and not subject to purposeful modification or legitimate deviation. While all societies exhibit actual deviations in behaviour from the ideal forms upheld in their recognized moralities, all known societies employ a variety of means to stabilize and enforce conformity to the forms they honour. Indeed, a large share of what is known as morality in every society is devoted to specifying the proper behaviour of family members toward each other.

The sociologist Charles Horton Cooley stated the influential proposition that moralization of communities at large, and ultimately of world society, consists of extending to secondary groups the relations characteristic of primary (face-to-face) groups. In view of the frequency of hatred and violence within families, his notion that family relations may be extended to less personal group relationships was probably more realistic than he supposed. Like Cooley, virtually all religions tend to conceive the proper relationships of mankind in family terms. Because of the interdependence of institutions, the growth of love within families and of brotherhood among nations is thought more likely to proceed in step than apart.

The devices that have traditionally been employed to strengthen observance of family rules and enforce moral obligations include ritual public announcement of changes in family status; ascription of sacramental significance to wedding and name-giving ceremonies; cultivation of fears of supernatural sanctions; ridicule and ostracism of violators, together with withdrawal of economic support or co-operation; and, of course, the sanctions of law, courts and the state. Only in the 20th century have there been tendencies in western European countries to construe marriage as simply a matter-of-fact civil contract. Because of the widespread decline of the religious and moral fortifications of marriage and the family, many spokesmen have expressed strong doubts as to whether families can remain sufficiently united to perform the functions for which they are still deemed indispensable.

Commitment to certain moral norms ultimately furnishes the structure of any society, without which its members cannot successfully organize and conduct their various interdependent activities. Yet moral commitment based solely upon individual self-interest is a contradiction in terms. This modern dilemma is causing both social scientists and philosophers to scrutinize deeply the conditions upon which marriage and parenthood may be freely contracted yet may effectively commit the partners to the discharge of their family obligations.

In the representative conjugal family, it is the quality of the marriage between husband and wife which principally guarantees successful performance by the family of its functions. On this account, although marriage and the family are quite distinguishable, they are almost merged as concepts in popular thought. Apart from the death or physical or mental breakdown of members, the major threat to any family is dissolution of the marriage which launched it. Correspondingly, the frequency of divorce is widely taken as the most significant index of family instability. Yet many unseparated families are quite unsuccessful in rendering to members the satisfactions they expect. Scholars are therefore engaged in research to find more precise and valid indexes of family success than the raw divorce rate; measures of welfare, happiness, solidarity, adjustment, development and competence.

Modern societies tend to require every person to achieve independence from his parents at adulthood. Asserting emancipation from parents often generates a stormy period of reorganization of family relationships during adolescence, which may overlap the period of courtship, mate selection and marriage. Marriage in a society holding to the conjugal type of family ordinarily marks the transition of a person's primary loyalty from his family of orientation to his family of procreation. To the extent that he does not so transfer his loyalty he endangers the stability of his marriage. Such readjustments require insight, skills and resources for handling problematic life situations. An important development which may contribute to increased family success is the belief that these insights, skills and resources may be improved through training and professional assistance. It may be debated whether in eras of large, consanguineal-type families and closely knit neighbourhoods such preparation for marriage and parenthood was more available or less needed; in either event, consciousness of the value of adequate preparation has been growing. It has given rise to a diffuse movement for family life education in schools and colleges. A vast array of remedial agencies, both public and private, has arisen to try to deal with family failures. Some of the remedial agencies are likewise turning their interest toward measures to prevent breakdowns through programs of education, recreation and community planning.

Where the consanguineal family system predominates, mate selection is usually not left to the two individuals who marry, but is arranged by parents, brokers or community functionaries. It is paradoxical that as successful marriage becomes more basic to stability of the family, it is less and less entrusted to experienced persons to arrange. Contemporary insistence by young people upon making free choice of mates introduces new hazards of unwise selection, especially as the average age at marriage has tended to drop. The uncertainties of making a wise choice have given rise to an impressive growth of both magical and scientific devices for predicting success in marriage before it is contracted. The scientific procedures are still in their infancy, though the magical procedures are very old (*see* MARRIAGE).

Widespread faith in the scientific method may have raised unjustified hopes that it could allay some of the perennial risks inherent in launching and conducting a family. Logically, however, there is no direct appeal that can be made to science, as to religion, to strengthen the bond of marriage. On the other hand, it may be justifiable at least to hope that research and experiment will progressively become able to state the conditions under which an optimum outcome is attainable. A description of these conditions may resemble no existing form of family life. Since the scientific approach is to evaluate such forms comparatively and experimentally, they would probably be conceived as tested organizational procedures rather than as sacred dogmas. Equipped with such a basis for predicting and controlling outcomes, however, human beings might as readily employ it in venturing upon new explorations as in eliminating the hazards to family solidarity. Were all the striving to stabilize this errant institution ever to succeed, human life would lose its familiar likeness to a game of chance and skill.

Values.—At the risk of oversimplification, changes in the family may be further analyzed in terms of a contrast between two general sets of values, familism and the pursuit of individual happiness. Some influential scholars, pointing to the trend from the large, patriarchal, consanguineal type of family to the small, equali-

tarian, conjugal type, ascribe this development to wider acceptance of the values of freedom, equality, participation in decision making and the development of personality. At the same time, spokesmen who deplore this change are inclined to blame it upon the weakening of certain traditional values: obedience to legitimate authority, loyalty to parents and kin, respect for ancestors and the past and the virtues of the large-sized family. Despite their important disagreements, it may be noted that partisans of each type of family assume that the values they hold will influence further developments. Moreover, each party claims that its favoured form of organization is more conducive to the optimal development of children—whose rearing both groups agree upon as the principal end served by families. It is quite conceivable that the family as an institution could be dispensed with altogether and society would survive, since theoretically all family functions could be transferred to other institutions. No influential contemporary theorists would hold with Plato that, for the best development of the children who are to become the guardians of society, they should be taken at birth from their parents and reared expertly by the state. However, the Soviet Union and Communist China have experimented for a time with various programs to reduce the role of the family and increase the role of the state in child rearing.

It is upon general commitment to the value of some kind of family, despite differences as to exact kind, that continuation of the institution depends. Thus it becomes useful to specify more closely the values sought in family life, and to regard these as diverse, variable, problematic. It is not valid to dispute the superiority of one type of family over another simply in terms of their relative efficiency in satisfying imputed fixed needs. The functionalist approach which characterized professional thinking during the period between World War I and II is making way for a more procedural analysis of family functioning. The latter approach stresses periodic appraisal of the forms and functioning of family life in relation to specified, desired outcomes, these in turn being concrete versions of general values. Thus nepotism and the inheritance of wealth are family practices highly honoured according to certain traditional family values; but where emphasis is upon equality of opportunity for the children of all families, they are viewed as unethical advantages. The sovereignty of parents over children, as against public intervention, is a dispute over values, expressed in the contrasting practices of child labour and compulsory education. The privacy of the home may be regarded as sacred in one country but an invitation to conspiracy against the state in another. The division between the individual and the state of financial responsibility for aged parents has become controversial.

To the extent that the forms and functions of family life come to be devised and deliberately revised according to conscious value judgments, the character of family living is seen as the product of specific social policies. In the modern world this definition has been given to many social institutions, and the family is apparently not to be excepted.

Public Programs.—Even an outcome ostensibly so much a matter of biology, of hope and fate, as the number of children a family will have is increasingly thought of as subject to influence by the population policy of government. Thus through several decades countries such as Sweden and France attempted to encourage the birth rate through such devices as child welfare programs and family allowances. Other governments give tax exemptions for dependents as an indirect form of assistance to families who raise children. Conversely, some countries which deemed themselves overpopulated ventured to conduct broad programs for discouraging birth rates. (*See* Birth Control.)

Policies that are in process of formulation in all modern countries affect other major aspects of family life: health, standard of living, legal obligation and personal development. Programs to implement these policies go considerably beyond mere remedial measures designed to correct cases of deviation from norms; they include definition of new norms as goals of concerted social effort, and thus constitute positive planning as distinguished from either therapy or philanthropy. In a number of European countries associations of heads of families have been organized into family unions with significant lobbying power which they use on behalf of families. Just as trade unions have affected national policies on unemployment and minimum wages, so do these family unions influence legislation on tax exemptions, family allowances, vacation allowances, transportation discounts and public housing programs.

Since prior to actual trial the outcome of programs of reconstruction is uncertain, they often arouse anxiety. The security of a dynamic society, however, appears to rest more in becoming able to make reliable predictions of outcomes than in attempting to establish a state of affairs in which change would cease. The growth of population, invention, mobility, knowledge and diversity of outlook make it improbable that any *status quo ante* could be restored and maintained. Yet, among the many instabilities of contemporary life, people may turn hopefully to their homes for the security they miss outside. Some theorists go on from this observation to declare that only well-prepared families can successfully foster the kind of balanced and competent personality that in turn can weather the strains of urban, industrial existence. If their belief is correct, public policy may become still further oriented toward strengthening the mental health of families and facilitating the optimal personality development of children.

Influence of the Family on Individual Personality.—Psychiatrists, contemplating the incidence of personality instability and breakdown, have turned intent scrutiny upon the family experiences of individuals from infancy onward. Until the post-World War II period, however, this scrutiny proceeded largely upon the assumption of some natural pattern of development. Distortions of this pattern, which could be diagnosed and dealt with remedially, were taken as the origins of maladjustment. Since then the view that personality development within the family is a continuous process of construction or fabrication of some complex identity as an expression of the family's values has gained renewed recognition. This perspective implies a heightened degree of responsibility of the family for the personality of each child it produces.

In the English-speaking countries, particularly, this outlook gained wide acceptance and led to formation of child study groups, courses for prospective parents, programs for dispensing expert knowledge, child-development research and professional counseling. At their outset, these activities involved mothers almost exclusively, but a trend toward participation by fathers gradually developed. Self-conscious improvement of competence as parents by these means is related to a general movement toward professionalization in industrial countries. In countries of high birth rates and low standards of living, however, the main aim in child rearing remains physical survival.

The popularity of existentialism (*q.v.*) in the years after World War II may be traced partly to the sense of personal isolation and loneliness which became common with the decline of family and neighbourhood solidarity. Psychoanalytic thought has been concerned with the processes of identification of children with their parents and the adverse effects on the individual of isolation. Immense quantities of popular literature have been devoted to the hazards and tragedies involved in the pursuit of romantic love in mobile, competitive settings. Much professional thought has gone into attempts to intensify the sense of intimacy and trust in quasi-family, that is, small, intimate, face-to-face, groups. Whether this strenuous intellectual ferment will produce a fresh synthesis or will eventually turn back toward restoration of traditional family life will probably depend upon whether it can find new ways for the individual to achieve a sense of identification with his fellow human beings.

The traditional family conferred upon each member an unquestioned sense of identity and even the feeling of being part of an immortal chain. It did this through associating the individual in a virtually permanent way with a definite physical place—an abode if not a piece of land—with a trade or enterprise which descended by inheritance and domestic instruction through successive generations, and with a closely associated body of kin (as in the analysis of the French family system by the early sociologist Pierre Guillaume Frédéric Le Play). So much was personal identity established by these three modes of placement in the social

order that most surnames are derived from these sources. Only individuals of the most talented or heroic distinction ever achieved surnames based upon personal traits.

The small, modern family of industrial countries, however, has neither fixed place of abode, family transmission of occupation nor more than a tenuous connection with kindred. A steadily growing practice among persons in public careers, as, for example, actors and entertainers, may be prophetic: the changing of names by individuals to foster or to distinguish their careers is a phenomenon that could spread to other fields. Some women in business and the professions keep their maiden names after marriage—though their children continue to take the father's name, at least until they choose their own professional names. If the changing of names at adolescence or at entry into a professional career were to increase, and the chosen identity could be satisfactorily established, then it could be asserted that the identity-conferring function of the family had been transferred to the career as a social institution. This possibility accords with a tendency in sociological circles to redefine marriage as a mutually contingent pair of careers; in this light, the ancient division of labour between man and wife, which has everywhere given function and solidarity to the family, receives a new definition.

On the other hand, the immense increase of leisure in the industrial countries has worked a curious reversal upon the earlier separation of work from residence. Though many mothers hold jobs which absent them more and more from their families, the reduction of hours of work has made it possible for fathers to spend more time with their families than was formerly the case. The possibility of using this leisure in forms of recreation conducive to optimal personal and family development is being grasped and employed by increasing numbers of families and family agencies.

Utilization of the opportunities presented may suffice not only to correct the previously disproportionate influence of the mother in rearing children, but may accentuate optimal child development as a principal value and goal of family functioning. As parenthood has become more voluntary, children are coming to be wanted more consciously as expressions of the creative and affection-giving potentialities of their parents. This trend may help to account for the decline of such institutions as orphanages. Among industrial countries the demand for children for adoption outruns the supply of children made available by illegitimacy, desertion or death of the parents. Demand has significantly become greatest for infants, rather than for children of working age, as used to be true for children taken from orphanages. Never in our history have children been more valued.

Family Policy.—Despite the hazards imposed by mobility and migration, the breakup of traditional supports and controls, the perils in readjusting authority and dependency roles, the greater ease of divorce and remarriage, there are probably as many grounds for hope as for anxiety regarding the future of the family. No doubt the outlines of the conjugal form will persist indefinitely, but the family is likely to be conceived increasingly as constituted by interpersonal values. Family policy, both public and private, may thus come to crystallize around a dynamic conception of personality development, dramatized by identities self-chosen at adolescence. As ever, the principal function of the family will remain the rearing of children, but for their own sake. Assuming an increasing sense of competence through scientific research and experiment, the people of industrial countries may view the developing drama of family life with mounting enjoyment rather than anxiety or dread.

See also references under "Family" in the Index volume.

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FAMINE, a general scarcity of food with resultant hunger and starvation for large numbers of people. The story of famine goes far back in history. The Bible, for example, relates how a young Jewish administrator named Joseph advised the pharaohs on famine relief measures in ancient Egypt. After this a long series of famines carries the history of famine down to the 20th century.

B.C. 436	Famine at Rome, when thousands of starving people threw themselves into the Tiber.
A.D. 42	Great famine in Egypt.
1005	Famine in England.
1016	Famine throughout Europe.
1064–72	Seven years' famine in Egypt.
1148–59	Eleven years' famine in India.
1344–45	Great famine in India, when the Mogul emperor was unable to obtain the necessities for his household.
1396–1407	The Durga Devi famine in India, lasting 12 years.
1586	Famine in England giving rise to Poor Law system.
1661	Famine in India. No rain fell for two years.
1769–70	Great famine in Bengal; a third of the population (10,000,000 persons) perished.
1783	The Chalisa famine in India extending from eastern edge of the Benares province to Lahor and Jammu.
1790–92	The Doji Bara, or skull famine, in India, so called because the dead were too numerous to be buried. Relief works first opened during this famine in Madras.
1838	Intense famine in North-Western Provinces (Uttar Pradesh), India; 800,000 perished.
1846–47	Famine in Ireland, resulting from the failure of the potato crop. Parliamentary grants up to £10,000,000.
1861	Famine in northwest India.
1866	Famine in Bengal and Orissa; 1,000,000 perished.
1869	Intense famine in Rajputana; 1,500,000 perished.
1874	Famine in Bihar, India. Government relief in excess of the needs of the people.
1876–78	Famine in Bombay, Madras and Mysore; 5,000,000 perished. Relief insufficient.
1877–78	Famine in north China; 9,500,000 said to have perished.
1887–89	Famine in China.
1891–92	Famine in Russia.
1897	Famine in India. Government policy successful. Mansion house fund £550,000.
1899–1901	Famine in India; 1,000,000 perished. The government spent £10,000,000 on relief, and at one time there were 4,500,000 people on the relief works.
1905	Famine in Russia.
1916	Famine in China.
1921	Famine in U.S.S.R.
1932–33	Famine in U.S.S.R.
1943	Famine in Bengal; about 1,500,000 perished.
1960–61	Famine in the Congo quickly relieved by the United Nations.

In the decade 1940–50, there was famine in the ghetto of Warsaw, in prison camps in central Europe, in the Netherlands, in Greece and in besieged Leningrad. A major famine occurred in Bengal. Many inmates of the Japanese prison camps lived under famine conditions as did some of the peoples of the Netherlands East Indies during the Japanese occupation.

Causes of Famine.—The primary causes of famine are four:

1. *Widespread Failure of Crops Because of Lack of Water.*—Vast numbers of people in tropical and subtropical countries have died in famines arising from drought. Irrigation schemes have enabled man to preserve and, in a relatively small way, to control the rain after it has fallen. Millions of acres of land are now partially independent of direct rainfalls. Yet there were no signs at mid-20th century that science would soon be able to ensure a regular rainfall over the cultivated areas of the world.

2. *War and Civil Disturbance.*—Europe, North America and most other temperate regions enjoy such a regular rainfall that natural famines caused by catastrophic failures of the crops from lack of water are rare. Most European famines have been caused by wars or civil disturbances. Armies fighting over a countryside may cause famine by destruction and, more especially, by requisition or looting of crops. In this way many famines arose, especially in the religious wars of the 16th and 17th centuries. In the 20th century, fighting in Europe was seldom so widespread or prolonged as to cause major destruction of the crops except in rela-

tively local areas, nor did the armies, in the west at least, generally live off the land.

Famine conditions have arisen in the great industrial cities more frequently than in the rural areas. The disruption of large transport systems and of the economic structure of society has often led to famine (*e.g.*, in Vienna in 1919). In some cases famine conditions have been deliberately produced for the purpose of exterminating large masses of people. This happened in the ghetto of Warsaw in 1942 and in the Nazi concentration camps.

3. *Destruction of Crops by Diseases and Pests.*—The great Irish famine of the 19th century was caused by the destruction of the potato crop by the blight, a fungus infection. In these famines, 2,000,000 to 3,000,000 persons died, and large numbers emigrated. Wherever a single crop dominates agriculture there is always a risk that the crop may perish from a plant disease. In those large areas of the world subject to plagues of locusts, safety from famine can be purchased only by constant vigilance.

4. *Great Natural Disturbances.*—Earthquakes and floods are a constant threat in many parts of the world. Great destruction of crops, food stores and communications may result.

Famine Prevention and Relief.—A sound agriculture with the best possible use of available water supplies is the best provision against famines in the tropics. Political and economic stability will usually prevent famine in temperate regions. A reasonable agricultural surplus to carry over from the last harvest is essential. This necessitates adequate storage accommodation.

Successive Indian governments acquired much experience in the handling of famines. Nearly all famines are relatively local and the main problem is the bringing of food from neighbouring areas. Transport is a key to the problem. The building of the Indian railways in the middle of the 19th century, for example, led indirectly to a great saving of life. A principle of British famine administration in India was that gratuitous relief should not be given. If money could be brought into the famine area, then food would follow automatically through the normal trade channels. The organization of large emergency public works was the means adopted to overcome the shortage of money. Elaborate plans were drawn up in all areas where famine was possible and works opened as soon as signs of scarcity arose. There are criticisms in detail of this method (for instance, persons doing manual labour need more food), but on the whole the measures prevented major disasters.

Famine conditions still arise in India almost every year, but only rarely do people die of starvation. In Bengal in 1943 at least 1,500,000 persons died when relief measures were not introduced until several weeks after famine had begun, but this occurred because adequate information about the scarcity in the villages was not available in Calcutta until too late.

The United Nations Relief and Rehabilitation administration (UNRRA) took effective relief measures against famine in Europe following World War II. As early as Nov. 1943, representatives of 44 nations met in Washington, D.C., at the invitation of the president of the United States, Franklin D. Roosevelt. The countries that had not been invaded agreed to contribute 2% of their income to the resources of the administration. UNRRA poured vital supplies into Albania, Austria, Belorussia, China, Czechoslovakia, Ethiopia, Greece, Italy, Poland, the Ukraine and Yugoslavia. Limited aid was also given to six other countries. Goods included locomotives, trucks and freight cars for the transport of food to centres of population, farm animals, tractors and plows and seed grains necessary for the restarting of agriculture, besides fully equipped hospitals and medical supplies. The most vital and immediate part of UNRRA's work was, however, the provision of food of every kind. The result was that at least three famines that might have involved 15,000,000 people in Europe were prevented; misery, hardship and underfeeding among many more millions were alleviated. The general assembly of the UN gave the Food and Agriculture organization the responsibility of keeping watch on threatening famine and reporting without delay.

In the last months of 1960, famine conditions arose in the Congo. As a result of the tribal war between the Luluas and the Balubas, about 300,000 refugees were concentrated in a small area of about 100 sq.mi. in south Kasai. A daily death rate of about 200 was reported. The United Nations responded rapidly. Donations of food were received from countries all over the world, and by Feb. 1, 1961, it was possible to distribute 75 tons of food daily, including 12 tons of dried fish. An airlift helped in the movement. The deaths were cut by 75% in a few weeks. Here an early forewarning of the situation by technical experts and prompt administrative action probably averted a major disaster. The success of the operation appeared as a minor triumph for the United Nations.

Effects of Famine.—If a group of persons are forced to live on a limited diet yielding only about 1,600 calories daily (equivalent to about one pound of cereals), at first they will lose weight rapidly. After a few weeks this process will slow down and after two to three months, when about 25% of their initial weight has been lost, they will be in equilibrium again and may continue to exist for many months on such a diet. Provided medical and good sanitary services are available, the death rate should be little above normal. If the calorie content of the diet is lowered still further, weight losses will increase rapidly, deaths from starvation will soon occur and become increasingly numerous. For women, children and persons of small build, slightly lower food intakes could be tolerated. If hard labour is forced upon the group, then deterioration will be more rapid and equilibrium cannot be reached. Some persons resist famine better than others. But deaths become frequent in any group in which, on the average, the weight has fallen more than 25% of the weight in health. The body is able to make remarkable adjustments to conserve energy. The reduction in weight reduces the active tissues, which use energy, and there is also a decreased rate of utilization of energy (metabolism) in the tissues which remain. There is in addition a great economy of movement. A marked lethargy prevents any unnecessary muscular effort. Psychologically the mind is dominated by a desire for food. Other emotions are dulled and there is a mental apathy, but the intellect can function normally if necessary. Moral standards fall and this may be aggravated by social circumstances. Murder and cannibalism have frequently been reported in famines.

Dropsy (*see* EDEMA) is often found in famine victims and in severe starvation there is a constant and very distressing diarrhea which is often the immediate cause of death. The pulse rate is slowed, the blood pressure falls and the heart is atrophied. This atrophy may be irreversible and resist all rehabilitation. Vitamin deficiencies are not common in simple starvation. Anemia is usual, but seldom severe. Amenorrhea usually soon sets in, and in both sexes the libido is markedly reduced. Epidemics of infectious diseases such as cholera, malaria, louse-borne typhus, influenza and tuberculosis add greatly to the death toll in famines.

A very important aspect of famine in a peasant community has been the disruption of family and village life. Whole villages may migrate and wander in search of food. Children may be separated forever from their parents; hordes of such children may roam the countryside capable of any crime in their search for food. *See* also FOOD SUPPLY OF THE WORLD.

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FAN in this article is the light hand instrument; for those employed in systems of ventilation *see* FAN (MECHANICAL). Fans of the kind described here may be divided into two main groups—

the rigid or screen fan, and the folding fan. The rigid fan has a handle or stick with a rigid leaf, or mount. The folding fan is composed of sticks (the outer two called guards) held together at the handle end by a rivet or pin. On the sticks is mounted a leaf which is pleated so that the fan may be opened or closed. A variant of the folding fan is the *brisé* fan in which the sticks are wider and bladelike, and thus still overlap each other when the fan is opened and thus themselves form the equivalent of a leaf. The sticks of a *brisé* fan are connected at the top by a ribbon or thread.

Ancient Fans.—Since hardly any fans from the ancient civilizations have survived, our knowledge of them is based on pictorial evidence. They were all of the rigid type derived from the leaf form, although the shapes varied considerably. A variant of the rigid fan is the feather fan in which the leaf is replaced by feathers fixed radially at one end of the handle. Feather fans with long handles are illustrated in Pharaonic Egyptian reliefs and two examples of such fans, found in the tomb of Tutankhamen (14th century B.C.), are in the Cairo museum. Rigid fans also played an important part in Assyrian, Indian and ancient Chinese ceremonial. The ladies of classical Greece carried small rigid fans, sometimes of the feather type, and their example was followed in the Roman world. The rigid fan was used in medieval church ceremony and was known by its Latin name *flabellum*. At this time it often took the form of a metal (sometimes silver) disk mounted on a long handle. The *flabellum* was normally held by the deacon and used *pro muscis fugandis*, "to drive away flies."

A modification of the rigid-leafed *flabellum* had a pleated leaf in the form of a cockade which could be folded shut and retracted into a container at one end of the handle. Two important examples of such medieval cockade fans have survived, one in the Bargello at Florence, Italy, which came from the abbey of Tournus and can be ascribed to the early 9th century A.D. (on the basis of an analysis of the rich decoration executed on the leaf and the carved handle), the other (probably also 9th, although sometimes ascribed to the 7th century) in the cathedral treasury at Monza near Milan.

Another variant of the rigid fan is the banner fan which resembles a small flag in that the leaf, often of rectangular shape, is attached to one side of the handle. Known in India and elsewhere, this form was also in favour in Italy during the Renaissance and may well have been introduced to Europe from the orient.

Oriental Fans.—From time immemorial the fan has played an important part in Chinese and Japanese life. They were carried by men as well as women and there were many classes, each reserved for some special purpose. Thus in Japan the fans carried by courtiers differed from those borne by the warrior caste, while the fans prescribed for the formal tea ceremony were unlike those used on the stage. With so much significance attached to the fan in the far east, a great deal of attention was paid to its decoration, and the exquisite taste displayed in the embellishment of high-quality Chinese and Japanese fans has never really been equaled. In Europe the painting of fan leaves was, until the 19th century, the work of artisans—clever decorators at best. In China, on the other hand, many of the great painters devoted their talents to their decoration and the resulting works of art were not always mounted for actual use as fans. Their works have long been collected by eastern connoisseurs of painting and kept in albums. A few examples dating from the Sung dynasty (A.D. 960–1279) have survived, but most are of later date.

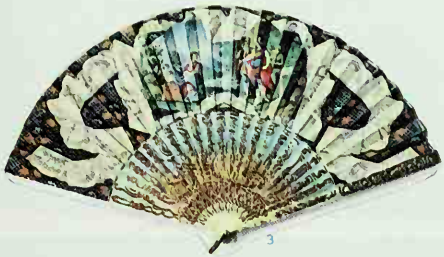
The rigid fan was apparently the more common type in China up to the end of the Sung dynasty but during the Ming dynasty (1368–1644) the folding fan seems to have come into fashion. The folding fan was invented in the far east (by the Japanese in the 7th century A.D., it is sometimes claimed) and it is possible that a few examples of such eastern folding fans reached Europe during the middle ages. However, the Portuguese traders who opened up the sea route to China in the 15th century were probably the first to bring oriental fans to Europe in any quantity and thereafter the importation of these curios increased. By the end of the 17th century enormous consignments of Chinese and, to a lesser extent, Japanese fans were reaching Europe. These were mostly of rather poor quality by oriental standards for they were made for the less discriminating European market, but the intricacy and skill with which even they were fashioned caught the imagination of Europeans who bought them eagerly. Chinese fans made for export before the middle of the 18th century are comparatively rare but large numbers of the delicately carved and pierced ivory *brisé* fans dating from the second half of the 18th and early 19th centuries have survived. The so-called mandarin fan was very popular with Europeans during the 19th century. These are also of the folding type and have gaily coloured leaves on which little figures are painted. Each figure has a tiny applied oval of ivory on which a face is painted. Japanese fans were greatly admired, especially in artistic circles, during the last decades of the 19th century.

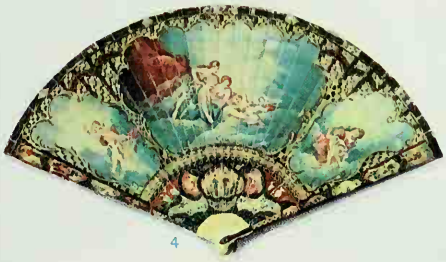
European Fans.—*Late Renaissance Period* (c. *1500–1650*).—Although the folding type of fan was known in Europe before 1500 it was a rarity until the end of the 16th century, and fashionable people carried variants of the rigid fan throughout this period. Feather fans were in great favour. The feathers were set in handles that were often beautifully carved and decorated in the prevailing style of the time. Artists of distinction occasionally provided designs for such work which was then executed by jewelers. Portraits painted during the 16th and first half of the 17th centuries often depict ladies holding fans of this kind. The folding fans of this period, on the other hand, were comparatively plain. The sticks were normally of a simple shape with little decoration. A portrait of Queen Henrietta Maria, consort of Charles I of England, shows her holding a simple pleated fan with guards of mother-of-pearl that are studded with a few large pearls. The leaf is of some red material, perhaps leather or silk, and seems to be unpainted. (The picture, by Honthorst, can be seen in the National Portrait gallery, London.) Painted decoration was probably rare until the middle of the 17th century. A few early folding fans have survived, the leaves of which rely for their decoration on cutout patterns resembling the patterns of reticella and early lace. These are ascribed to the late 16th or early 17th centuries.

Baroque Period (c. *1650–1730*).—After the middle of the 17th century France usurped Italy's position as the chief producer of Europe's luxury wares, and from then on the finest fans were mostly made in Paris although Italy continued to provide many splendid examples until the close of the 18th century. Surviving fans of the baroque period are comparatively rare and nearly all of high quality. The decoration of both sticks and leaves is executed with a care rarely bestowed on fans of later periods.

During the middle decades of the 17th century the folding fan with a painted leaf came into fashion in Europe. Fan leaves were decorated with intricate compositions which usually covered the whole surface of the leaf, there being little or none of the subsidiary ornament at the edge which is found on 18th-century fans. Attention was also paid to the back of the leaf which was frequently decorated all over. In the Schreiber collection (British museum, London) is a painted fan leaf showing the marriage of Louis XIV to Maria Theresa of Spain which took place in 1660. However, the scenes on fans of this period are normally of classical or mythological subjects. The sticks are usually quite narrow, often with a slight swelling below the leaf. They may be plain ivory or the ivory may be inlaid with silver piqué work in delicate patterns.

By the 18th century the fan had become a necessary part of any lady's toilette; fans were therefore made in large quantities and many qualities, and Parisian fanmakers carried on an extensive export trade. Piqué work became rarer toward 1730 and the carving of ivory and also of mother-of-pearl became more intricate. During the first three decades of the century the *brisé* fan came into vogue in Europe, obviously inspired by oriental examples. Made of ivory, these fans were usually smaller than those with pleated leaves. The surface to be decorated was divided into two fields, the part nearest the rivet generally being painted with small *chinoiserie* subjects while the main field above carried some scene, usually of a pastoral nature or of a *fête galante*. The finest of these small *brisé* fans are exquisite objects and go by the name of Vernis Martin fans because over the painted decoration is a coat of clear varnish of a type perfected by the brothers Martin in Paris. Their workshops were famed for fine lacquer work but whether even the finest of these little fans were really



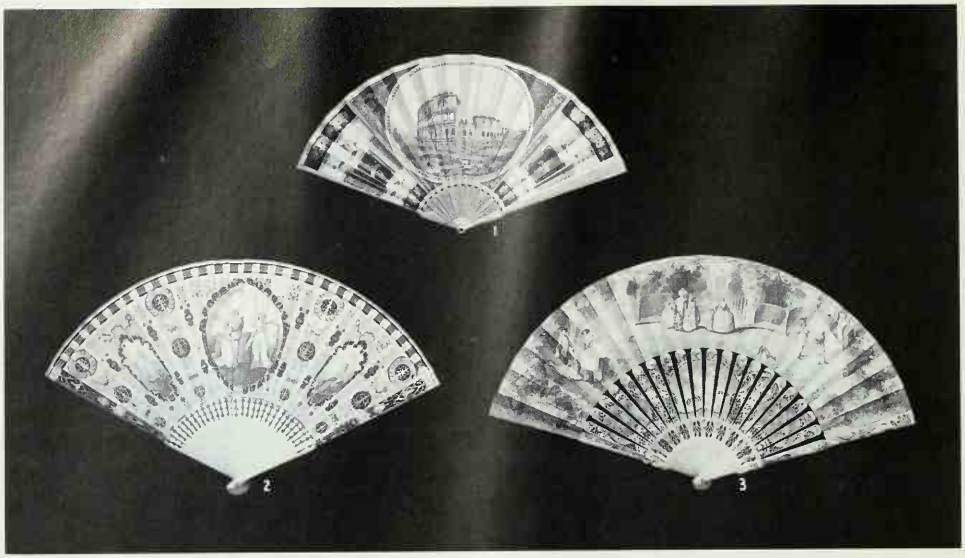


BY COURTESY OF (5) THE METROPOLITAN MUSEUM OF ART, NEW YORK, FROM (1, 2) THE COLLECTION OF ESTHER OLDHAM, WELLESLEY HILLS, (3, 4) THE COLLECTION OF DE WITT CLINTON COHEN, NEW YORK

FANS OF THE 18TH CENTURY

1. Cabriolet fan, with three strips of painted skin, sticks and guards of painted ivory. This type of folding fan was in vogue about 1755 when the cabriolet, a light two-wheeled carriage, which is often represented in the scenes or engraved on the fan leaves, became popular in France
2. Mask fan, popular in Spain during the second quarter of the 18th century. The leaf is of paper
3. Fan of painted skin with ivory sticks and guards, used in France during the third quarter of the 18th century
4. Vernis-Martin fan. This variety is one of the rarest and most sought after by collectors. The name is derived from the translucent varnish accidentally discovered by the brothers Martin, French coach painters, while they were attempting to imitate Japanese lacquer. The painting on the fan reproduced is attributed to Boucher
5. Elaborate French fan of the 18th century. On the parchment leaf are painted the figures of Louis XVI., Marie Antoinette, the princess royal and the dauphin. This fan, a product of the period when the most extravagant and luxurious ornament was in vogue, has sticks and guards made of carved and gilded mother-of-pearl

FAN



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FANS OF THE SIXTEENTH, EIGHTEENTH AND NINETEENTH CENTURIES

1. Italian fan, early 19th century. Leaf of skin painted in *gouache* with view of the Colosseum; sticks and guards of pierced mother-of-pearl. 2. Ivory brisé fan with painted medallion in style of Cosway. English, late 18th century. 3. Fan with mount of painted skin, sticks and guards of carved and painted ivory. English, middle of the 18th century. 4. French fan, mount of Argentan lace, sticks and guards of carved ivory. Third quarter of the 18th century. 5. Carved ivory brisé fan. Chinese, 18th century. 6. Late 16th century Italian fan with mount of parchment cut out in a geometric design. The sticks are of ivory

produced there is another matter. It is certain, however, that these fans were made in several qualities, the painting on some being poor. What is more, many are not varnished at all, which makes the name Vernis Martin misleading for the group as a whole. They have long been sought by collectors, and dealers have gratified the demand by providing many not very convincing imitations as well as actual forgeries, particularly in the 19th century.

Rococo Period (c. *1730–60*).—The fans of this period are generally larger than those of any other period. There is more charm but less gusto about the decoration than hitherto. The painting can be very good but was probably never the work of any of the great artists of the day; it was the work of craftsmen, governed by a guild. Eighteenth-century fan painters rarely signed their fans and only a handful of authentic examples are recorded. The paintings of François Boucher provided the style most frequently imitated, so that the majority of French fans from this period are embellished with pretty scenes of *galanterie* painted mostly in powdery blues and pinks, framed by scrollwork in the normal rococo style and with the figures rather smaller than on earlier fans. The finest fans of the period had the same care bestowed on painting the back of the leaf as on the front, although the average grades rarely had more than a vignette on the back.

Throughout the century Italian fan painters adhered to the older baroque tradition of painting a scene right across the whole leaf. Small-scale reproductions of 17th-century wall paintings by such artists as Guido Reni and the Carracci are not uncommon on Italian fans made in the first two-thirds of the century. These subjects were superseded toward 1800 by Roman or Neapolitan views. Spain seems to have produced few fans during the first half of the 18th century when the political and economic instability of the country discouraged luxury trades like fanmaking. The inscription *Real fabri, D. Madrid, 1757* on a fan in a Spanish collection shows that there was a royal Spanish fan factory there, but France probably supplied most of the fine fans that were needed until quite late in the century.

Louis XVI Period (c. *1765–90*).—The sticks of fans made during the first half of the 18th century usually overlapped each other slightly when the fan was open but later fans were commonly made with narrow sticks that were separated and splayed out like the spokes of a wheel. This new form and the rectangular, spade-like shape of the guards reflect the revived interest in classical form that began to show itself in Paris about 1750. In the decoration, too, this same tendency soon made its mark; the guards were carved with the urns and frigid scrollwork so typical of the Louis XVI style while the gay nonsense of the rococo idiom gradually became rarer. The painting tends to be confined to compartments (usually three) of various shapes. The subjects depicted remain much the same as during the rococo phase but rarely hold attention. Extra decoration with gilt thread and sequins is found on many fans from about 1770 onward. Fans with leaves adorned with printed decoration became very common toward the end of the century. Their subjects were generally of topical interest, often made to be used on some special occasion. During the second quarter of the century the English started the wholesale production of printed fan leaves, much to the chagrin of the fan painters. Early printed fans are very rare (there is a comprehensive collection in the British museum) and they are nearly all of extremely poor workmanship, with bad printing supplemented by patches of colour crudely applied.

Neoclassical Period (c. *1790–1825*).—About the end of the 18th century both painted and printed fans depicted figures in neoclassical dress, and fans with silk or gauze leaves entirely decorated with spangles came into vogue. Very small fans with a radius of about eight inches were in favour during the first three decades of the 19th century, their size being more in keeping with the narrow and light dresses of the empire style. Most of these small fans were of the *brisé* type, and of horn, ivory, mother-of-pearl and even of iron (in Germany), with pierced and fretted decoration.

Since 1825.—Some charming printed fans were produced during the 1830s but fans were apparently not carried much during the 1840s. About the middle of the century fans became larger again, echoing the voluminous dresses of the period. Fan sizes continued to increase during the latter part of the century, some typical late-Victorian fans being more than 20 in. long. Famous artists often painted and signed fans during the later part of the century. The painting on most Victorian and French second empire fans is somewhat insipid but a few examples compare favourably with some of the best work of the 18th-century fan painter. A few 18th-century fans had been furnished with leaves of lace instead of the more usual pleated paper or silk. The form was revived in the 19th century and lace fans became extremely popular from about 1870 onward. They came, like other fans, in several qualities; from the finest with handmade lace to the cheap products with leaves of machine-embroidered net. After about 1900 use of the fan began to die out; the busy woman of the 20th century found it an encumbrance and to some extent its place was taken by the cigarette.

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FAN (MECHANICAL), a device for moving air or other gases or vapours. (For the light hand instrument, *see* FAN.) Mechanical fans are used in systems for ventilating, heating and air conditioning buildings; for cooling and drying different materials and products; for cooling internal-combustion engines; for dust exhaust; for conveying light materials; and for induced and forced draft for steam boilers. In a fan the change in fluid density is so small that the gas is regarded as incompressible. A fan develops a relatively low pressure difference of the order of a few inches of water to less than one pound per square inch. As a contrast, in an air or gas compressor the density change is appreciable; the pressure developed by the compressor is measured in pounds per square inch instead of inches of water.

Sometimes various qualifying terms are applied to a fan. In a so-called exhaust fan, piping may be connected only to the inlet of the fan, and the fan discharges directly into the atmosphere. In a blower fan, piping may be connected only to the outlet of the fan, and the fan inlet is open directly to the atmosphere. A desk fan is a relatively small portable unit used to circulate air within the room in which it operates; fans also may be fixed to a wall or a ceiling to circulate air in a room.

Fans are frequently classified according to the motion of the fluid through the rotating member; this rotating member may be called an impeller, rotor or a runner. Fig. 1 illustrates a centrifugal fan. Air is led through the inlet pipe to the centre or eye of the impeller. The impeller throws the fluid into the volute or spiral casing or scroll, where it is led to the discharge piping. If the flow through the impeller is primarily in a radial direction, the impeller could be classed as a radial-flow runner.

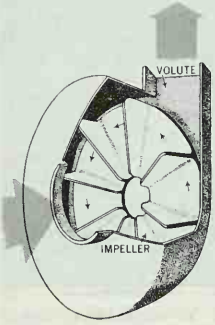

FIG. 1.—CUTAWAY VIEW OF CENTRIFUGAL FAN (*see* TEXT)

Fig. 2 illustrates an axial-flow fan, with the runner and guide vanes in a cylindrical casing or housing. The air passes through the runner essentially without changing its distance from the axis of rotation. In a centrifugal fan, air moves from one inner radius to another outer radius; there is a centrifugal force effect which increases the air pressure. In an axial-flow fan, however, this centrifugal force effect is not present. In a mixed-flow runner, the air flows through the runner partly in an axial direction and partly in a radial direction. Fig. 2 shows an axial-flow fan with fixed inlet guide vanes and fixed exit guide vanes; these vanes are sometimes called stator

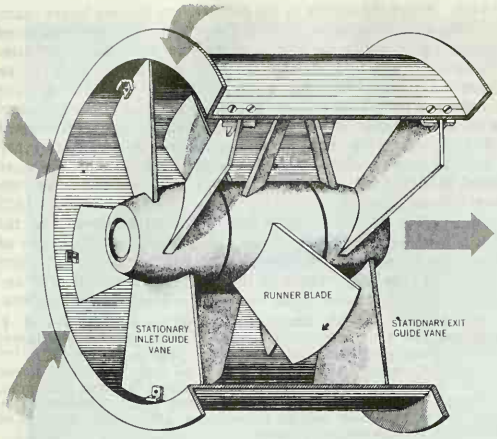

FIG. 2.—CUTAWAY VIEW OF AN AXIAL-FLOW FAN

vanes. Guide vanes serve to modify performance and improve efficiency. The phrase "vane-axial" is sometimes used to designate a fan with a runner and a set of inlet or exit guide vanes in a cylindrical casing; the term "tube-axial," to designate a fan which has only a runner in a cylindrical casing and no guide vanes. A propeller type of fan is one with a propeller or disk within a mounting plate or ring. The fan housing or casing may be constructed of sheet metal or cast metals with or without protective coatings, as rubber, lead or enamel. Fan wheels may be constructed of sheet metal or cast metals. The sheet metal may be steel or an aluminum alloy. In centrifugal fans the number of blades may range from 5 to 66; in axial-flow fans, from 3 to 26.

A fan runner may be driven by a high-speed electric motor, an internal-combustion engine, a steam turbine or a gas turbine. Belt drives and direct connections between driver and fan wheel are used.

Various factors or parameters are used in correlating data on performance and design. One useful factor is the specific speed N_s which is defined as

$$N_s = \frac{N\sqrt{C.F.M.}}{H^{\frac{3}{4}}}$$

where N is the angular speed of the runner in revolutions per minute, $C.F.M.$ is the flow through the fan in cubic feet per minute and H is the fan head in feet of the fluid flowing. For narrow straight-blade centrifugal fans, N_s varies from about 140 to 900; for curved-blade centrifugal fans, from about 1,000 to 3,000; and for axial-flow fans, from about 4,000 to 8,000. Generally speaking, an axial-flow fan is suitable for a relatively large rate of flow with a relatively small pressure boost and a centrifugal fan for a small rate of flow and a large pressure boost. In some cases it is desired to obtain a relatively high pressure boost with a relatively large capacity. Two or more axial-flow fans can be staged. When staged, several fans are essentially connected in series, so that the same capacity goes through each fan, but each fan adds to the pressure boost.

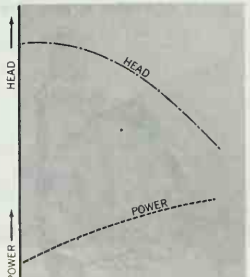

FIG. 3.—PERFORMANCE CHARACTERISTICS OF A FAN AT CONSTANT RUNNER SPEED

The capacities of fans may range from 100 to 500,000 cu.ft. per minute. That of small kitchen fans may range from 300 to 800 and the capacities of attic window fans from 3,000 to 8,000. Exhaust fans for use in a central system may have capacities ranging from 2,000 to 100,000.

In selecting a fan it is frequently necessary to consider performance characteristics. It is customary to test a fan at constant speed of the runner. Measurements are made of the head or pressure rise across the runner, the capacity or volume rate of flow through the fan and the power input to the runner. Fig. 3 illustrates a plot of head versus capacity and a plot of power versus capacity. The head characteristic is important in matching a fan to a system, in order to maintain the proper flow through the system. The power characteristic is important in deciding the size of the motor or engine needed to drive the fan. Different fans have different performance characteristics. By examining the performance characteristics one can match a fan to a particular system over a range of flow rates.

As an example, consider a centrifugal fan with blade tips which are forward-curved, that is, the blade tips are curved in the direction of rotation. In general, such a fan has a head characteristic which is flat; it does not change much with change in capacity. In some applications a flat characteristic is desirable. On the other hand, a backward-curved blade tip has a steep head-versus-capacity curve, that is, there is a marked change in head with capacity. Some cases require a steep characteristic. A radial-blade centrifugal fan (illustrated in fig. 1) has a head characteristic between that of the forward-curved fan and the backward-curved fan. The forward-curved fan is slower and the backward-curved fan is faster than the radial-blade fan in developing the same pressure boost and capacity.

The efficiency of a fan is the ratio of the useful power added to the fluid divided by the power input to the runner shaft. The nominal or design rating of a fan at a certain speed is the head and capacity at the point of maximum efficiency. Consider a fan operating at different speeds, but with essentially the same efficiency. Certain approximate relations are used for estimating performance. These relations are: the capacity varies directly as the runner speed N; and the pressure boost across the fan varies directly as N^2. Consider a series of geometrically similar fans of different sizes but having similar flow patterns and operating at the same shaft speed and same efficiency. Let D represent the outside diameter of the runner. Some useful approximate relations are: the fan head varies directly as D^2; and the capacity varies directly as D^3. The flow is steady, or practically so, in many installations of a fan and connected system. In some cases, however, there is a marked periodic fluctuation superposed on the main steady flow; this fluctuation is usually called surging. Surging may become dangerous and may limit the useful range of operation of a fan. Surging occurs at low-volume rates of flow, when operation is in a region in which the fan characteristic shows an increase in head or pressure with an increase in capacity. Surging does not occur when the fan characteristic shows a decrease in pressure with an increase in capacity. Surging can be avoided sometimes by bypassing some of the flow from the fan before it enters a particular system in which a lower rate of flow is desired.

Fan noise is an important factor in various applications. A fan may be mechanically efficient but not suitable if it is considered noisy. Noise is a particularly important factor in domestic applications. Fan noise may be reduced by proper blade design, operating conditions, proper balancing and mounting. Fans can be installed in ducts so arranged that the noise is absorbed before it leaves the duct. In general, noise from an air stream is proportional to some mathematical power of the air velocity. Reducing the air velocity reduces the noise. Generally speaking, the lowest fan noise is developed at the point of highest efficiency.

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FANFARE, a ceremonial flourish of trumpets traditionally sounded three times to herald the arrival of royalty or to an-

nounce the beginning of a joust or a dramatic entertainment. One of the earliest surviving fanfares is the toccata at the opening of the opera *Orfeo* (1607) by Claudio Monteverdi. Trumpet fanfares are sometimes accompanied by kettledrums.

FANG, strictly a Bantu tribe of about 176,000 persons occupying the northern half of the Gabon Republic, Rio Muni and the southernmost districts of Cameroon. Anthropologists use the term Fang (together with French *pahouin* and Spanish *pamue*) to cover a group of kindred tribes extending from the Sanaga river (4°30′ N.) in Cameroon to the Ogooué estuary (1°20′ S.) in Gabon, with a total population slightly under 1,000,000.

The Fang can be divided into three subgroups, chiefly according to linguistic criteria: Beti to the north, the main tribes being the Eton, Ewondo (or Yaounde) and Bene; Bulu, with the Bulu proper, Fong, Zaman and Yelinda; in the south the Fang, with the Fang proper (or Fang-Fang), Ntumu and Mvae.

According to tradition the Fang migrated into the forest from the savannah plateau on the right bank of the Sanaga at the beginning of the 19th century, reaching the coast near Libreville (Gabon) in 1893. They were fine warriors and hunters, with a reputation for cannibalism. Under German, French and Spanish colonial rules they engaged in ivory trading and after World War I turned to cocoa farming on a large scale, especially among the Bulu.

The Fang kinship system is strongly patrilineal, with patriarchal extended families (*nda bot*) and exogamic patriclans. Among the southern Fang there is no political unit larger than the *nda bot* hamlet, while in the north the Eton have clan chiefs. Authority goes with age seniority, and in the past a few ritual and political societies insured some degree of tribal cohesion.

By 1939 the whole population was reportedly Christian. Since 1945, however, there has been a rapid growth of syncretistic sects such as the *bwiti,* or *mbuti,* which combines animistic and Christian beliefs with a cargo-cult (*q.v.*) element. All the native crafts, including wood carving and their once reputed work in iron and steatite, have disappeared under western influence. Through education and relative economic prosperity, the Fang have become influential politically, especially in Gabon, where, in the early 1960s, they were practically in control of the government. *See* also AFRICA: *Ethnography* (*Anthropology*): *West Central Africa.*

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(P. H. AL.)

FANGLOMERATE is a poorly sorted, coarse fragmental rock that is the product of the partial or complete consolidation of material deposited on an alluvial fan, usually in an arid or semi-arid region. The biggest fragments in the rock must be larger than sand size; they may be blocks many feet in diameter. Few of the larger fragments are well rounded as they are in a conglomerate (*q.v.*), and so the rock may be considered one variety of breccia (*q.v.*). The rock fragments are commonly of considerable variety. They reflect more or less faithfully the range of rock types represented in the region of erosion. The interstices between the larger fragments are filled with smaller ones, down to sand, silt or even clay size. The cementing material is usually clay or calcium carbonate.

Fanglomerates form near the heads (apices) of alluvial fans and grade downslope into sandstone or siltstone. The recognition of a fanglomerate, after the characteristic shape of the fan's surface has been obscured by overlying sediments, partial erosion or deformation, is facilitated by the discovery of lateral gradation into sandstone and then siltstone. Rocks called fanglomerates have been found in many parts of the world and in most parts of the geologic column, but especially in the Mesozoic and Cenozoic successions of western North America. (A. O. W.; X.)

FANO, an Adriatic coastal town of Pesaroe Urbino province, region of the Marches, Italy, lies 9 km. (6 mi.) S.E. of Pesarotown by road. Pop. (1957 est.) 39,594 (commune). Sta. Croce and Sta. Maria Nuova churches contain pictures by Giovanni Santi, the father of Raphael. S. Agostino contains a painting of the "Angelo Custode" by Guercino, the subject of a poem by Robert Browning. The fine Gothic palazzo della Ragione (1299) is now a theatre, and the palazzo Malatesta is a rich museum. S. Michele church, built against the arch of Augustus, is an early Renaissance building (1475–90) with an ornate portal. Other notable churches include the 14th-century Romanesque S. Domenico and the 17th-century baroque S. Pietro in Valle. Fano is on the main Milan-Bari railway and is a favourite summer resort. The harbour was restored by Pope Paul V. Agriculture (especially vegetables and sugar beets) and fishing are the chief occupations. The town is on the site of the ancient Fanum Fortunae (the temple of Fortune), said to have been founded in the 2nd or 3rd century B.C., and was occupied by Julius Caesar in 49 B.C. Augustus planted a colony there and built walls of which there are some remains. A triple arch erected in his honour still stands. Destroyed by Vitiges in 540 Fano was rebuilt and later flourished under the Malatesta of Rimini. In 1463, under Pius II, it became part of the papal states until it passed in 1860 to the kingdom of Italy. (T. FE.)

FANSHAWE, SIR RICHARD, BART. (1608–1666), English poet, translator and diplomat whose version of Camões' *Lusiad* is a major achievement of English verse translation, was born at Ware Park, Hertfordshire, in June 1608. Educated at Jesus college, Cambridge, in 1635 he was appointed secretary to the English embassy at Madrid. At the outbreak of the Civil War he joined the king. In 1644 he married Anne Harrison, whose *Memoirs* contain an admirable account of her husband's career. In 1648 he became treasurer to the navy, and in 1650 was dispatched by Charles II to obtain help from Spain. Although this was refused, Fanshawe was created a baronet; he rejoined Charles in Scotland and was taken prisoner at the battle of Worcester. On Cromwell's death he re-entered the king's service in Paris, and after the Restoration was appointed ambassador to Portugal and later to Spain. He died at Madrid on June 26, 1666.

Fanshawe published a translation of *Il Pastor Fido* by Baptista Guarini in 1647. A second edition "with divers other poems" (1648) included his version of the fourth book of Virgil's *Aeneid.* His *Selected Parts of Horace* appeared in 1652. The great work of his retirement during the Protectorate was his translation of the *Lusiad* of Camões (1655). His other works include a version of a comedy by Antonio de Mendoza (1654) and a Latin translation of John Fletcher's *Faithful Shepherdess* (1658). Fanshawe's version of the *Lusiad* is at once a faithful rendering in the original metre and a lively, picturesque English poem. His translation of *Il Pastor Fido* is equally distinguished.

His *Fourth Book of the Aeneid* is in the Spenserian stanza and few translations of Virgil have so well conveyed the nobility and delicacy of the original.

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(V. DE S. P.)

FAN-TAN, a Chinese gambling game and also the name of a card game. In the gambling game, a square is laid out in the centre of a table, its sides being marked 1, 2, 3 and 4. The banker empties onto the table a double handful of small coins—in China "cash"—beans, or similar articles, which he covers with a metal bowl. The players bet as to what will be the remainder when the pile is divided by four by setting their stakes on the side of the square which bears the number each favours. When all have staked, the bowl is lifted and the banker, with a small stick, removes coins (or beans, etc.) from the heap, four at a time. When the final batch is reached, the number of coins it contains determines the winning number; if four coins, the backer of no. 4 wins; if three, the backer of no. 3 wins, and so on. The banker deducts 25% from each winner's stake; then he pays each winner five times the amount of his stake thus reduced, which is to say, 2.75 to 1 when the true odds are 3 to 1.

The card game fan-tan may be played by any number of players up to eight. The full pack of 52 cards is dealt out, one card at a

time. Thus some hands may contain one more card than others. All players ante to a pool; in some games, players dealt fewer cards than others are required to ante an extra counter.

Only one card is played at a turn. Beginning with eldest hand (the player to the left of the dealer), each in turn must play a card if able; whenever unable to play, he must pay one counter to the pool.

The first card played must be a seven. The next player may add a card next in rank and of the same suit—*i.e.*, the eight or the six—or he may play another seven. Thereafter, each must play a card of the same suit and in unbroken sequence with one already on the table, or may play a seven. Sequences build up to the king; down to the ace. The player who first gets rid of all his cards wins the pool, to which each of the others must add one counter for each card remaining in his hand. A player who passes when able to play must pay three counters to the pool as an additional penalty. (R. L. Fy.)

FANTASIA (Fantasy), a piece of instrumental music, the form of which is governed entirely by the composer's wishes. In the 16th and 17th centuries the term described a fugal type of composition (*see* Fugue) for a "consort" of string or wind instruments or for solo keyboard instrument, lute or guitar.

The one-movement fantasia, the earliest form, appeared at the beginning of the 16th century. Consisting of short sections expertly knit together and based on one or more motives, it had much of the quasi-improvised quality found in the 15th-century organ *preambula* (preludes) and the early 16th-century lute and keyboard *ricercari*. At this time the terms ricercare, which stressed the improvisatory aspect, and fantasia were often interchangeable. In England the fantasia (also called fantasy or fancy) had a late flowering. Most of the great English composers from William Byrd to Henry Purcell wrote fantasias either for lute, keyboard instrument or viols; those for viols were by far the most numerous and embraced masterpieces ranging from duets to six-part consorts. The term fantasia (or *Fantasie*) was used by the 18th-century German organists to describe a keyboard piece of a free improvisatory character, which provided the maximum possible contrast with the fugue that often followed.

This idea of freedom in form and the additional ingredient of extempore feeling persisted in the fantasias of C. P. E. Bach, as well as in the works of certain composers of the romantic period. Brahms in his *Fantasien*, Opus 116, and Schumann in his *Fantasiestücke* maintain the tradition of single, self-contained movements, although more modern works such as A. Schoenberg's *Fantasia for Violin and Piano* have something in common with the sectionalized forms of the Renaissance. Complex and contrapuntal fantasias inspired by J. S. Bach's name or his music have been written by Liszt, M. Reger and F. Busoni. Some fantasias are in several movements and take on the aspect of free sonata form, as in Beethoven's two sonatas of Opus 27 and Schumann's *Fantasy*, Opus 17. Others have the character of program music, ranging from the fantasia on the weather by John Munday (d. 1630) to Tchaikovsky's *Francesca da Rimini*.

From the earliest times fantasias have been used as musical vehicles for the elaboration of popular songs; *e.g.*, in the 16th century, Nicholas de la Grotte's version of C. Rore's *Ancor' che col partire* and G. Farnaby's fantasia on one of his own madrigals, and later Schubert's "Wanderer" fantasia and the potpourris on songs and arias by Liszt, J. N. Hummel and I. Moscheles. Yet another aspect of the fantasia may be seen in the works with this title based on given themes, such as the popular hexachord fantasias of the 16th and 17th centuries; the consort music of Eustache du Courroy (1549–1609), drawing on both sacred and secular melodies; the *Choraljantasien* of Bach and his contemporaries, who take Lutheran chorales as the basis of their works; and the Beethoven *Choral Fantasia*, which brings in the melody of one of the composer's own songs, used as the theme for an elaborate set of variations. The early years of the 20th century saw an artificial revival of the English "fancy" in the so-called "phantasy quartets" of W. Y. Hurlstone, Frank Bridge, John Ireland, T. F. Dunhill and Ralph Vaughan Williams.

FANTI, MANFREDO (1806–1865), Italian general prominent in the wars of the Risorgimento, was born at Carpi on Feb. 23, 1806, and educated at the military college of Modena. Implicated in Ciro Menotti's rising in 1831, he fled to France, where he received a commission in the French corps of engineers. He took part in Giuseppe Mazzini's abortive invasion of Savoy in 1833 and served in Spain against the Carlists in 1835. He stayed in Spain for 13 years and rose to high rank as staff officer.

When war broke out between Sardinia-Piedmont and Austria in 1848, Fanti hurried back to Italy. At first both Piedmont and the provisional government of Lombardy rejected his services, but in the end he secured the command of a Lombard brigade. When Charles Albert of Sardinia suffered defeat on the Mincio and fell back on Milan, the people there rose against him. In the attendant confusion Fanti, through his courage and tact, saved the situation. He was elected to the Piedmontese chamber in 1849. When war flared up again, he resumed command of a Lombard brigade under Gen. G. Ramorino. The Piedmontese were defeated at Novara (March 23) and a peace was concluded, but a revolt broke out in Genoa. Fanti just managed to restrain his Lombards from joining in. In spite of this, the higher Piedmontese officers mistrusted him as a Mazzinian and a soldier of fortune and had him court-martialed. He was acquitted, but not re-employed until the Crimean expedition of 1855.

In the war of 1859 against Austria, Fanti commanded the second division and had a share in the victories of Palestro, Magenta and San Martino. After the peace of Villafranca he built the army of the Central Italian league (made up of the provisional governments of Tuscany, Modena, Parma and Romagna) into a well-drilled force of 45,000 men. He steered a middle course between the overcautious Bettino Ricasoli, who wanted to recall the troops from the border, and the rash Garibaldi, his second in command, who was bent on an early invasion of Romagna even at the risk of Austrian intervention.

Minister of war and marine under Cavour from Jan. 1860, Fanti merged the Central Italian league's army with Piedmont's. When Garibaldi's invasion of Sicily made Victor Emmanuel of Sardinia decide at last that he too must intervene in the south, Fanti was sent with a strong Italian force into the papal states. He took Ancona and other fortresses and, at Castelfidardo, defeated the papal army, capturing its commander, Gen. L. Lamoricière. In three weeks he had conquered the Marches and Umbria and taken 28,000 prisoners. When the army crossed into Neapolitan territory, the king took supreme command. Fanti, as his chief of staff, defeated a large Neapolitan force at Mola and organized the siege of Gaeta. Then he returned to Turin to carry out important army reforms. His refusal to let Garibaldi's 7,000 officers join the regular army at their own grades made him unpopular and earned him severe censure from Cavour. He resigned in 1861 and took command of the V army corps in Florence. There he died on April 5, 1865.

FANTI, a Negro people who live along the south coast of Ghana, between Accra and Sekondi, with the Ga-Adangme peoples to the east and the Ahanta to the west.

According to tradition they were among the earliest migrants from the Sahara who founded the first Akan state of Bono-Mansu at the end of the 13th century. In the 18th century they traveled southward and by the 19th century had formed the strong Fanti confederacy which included the states of Mankesim, Nkusukum, Abora Dunkwa, Abora Abeadze, Abora Kwamankese, and Ekumfi.

The Fanti belong to the Akan (*q.v.*) stock and speak a Twi dialect. Like the other Akan peoples, inheritance, succession and political allegiance are based on matrilineal descent, but the dual lineage system gains greater emphasis among the Fanti through the *asafo* organization. This is the chief difference between the Fanti social organization and that of the Ashanti (*q.v.*). The *asafo* embraces both men and women; membership and succession to offices is patrilineal. The organizations serve social and political as well as military purposes. They have dancing and social bands, military companies for defense, and provide avenues for the expression of political opinion and criticism of the chief and his councilors. The Fanti have the clan organization common to the Akan-speaking peoples, and share the general religious beliefs and

practices based on belief in a supreme deity (the creator), lesser deities deriving their powers from the supreme deity, clan totems and the ancestors who guard the tribe.

See M. Manoukian, "Akan and Ga-Adangme Peoples of the Gold Coast," *Ethnographic Survey of Africa: Western Africa*, pt. 1 (1950). (K. A. Bu.)

FANTIN-LATOUR, IGNACE HENRI JOSEPH THÉODORE (1836–1904), French artist noted for his paintings of flowers, still life and portraits, was born at Grenoble on Jan. 14, 1836. He studied first with his father, a pastel painter,

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STILL LIFE BY HENRI FANTIN-LATOUR

and then at the drawing school of Lecoq de Boisbaudran. He was the friend of Ingres, Delacroix, Corot, Courbet and others. He exhibited in the Salon of 1861 and many of his more important canvases appeared on its walls in later years, though 1863 found him with Harpignies, Manet, Legros and Whistler in the Salon des Refusés. His style remained independent and academic, however. His portrait groups, arranged somewhat after the manner of the Dutch masters, are as interesting for their subjects as they are from the artistic point of view. "Hommage à Delacroix" showed portraits of Whistler and Legros, Baudelaire, Champfleury and himself; "Un Atelier à Batignolles" gave portraits of Monet, Manet, Zola and Renoir, and is now in the Luxembourg; "Un Coin de table" presented Verlaine, Rimbaud, Camille Péladan and others; and "Autour du Piano" contained portraits of Chabrier, D'Indy and other musicians. His paintings of flowers are perfect examples of the art. In his later years he devoted much attention to lithography. After "L'Anniversaire" in honour of Berlioz in the Salon of 1876, he regularly exhibited lithographs, some of which were examples of delicate portraiture, others being elusive and imaginative drawings illustrative of the music of Wagner, Berlioz, Brahms and other composers. He illustrated Adolphe Jullien's *Wagner* (1886) and *Berlioz* (1888). There are excellent collections of his lithographic work at Dresden, Ger., the British museum and the Louvre. He died on Aug. 25, 1904.

FARABI, AL- (Mohammed ibn Mohammed ibn Tarkhan abu-Nasr al-Farabi; Lat. Alfarabius) (*c.* 870–950), Arabic-writing Muslim philosopher of Turkish origin, was born *c.* 870 in Transoxiana (the central Asian province north of the Oxus river). Having studied first in Khurasan and then in Baghdad, where he lived for a considerable time, he eventually transferred himself to the court of the Shi'ite ruler of Aleppo, Saif al-Daula. He died near Damascus in 950.

Al-Farabi's teachers, the Christian Arabic philosophers of Baghdad, were late descendants of the 6th-century Christianized school of Alexandria, and his writings show everywhere the influence of this blend of Aristotelian and Neoplatonic thought. Most later Arabic philosophers depend on his achievement. He believed in the essential identity of Plato's and Aristotle's views, following Plato in politics and Aristotle in logic and physics; his metaphysics combine Aristotelian and Neoplatonic thought. His renowned commentaries on the Aristotelian treatises are lost; and his *Paraphrase of Plato's Laws* is written in support of special political theories of his own and is not meant to give an accurate account of the work in all its detail. We have, however, three comprehensive works on the whole of his philosophy. The earliest comprises three books, book i being a discourse on the attainment of happiness, book ii being a survey of Plato's philosophy and book iii dealing with Aristotle. The other two are the *Views of the Citizens of the Perfect State*, which is perhaps the most accomplished of his works, and the *Book of the Government of the State*. The *Aphorisms of the Statesman* is a short work intermediate between the *Views* and the *Book of the Government*. Whereas these books remained unknown to the Latin schoolmen, al-Farabi's *De divisione scientiarum*, a survey of the entire body of philosophical knowledge, including specific Islamic sciences, was translated by Gerard of Cremona and extensively used by Dominicus Gundisalvi in his *De divisione philosophiae*. There were also medieval Latin versions of his treatise *De intellectu* and of some of his writings on music.

The *Book of Gems*, formerly attributed to al-Farabi, is by Avicenna. For an account of al-Farabi's thought, *see* Arabic Philosophy.

For the writings on Plato see *Plato arabus*, vol. ii, edited by F. Rosenthal and R. Walzer (1943), and iii, edited by F. Gabrieli (1952); for the *Views of the Citizens*, the text edited by F. Dieterici (1895) and the French translation by R. P. Janssen *et al.*, *Idées des habitants de la cité vertueuse* (1949); for the *Book of the Government*, the German translation by F. Dieterici, *Die Staatsleitung von Alfarabi*, edited by P. Brönnle (1904); for the *Aphorisms*, the English translation by D. M. Dunlop in *Iraq*, xiv (1952); for the *De divisione scientiarum*, the text edited with Latin and Spanish translations by A. Gonzalez Palencia, 2 parts (1932); for the *De intellectu*, the text edited by E. Gilson in *Archives d'histoire doctrinale et littéraire du moyen âge*, iv (1930); for the musical writings, H. G. Farmer, *Al-Farabi's Arabic-Latin Writings on Music* (1934); for other works, F. Dieterici, *Alfarabi's philosophische Abhandlungen*, German translation (1892), and D. M. Dunlop, ar- articles in *Islamic Quarterly* (1955 ff.).

See I. Madkour, *La Place d'Al-Farabi dans l'école philosophique mussulmane* (1934); R. Hammond, *The Philosophy of Alfarabi and its Influence on Medieval Thought* (1947); also R. d'Erlanger, *La Musique arabe*, vol. i and ii (1930). (R. R. Wr.)

FARAD. A unit of electric capacity, named for Michael Faraday (*q.v.*). The capacity of a conductor or condenser is one farad when a quantity of electricity equal to one coulomb increases its potential by one volt. *See* Capacitor; Electricity: *Condensers: Capacitance;* Physical Units.

FARADAY, MICHAEL (1791–1867), English physicist, chemist and physical-chemist or, as he himself would have said, natural philosopher, was the discoverer of electromagnetic induction, of the laws of electrolysis and of fundamental relations between light and magnetism, as well as being the originator of the conceptions that underlie the modern theory of the electromagnetic field. Faraday was born on Sept. 22, 1791, at Newington, Surrey, which later became part of the borough of Southwark in south London, but was then in the country. His father was a blacksmith who had migrated from Yorkshire. The family having moved to north London Michael, at the age of 14, was apprenticed to a bookseller and bookbinder, in whose shop he read with keen interest books on science which came into his hands. Having heard Humphry Davy lecture at the Royal institution and conceiving an eager desire to "enter into the service of science," to use his own words, he applied to Davy for employment, sending him, as evidence of his interest, the notes which he had made of the lectures. As a result he was, at the age of 21, appointed assistant to Davy, to help with both lecture experiments and research. He accompanied Davy on a tour in Europe, where he had many menial duties to perform, but also saw much of active scientific research and, in general, expanded his view. As J. H. Gladstone, who knew

him well, wrote, "His University was Europe; his professors the master whom he served, and those illustrious men to whom the renown of Davy introduced the travellers."

His first published paper, which appeared in 1816, was of no importance. In 1820 he was devoting much attention to steel, the preparation of a rustless steel being one of his objects, and this work continued for some years, but beyond the finding that small quantities of added metals had a pronounced effect on the properties, no result of importance was obtained. In 1820 Faraday discovered two unknown chlorides of carbon and a new compound of carbon, iodine and hydrogen. It was in this year that the Danish physicist, H. C. Oersted, announced his discovery that a wire conveying an electric current deflected a pivoted magnetic needle to which it ran parallel, a discovery which aroused great interest but was imperfectly understood. Faraday grasped that the force was a circular one round the wire and on this basis made in 1821 the first of his great electrical discoveries, that of electromagnetic rotation. A rigid wire, so mounted that it could turn about the point of suspension, hung with its lower end in a pool of mercury. A vertical magnet was fixed with one pole beneath the point of suspension. When a current was passed through the wire it rotated rapidly. This discovery brought Faraday widespread fame, but also some trouble with W. H. Wollaston (*q.v.*), who had been unsuccessfully attempting something similar. In the same year Faraday married Sarah Barnard. The union was a happy one, but childless.

In 1823 Faraday liquefied chlorine, which aroused the jealousy of Davy, who considered that he had initiated the work and was entitled to the credit. In consequence he opposed Faraday's election to the Royal society, which nevertheless took place in 1824. The next year Faraday made a chemical discovery of the first importance by isolating benzene or, as he termed it, bicarburet of hydrogen, from a liquid obtained in the production of oil gas. About the same time he was concerned with a research, to become prolonged, on optical glass, to which he devoted much labour without great immediate result. The "heavy glass" which was one of the products played, however, an essential part in his great discovery of the rotation of the plane of polarization of light in a magnetic field. It was in 1825 that Faraday's position at the Royal institution was improved by his promotion to the post of director of the laboratory. The next year he began to give formal lectures for the members of the institution on Friday evenings, which have continued, as Friday evening discourses, ever since. He also initiated the Christmas lectures for young people, known formally as Christmas Courses of Lectures Adapted to a Juvenile Auditory, of which he himself gave 19 courses. As an inspiring lecturer and as a deviser of effective lecture experiments Faraday was supreme and there are many contemporary accounts of the interest and enthusiasm which his discourses aroused.

The second period of Faraday's researches may be said to have begun in 1831. His mind was governed by the conviction that the various forces of nature with which physics, always termed by him natural philosophy, was concerned were intimately interconnected. The electric current produced magnetic force, and the magnet acted, as he had shown, on the electric current. He was sure that it should be possible to make magnetism produce electricity: in fact as early as 1822 his notebook contains the words "Convert magnetism into electricity." From time to time he had tried to produce currents by stationary dispositions of magnets with respect to wires or coils of wire, without success. In ten days in 1831 he carried out a series of experiments convincingly demonstrating the discovery of electromagnetic induction, experiments of such importance that in 1931 the centenary was celebrated at a conference, to which came delegates from all parts of the world, organized by the Institution of Electrical Engineers in London. The most famous experiment was that of the induction ring, a ring of soft iron on which were two different windings of insulated wire, one of which was connected to a simple galvanometer. When the two ends of the other winding were permanently connected to a battery there was no effect, but when the circuit was made or broken the galvanometer indicated a current. A similar effect was obtained with an iron cylinder with a helix wound on it. When, by means of magnets, the magnetic flux in the cylinder was changed, there was a momentary current in the helix. A variation of this experiment was to introduce a magnet into a helix, or to withdraw it. In general, what Faraday showed was that change of magnetic flux through a circuit produced a current in the circuit.

He also rotated a copper disk between the poles of a large electromagnet and showed that a current could be obtained from contacts with the axis and with the edge of the disk—the first dynamo. He soon followed these experiments with others demonstrating the inductive effect of a current circuit on another circuit, without the presence of iron. In discussing these fundamental discoveries Faraday employed the conception of magnetic lines of force to make his ideas clear, for he was no mathematician. Somewhat later, in the course of his researches on static electricity, he developed the analogous conception of lines of electric force, whose course and concentration expressed the various effects. It is in acknowledgment of his fundamental discoveries concerning the functions of dielectrics that the unit of capacity is named the farad (microfarad in more general use). In this work he discovered the significance of what he termed "specific inductive capacity," later called dielectric constant.

Faraday's conceptions of electric and magnetic force and their interrelations, expressed in terms of his lines of force, were fundamental. It was from them that James Clerk Maxwell (*q.v.*) developed his equations, which lie at the base of all modern theories of electromagnetic phenomena.

It was shortly after his work on electromagnetic induction that Faraday, once more in search of unity, showed that the five kinds of electricity then distinguished—frictional, galvanic, voltaic, magnetic (induced current) and thermal—were fundamentally the same. "Electricity, whatever may be its source is identical in its nature." In the same period of his researches he arrived at the basic laws of electrolysis which bear his name, and introduced the terms that are universally used, "anode," "cathode," "anion," "cation" and "electrode."

After this succession of epoch-making discoveries ensued a period of exhaustion, reminiscent of Sir Isaac Newton's nervous breakdown, from which Faraday gradually recovered. The third and last period of his researches began about 1844 and includes as the main discovery that of the rotation of the plane of polarization of light in a magnetic field, in which his heavy glass played an essential part. This, again, was the outcome of a fixed idea that light and magnetism must be in some way connected. In 1850 he tried to establish experimentally a relation between gravity and electricity, concluding his paper with "Here end my trials for the present. The results are negative; they do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that it exists."

In 1858 he retired to live in a comfortable house near Hampton Court, Surrey, provided by Queen Victoria. At that time he still retained a lively interest in science, but his health and his powers gradually waned and there he died peacefully on Aug. 25, 1867.

Faraday was possibly the greatest experimental genius the world has known. "He smells the truth," said the German professor F. W. Kohlrausch, speaking to John Tyndall. Something incessantly prompted him that certain fundamental relations were waiting to be found and he was not dismayed by dozens of fruitless experiments from persisting until basic discoveries, of the type described here, were finally established. In theoretical physics he provided the fundamental conception, expressed by his lines of force, that the medium was the seat of electromagnetic action, which at the hands of Clerk Maxwell led to the conception of electromagnetic waves. To all his other gifts he added that of being able to express his experimental results and his thoughts concerning them in clear and simple language.

His published works were *Chemical Manipulation* (1827); *Experimental Researches in Electricity* (1839–55); *Experimental Researches in Chemistry and Physics* (1859); *A Course of Six Lectures on the Chemical History of a Candle*, edited by W. Crookes (1861); *On the Various Forces in Nature*, edited by W. Crookes (1873). His *Diary*, edited by T. Martin, was published in eight volumes (1932–36).

See ELECTRICITY: *Direct-Current Circuits: Batteries: Faraday's Law of Electrolysis;* ELECTROMAGNETIC WAVES: *Origin of Electric Wave Concept; see* also references under "Faraday, Michael" in the Index.

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FARADAY'S LAW: *see* ELECTRICITY: *Direct-Current Circuits: Batteries: Faraday's Law of Electrolysis.*

FARAH (FARRAH; FERAH), a town and capital of the minor province of Farah and Chakhansur in southwest Afghanistan, is situated on the left bank of the Farah Rud, 163 mi. S. of Herat and 235 mi. W.N.W. of Kandahar, and on the Herat-Kandahar road. Pop. (1962 est.) 26,562. The town is situated in a position of strategic importance by the river crossing, commanding the approaches from Herat to Seistan and the India-Pakistan subcontinent. A bridge was built over the river in 1958 and the improvement in the Herat-Kandahar road gave back to the town some of its old importance. A difficult road connects it with Chakhansur in Afghan Seistan from where there is communication with Zabol in Iranian Seistan. Farah lies in an exposed position in the plain with open desert to the south and is hot, dusty and unhealthful during the summer. The people of the town are chiefly of Tadzhik (Tajik) origin although Durrani Afghans live in the surrounding villages. Farah is an agricultural and commercial centre though it has not retained the importance that it once held as one of the gateways to the flourishing province of Seistan. Usually identified with the ancient Phra mentioned by the Greek geographer, Isidore of Charax, in the 1st century A.D., it flourished until destroyed by Mongol raids in 1221. It revived but was again devastated by Nadir Shah of Persia in 1731 and remained long in ruins. Near the present town stand the deserted houses of one of its predecessors, in a rectangular enclosure surrounded by high mud walls. This skeleton "old town" is probably less than 100 years old.

FARAH PROVINCE, a desert country of high plains and low mountain ranges, is bounded north by Herat and Ghor provinces, west by Iran, south by Pakistani Baluchistan and east by Girishk province. Pop. (1954) 318,488; (1962 est.) 218,827. Area about 30,000 sq.mi. It is traversed by the lower valleys of the Adraskan, Farah, Khash and Helmand rivers, all of which drain into the low-lying Seistan region, and includes the Afghan parts of the Seistan lake depression and Gaud-i-Zirreh (a salt tract only 1,550 ft. above sea level, which receives the seasonal overflow of the Seistan depression), and the sandy plain, Dasht-i-Margo, which lies toward the south and extends toward Girishk. The climate is hot and dry in summer and the intense heat is sometimes accompanied by a hot wind. Winters are pleasant.

Irrigated agriculture is the main occupation and water is obtained from the rivers or from underground water channels (*karez*). Wheat, barley, alfalfa, cotton, tobacco and grapes are the principal crops. Domestic animals include camels, donkeys, cattle and sheep.

Most of the population is Pashto-speaking and is concentrated in the agricultural centres. But there are Tadzhiks in the towns of the north and also in Seistan, and some Baluchis in the south of the province. Beside Farah, the main towns are Chakhansur, near the Iran border in Afghan Seistan, and Dilaram on the Khash river.

In the sands of Afghan Seistan, which together with what is now Iranian Seistan once formed one of the most flourishing and populous provinces of Asia, lie half-hidden many castles and cities, some in a good state of preservation. Numerous invasions culminating in the Mongol onslaught of the 13th century A.D. destroyed the ancient system of irrigation and thereby turned large areas into unproductive desert.

FARAH RUD, a river of western Afghanistan, rises in the southern slopes of the Siah Koh ("black mountain"). It follows a southwesterly course for about 200 mi. past the towns of Farah and Lash-Jawain and falls into the Helmand swamps (on the border between Afghanistan and Iranian Seistan), which in turn enter the lagoons of the Seistan depression. The catchment area is about 12,500 sq.mi. At Farah, the chief town of Farah province, the river is 150 yd. wide in the dry season with 3 ft. of water and a clear swift stream. It is liable to floods in the spring, when it becomes impassable for weeks. The lower valley is fertile and well cultivated. The town of Lash-Jawain farther downstream from Farah town consists of two sections, developed around the ancient ports: Lash on the right bank and Jawain on the left. (J. P. C. N. H.)

FARAZDAQ, AL- (AL-FERAZDAQ; originally HAMMAM) (*c.* 641–*c.* 728), Arab poet, famous chiefly for his satires, was born at Basra, and at the age of 15 was already known as a poet. He devoted his talent to attacks on the tribes of bani Nahshal and bani Fuqaim. When Ziyad, a member of the latter tribe, became governor of Basra, the poet fled, first to Kufa, and then to Medina. He remained there about ten years, writing political satires on the Bedouin tribes, but taking no other part in political life. He lived a prodigal life, and his amorous verses (in which, as in his life, he indulged in unbridled licence) led to his expulsion by the caliph Marwan I. On the death of Ziyad he returned to Basra, where he secured the favour of Ziyad's successor, 'Obaidallah ibn Ziyad. Much of his verse during this period is concerned with his dispute with his wife, his cousin Nawar, whom he married against her will. Another subject which occasioned a long series of verses was his feud with his rival Jarir (*q.v.*) and his tribe the bani Kulaib. Al-Farazdaq was prevented by fear from taking an important part in political life. He seems, however, to have been attached to the house of 'Ali. During the reign of Mu'awiya I he entirely avoided politics, but later gave his allegiance to Abdallah ibn Zobair. He died at Basra about 728.

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FAR EAST is a regional term commonly used to cover east and southeast Asia. The far east encompasses east Asia, which refers primarily to China, Korea, Formosa and Japan, usually including Mongolia as well, and on occasion the Pacific littoral of the U.S.S.R., and southeast Asia, sometimes called farther India (*Chinese:* Nan-yang; *Japanese:* Nan-yō), which refers to the region between India and China, including Burma, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, Timor and the Philippines. Although at times India, Pakistan and adjacent territories have been subsumed within the far east concept, they are correctly excluded from it and belong more appropriately within the area known as south Asia (India, Pakistan, Ceylon, Nepal, Bhutan, Afghanistan). In its most restricted sense, the term far east often is equated with east Asia alone.

Historically, the far east described those portions of the Eurasian land mass and archipelagoes farthest from and of greatest interest to the maritime powers of western Europe. It was one of a trichotomy of regional expressions of which the other two were the middle east (south Asia plus Iran and on occasion portions of Soviet central Asia) and the near east (the Levant and northern Africa). The orient is a term popularly connoting all countries of the east (including middle and near east) or of Asia generally.

See also MIDDLE EAST; SOUTHEAST ASIA; and countries referred to above. (N. S. G.)

FAR EAST: RELATIONS WITH THE WEST. The term "far east," as used in this article, applies to Japan, China, eastern Siberia and adjacent portions of eastern Asia. Not until the 16th century, with the opening of the sea routes to India and the far east, did Europeans begin to change the face of Asia. When the Portuguese admiral Vasco da Gama rounded southern Africa and sailed, in 1497–98, to Calicut on the southwestern

coast of India, a war to the death began between the Portuguese and the Arabs for control of the Indian ocean and the trade of the Indies. The Arab hold was broken in 1511 with the Portuguese capture of Malacca, entrepôt of trade by sea between the middle and far east. On arriving there the Portuguese came into direct touch with the peoples, cultures, riches and power of the extreme eastern world.

The article is organized according to the following outline:

I. Early European Relations
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4. Russian Influence
II. The 19th Century
1. England and China
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1. Russo-Japanese War
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I. EARLY EUROPEAN RELATIONS

1. Portuguese and Spanish Penetration.—The handful of Portuguese who invaded the far east in the 16th century owed their success to their superior arms and ships, their crusading determination, their wisdom in limiting their objectives to relatively isolated places and the haughty confidence of the Chinese court in its ability to deal with the alien intruders at its own convenience. Despite wars between the invading Europeans and China's vassals in Malaysia, relations between Portugal and China might possibly have been established in a mutually satisfactory manner had it not been for the outrages and piratical activities of the Portuguese along the coast of southern China.

The first Portuguese ambassador, Tomé Pires, who arrived in southern China in Aug. 1517, was not permitted to reach Peking until approximately three years later. Moreover, when the letter from the king of Portugal was opened its tone was judged to be lacking in respect. The Portuguese embassy was rejected and Pires was ordered back to Canton where he was imprisoned. Although diplomatic relations were not permitted, trade relations were continued illegally after 1521 at the wish of mercantile elements of both peoples and with the purchased connivance of the Chinese official hierarchy. By 1557 the Portuguese had established a settlement at Macao by consent of local officials. Ground rent, symbol of sovereignty, was paid to China until 1849. Only in 1887 did China by treaty confirm Portugal's right of government with perpetual occupation—while Portugal agreed never to alienate the territory and its dependencies without China's consent.

The conquest of Malacca was followed during the autumn of 1511 by the dispatch of a Portuguese expedition to the Moluccas and other islands of the Malay archipelago. Some of the leaders, shipwrecked on the return voyage, are said to have landed on Mindanao. Not to Portugal, however, but to Spain fell the ownership for more than three centuries of the archipelago named, in 1561, in honour of Philip II. In 1521, about nine years after these initial landings, Ferdinand Magellan arrived in these islands after a voyage across the Pacific ocean. In so doing he opened to the country of his adoption the western route to the far east, via the Atlantic and Pacific oceans, and thenceforward the Spanish used Mexico as a base for conquest, trade and religious propaganda in the east. Manila was captured by Miguel López de Legazpi in 1571, and shortly became capital of the colony.

The Portuguese and Spanish were amazed by the numbers and wealth of the Chinese people, their philosophical pacifism and military and naval ineptitude. In 1598, 18 years after the union of the crowns of Spain and Portugal, the Spanish obtained permission to trade at Canton. But Portuguese opposition, in conjunction with the preference of the Chinese for trade at Manila where they could more easily obtain goods from Spain and Mexico, prevented relations of the two peoples on the mainland from developing to any considerable extent along either religious or economic lines. Thus Manila became the clearinghouse for Chinese-Spanish trade as Canton had become for Chinese-Portuguese. The Chinese in the Philippines increased in numbers and wealth; they, rather than the Spanish, profited from the trade with Mexico.

2. Relations With Japan.—From 1432 to 1549 Japan was officially in vassalage to China. Meanwhile, in about 1542, shipwrecked Portuguese reached a tiny island off the southern extremity of Kyushu. In this manner were opened Portuguese-Japanese relations which lasted 98 years. For two generations no other Europeans appeared in Japan. With the arrival of the Spaniards, however, toward the end of the 16th century, European relations with Japan—as well as with China—became increasingly complicated. This was a result of national and religious rivalries, carried on between the westerners and the Asians and among the westerners themselves.

As early as 1577, within a generation after the breaking of Japan's vassalage, Toyotomi Hideyoshi was planning the unification of China and Korea with Japan. Before long he was envisaging annexation of Formosa, the Philippines and India as well. On July 25, 1591, he warned the Portuguese viceroy at Goa of his intention to invade India as soon as his "heavenly mission of conquering China" had been completed. On Sept. 15 following he sent a letter to the Spanish governor of the Philippines making similar threats. During the following two years and in 1597–98 two great campaigns were fought in Korea and its waters to force that kingdom to serve as a roadway to China. This effort was defeated when China came to the aid of its Korean vassal.

Out of Hideyoshi's expressed intentions with respect to the Philippines arose the opportunity for Spanish priests to poach upon the Jesuit-Portuguese preserve of Japan. Through Macao, and under the aegis of Portugal, the Jesuits had entered both China and Japan during the latter half of the 16th century. By intelligently directed zeal, subtle diplomacy and scholarship they made their conquests in both countries, but approximately a generation earlier in Japan than in China. Although anti-Christian decrees had been issued in Japan during 1565, 1568 and 1587, there were in Japan by 1595, an estimated 300,000 converts and 137 Jesuits. In 1593 Governor de Marinas sent an embassy with a reply to Hideyoshi's demand of 1591 that he should travel to Kyushu "to make submission to us." Circumventing a bull of Gregory XIII and a Spanish-Portuguese agreement, four Franciscans now entered upon rival religious propaganda. The Franciscan-Jesuit, Spanish-Portuguese quarrels which ensued strengthened the position of the enemies of the groups concerned, native and alien, especially that of the Protestant Dutch. The Dutch, arriving in Japan in 1600, hated the Catholic Portuguese and Spanish, against whose rule they were rebelling in Europe. Weakened by Hideyoshi's continental wars and fearful of attempts by Spain to conquer the country, Japan attempted the extirpation of Christianity and, around 1640, closed its doors to Europeans (with the exception of a handful of Dutch) for the next three centuries and more.

3. Developments in China.—Even before this Japanese-European drama had reached its climax, other aspects of the far eastern problem, religious and secular, were developing in China. During the period about 1635–1742 there occurred a cultural-political-religious struggle, generally referred to as the rites controversy, between the Jesuits and their Catholic critics and rivals, chiefly the Dominicans and Franciscans. This centred in the relative values of Chinese and European-Christian culture and the spiritual authority of Manchu emperors and Roman popes. Although no approximate parallel to this problem occurred in Japan, the results in both countries were the same: Christianity and western influence suffered a serious setback.

Contemporaneously with this essentially spiritual and intellectual struggle between China and the west, other difficulties more material in nature were occurring. The Dutch, who had contributed to the collapse of Portuguese influence in Japan, themselves suffered in China at the hands of the Portuguese. Attempts of the Dutch East India company to trade at Canton in 1604, 1607 and 1653 were blocked from Macao; the Dutch attack on that Portuguese stronghold in 1622 was disastrously repulsed; the company's missions to Peking of 1655, 1665 and 1795 effected little of value. Consequent upon their repulse from Macao, the Dutch established themselves (1624) on the primitive island of Formosa whence they were expelled (1662) by Koxinga (Cheng Ch'eng-kung), an adherent of the recently conquered Ming dynasty. Against Koxinga the Hollanders aided the Manchu (Ch'ing) K'ang Hsi emperor (1662–1722), in return for which they were rewarded by having their country listed among the vassals of Peking and by little else.

4. Russian Influence.—The western Europeans of the 16th and following centuries approached the far east from the west and south by way of the sea. The Russians approached overland from the west and north. Russia was the first European power to fight —and lose—a war with the Manchu empire and the first to enter into treaty relations with it. In two generations, approximately 1581–1639, the Muscovites pushed across northern Asia, thereby becoming an important factor in the far east. The northern frontiers of the Manchu-Chinese empire not being precisely defined, hostilities were caused by the encroachments and aggressions of the Russians in the Amur river valley. The treaty of Nerchinsk was negotiated in 1689. Russia withdrew from its outposts behind the Argun river and the watershed of the Amur. Transfrontier trade was arranged, and extraterritoriality in part was to be administered by both parties. The form, as well as the content, of the treaty implied equality of the contracting states. Except for provisions in art. v of the Kyakhta treaty of 1727, relations between Russia and China remained essentially unchanged from 1689 to 1858–60—although during the years 1789–91 plans were formulated for the seizure of the Amur valley and possibly Japan as a means of aiding Kamchatka and developing the fur trade. But by the Nerchinsk treaty the Russians were cut off from convenient entrance to the Pacific and from easy access to the marts of eastern Asia. This made it extremely difficult for Russia to establish permanent settlements in its easternmost provinces and to participate readily in the trade and conquest of the far east until after the middle of the 19th century.

II. THE 19TH CENTURY

Although the Portuguese were the first Europeans in modern times to have relations with China and Japan, it was not they but the English and the Americans who, mainly in the 19th century, opened those states respectively to world intercourse. During the middle and later years of this period the far eastern problem became increasingly acute, largely as a result of political and military weaknesses and confusion which prevailed in eastern Asia and of the effects upon western Europe, particularly Great Britain, and later upon the United States, of the Industrial Revolution. Britain's need for raw materials at home and markets for manufactured goods and investments abroad induced that country to take the lead in "opening" China. This was accomplished ultimately by war, in and after 1839, consequent upon more than two centuries of peaceful relations.

1. England and China.—From 1635 various diplomatic attempts were made by England to establish intercourse with China on a basis of equality between nations with prevention or removal of irritating exactions upon westerners and extreme limitations upon their trading and religious activities. The mandates from the Ch'ien-Lung emperor (1736–96) to King George III, in connection with the embassy of Earl Macartney, 1793, indicate the conflicting aims and viewpoints of the governments concerned at that time and later. The English ruler was commended for his "respectful humility" in sending a "memorial and tribute." The request that an English envoy be permitted to reside in Peking was refused, it being disclosed that China itself had no desire to be represented abroad. "Swaying the wide world, I have but one aim in view, namely to maintain a perfect governance . . . Our dynasty's majestic virtue has penetrated into every country under Heaven and Kings of all nations have offered their costly tribute by land and sea. As your Ambassador can see for himself, we possess all things. I set no value on objects strange or ingenious, and have no use for your country's manufactures." China's goods, however, "are absolute necessities to European nations"; therefore, "as a signal mark of favour" trade might be carried on at Canton —but not, as the English had asked, at "Ningpo, Chusan, Tientsin and other places . . . ," including storage of goods at Peking. As to the propagation of Christianity: "The distinction between Chinese and barbarian is most strict, and your Ambassador's request that barbarians shall be given full liberty to disseminate their religion is utterly unreasonable." Arrogant in tone as the Ch'ien Lung mandates might appear, they no more than manifested the indisputably unique position of the ruler of the Manchu empire and of that vast area's civilization and self-sufficiency.

Another aspect is worthy of note: throughout the documents is indicated the principle of western international law embodied in the most-favoured-nation clause. For example, "Consider, moreover, that England is not the only barbarian land which wishes to establish relations with our civilization and trade with our Empire: supposing that other nations were all to imitate your evil example and beseech me to present them each and all with a site for trading purposes, how could I possibly comply?"

Having dispatched to China an envoy whose conveyances inland bore flags marked "Ambassador bearing tribute from the country of England," and who presented gifts ("tribute") to the imperial court even though he did not perform the kowtow, Britain was now definitely rated a vassal kingdom. Lord Macartney, however, equally well informed of his own country's strength and of China's weakness in defense forces, was fearful that war would not only upset for an indefinite time the trade in tea and woolens but would also bring Russia into the fray. He therefore concluded that peaceful relations with China were best. For almost half a century longer, despite increasing friction over impositions and limitations upon its trade, England maintained peace with the Manchus and their subjects—as, in general, did the United States from the beginning of its intercourse with them in 1784 to the dissolution of the empire in 1911–12.

During 1839–42 and 1856–60 London took the lead in challenging Manchu-Chinese pretensions to "sway the ten thousand kingdoms," and in insisting upon recognition by Peking of the western state-equality concept. Notwithstanding, London came increasingly to fear collapse of the Manchu empire with inevitable wide-scale confusion and tended fundamentally, almost as definitely as did Washington, to aid the Manchus to maintain their dynasty.

To the previously indicated causes for friction lying back of the first (1839–42) and second (1856–60) Anglo-Chinese wars— in the latter of which France participated—the opium trade must be added. From the 10th century at least the Chinese were acquainted with the medicinal value of opium poppy seeds; from the 15th century opium itself was manufactured in China. Foreign, in contrast to native, opium was imported into China first by the Portuguese, later by other westerners including English and Americans. Until April 22, 1834, the English East India company held a monopoly on English trade with China. Following a precedent established by the Mogul rulers of India, the company began farming out opium in Bengal in 1773, in which year the drug was first imported from Calcutta into Canton. Seven years later the company assumed a monopoly of the Anglo-Chinese trade in the commodity. Determination of the west to have Chinese teas and other products; light demand by the Chinese for western products including English woolens; unwillingness of westerners to drain their lands of and load their ships with silver bullion and specie to pay for Chinese goods; the high value of opium in small bulk and its popularity for purposes of smoking; these explain the phenomenal growth of the opium trade despite the issuance of Manchu imperial antiopium edicts from 1729 on, edicts which were ordinarily disregarded by native officials and nonofficials and

aliens alike. Important, however, as was opium in contributing to the outbreak of hostilities in 1839, the war itself, as with that of 1856–60, was basically one between two worlds and two differing conceptions of international relations.

The treaty of Nanking, signed Aug. 29, 1842, between China and Britain opened 100 years of relations between the west and the extreme east based on written agreements. This was followed within a few years by treaties and other types of agreement between China and the United States, France, the kingdom of Norway and Sweden, the German confederation, Russia, Japan and other states. Among the developments of outstanding importance from the wars, ensuing negotiations and the treaties and agreements were: (1) the cession of Hong Kong to Great Britain; (2) the opening first of Canton, Amoy, Foochow, Ningpo and Shanghai, and after 1860 of other coastal and interior cities, as treaty ports for residence and trade; (3) the right of foreign nations to appoint consuls at treaty ports; (4) uniform tariffs of about 5% on most imports and exports; (5) equality of foreign with native officials of corresponding ranks; (6) most-favoured-nation treatment (*q.v.*); (7) extraterritoriality; (8) toleration of both Roman Catholic and Protestant forms of Christianity; (9) legalization, by the provincial and the imperial governments of China, of the opium trade both before and by the treaties of 1858; (10) the residence in Peking after 1860 of foreign envoys; (11) the right of aliens to travel with passports—but not to reside—and of missionaries to hold property, reside and carry on their activities in the interior, *i.e.*, outside of treaty ports, after 1860; (12) the formation of the imperial maritime customs service under western (predominantly British) administration; (13) the legalization of study of the Chinese language by foreigners.

2. Russian Influence.—Advance of British power northward in eastern Asia contributed immediately to a renewal of Russian pressure southward. Anglo-Russian rivalry in the far east was but a projection of that in Europe, the near east and the middle east. If the British were to control the deltas—and possibly more—of the chief rivers of China proper why should they not advance to the Amur? In 1847 Tsar Nicholas I appointed Nicholas Muraviev to the office of governor general of eastern Siberia. Three years later Muraviev transferred the Russian naval base from Okhotsk to Petropavlovsk on Kamchatka. On an exploratory voyage, by order of Governor General Muraviev, G. I. Nevelskoi, a naval officer, discovered that Sakhalin is an island and that therefore the Amur is accessible from the south and not alone from the north as the Russians had previously supposed. Advancing about 20 mi. up the Amur, Nevelskoi raised his flag and established, in 1850, the port of Nikolayevsk. In 1853 he claimed Sakhalin. Meanwhile, he pushed south, establishing posts on the coast of the mainland practically to the border of Korea. Events taking place at this time in Europe foreshadowed the Crimean War and in Jan. 1854 the tsar gave Muraviev complete freedom of action in eastern Siberia. Fearing attack upon Petropavlovsk, the governor general, disregarding Chinese protests, immediately established steamers on the Amur to connect with Kamchatka. This was the first occasion on which the Amur had been traversed by Russians since 1644.

In 1854 an Anglo-French fleet twice attacked Petropavlovsk and was repulsed with severe losses. These victories strengthened Muraviev's hand in his negotiations with Manchu-Chinese officials, as did the transfer of the naval base from Petropavlovsk to Nikolayevsk and the transport down the Amur of several thousand Russian subjects for colonization of the coast. He was not, however, able to obtain the signing (May 1858) of the treaty of Aigun until after the defeats to China administered by the Anglo-French allies (1856–58), and then only by the double persuasion of having on the Amur sufficient force to advance to Peking and of pointing to the danger of England's seizure of that river. By this agreement Russia's sovereignty over the northern left bank of the Amur was recognized, as was China's over the south bank as far as the Ussuri. The territory between the Ussuri and the sea was to be jointly held for the time. Navigation of the two rivers and the Sungari was to be limited to vessels of the two empires. In June 1858, by the treaty of Tientsin, which contained the most-favoured-nation clause, Russia obtained through diplomacy all that England and France had won through war, particularly treaty-port rights, including that to trade with China by way of the sea and not, as hitherto, merely overland by way of Kyakhta. Following the Anglo-French march on Peking in the autumn of 1860, Russia, by additional diplomacy and again without use of arms, obtained on Nov. 14 a convention ceding the territory between the Ussuri and the sea. This became the maritime province of Siberia. In the preceding July (1860) Muraviev had ordered the occupation of the site which was named Vladivostok. To the further annoyance of Japan, Russia's far eastern naval base was moved in 1872 to Vladivostok from Nikolayevsk.

Not alone in farthest Asia did Russia consolidate its position in 1860. By the Peking convention of Nov. 14 Russia was permitted to trade and open consulates in Outer Mongolia and Sinkiang at Urga (Ulan Bator) and Kashgar (Shufu). Continued pressure from the north and northwest upon China, Korea and the kingdom of Japan followed. Rebellions against Chinese rule in Sinkiang in 1864 and 1866 offered opportunity to Russia, in 1871, to occupy Ili. Ten years later, as a result of China's readiness and ability to fight Russia if necessary, the treaty of St. Petersburg was ratified. By this treaty the greater part of the occupied territory, including the most strategic passes, was returned to China in exchange for an indemnity and permission for Russia to open consulates and trade and for Russians to reside in certain cities of Sinkiang and Mongolia. Expansion of Russian trade in the vast territories as far as the Great Wall was also permitted.

3. Relations of France and China.—In its relations with France regarding the old Annamite empire, China was less fortunate. From 1787 a degree of interest in Annam was from time to time evinced by France. Between 1843 and 1857 several expeditions were sent to avenge the deaths of Roman Catholic missionaries. From 1858 to 1862, France and Spain waged war upon Annam which resulted in the cession to France of Saigon, three of six Cochin Chinese provinces and the island of Poulo-Condore (Pulo-Condor); a promise in perpetuity by the Annamite emperor to cede territory to no power other than France; and the payment to France and Spain (which had sent a squadron from Manila) of an indemnity. In 1863 France supplanted Siam and Annam as protector of Cambodia. Four years later the remainder of Cochin China was swallowed to give France control over the outlets of the Mekong river.

France's determination to penetrate the southwestern provinces of China by way of the Red river route led to negotiation of the Franco-Annamite treaty of Saigon in March 1874. Ignoring the vassalage of Annam to China, France recognized the complete independence of Annam and promised protection against external aggression and internal disorder. China, however, continued to assert its suzerainty over Annam, and Franco-Chinese relations steadily deteriorated. By the treaty of Hué, Aug. 25, 1883, Annam was forced to recognize and accept the status of a French protectorate and to agree that all foreign relations, including those with China, should be controlled by France; territory was ceded to French Cochin China; Tongking was put under the administration of French residents; the customs and public works of Annam were brought under French control; French military posts were for an indefinite period to control the course of the Red river. Hostilities between the rival suzerains began in Dec. 1883; after alternating with desultory resorts to diplomacy, they ended in April 1885. When finally, after an expenditure by France of 344,000,000 fr., the treaty of Tientsin was signed on June 9, 1885, the suzerainty of China over Annam was surrendered; the frontier between China and Tongking was delimited in favour of France; and trade over the frontier, which Peking had previously forbidden, was granted.

4. United States and Japan.—The results of the Franco-Annamite-Chinese imbroglio of 1858–85 served as a lesson to Japan, which was then being reopened to international intercourse. During the period of Japan's closure, of Russia's overland approach to China and the Pacific and of the western European-American maritime approach, the Pacific ocean routes to Asia had been of minor importance. Transcontinental expansion of the United States; sustained American interest in the present and

future markets of China and the potential markets of Japan; application of steam to ocean-going vessels with consequent need for coaling stations; rebuffs and insults to American civilians and naval officials who had called at Japanese ports; mistreatment of shipwrecked Americans cast up on the shores of the archipelago; all these lay back of the Matthew C. Perry expedition of 1853–54.

Long before Perry's arrival, a few Japanese modernists had advocated the reopening of their country. Russians, Dutch, English, French and Americans had also attempted in a variety of ways to persuade the Tokugawa officials to change their policy on closure. Had the Fillmore administration made no attempt, or had it failed, Japan would still have been opened, voluntarily or involuntarily, within a comparatively short time. The factor of outstanding significance was, accordingly, not the time but the agent. The United States desired friendship and trade with Japan as it did with China, and it had no more desire to witness the disintegration of the one than of the other. Furthermore, the United States, unlike the western European powers and Russia, was not considered powerful enough to threaten the sovereignty of the independent states of eastern Asia. Japanese-American relations in their first half century were characterized by friendliness.

The Perry treaty of Kanagawa, March 31, 1854, laid the groundwork for the superstructure of foreign rights and interests—essentially paralleling that in China—which limited the sovereignty of Japan for two generations and more. The reactions of Japan to the westerners and their treaties were notably different from those of China. Japan was motivated by no deeper admiration and affection for the interests and actions of aliens within its borders than was China, but it set to work in 1868 to construct a powerful government able to meet the requirements of the west without further sacrifices of sovereignty. Japan simultaneously safeguarded the ages-old spiritual core of its life while at the same time modernizing its institutions and working for revision of the treaties that infringed upon its rights as a sovereign nation. At the same time its leaders began to outline a national policy of expansion that was calculated to make Japan the leading nation of the far east.

In Japan the year 1871 marked the passing—in law if not in national thought—of feudalism. The ministry of education was also reorganized and diplomatic missions were dispatched to China and the west. The mission of Lord Tomomi Iwakura to the United States and Europe (1871–73) was primarily "to study the institutions of the civilized nations, adopt those most suited to Japan, and gradually reform our government and manners, so as to attain the status equal to that of the civilized nations." Little or nothing was accomplished by this mission in obtaining the revision of treaties, but much was gained from the knowledge of conditions in the west which its members carried home. Shortly thereafter, Tokyo took the step, unprecedented for an eastern Asiatic government, of establishing permanent legations in five western countries. This move helped to break down the co-operative policy of European diplomats in the Japanese capital, as Japan's problems were brought directly to the attention of the western governments.

5. Chinese-Japanese Relations.—On Sept. 13, 1871, Japan signed at Tientsin a treaty which—since the western powers had treaties with the Manchu empire—was, from the viewpoint of Tokyo, better than no treaty, but which was nevertheless disappointing. Formulated on the assumption of equality of the contracting parties, it was no more satisfactory to China, longtime suzerain of Japan, than to the former vassal intent on "standing with European countries" on a plane superior to that occupied by China. The terms were meticulously reciprocal—and the most-favoured-nation clause was not included. To the momentary consternation of those European adventurers and statesmen who were as assiduous as most of the Japanese, and for the nonce more experienced, in "protecting" the Manchu empire, art. ii of the treaty of 1871 declared it to be "the duty of each [of the contracting parties] to sympathize with the other, and in the event of any other nation acting unjustly or treating either of the two Powers with contempt, on notice being given [by the one to the other], mutual assistance shall be rendered or mediation offered for the arrangement of the difficulty, in fulfillment of the duty imposed by relations of friendship." Instead of following a policy in consonance with this sentiment, Japan set out immediately to wrest leadership in the far east from China, to seek a dominating position in China's foreign relations and to limit as much as possible the influence of the western nations in the affairs of eastern Asia.

While China resorted first to passive, and then, at the turn of the century, to madly active resistance to aliens and the unilateral treaties, Japan patiently used diplomacy through the years 1871–94. In London, on July 16, 1894, one week before the outbreak of war with China, Tokyo succeeded in signing with Great Britain what served as the master treaty of a series providing for gradual removal of limitations upon Japanese sovereignty which went into force simultaneously in 1899. Consular jurisdiction ended in 1899. The conventional tariff remained in force until July 1911; and in March 1937 the powers finally relinquished perpetual leases in the former foreign settlements.

Europeans sought control of eastern Asiatic shores by seizure first of delta areas and river ports, and the Japanese did likewise with the archipelagos and islands controlling the sea approaches to the eastern coast of Asia. From 1868 they officially manifested what they themselves termed a "peculiar" interest in Korea, the mainland territory nearest them. Fear and anger were aroused by the Russian invasion of Sakhalin, but not until after the "restoration" of the tennō (emperor) and the organization of a new government after 1867–68 was Japan able to focus attention upon the complicated Russian problem. Finally, a treaty was signed on May 7, 1875, by which Japan and Russia relinquished their respective claims to Sakhalin and the Kuril Islands. Tokyo rejoiced in an agreement signed on the basis of equality with a power which was considered European, and for 30 years the problem of Sakhalin was shelved.

The Luchu (Ryukyu) Islands between Japan and Formosa had for centuries been vassals of both China and Japan. In 1871, according to Japanese charges, shipwrecked Luchuans were killed by Formosan aborigines. This "incident" offered an opportunity to Tokyo to break Luchuan vassalage to China, to foreshadow a claim to Formosa and to create a precedent followed later in Korea. The king of the archipelago was "invited" to Tokyo and given a Japanese peerage and a pension. Members of the diplomatic corps in Tokyo were informed that henceforth Luchuan foreign relations would be controlled, and obligations met, by Japan. Peking protested, made a feint at military action and, following an ultimatum, signed in Oct. 1874 an agreement of an unprecedented type. The justice of Japan's actions was admitted, and the Manchu empire paid an indemnity. Many of the methods used time and again thereafter were applied by Japan during these years, but to westerners these appeared less meaningful than the unveiling of China's weakness.

While they were attempting to bring the islands off the mainland under their control as rapidly as possible, Japan's leaders were aiming at the same objective in the Korean peninsula. There the deeds of 16th-century Japanese invaders had by no means been forgotten. Korea was, moreover, scornful of its small neighbour's attempts at modernization, desirous of maintaining closed-door policy as regards both east and west, but satisfied to remain vassal to China, and it treated with contumely Tokyo's overtures in 1868 and the following years. Except for fear of Russian or British intervention, war between the two countries would probably have begun in 1873. As a substitute for hostilities, Japan imposed independence upon Korea by the treaty of Kianghwa, Feb. 26, 1876, thereby following French precedent established in Annam approximately two years earlier. Little attention was paid by the west to this indication of Tokyo's determination to upset the balance of power in the far east. Henceforth until its annexation by Japan in 1910 Korea was a paralytic upon the international highway.

In part incidental to the buffeting of Korea; in part as a result of Japan's broader aims; in part because of ancient differences, nonmaterial as well as material, between Chinese and Japanese, war broke out between China and Japan in 1894–95. Japan's easily won victory led to the treaties of April 17, 1895, and July 21, 1896. Japan, by virtue of the most-favoured-nation clause plus rights not hitherto granted to aliens, obtained a position vis-à-vis China stronger than any hitherto held by a western power. Formosa and

the neighbouring Pescadores were ceded to Japan; thus the maritime approaches to China were brought under Japanese control and Japan obtained an important base from which to advance indefinitely southward and westward. Likewise ceded—temporarily—was a considerable section of southern Manchuria including mainly the Liaotung peninsula. Indemnity was paid which strengthened Japan's preparation for its second challenge to the west.

Defeat of China and annexation by Japan of territory on the mainland upset the diplomatic equilibrium. Great Britain, having found it impossible to persuade the continental European powers and the United States to intervene in the struggle against Japan, concluded that the friendship of Nippon would be valuable in obstructing Russia's advance. The foundations were laid for the Anglo-Japanese alliance of 1902; and China was conditioned for the secret defensive alliance with Russia of 1896. This alliance, helpful to Russia during the next eight years in its expansion into Manchuria, did China no more good than had art. ii of its treaty of 1871 with Japan. Russia and Germany were determined that Japan must not advance onto the continent, especially in the quarter earmarked as their own preserve, and, with France, they intervened to prevent Japan taking over Manchurian territory. Wounded and furious, Tokyo permitted Peking to pay an additional indemnity and relinquished, temporarily, its hold on Liaotung.

III. THE 20TH CENTURY

That nature abhors a vacuum has rarely been more clearly illustrated than during the years 1895–1903 in the scramble for concessions in China and the ensuing Boxer tragedy. Among the concessions made by the Manchu government were the leases, with additional rights, during 1898 of Kiaochow in Shantung to Germany; of Port Arthur (Lü-shun) and Dairen (Ta-lien) on the Liaotung peninsula in southern Manchuria to Russia; of Kwangchowwan in Kwangtung to France; of Wei-hai-wei in Shantung and the Kowloon peninsula close to Hong Kong to Great Britain. The Manchu empire would almost certainly have been divided by the continental European powers had they been able to agree among themselves and with Great Britain and the United States. This being impossible, the form of empire and part of its content were preserved, largely through the operation of the power balance. Japan was not yet in condition "to put meddling powers in or [out of] their places" and to attempt to control all of China. Great Britain and the United States had more to gain from trade with the empire as a whole than from exploitation of one annexed part, while at the same time being excluded from the parts annexed by other powers.

The year 1898 marked the flood tide of concession bagging in China and also the transformation of the United States into a Pacific and Asiatic power by the annexation of the Hawaiian and the Philippine islands. In September and November of 1899, partially at the instigation of London, the more-than-century-old U.S. and English policy in China of most-favoured-nation treatment (meaning equality of opportunity with reference to trade and commerce) was re-enunciated. Henceforth it was known as that of the open door. The corollary policies of territorial integrity and administrative entity were laid down officially by Secretary of State John Hay on July 3, 1900, during the course of the Boxer outbreak. These policies were formulated primarily in defense of United States (and British) interests; incidentally they were favourable to China and were formally recognized by that state in the nine-power Washington treaty of 1922.

1. Russo-Japanese War.—The struggle over China south of the Great Wall was one open to all. The simultaneous struggle for Manchuria and Korea was a relatively more exclusive affair waged between Russia and Japan. Back of the latter, but not very far back, was Great Britain, an ally after Jan. 30, 1902. Great Britain stood by when Japan, having been unsuccessful in persuading Russia to divide Manchuria and Korea with it, struck without declaration of war on Feb. 8, 1904. By the war of 1894–95 China had been eliminated from Korea; by that of 1904–05 Russia was likewise eliminated. Moreover, it was thrust from southern back to northern Manchuria and required to cede to Japan the southern half of Sakhalin. As it had after 1871 so after 1905 Japan made clear its decision to "stand with European countries" in exploiting China rather than, in co-operation with the United States, to aid China to modern nationhood. By this choice Japan came increasingly to look upon China, Europe and the United States as basically its enemies instead of its friends, actual or potential.

Throughout the course of the Russo-Japanese War the neutrality of the United States was friendly to Japan. In April 1905, consequent upon Tokyo's intimation that the U.S. president's good offices were desired to end the war, Theodore Roosevelt stipulated that Japan should maintain the open door in Manchuria and restore that area to China. To this Jutaro Komura, minister for foreign affairs, agreed. Both provisions were incorporated into the Portsmouth treaty. On Aug. 12, before the signing of the treaty on Sept. 5, the Anglo-Japanese alliance was renewed. By the secretly negotiated Taft-Katsura executive agreement of July 29, 1905, which was based perhaps on President Roosevelt's fear that Japan might attack the Philippine Islands and Japan's desire that the Washington government should maintain a complaisant attitude with respect to Japanese-Korean relations, the United States became a silent partner in the Anglo-Japanese alliance until the Roosevelt administration came to an end on March 4, 1909. The second Anglo-Japanese alliance and the U.S.-Japanese agreement contributed directly to the annexation of Korea.

In 1907, two years after Portsmouth, Japan signed agreements with France and Russia providing for continuance of "sphere-of-influence" and "special-interest" policies in China, a practical nullification of the open-door policy. Successive agreements between Russia and Japan foreshadowing their ultimate absorption of Manchuria and Inner and Outer Mongolia were signed in 1910, 1912 and 1916, the last a secret treaty of alliance which related to "China" and not merely to its dependencies. The 1917 revolution in Russia rendered this secret alliance valueless.

From the ending of the Russo-Japanese War to the outbreak of World War I in 1914, Russia, France, Great Britain and Japan dominated China in almost complete disregard of the United States and its open-door policy. Abdication of the Manchu dynasty (1912) and the establishment of a republic in place of the monarchy considerably aided occidental—including U.S.—and oriental imperialists of all types; *e.g.*, the land-hungry British in Tibet as well as the French, Russians and Japanese elsewhere, the railway concessionaires, exploiters of mines and other sources of raw materials, investment bankers and others.

2. World War I and After.—Japan took advantage of Europe's absorption in World War I to try to "become the chief nation of the orient" and the western Pacific. The Germans were expelled from Kiaochow following a declaration of war, but Japan consistently refused to send military forces to Europe; the German islands in the Pacific north of the equator were seized; Japanese and British fleets eliminated German naval forces from the Pacific and the Indian oceans; the Japanese naval forces performed valuable services in the Mediterranean in exchange for Britain's promise to support Tokyo's claims to become Germany's heir in the far east.

Tokyo wanted more than Germany's possessions in China and the South seas. In the autumn of 1914 there appeared another of the revelatory documents which so often marked Japan's advances to empire. Known as the Black Dragon memorandum, this one called on the government to "decide upon a course of action towards China which shall be practical in execution." The means was to be "a defensive alliance with [China] under secret terms" by which political, financial and military control of the sometime suzerain would fall to the sometime vassal. With characteristic abruptness Japan presented to Pres. Yuan Shih-k'ai, on the night of Jan. 18, 1915, 21 demands in five groups making clear, among other things, Japan's will with respect to: Shantung, South Manchuria and eastern Inner Mongolia; the future joint control of the Han-yeh-p'ing (iron-mining and iron-smelting) company; the nonalienation of Chinese coastal territory or waters to a "third power"; Japanese Buddhist "missionary propaganda in China"; the employment of Japanese political, military and financial advisers; Japanese railway construction; purchase of munitions from

Japan; and Japanese priority in the lending of funds to China.

Of the powers, the United States was the only one in a position to challenge the Japanese actions. Following the dispatch of an ultimatum by Tokyo to Peking, both governments were informed by Washington that it could not "recognize any agreement or undertaking . . . impairing the treaty rights of the United States and its citizens in China, the political or territorial integrity of the Republic of China, or the international policy relative to China commonly known as the Open Door policy." Here was clearly foreshadowed the American nonrecognition doctrine announced by Secretary of State Henry L. Stimson on Jan. 7, 1932, as a result of Japan's later aggressions in Manchuria. Nevertheless, Secretary of State William Jennings Bryan had earlier declared that with respect to "Shantung, South Manchuria and east Mongolia, the United States frankly recognizes that territorial contiguity creates special relations between Japan and these districts."

Two Chinese-Japanese treaties, with accompanying exchanges of notes, were signed on May 25, 1915, by which Peking acceded to part of the demands, others having been postponed for later consideration. The position of Japan in regard to South Manchuria, eastern Inner Mongolia, Fukien and the Han-yeh-p'ing company was strengthened. Although Japan did not obtain all it had demanded, its aims had been made abundantly clear; these aims, and more, were held as goals during the next quarter century. Not ratified by the Chinese parliament, as constitutionally required, the treaties of 1915 were never considered valid in China by either government or people. Despite Tokyo's objections China entered World War I in Aug. 1917. Thereby it obtained membership in the Paris peace conference and ultimately in the League of Nations.

The peace conference of 1919 (*see* PARIS, CONFERENCE OF) proved as rich a seedbed for war as any in world history, the east equaling the west in the gravity of issues involved. However, many of the factors contributing to renewal of hostilities long antedated the meeting in Paris; *e.g.*, Chinese-Japanese antagonism and the demand for racial equality advanced by the Japanese. In general they were successful in their claims as heir to Germany in Shantung and the northern Pacific islands. The mandating of these archipelagos to Japan constituted another advance southward by water to balance land extension westward. On the racial question the Japanese and the other "Coloured" peoples of the earth were defeated.

The rebuffs sustained by China at Paris brought to the fore a strong feeling of resentment against the west. Elsewhere in eastern Asia frustrated national feelings also were powerfully stimulated by Wilson's promise of "self-determination." Many thousands of Koreans made clear their attitude toward their Japanese overlords by a wide-scale peaceful demonstration in 1919 in favour of freedom. The relations of the Indochinese and their French masters improved despite the general attitude of Paris that liberty, equality and fraternity were better suited to French citizens than to Asian subjects. In 1927 the government council for Indochina was reorganized on a membership basis of 25 natives to 35 aliens. In Siam (Thailand) significant steps toward sovereignty were taken when new bilateral treaties were negotiated between 1920 and 1926 to replace the former unilateral treaties.

The Bolshevik Revolution of Nov. 1917 caused confusion throughout the Russian empire, dissolved the Russo-Japanese alliance of 1916 and gave the expansionists of Japan an opportunity for the invasion of Siberia. In May and September 1918 the largely Japanese-controlled Peking government signed military and naval pacts with Tokyo for joint operations in Siberia. In July Vladivostok was seized by the allied and associated powers. Japan, France, Great Britain and Belgium desired intervention and at length the Wilson administration proposed to Tokyo a joint Siberian expedition. Contrary to preliminary agreement, Japanese forces greatly outnumbered those of any other intervening power and friction between the United States and Japan appeared for a time before the Armistice in Europe to threaten hostilities. Early in 1920 all intervening troops except those of Japan were withdrawn; the Japanese forces were increased to strengthen their hold on the Transbaikal and maritime provinces and to enable them to seize the northern half of Sakhalin, which they held until the spring of 1925. Intervention, particularly the actions of the Japanese, directly contributed to reunification of Russia under the Bolsheviks. Japanese forces were finally withdrawn from continental Siberia in the autumn of 1922.

3. Washington Conference.—Relations between the United States and Japan were not improved by their co-operation in Siberian intervention but were later somewhat brightened by the treaties and agreements negotiated as a result of the Washington conference (*q.v.*). This meeting of the representatives of nine states in or having important interests connected with the far east—but excluding the Soviets—was convened in the hope of solving problems threatening the peace of east and west alike. Outstanding among the questions considered were those of U.S.-British-Japanese naval rivalries, renewal of the Anglo-Japanese alliance of 1911 and Chinese-Japanese-occidental relations. From the sessions, held Nov. 1921 to Feb. 1922, emerged 7 treaties and 12 resolutions (*see* WASHINGTON, TREATIES OF). Two other treaties were signed outside but during the period of the conference. These were the Chinese-Japanese Shantung agreement and the U.S.-Japanese settlement of the issue over Yap, an important cable station in the Pacific.

The Anglo-Japanese alliance, as unpopular in parts of the British empire as it was in the U.S. (now that Japan rather than Russia appeared to threaten the balance of power in eastern Asia), was superseded by the four-power Pacific treaty. Great Britain, Japan, France and the United States each agreed for a period of ten years to respect the others' position in the Pacific. Japan was considerably strengthened by this agreement, but naval rivalries were temporarily allayed by it and by the five-power naval treaty which fixed a capital-ship ratio of 5–5–3–1.67–1.67 for the United States, Great Britain, Japan, France and Italy respectively, and restricted fortifications in the Pacific.

China participated in the Washington conference in the hope of solving its external problems, particularly those related to limitations on its sovereignty imposed by the unilateral treaties and the treaty-port system. But the position of the foreign powers in China was little affected. The continued confusion in China and the limited evidence offered by the governments and people of that country of their ability to meet the obligations of a sovereign state led the western nations to maintain their special privileges.

By the Chinese-Japanese Shantung treaty earlier mentioned, the former German-leased territory of Kiaochow was returned to China —Japan retaining large commercial interests therein and otherwise safeguarding its financial interests in Manchuria. Japan's position was further enhanced inasmuch as the 1915 treaties were fruitlessly protested by the Chinese representatives.

A nine-power "treaty regarding principles and policies to be followed in matters concerning China" was signed on Feb. 6, 1922. The contracting governments, other than the Chinese, bound themselves to respect the sovereignty, independence and territorial and administrative integrity of China and to afford that distracted country opportunity to establish effective rule; also to use their influence toward maintenance therein of the open-door principle. In turn, China undertook for the first time to be guided by this principle. Noble in conception, the nine-power treaty lacked two requisites for a solution of the problems with which it dealt: ability and willingness on the part of the cosignatories, including China, to carry into effect its promises and provisions.

The Washington settlement of 1922 was based primarily upon U.S.-British policies. To a considerable degree it was favourable to China, although the safeguarding there of most of the foreign rights and interests made it clear that that country had failed to attain a majority of its declared objectives. Japan's short-run position was felt to be strengthened but potentially it was weakened —from Japan's viewpoint at least—since an actually independent and strong China must divert Japanese expansion into other channels.

4. China's Problems.—Maintenance of the *status quo* as desired by Washington and London was unlikely to be long tolerated by Tokyo or Peking or Nanking, and assuredly not by Bolshevik Moscow. Russia's urge to the east and its influence there were about equally marked under tsars and commissars—to the in-

creasing wrath and fear of Japan. No less fear-stimulating and wrath-inspiring was the development of nationalist-militarist-industrialist-capitalist Kuomintang China and nationalist-militarist-agrarian soviet China, inspired respectively by the U.S. and Britain and by the U.S.S.R. By war and diplomacy Japan attacked both Kuomintang-nationalist and soviet-nationalist China. The Chinese, disunited but determined to recover unity, along with lost sovereignty, territories and national dignities, continued in the third and fourth decades of the 20th century, as they had in times of weakness through the ages, to play off one power or group of powers against another. In the 15 years preceding the outbreak of war in the Pacific in 1937, they made marked progress in removing some of the causes of domestic weakness that had forced them to fall back on such uncertain means of protection.

Time after time during the preceding four centuries the far eastern problem had reflected the power struggles of Europe. This was the case with Russo-Chinese relations after 1920, when, having failed to bolshevize Europe, Lenin and his co-workers attacked the western nations through their Asiatic possessions. In China south of the Wall, in Manchuria, in Outer Mongolia and in Sinkiang, the impact of Bolshevism was felt by the Chinese. Tsarist privileges and concessions were largely renounced while revolutionary ideology was widely disseminated, and wherever possible the nationalist aspirations of colonial and semicolonial Asia were encouraged. Outer Mongolia was sovietized despite Moscow's recognition of China's sovereignty therein. Throughout the first third of the century the political and social confusion prevailing in China aided both native and foreign predatory elements.

Sun Yat-sen, leading anti-Manchu revolutionary, for a few weeks in 1912 provisional president of the Chinese republic and for 13 years thereafter chief southern opponent of northern Chinese militarists and their Peking governments, strove, while alternately in and out of office in successive revolutionary governments at Canton, to obtain help from the western powers in the implementation of his social, economic and political policies. Disappointed and embittered he turned to the U.S.S.R. early in 1923, and that country, through the third international, sent him political and military advisers and other aid. Reorganized and revivified, the Kuomintang within five years brought most of China under its control, split with and expelled the Russian advisers and established a national government at Nanking. The break between the Kuomintang and the Muscovites in the summer of 1927 marked the failure of the third international's offensive in Asia but it did not end Soviet influence in China. This was demonstrated by the sporadic struggles between the Kuomintang and the Chinese soviets during 1927–41, and by the inability of Nanking to eradicate the communist movement as a political and military threat.

5. Japan's Ambitions.—Consequent upon Stalin's three five-year plans (1928–42), Siberia—western, northern and eastern—was developed as a potential base of military action. Before these plans could be fully realized, however, Japan's seizure of all Manchuria (1931–32) threatened eastern Siberia, especially rail communications between Moscow and Vladivostok. The Chinese Eastern railway, a product in part of the Chinese-Russian secret alliance of 1896, which Soviet diplomats had maintained a firm hold on hitherto, was sold in 1935 as a matter of expediency to the Japanese puppet state of Manchoukuo.

Offsetting Japan's advance into northern Manchuria and Inner Mongolia were Soviet construction of the Baikal-Amur railway; development of new towns, ports, engineering and industrial projects—conspicuously that of the Angara-Yenisei riverine area—in eastern Siberia; opening in 1932 of the Eurasiatic sea route via the Arctic ocean; double-tracking of parts of the Trans-Siberian railroad; and continued manifestation of Soviet interest and influence in Sinkiang, bordering which, not far to the west, the Turkistan-Siberian railway had been completed in 1930.

In 1935 the government of the new commonwealth of the Philippines (preliminary to the attainment of independence by those islands on July 4, 1946) was inaugurated. In that same year, the popular front was adopted by the seventh congress of the third international (*q.v.*). Repercussions of this policy were felt both within China and between China and Japan. Chinese-Japanese hostilities were renewed on July 7, 1937. In partial reply to the popular front, and as a precursor to the outbreak of hostilities, the anti-Comintern pact between Nazi Germany and Japan was signed on Nov. 25, 1936. Shortly thereafter adhered to by Italy, this agreement led directly to the triple military alliance of Sept. 27, 1940.

Other events and conditions also made apparent the determination of Japan's militarists to build a new far east consonant with their national mythology and political philosophy. On April 17, 1934, the so-called Amau declaration (after Amau Eiji, a foreign ministry spokesman) was issued. In direct defiance of the open-door doctrine, this declaration enunciated Tokyo's claim to act alone as guardian of "peace and order in eastern Asia," definitely discouraged joint operations by foreign powers in aid of China and expressed determined opposition to their "supplying China with war planes, building airdromes . . . and detailing military instructors or military advisers . . . or contracting a loan to provide funds for political uses." On Dec. 29 of the same year, Tokyo notified of its intention to withdraw from the naval limitation treaty of Washington as of Dec. 31, 1936. A naval race, hitherto avoided, was now begun—immediately by Japan, tardily by the United States—and in less than one year from the expiration of the treaty the U.S.S. "Panay" and three United States merchant vessels were bombed on the Yangtze (Dec. 12, 1937) by Japanese airmen.

Acceptance by Washington of Tokyo's hasty assurance of regret, accompanied by indemnity, contributed to a delay of almost four years before full-dress war broke out between the two chief rivals in the Pacific. This delay permitted U.S. citizens to sell limited quantities of goods on a cash and carry basis to China, and practically unlimited quantities to Japan. The sales to Japan made possible not only that country's sustained attack on China but the destruction, in China, of U.S. lives, property and moral reputation.

IV. WORLD WAR II AND AFTER

During the years 1938–40 Washington indicated disapproval of Japanese actions in China by loans to China to be repaid in wood, oil and tin; by announcing, in Dec. 1938, as if in rebuttal of the Amau presumption: "This government does not admit . . . that there is need or warrant for any one power to take upon itself to prescribe what shall be the terms or conditions of a 'new order' in areas not under its sovereignty and to constitute itself the repository of authority and the agent of destiny in regard thereto"; by gradually limiting, practically to the point of elimination, exports of commodities needed by Japan's air forces; and by abrogating as of Jan. 1940 the U.S.-Japanese trade treaty of 1911. In China itself the war ground on. Both the nationalists and communists pursued a policy of exchanging territory for time, persevering against Japan through a period of stalemate, exhausting that country while strengthening China and finally counterattacking. Japan, frustrated in China after 1938, decided to seize upon the confusion of western Europe and concluded (April 13, 1941) a five-year nonaggression pact with the U.S.S.R. Despite the opposition of the United States, Japan also decided to effectuate at last its long-meditated policy of advancing into southeastern Asia and the southwestern Pacific. All this brought about increased tension. U.S. Ambassador Joseph C. Grew warned from Tokyo in Jan. 1941 that a surprise attack might be expected. But no agency of government or military authority in the United States was prepared for the Pearl Harbor attack of Dec. 7, 1941. Bitter efforts were made to determine the responsibility for America's unpreparedness, but to little avail. (H. F. MacN.; D. F. L.)

1. China at War.—From 1937 to 1945 China lived in a state of siege. The united front between nationalists and communists permitted both Chinese groups to battle the Japanese while maintaining a truce with each other. After 1941, as the major western powers gradually began to take the lead in the war against Japan, the nationalists and communists became determined to resume their civil war for control of China. Pres. Franklin D. Roosevelt sought by all means to keep China actively engaged in the war against Japan, and continuously worked for the elevation of China to a position of international leadership and heir to Japan as the leading power in the far east. In this policy Roosevelt had neither the wholehearted support of his European allies nor of the Soviets

even though all of the antifascist powers recognized and nominally, at least, supported the national government of Chiang Kai-shek.

Chiang (*Soviet Russia in China*, 1957) asserted that "once the war was over, Moscow immediately unleashed its comprehensive plan to conquer China from without and subvert her from within." Though it was not all this simple, the U.S.S.R. certainly took a greater interest in the future of Chinese communism at the end of the war than at the beginning. At the Yalta conference of Feb. 1945, President Roosevelt, under pressure to obtain Russian participation in the war against Japan at the earliest possible date, acceded to a number of Stalin's demands in the far east and promised to secure Chiang's assent. In return for U.S. co-operation, Stalin agreed to conclude a pact of friendship and alliance with the national government of China.

While Soviet forces prepared to move against the Japanese in northeastern Asia, a Chinese-Soviet treaty was being worked out in Moscow in July 1945. By its terms the U.S.S.R. reaffirmed its formal recognition of the Kuomintang government, its respect for China's full sovereignty over Manchuria and its determination not "to interfere with China's internal affairs." On their side the Chinese agreed to joint ownership of the Manchurian railways, joint use of Port Arthur as a naval base and the opening of Dairen to all nations as a free port. It was also agreed to hold a plebiscite in Outer Mongolia on the question of independence, the result of which was the declaration of Mongolian independence in the fall of 1945.

The final decisions in northeastern Asia, however, were not to be made at the conference table or by voting, but rather by force of arms. While Japan writhed in military defeat, Soviet forces carried out an extensive occupation of Manchuria. The surrender of Japan in 1945 was the signal for the opposing forces in China to advance their respective causes. Each side was particularly anxious to gain control over Manchuria, the strategically and economically vital nexus of northeastern Asia. But for the nonce the Soviets occupied Manchuria and their inclination was to allow the Chinese communists gradually to take over strategic points and key cities. While the nationalists protested, seconded by dispatches from Washington, no military pressure of consequence could be brought to bear on the firmly entrenched Soviets. By the time the Soviets carried out a formal withdrawal in the spring of 1946, the Chinese communists had acquired arms, a firm foothold and a staging ground for their subsequent advances into China south of the Wall, where other communist units were already in operation. While the U.S.S.R. gradually moved to the support of the Chinese communists, the United States until 1947 promoted the nationalist cause in international agencies, continuing to give military and technical advice and aid to the Kuomintang armies, and to seek a peaceful solution to the Chinese civil war. The United States also tried to perpetuate the united front by urging both sides to compromise to the point where a coalition government might become viable. To this end Gen. George C. Marshall arrived in China in Dec. 1945 as head of a mediation mission. After a year of frustrating efforts, Marshall gave up his task in despair, concluding that "extremist elements of both sides" made compromise impossible to realize. While Marshall contemplated withdrawal, the United States signed on Nov. 4, 1946, a bilateral commercial agreement with the national government.

The failure of mediation was followed shortly by the withdrawal of U.S. military forces from China. Washington decided to postpone further activities there to concentrate on the containment of communism in Europe. As "the dust settled" in China, it became ever more obvious that time favoured the communists. The Kuomintang government, which had had its chance since 1928, appeared 20 years later to have lost its popular appeal and revolutionary fervour. The communists, attributing most of China's ills to western capitalist exploitation, seemed to offer an opportunity for a fresh start on the road to internal stability, security and independence. Fighting alone, the forces of Chiang Kai-shek were unable to stem the communist advance that was clearly receiving encouragement and stimulation from the U.S.S.R.

While it may be argued that no amount of U.S. support could have maintained the Kuomintang in power, it is clear that the withdrawal of troops and diplomatic support by the United States in 1947 hastened the collapse of nationalist China. By the autumn of 1949 the communists had taken over intramural China, and the remnants of the Kuomintang forces (numbering about 2,000,000) sought refuge on the island of Taiwan (Formosa), 90 mi. E. of Fukien province.

2. People's Republic of China.—The proclamation of the People's Republic of China on Oct. 1, 1949, was followed by a complete repudiation of the old treaty structure and the inauguration of a Marxist foreign policy centred on the promotion of world revolution. The United States was clearly identified in Peking's pronouncements as the major "imperialist" enemy and the new regime committed itself to the side of socialism and to co-operation with the U.S.S.R. Peking let it be known that foreign relations in the future would be conducted on its own terms and without reference to China's past commitments. Foreign nationals in China were put under close surveillance, arrested or forced to leave. Diplomatic installations and other foreign properties were seized and strict limitations were imposed on western missionary and educational activities. As a precondition for normal diplomatic relations, Peking demanded from the other nations immediate recognition, severance of ties with the nationalists and China's seat on the Security council of the United Nations.

The first nation to conclude a treaty with the new Peking regime was the U.S.S.R. On Feb. 14, 1950, the cornerstone in their relations was laid in a bilateral treaty and two subsidiary agreements concluded in Moscow, and notes were exchanged to render null and void the Soviet treaty of 1945 with nationalist China. By the terms of these agreements the U.S.S.R. retained a place in the border states, control over which had long been in dispute between the two nations, though the Manchurian railways were to revert to China by 1952. Nominally the treaty was a military agreement against Japan, but in reality it was aimed at "any other state that may collaborate with Japan in acts of aggression." Clearly the prime target was the United States, the country mainly responsible for the occupation and rehabilitation of Japan after 1945. The U.S.S.R. also agreed to advance credits to China, and provisions were made for economic and cultural interchange. Meanwhile, Peking began military action against Tibet to bring that ancient theocracy under its sway before serious interference could come from the outside world.

The future of relations with communist China was hotly debated after 1949 in the UN and among the foreign ministers of the various western countries. In the early months of 1950 Washington pursued a policy of watchful waiting, while Great Britain and several other western European countries extended legal recognition to the new Peking regime. The U.S.S.R. in the same period, began to call for the unseating of nationalist China in the UN and for the immediate seating of communist China on the Security council as the government exercising "effective authority" on the China mainland. Any possible success of such efforts was checked by the outbreak of the Korean War on June 25, 1950, but the efforts were resumed later and made some headway.

3. Korea.—The end of Japanese control over Korea in 1945 brought with it a "temporary" division of the peninsula at the 38th parallel for the purpose of accepting the Japanese surrender. North of this arbitrary line Soviet troops carried out the occupation, and south of it U.S. forces disarmed the Japanese and operated under an interim military government. Meanwhile the fires of Korean nationalism, which had been relighted by the spark of hope contained in the Cairo declaration of Dec. 1943 that Korea "in due course shall become free and independent," began to spread both north and south of the parallel. As nationalist leaders jockeyed for position in the ensuing political scramble, the problems of the occupying forces increased. While Koreans tried to stake out their own future, the decision was being taken out of their hands by international arrangements. At the Moscow council of foreign ministers in Dec. 1945 a four-power (United States, U.S.S.R., Great Britain and China) trusteeship was agreed upon "to prepare Korea for its independence within five years." But this was about all on which the U.S.S.R. and the United States could agree, and after 1945 their military commands went ahead with separate and

differing programs designed to lay the foundations for Korea's independent future.

In northern Korea the Soviets quickly carried forward a swift economic and social revolution in conjunction with native communist leaders. In the U.S. zone a more gradual program of reorientation was instituted, without much advice or co-operation from native groups. In 1947 the United Nations sent a team to Korea to help in the reunification of the peninsula and to seek ways for bringing an end to the occupation. Despite protests from the Soviet Union that it had no jurisdiction in Korea, elections were held in Korea on May 10, 1948, under the supervision of the UN commission. Syngman Rhee emerged victorious from this election, which was conducted mainly south of the parallel, and thereafter went ahead with the organization of a permanent government which claimed jurisdiction over the whole of the country. In the north the communist-sponsored government set itself up on a permanent basis and also claimed to be the legitimate government of the entire peninsula.

The proclamation of the two permanent governments, each claiming the other to be illegal, brought about a local and international stalemate in Korea. The U.S.S.R. recognized and supported the northern government at P'yongyang, and the U.S., supported by the UN, recognized and aided Rhee's government at Seoul. All the parties were dissatisfied by this impasse, and the northern regime sought by propaganda and subversion to undermine Rhee's power. The victory of the communists in China in 1949 encouraged North Korea to even more overt attacks upon its southern rival, culminating in the outbreak of civil war in June 1950.

The armed invasion of South Korea by North Korea was immediately denounced by the Security council of the UN as a breach of the peace. Shortly thereafter U.S. sea and air forces were dispatched from Japan to aid the fleeing South Koreans, and the Security council invoked military sanctions against North Korea. Such a decision was possible because the Soviet Union had temporarily withdrawn from the Security council in an effort to push the UN into recognition of communist China. Officially the communists took the position that no international frontier had been transgressed and that the Korean civil war was legitimately only of concern to the Korean people. Meanwhile U.S. ground forces and British and Australian fleet units were rushed to the scene. Gen. Douglas MacArthur took command of the UN forces which fought desperately in the summer of 1950 to retain a toehold in Korea, and which launched a counteroffensive in the autumn that moved swiftly northward.

On the first anniversary of its inauguration, the Peking government warned on Oct. 1, 1950, that it would not stand idly by should "the imperialists wantonly invade the territory of North Korea." MacArthur's forces, nevertheless, continued their northward drive and in mid-October took Pyongyang. By Nov. 1 Chinese "volunteers" in constantly increasing numbers began to appear in North Korea. MacArthur soon proclaimed to the Security council that a "new war," clearly of international magnitude and of greater potential danger to the peace of the rest of the world, was in the process of breaking out in Korea.

The first UN attempt to negotiate the Korean War took the form of an invitation to Peking to send representatives to Lake Success in Nov.-Dec. 1950. While the battle raged in Korea, the Peking delegation charged the United States with aggression in Asia. It was alleged that the United States was the only outside force that persisted in intervening in eastern Asia, that it occupied Japan, that it led the intervention in the Korean civil war and that Washington had resumed its policy of interfering in the Chinese civil war by its decision of June 27, 1950, to seal off the island of Formosa from the mainland. On its side the United States took retaliatory measures in Dec. 1950 by seizing Chinese communists' assets in the United States, by proclaiming an embargo on trade with the China mainland and by advancing additional credits and support to Chiang Kai-shek. On Jan. 20, 1951, the United States introduced a resolution in the UN asking that communist China be branded an aggressor in Korea. Though the Arab-Asian bloc called for compromise, the general assembly on Feb. 1 approved the U.S. resolution, thereby declaring Peking the aggressor in Korea. At this point it seemed as if the war in Korea must settle down to a war of attrition that might at any time precipitate a general war.

In the spring of 1951 the "great debate" over possible future action raged in the U.S. MacArthur and a highly vocal minority wanted to bring the stalemate to a quick end by an attack on China directly. The Truman administration, acutely aware that U.S. policies were not winning approval in western Europe or with the Arab-Asian nations, preferred to follow a less drastic policy. The climax in the "great debate" came with the dismissal of MacArthur on April 11, 1951. Though the military stalemate in Korea continued, both sides agreed in the summer of 1951 to inaugurate negotiations for a truce. After repeated deadlocks over a demarcation line, truce teams and exchange of prisoners, a truce agreement was finally arrived at on July 27 (Korean time), 1953.

The Korean War lasted more than three years; the truce talks dragged on for the last two years while the fight continued. Casualties were high for all the parties, especially the Koreans. Over 1,000,000 persons were killed, 2,500,000 found themselves homeless and property damage was estimated at more than $1,000,000,000. Korea remained disunited, devastated and hungry. Perhaps the greatest positive accomplishment of the war was the UN's success, costly as it was, in halting defiant aggression and proving to the Peking regime that it could not act unilaterally and arbitrarily without fear of military retaliation. (See KOREAN WAR.)

4. Japan.—While waging war in Korea, the United States was also occupied with bringing the occupation of Japan to an end and preparing Japan for reinstatement in the family of nations. The occupation that had begun with the surrender of Japan in Aug. 1945 went through two phases. Originally it was the objective of MacArthur and the SCAP (supreme commander Allied powers) organization to demilitarize, democratize and re-educate Japan. Beginning in 1948, as conditions in Europe and China became more favourable to the spread of communism, the major objective of the occupation came to be the economic rehabilitation of the country. Though Australia, the Philippines and others protested, the U.S. concern with the spread of communism led MacArthur to adopt policies which aimed at making the Japanese economy viable in an effort to keep Japan from following China down the road to communism.

The United States also took the lead in negotiating a peace treaty with Japan as a cornerstone for future relations. MacArthur proclaimed in March 1947 that Japan was ready for a peace treaty. Immediately a conflict developed between the United States and the U.S.S.R. over procedure, and so for about two years little was accomplished. The spread of communism in eastern Asia led the United States in 1949–50 to press for a Japanese peace treaty, whether or not the communist states were agreeable. Though the Japanese socialists opposed a "one-sided treaty" from the beginning, Washington in the spring of 1950 inaugurated diplomatic conversations and written exchanges with those noncommunist nations which had waged war against Japan. The outbreak of the Korean War in the summer of 1950 highlighted for even some of the most skeptical countries the importance of working out a clear-cut peace formula with Japan. Over the course of the following year a treaty was worked out that was found acceptable by most of the noncommunist nations.

From Sept. 4 to 8, 1951, Japan and its former enemies met in San Francisco to sign the treaty and accompanying agreements. The Soviets attended the conference to register their protests, but they refused to sign the treaty. Forty-nine nations, including Japan and a protesting Indonesia, finally signed the document that formally brought to an end the state of war. The treaty acknowledged the return to Japan of full sovereignty over its four main islands and their territorial waters. But Japan was required to recognize the independence of Korea and to renounce all rights to Formosa, the Pescadores, the Kurils, south Sakhalin, the former mandated islands, Spratly and the Paracels. About the Luchu (Ryukyu) Islands and the Bonins, Japan was required to "concur in any proposal of the United States to place them under its trusteeship system." In China, Japan was forced to give up all

"special rights and interests." Finally, Japan was obligated to negotiate reparations claims made by countries that had suffered from Japan's wartime depredations. A separate treaty was signed with the United States on Sept. 8 permitting the establishment of American "land, air, and sea forces in and about Japan" with an accompanying promise that similar rights should not be granted "to any third power" without Washington's consent.

The peace treaty and the accompanying security pact did not go into effect until April 28, 1952, and shortly thereafter the occupation of Japan formally ended. Japan's subsequent foreign policy centred upon the problem of increasing exports, maintaining security in a bipolarized world, re-establishing economic and political ties in eastern Asia and in winning admission to the United Nations. For over four years the U.S.S.R. vetoed Japan's admission to the United Nations. But finally in Oct. 1956 a Japanese-Soviet joint declaration was signed in Moscow to restore normal relations between the two countries. Two months later Japan's application for admission to the United Nations was approved, thus enabling Japan for the first time since the war to have an independent voice in the decisions of the nations.

5. Taiwan (Formosa).—Divisions of opinion over the Korean War and the Japanese peace treaty brought about tensions between the United States and its western European allies. But the issue of Taiwan (Formosa) provoked even more division in policy. Beginning in June 1950 the United States again lent its support to the nationalist cause and in so doing was accused in Europe, Africa and Asia of meddling in the Chinese civil war. Peking persisted in claiming legal jurisdiction over Taiwan and its claims were supported by the communist nations and by the 15 noncommunist states that recognized the government of Mao Tse-tung. In spite of the denunciations of the communists and the protests of other less interested states, the United States after 1950 consistently championed the nationalist cause through military, technical and psychological aid. This policy was based on the belief that Taiwan in the hands of the communists would endanger Japan, Okinawa, the Philippines and southeast Asia. It was also based on the hope that the continued existence of a noncommunist China would give the Chinese, both inside China and in the overseas world, an alternative to communism.

On Taiwan itself the direct support from the U.S. made the island of over 10,000,000 persons into a heavily armed fortress. Nonmilitary aid helped to strengthen the island's economy, which had always been rich in rice. While the Kuomintang government rectified many of its past errors, it continued to maintain tight political control over the island. Its position was strengthened by U.S. support, and particularly by the conclusion in 1954 of a mutual defense pact. By its terms the United States guaranteed to protect Taiwan and the Pescadores from "armed attack and communist subversive activity directed from without against their territorial integrity and political stability." Meanwhile, Chiang and his cohorts continued to prepare for the day when they would return to the mainland. The communists on the mainland continued to inveigh against the American "imperialists" and promised that they would never relinquish their claim to Taiwan.

6. Indochina.—Though the United States successfully helped Taiwan remain free of communist control, Peking won a degree of success in Indochina after the conclusion of the Korean truce in 1953. French authority in this peninsula had been seriously undermined during the war, and after 1945 the Indochinese national movement fell increasingly under the influence of the communists. The United States and Great Britain, while fearing the spread of communism into Indochina, urged their French ally to follow the path of negotiation rather than war. For even after seven years of bitter war few permanent successes had been won by French arms. Finally, it was agreed to convene a conference of the four major powers to which Korean and Indochinese representatives might present their conflicting views.

The conference opened at Geneva on April 26, 1954. After three months of parley, the Korean phase of the discussions ended in a deadlock. On July 21, just one year after the initialing of the Korean truce, an agreement on Indochina was concluded despite the fact that the United States was not pleased with some of its conditions. France agreed to withdraw its military forces from the Red river delta, Hanoi and Haiphong, and the Vietminh (League for Independence) agreed to evacuate southern Vietnam and southern Laos and to respect the territorial and political integrity of Cambodia. A neutral commission made up of representatives from Canada, India and Poland was set up to supervise the truce. These agreements in effect permitted the communist-dominated Vietminh to control the northern half of the peninsula and its 12,000,000 persons. The southern half of Vietnam was to remain, temporarily as it turned out, in the hands of the French-approved ruler, Bao Dai. After 1954 communist influence steadily mounted and guerrilla warfare ensued. Bao Dai was deposed and Ngo Dinh-Diem became president in 1955. He was re-elected in 1961 and, with extensive U.S. aid, continued to resist communist attacks from North Vietnam.

7. Security Pacts.—Fear of the spread of communism into southern Indochina and the other independent countries of southeastern Asia prompted the western powers under the leadership of the United States to lay foundations for a regional security program. The war and its aftermath had brought colonial control to an end in the Philippines (1946), Burma (1948), Indonesia (1950) and Malaya (1957). Thailand had always managed, though under great difficulty, to retain its independence. With the experiences of China, Korea and Indochina behind them, the leaders of the noncommunist nations, in conjunction with their colleagues in some of the newly independent states, began around 1950 to design a program for stopping the growth of communism in southeastern Asia.

The trend toward collective defense efforts began after it became clear that economic aid would not be enough to keep communism in check. In 1951 the United States, Australia and New Zealand concluded a Pacific defense treaty (known as Anzus), and in the following year organized a Pacific Defense council. At the Asian and Pacific peace conference held at Peking in 1952, the communists characterized the new defense operation as the old imperialism in a new dress. Communists throughout the world were encouraged to do their utmost to sabotage the economic aid-programs, such as Point Four and the Colombo plan.

After the debacle in Indochina, a conference of western and Asian nations was called at Manila for Sept. 1954. The result of this conference was the conclusion of the southeast Asia collective defense treaty and the publication of a Pacific charter. Eight nations took membership in SEATO (Southeast Asia Treaty organization; *q.v.*): Australia, France, New Zealand, Pakistan, the Philippines, Thailand, the United Kingdom and the United States. The object of the charter was to try to reassure the new nations of the benevolent intentions of the western powers and of their desire to see orderly political, economic and social progress in the new states. The treaty pledged the member states "to maintain and develop" their individual and collective capacities to resist armed attack and subversion directed against "the territorial integrity and political stability" of the countries of southeastern Asia, and the southwestern Pacific regions. The participants also agreed to collaborate on economic and technical programs and to establish a council for the co-ordination of their military programs. Conferences on problems of mutual concern were held at frequent intervals.

Despite many such efforts to bring the other new nations of eastern Asia into alliance with the western powers, neutralism in Asia continued after World War II to grow as an international political factor of significance. After independence it was adopted as the official policy of the governments of India, Burma and Indonesia. And it was an attitude shared by many intellectuals within all the Asian countries. Its proponents asserted that their governments must limit their involvement with both of the great power blocs to preserve their national independence and to give themselves the opportunity to act as a third force in world affairs. Shortly after the end of World War II Prime Minister Jawaharlal Nehru of India sought through a series of conferences to develop regional solidarity, regional co-operation and even a permanent organization for the promotion of Asian unity. These efforts, based as they were primarily upon geographical ties, common problems

and general hostility toward colonialism, achieved only a limited success. Nevertheless, the neutralist governments of Asia in combination with the Arab nations were able to throw their collective weight into international negotiations with considerable success. But, as in the case of Indonesia, it appeared that the cost of pursuing a neutralist foreign policy might come high and might have to be paid for in terms of economic dislocations, social unrest and even civil war.

Throughout the history of modern far eastern international relations, China has stood at the centre of affairs, with the possible exception of the period from 1905 to 1945. The major problem after 1949 was that of dealing with a China dominated by communism and closely tied, politically and economically, to the Soviet Union. The United States took the leadership in constructing a defense perimeter to halt the spread of communism through its program of mutual security treaties with Japan, Korea, nationalist China and the Philippines, through its part in the creation of SEATO and by its economic and technical aid programs. By the early 1960s no general far eastern settlement had been agreed to and as a result many issues remained unresolved in the area. At best it might be said that in the bipolarized world of the second half of the 20th century an uneasy truce had been established in the far east. *See* also UNITED NATIONS and *History* sections of CHINA, JAPAN, KOREA and other countries of the far east.

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FAREHAM, a market town, seaport and urban district in the Gosport and Fareham parliamentary division of Hampshire, Eng., 13 mi. E.S.E. of Southampton by road and bridge, at the head of a creek opening into the northwestern corner of Portsmouth harbour. Pop. (1961) 58,277. Area 28.7 sq.mi. The ancient church of SS. Peter and Paul belonged to an Augustinian priory founded by Henry I; it has been several times rebuilt.

The fact that Fareham (Fernham in Domesday Book) formed part of the original endowment of the see of Winchester fixes its existence certainly as early as the 9th century. There is evidence to show that Fareham had become a borough before 1261; it is mentioned in Domesday Book as subject to a reduced assessment because of its exposed position and liability to Danish attacks. It was a mesne borough held by the bishop of Winchester, but by 1835 it had lost this status. It became an urban district in 1894. Fareham was represented in the parliament of 1306, but two years later it petitioned against representation on the ground of expense. A fair was held under grant of Henry III, and in the 18th century was mainly important for the sale of toys; it was abolished in 1871. The modern Monday market developed from the ancient street market.

Fareham in medieval times was a free port and had a considerable trade in wool and wine. Its modern trade is in corn, timber and coal, the creek being accessible to vessels of 300 tons. There is a large public abattoir built in 1949. The principal industries are boatbuilding, light engineering and the manufacture of bricks, coarse earthenware, terra cotta and leather. Among the localities comprising the urban district are Portchester, Wallington, Stubbington, Hill Head, Titchfield, Warsash, Locks Heath, Park Gate, Sarisbury Green, Swanwick and Burridge.

About 3 mi. W. is Titchfield, with a partly Saxon church and the remains of a Premonstratensian abbey of the 13th century, incorporated in a now ruined mansion after the Dissolution. The ruins of Portchester castle, on Portsmouth harbour (3 mi. E. of Fareham), consist of an extensive walled enclosure retaining its Norman keep and showing considerable evidence of Roman workmanship in its outer walls. The castle walls enclose the church of St. Mary, and the grounds are open to the public.

FAREL, GUILLAUME (1489–1565), French reformer and preacher who brought the Reformation to French-speaking Switzerland, was born in Gap, Dauphiné. Choosing an academic life in opposition to his father's wishes, he entered the University of Paris at the late age of 20. He was the pupil and friend of Jacques Lefèvre d'Étaples, through whose influence he became professor at the Collège Cardinal LeMoine, teaching grammar and philosophy. A little later he was advanced to regent of the college. Sometime between 1516 and 1521 he was converted to the beliefs of the Reformation.

Thereafter, his life falls into two parts, with the years 1536–38 as the dividing line. Before 1536 he was one of the leaders of the Reformed Churches—probably the chief French Reformer. In 1521 the reforming Guillaume Briçonnet, bishop of Meaux, appointed him one of his 32 diocesan preachers; but the bishop's dilatoriness and Farel's impetuousness accorded ill, so that he had to return to Paris in 1523. The outburst of persecution soon forced him to seek shelter in sympathetic Basel. But there a violent controversy with Erasmus brought about his banishment. Over the next two years Farel visited Montbéliard, Strasbourg, Basel and Bern, until at last he settled in Aigle, preaching there and in all that district from 1526 to 1530. He then turned to Neuchâtel and afterward (1532) to Geneva, which declared for the Reformation in 1536. Later that year he persuaded John Calvin to be his assistant; by 1538 Calvin was his colleague; from then on Farel, working in the narrow sphere of Neuchâtel and its district, became the junior partner, obscured by Calvin in Geneva. He died at Metz on Sept. 13, 1565.

Farel's work was evangelization, his strength the vigour of his preaching. No sermons have been preserved, but contemporaries speak of them with awe. His word was like thunder, said Theodore Beza. Even the independent-minded Calvin shuddered and obeyed when Farel declared his life of study accursed by God. Without doubt this preaching was a governing power in bringing French-speaking Switzerland into the Reformation.

As a writer Farel is far less important; he remained a pre-Renaissance man—his Latin style, for example, belonged to the later middle ages. Yet his French books are usually clear, forceful and direct. Apart from his letters, his chief works were an elementary dogmatics, *Summaire et briefve declaration d'aulcuns lieux . . .* (1525; revised edition, bringing it into agreement with Calvin, 1552); a liturgy, *Le Manière et fasson . . .* (1533); a polemic against the Libertines, *Le Glaive de la parole véritable* (1550); and an attack on the use of images and relics, *Du Vray Usage de la croix de Jésus Christ* (1560).

Though Farel's conversion was occasioned by Lefèvre, he did not accept Lefèvre's humanist theology. Lefèvre showed him the way out, but then it was to the "Reformed" wing of the Reformation that he turned. A man of convictions rather than thought, he was content with the formulations of others—but all had to be "agreeable to the Word of God." Once he had met Calvin he came increasingly under his influence.

Farel's greatest claim to remembrance does not lie in his own activities. He was the midwife who brought to birth the Presbyterian Churches when in Oct. 1536 he forced Calvin to stay in Geneva. That one evening influenced church history more decisively than all the rest of Farel's work and life.

See *Guillaume Farel, 1489–1565* (Paris, 1930). (T. H. L. P.)

FARGO, WILLIAM GEORGE (1818–1881), pioneer organizer of U.S. express companies, was born in Pompey, N.Y., on May 20, 1818. After three years as a railroad freight agent, express messenger and resident agent in upper New York state, in 1844 Fargo joined with Henry Wells (*q.v.*) and Daniel Dunning to organize the first express company to operate west of Buffalo. In March 1850, when the American Express company was organized, Fargo became secretary and Wells president of the company. In

1852 the two men organized Wells, Fargo and company to conduct an express business between New York and San Francisco by way of the Isthmus of Panama. In 1866 Wells, Fargo and company bought the Overland Mail company of which Fargo had been one of the original promoters. From 1862–66 he was mayor of Buffalo, and from 1868 to his death on Aug. 3, 1881, he was president of the American Express company. He was also a director of the New York Central and Northern Pacific railways. *See* also Express; Southern Overland Mail. (W. H. D.)

FARGO, the largest city of North Dakota, U.S., and the seat of Cass county, lies at the state's eastern boundary on the fertile bottom soils of ancient glacial Lake Agassiz, on the Red River of the North opposite Moorhead, Minn. The population in 1960 was 46,662 by federal census. The Fargo-Moorhead standard metropolitan statistical area (which includes Cass county, N.D., and Clay county, Minn.,) had a population (1960) of 106,027. (For comparative population figures *see* table in North Dakota: *Population.*)

Founded by the Northern Pacific railway in 1871 in advance of settlement and named for William George Fargo (of Wells, Fargo and company), pioneer American expressman, Fargo's early prominence was due to its rail, steamboat and stagecoach facilities at the head of navigation, where it served as an outfitting point for the first settlers. Wheat planting in the mid-1870s disclosed the soil's productivity and attracted emigrants from Europe, especially Scandinavians. The development of wheat growing confirmed Fargo's role as a transportation, marketing and distribution centre. Railroad expansion ended stagecoaching and steamboating but the Red river's water supply became important to industry. The manufacture of farm machinery and food products engage many factories. About one-third of the labour force is employed in wholesale and retail activities. Significantly identified with the city is the North Dakota Agricultural college, which was provided for by the state constitution and established in 1890 by the first legislative assembly. The agricultural experiment station maintains branches at Casselton, Langdon, Edgeley, Minot, Dickinson, Hettinger and Williston.

There are ice rinks and toboggan slides throughout the city in winter. Summer recreation is centred in the parks, playgrounds, municipal swimming pools and the Fargo-Moorhead Symphony orchestra's "Music under the Stars" concerts. (R. P. J.)

FARIDPUR, a municipality, is the headquarters of Faridpur district in the Dacca division of East Pakistan. The town, which is a railway terminus for a branch line connecting Goalundo with Calcutta, India, stands on the bank of a small stream called Mara Padma. It takes its name from a Muslim saint, Farid Shah, whose shrine is there. Pop. (1961) 28,333. There are two colleges affiliated to Dacca university.

Faridpur District has an area of 2,694 sq.mi. Pop. (1961) 3,178,945. It consists of a flat plain intersected by numerous rivers and streams. The villages are built on artificial mounds or on the high banks of the deltaic streams. Boats are the chief means of communication, especially during the rainy season when practically the whole district is flooded, including the northern part where the sandy soil becomes exceedingly dry during the hot weather.

The Padma (Ganges) flows along the northeastern boundary of the district and Goalundo is an important steamer station on its banks. The cultivated area is extensive and rice and jute are the chief crops. The marshes that occupy the depressions between the rivers are gradually silting up and are being reclaimed. Large deposits of peat have been found covering an area of about 200 sq.mi. The district has four subdivisions and 23 *thanas* (police divisions). (K. S. Ad.)

FARID UD-DIN 'ATTAR (*c.* 1150–*c.* 1230), Persian poet and Muslim mystic, whose most famous work, the *Mantiq ut-Tair* ("Language of the Birds"), describes, allegorically, the religious experience of the Sufis (*see* Sufiism). Born in Nishapur, northeast Persia, toward the middle of the 12th century, he was a forerunner of the great Jalal ud-din Rumi (1207–73). He died *c.* 1230, or in any case after 1221, the year in which the Mongols sacked and destroyed his native city; there is therefore no truth in the story that he lost his life in that catastrophe. It seems probable that he ended his days in Mecca, where, in extreme old age, he wrote his last poem, the *Lisan ul-Ghaib* ("Tongue of the Unseen"). His personal name was Abu Talib (or Abu Hamid), Farid ud-din being his title and 'Attar his pen name, chosen because he followed the profession of pharmacist (*'attar*) or, rather, physician, having a sort of dispensary to which patients came daily for treatment.

As a young man Farid ud-din had traveled widely, visiting Egypt, Syria, Arabia, India and central Asia; he then settled down in his native town, where for 39 years he was occupied in collecting the verses and sayings of the Sufi saints.

The *Mantiq ut-Tair* is an allegorical poem describing the quest of the birds (*i.e.,* the Sufis) for their king, the mythical Simurgh or Phoenix (*i.e.,* God). As their leader in the search they elect the hoopoe, who had guided King Solomon across the desert to the queen of Sheba, and who describes the long and hazardous journey they must undertake through seven valleys (representing the seven stages of Sufiism). Many excuse themselves and draw back; and of those who finally set out, only 30 birds (*si murgh*) succeed in entering the presence of the Simurgh, to discover that in so doing they have lost their identity, that they are he and he is they. In this way the poet allegorizes the final stage in the Sufi's progress, "annihilation in God."

The text of the *Mantiq ut-Tair* was published by Garcin de Tassy in 1857, and a French translation followed in 1863. An English version of this translation, *The Conference of the Birds,* by S. C. Nott, appeared in 1955. Farid ud-din was a prolific writer, and among his other works may be mentioned the *Pand-Nama* ("Book of Counsels"), translated by Silvestre de Sacy (1819); and the prose *Tadhkirat ul-Auliya* ("Memoirs of the Saints"), a series of biographies of the early Sufis (ed. by R. A. Nicholson in *Persian Historical Texts,* 2 vol., 1905–07).

See E. G. Browne, *A Literary History of Persia,* vol. ii (1906–24); H. Ritter, *Das Meer der Seele: Mensch, Welt und Gott in den Geschichten des Fariduddin 'Attar* (1955). (J. A. Bl.)

FARINACCI, ROBERTO (1892–1945), Italian politician and statesman of the Fascist period, was born Oct. 16, 1892, at Isernia, in the province of Campobasso. Educated at Cremona, he entered the state railway administration, becoming stationmaster at Cremona. While a young man, he took part in the Italian Socialist movement, as a follower of Bissolati-Bergamaschi (*q.v.*). After World War I he changed sides and was one of the first to join Mussolini's *Fasci di combattimento.* He founded the Fascist daily paper *Cremona Nuova* and was one of the leaders of the Fascist armed squads (*squadre d'azione*) in southern Lombardy. He helped to destroy many democratic institutions, among them the Catholic peasant co-operatives of the province of Cremona.

Farinacci became one of the most powerful personalities of the Fascist regime. Appointed general secretary of the party on Feb. 12, 1925, he encouraged the Fascists and the "fascistized" police to suppress the activities of the opposition. However, the hooliganism of some of his followers antagonized high officials of the bureaucracy. On March 31, 1926, therefore, he was replaced as general secretary by A. Turati. Subsequently, having received a doctorate in law from a "fascistized" university, he practised law and became very rich. Appointed a member of the Fascist Grand council in 1935 and minister of state in 1938, he became the most enthusiastic supporter of Nazi policy in Italy and played an important part in bringing Italy into World War II. After Mussolini's deposition in 1943, Farinacci fled from Rome. Late in April 1945 he was arrested by Italian partisans, brought to Milan and promptly tried and executed (April 28).

FARINATO (Farinati), **PAOLO** (*c.* 1524–*c.* 1606), Italian painter, engraver and architect, one of the leading painters at Verona of his day, was born at Verona; the year is not recorded but on a picture dated 1603 he claimed to be 79 years old. His father, Giovanni Battista, was also a painter and may have been his first master; later he probably worked under Nicolò Giolfino. Farinato was active almost entirely in Verona. According to Carlo Ridolfi, a Madonna painted by him attracted the attention of Philip II of Spain when passing through Villafranca on Jan. 17, 1549. The first certain date is 1553, for by March of that year

his St. Martin altarpiece for the cathedral at Mantua (still *in situ*) is recorded as finished in a joint letter from Farinato, Domenico Brusasorci, Paolo Veronese and Battista del Moro to Cardinal Gonzaga. All these artists had received commissions for Mantua in 1552. Some dated pictures occur at intervals, the last in 1603 ("Miracle of the Loaves and Fishes" in S. Giorgio in Braida, Verona) where Farinato adds his age of 79 to the signature and date. From 1573 onward he kept a diary of commissions with details of some of his work. His last years were divided between domestic squabbles with his sons and furtherance of his belief that he was related to the noble Florentine family of Farinati degli Uberti. His last will is dated July 23, 1606, and he is assumed to have died shortly after. He was buried in S. Paolo at Verona, where he had had his tomb constructed in 1594. Most of his vast output of paintings was for churches in Verona and its environs, where much of it has survived. He was strongly influenced by his younger contemporary Veronese and also by Parmigianino among others. He also executed a few engravings, some architectural projects which apparently included work on the Castello S. Felice at Verona and very many drawings. It is by his drawings that he is most widely known and represented; an important series of them is in the royal collection at Windsor. Farinato often signed his work with the device of a snail, sometimes accompanied by his initials.

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FARINELLI (CARLO BROSCHI) (1705–1782), the most admired *castrato* singer of his age, known for his technical skill, was born Carlo Broschi at Andria, Italy, on Jan. 24, 1705. He adopted the surname of his benefactors, the brothers Farina. He probably studied in Naples with Niccolo Porpora, in whose opera *Eomene* he made his debut at Rome in 1721. Later he sang in Porpora's *Angelico e Medoro,* on a text by Pietro Metastasio, with whom he formed a close friendship. His fame spread throughout Italy, and he became a favourite in Vienna and also in Venice, where he was associated with the composer J. A. Hasse. In 1734 he joined Porpora in London, appearing there in his operas and, together with the *castrato* Senesino, in Hasse's opera *Artaserse.* In 1737 he went to Spain, where his singing was able to relieve the deep-seated melancholia of Philip V. He stayed in Spain until 1759, achieving distinction as an impresario and also taking an active part in public affairs. Though dismissed from his post at court by Carlos III, he had accumulated great wealth and was able to spend the rest of his life peacefully in Italy. He died at Bologna on July 15, 1782. (WI. S. M.)

FARINI, LUIGI CARLO (1812–1866), Italian statesman and historian, was born at Russi, near Ravenna, on Oct. 22, 1812. After completing a brilliant university course at Bologna, which he interrupted to take part in the revolution of 1831, he practised as a physician at Russi and at Ravenna. Expelled from the papal states in 1843, he resided successively in Florence and Paris and traveled about Europe as private physician to Prince Jerome Bonaparte. When Pius IX became pope and embarked on what appeared to be liberal and nationalist policies, Farini returned to Italy. He was appointed secretary general to G. Recchi, the minister of the interior, in March 1848, but resigned with the rest of the ministry on April 29. War with Austria having meanwhile broken out, Pius sent him to hand over the command of the papal contingent to Charles Albert, king of Sardinia. Recalled to Rome, he resumed his secretaryship, in T. Mamiani's cabinet; later he became director general of the public health department. When, after the pope's flight to Gaeta in 1849, the republic was proclaimed, Farini resigned but resumed office for a while when Pius returned to Rome with the protection of French arms. However, a reactionary policy was now adopted, and he went into exile at Turin. There he contributed to Count Cavour's paper *Il Risorgimento,* to *La Frusta* and to *Il Piemonte,* of which latter he was at one time editor. In 1850 he wrote his chief historical work, *Lo Stato Romano dal 1815 al 1850.* From Oct. 1851 till May 1852 he was minister of education in the D'Azeglio cabinet. In the Sardinian parliament and in the press Farini strongly supported Cavour and urged that Piedmont participate in the Crimean War. When war broke out in 1859, Francis V, duke of Modena, was expelled and a provisional government set up. Farini was sent to Modena as Piedmontese commissioner. After the peace of Villafranca he was recalled but stayed behind to become a Modenese citizen and dictator of the state. In promoting his plan to annex central Italy to Piedmont, he negotiated alliances with the new provisional governments of Parma, Romagna and Tuscany. This whole alliance finally voted for annexation to Piedmont, and Napoleon III at last agreed to the move. Farini returned to Turin, and Cavour made him minister of the interior (June 1860) and later viceroy of Naples; but ill health soon forced him to resign. Cavour died in 1861; Farini succeeded U. Rattazzi as premier in 1862 but resigned in 1863. He died at Quarto, near Genoa, on Aug. 1, 1866.

FARLOW, WILLIAM GILSON (1844–1919), U.S. mycologist and plant pathologist who pioneered investigations in plant pathology; his course in this subject was the first taught in the United States. He was born Dec. 17, 1844, in Boston, Mass., and received his A.B. (1866) and M.D. (1870) degrees at Harvard university. Later he studied in Europe. In 1874 Farlow returned to Harvard where he was professor of cryptogamic (flowerless and seedless plants) botany from 1879 until his death on June 3, 1919, in Cambridge, Mass.

Although his publications were mainly on taxonomic and bibliographic phases of mycology, he also wrote articles on algae, lichens and ferns. His extensive library and collections of fungi, algae, lichens and mosses became the nucleus of Harvard university's Farlow library and herbarium. Several of his students became prominent in botanical fields.

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FARM: *see* AGRICULTURE; FARM BUILDINGS; FARM MANAGEMENT; FARM TENANCY; SMALL HOLDINGS.

FARMAN, HENRI (1874–1958), French aviator and aircraft constructor, was born in Paris May 26, 1874, the son of an English journalist. He was first a painter, later a racing motorist. With his brother Maurice he modified a Voisin pusher biplane and with it in Jan. 1908 won a £2,000 prize for a circular flight of one kilometre. In 1909 he set world's endurance and speed records. As early as 1908 Henri Farman had a school of aviation and a construction works at Buc, near Versailles. Somewhat later Maurice Farman began to manufacture aircraft, and in 1912 the brothers merged their interests in the Farman works at Boulogne-sur-Seine, making many planes of their characteristic pusher biplane type for military and training purposes. The 1914 model was extensively used for artillery observation and reconnaissance in World War I. The Farman Goliath was the first long-distance passenger airliner, beginning regular Paris-London flights on Feb. 8, 1919.

Farman-type planes derived from the Voisin machine of 1908, which depended on inherent stability for lateral control; the landing gear had wheels. After the Wright brothers' public flights in 1908 first disclosed wing warping for lateral control, Farman machines adopted ailerons, a simpler aerodynamic equivalent; the Wright machines adopted wheels. Subsequently, ailerons and wheeled landing gear came into general use on all planes. Henri Farman retired in 1937 when the French aircraft industry was nationalized. He died in Paris on July 18, 1958. (J. C. HR.; X.)

FARM BUILDINGS. The buildings on a farm provide a home for the family and structures needed for farming operations. Ideally the house should afford suitable space and the conveniences, comforts and satisfactions that determine the family's standard of living. The service buildings consist of barns, shelters, storages and working arrangements for animals, crops and products. These buildings should be economical in cost and upkeep, include labour-saving facilities and safeguards against loss or damage, and be readily adaptable to changing needs.

Some types of farming do not require service buildings, nor that the operator live on the farm. In such cases, the operator's dwelling may be located in a town or village or nearby in the open country and animals or crops may be marketed directly from field or pasture. Under some conditions the farmhouse is combined with storerooms, stables, sheds and work areas into one major multipurpose building. Sometimes centralized service buildings are set up to serve a large area.

On general-purpose farms the buildings usually include a dwelling, small structures such as garage, well house, workshop, etc., and whatever service buildings are needed for the particular farm. Needs differ from farm to farm, and between localities, regions and countries. The principal influences that determine choices are type of farming, climate, topography, size of enterprise, income and resources and the habits and customs of people. The buildings are most important on farms that are operated as full-time, profit-making enterprises.

This article deals primarily with farm buildings and their development in relation to the changing needs brought about by the rapidly expanding mechanization of agriculture in the second half of the 20th century, especially in the United States. Problems of investment, construction, materials and planning are discussed briefly in the following paragraphs. Then each major type of building is considered separately.

No one farm has all the buildings described; on the other hand, many types of buildings are not mentioned. Wide differences in kind, size and quality of buildings are found in different climates and on different types of farms. In many parts of the world, especially in underdeveloped areas, farming was still largely on a subsistence basis in the second half of the 20th century and farm dwellings and other buildings were of the most primitive sort. Information about living conditions and agricultural methods and production in various lands will be found in the separate articles on individual countries, and on continents. In addition to the references to related articles given in the sections of this article, *see* FARMSTEAD ARRANGEMENT, U.S. For material on structures designed for processing or storing specific crops the reader is referred to the separate articles on those crops; for example, for information on the construction and design of hop kilns or oast-houses, *see* HOP. The U.S. reader who is interested in a given region or kind of farming may obtain more detailed information from the United States department of agriculture, Washington, D.C., and the college of agriculture in each state. In other countries, the government department or ministry of agriculture should be contacted as the first step in seeking information. In each locality, it is advisable to consult with carpenters, materials dealers and building contractors.

REQUIREMENTS

Constant changes occur in farm-building requirements as new needs appear. Building improvements should take account of field mechanization, electric service, the cost and value of labour and demands for sanitation, disease control and improved products. Industrial development creates new materials and methods, better designs and more efficient equipment. Research brings new knowledge of crop storage, animal housing and product processing.

Building Investment.—Relatively high investments are necessary to provide adequate buildings for major farm enterprises, particularly dairying, poultry raising, tobacco curing and grain conditioning. The farm-building investment in the United States, in the second half of the 20th century, was estimated at $20,000,000,000, which was about one-third of the entire farm real estate value. On many livestock farms the buildings were valued at more than the worth of the land. Spending for repairs, upkeep and new construction was at the rate of $2,000,000,000 a year.

Costs of buildings increased rather steadily in line with the general price level. The cost by the second half of the 20th century was fully double pre-World War II cost and three times that which prevailed before World War I. Building costs consist of about equal proportions for labour and materials.

The building investment on farms went up at a greater-than-average rate as labour-saving devices, sanitation controls and processing equipment were added. But farmers also were in a good position to save by doing some of their own work, remodeling buildings already on the farm and using low-cost, locally available materials.

Construction.—Much on-the-farm construction is done by the farmer, by himself or with the help of neighbours or rural builders. Most farm buildings are constructed on the site, largely by traditional methods, although prefabrication increased greatly after World War II. Small "prefabs" were delivered as complete units while the larger ones were in parts, panels or sections that could be quickly erected on foundations made ready by the owner.

Buildings are set on masonry foundations or built on a framework of treated-wood poles set firmly in the ground. Movable structures and temporary buildings are placed on posts, treated wood or concrete sills, or on concrete floor slabs.

Materials.—Farm-building materials need to be durable, easily worked, resistant to destructive forces and to have special qualities where it is important to obtain insulation, watertightness, smooth surfaces and the like. In the United States, the most widely used materials are softwood planks and board lumber, concrete (both cast-in-place and masonry units), treated poles, plywood, sheet metal (mainly steel and aluminum) and asphalt or asbestos coverings. Common local materials include native lumber, ungraded pit or bank gravel, stone and sometimes bamboo or saplings for framework, thatch for covering and adobe for walls and floors.

Plans.—The ideal building plan provides for the space, shape, arrangement and equipment proven suitable by experience and research. Any one of two or more plans may be equally good and the choice is made according to preference or conditions. Many typical plans have been put into books, bulletins or blueprints, so that excellent designs may be had at little or no cost. Sometimes a building already in use in the community is the best guide to follow.

Each type of building tends to fall into a typical pattern. The combination of plan, materials and typical construction produces the buildings characteristic of a region or type of farming. Examples are the general-purpose barn, silo, corncrib, poultry house and tobacco barn. Many farm needs can also be met by multipurpose buildings. They should have sturdy framework, weathertight enclosure and unobstructed floor space. They are generally one-story, ground-level structures, often prefabricated. The interior plan and the conditions of temperature, light, air circulation and moisture may be made to suit any one of several needs.

FARMHOUSES

The farm dwelling differs from housing for nonfarming people of comparable tastes and incomes mainly because of its location on and attachment to the farm. Because of obstacles to improvement so often encountered, the condition of farm housing may be less adequate than urban housing on the average. Values are lower, houses are older, more of them are obsolete and the arrangement and equipment are sometimes unsuited to the needs of the present occupants. On the other hand, farmers can contribute labour, supplies and the use of equipment to the improvement of their own houses. Excellent plans and planning aids are available, especially from colleges of agriculture, and modern designs may be used most effectively for the betterment of rural housing.

The farmhouse should first meet the basic requirements for family living, the needs for sleep and rest, sanitation, preparation and serving of food, family group activities and storage of possessions. The unique features of a farmhouse are based largely upon the nature and pattern of farm life. Farming is a family activity with much traffic in and out of doors and from the back door to barns, fields and gardens. A convenient wash-up space and wrap-storage space are needed, and preferably a toilet and lavatory near the rear entrance. Access to the house is normally from a service yard or drive, so the main entrance should be reached readily from the driveway side. Visitors' parking is needed nearby, and the garage or carport should be attached or adjacent to the house.

Ample storage and workroom space is needed since farm families do most of their own service work—laundering, canning, proc-

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FIG. 1.—MODERNIZATION OF A MIDWESTERN U.S. FARM: THE OLD BUILDINGS (RIGHT) ARE NO LONGER ADEQUATE AND ARE GIVING WAY TO NEW STRUCTURES (CENTRE AND LEFT) THAT INCLUDE HOG SHELTER, CATTLE HOUSING SHED, FEED LOT, MILKING-MILK ROOM COMBINATION, TOWER SILO AND MACHINERY STORAGE

essing home-grown food—and often prepare produce for market. The house may also serve as a community meeting place, as a business centre for the farm and for activities in which the entire family takes part. Thus ample living, dining and family rooms are desirable. At least three sleeping rooms are needed for the typical farm family.

Since the family cannot move to another house as its needs change, and because one farmhouse over a period of years may be occupied by a succession of families, it is desirable that the house be made highly adaptable by multiuse rooms. It should have portions that can be shut off or opened up as needed and otherwise meet the needs of most families rather than one specific family.

Old houses can be made more livable by remodeling and the addition of new finishes, appliances and utilities. The advent of power-line electricity in rural areas enables the farmer to have a water-supply system, plumbing, sewage disposal, heating and air conditioning and other equipment and appliances fully as adequate as those found in urban housing. The farm owner may largely control his own housing, for it is not necessary to conform to building codes and zoning restrictions that apply in many towns and cities and much freedom is possible in planning and design. There is usually a choice of location and there are no limitations as to facing, lot lines, streets and nearby structures.

See also RURAL ELECTRIFICATION.

BARNS

A barn is a building for the accommodation of animals and of feed and other supplies for their use. Barns are named according to the purpose they serve, as hog barns, dairy barns, horse barns, etc. The principal type in the United States is the general-purpose barn, intended mainly for work horses and mules and their feed supply and also for cows, calves, sheep, hay and grain storage, etc. Although the need for the general barn declined with the advent of tractors and electric service, one or more barns are still found on the majority of North American and European farms. Many have been adapted to other uses.

For horses, it is customary to provide a tie stall 5 ft. wide and 9 ft. long for each animal. A feedbox and hay manger are provided in each stall. A feedway 3 ft. wide in front of the manger and a 9- to 10-ft. alley behind the stall are recommended. Horses may be confined in 12 ft. by 12 ft. box stalls. Mules may be kept together in large pens.

QUARTERS FOR ANIMALS

Dairy Housing.—Buildings and equipment for dairying should aid in producing clean milk, saving labour and maintaining healthful conditions in the herd. For grade-A milk, the buildings must meet requirements of space, light, ventilation and cleanliness prescribed by public-health authorities. Housing for dairy cattle includes a barn, shed or shelter for animals, a place for milking, a room for handling milk, storage for silage, grain and feed supplement, a covered area for hay and bedding, an exercise yard or pen, and facilities for the removal of manure. These should be arranged into an organized unit, adapted to herd size and recommended methods of operation.

The requirements for dairying may be met by either of two housing methods known as the stall-barn and the loose-housing systems. In the stall barn each cow is confined in a stall when in the barn for resting, feeding, milking and watering. Stalls are arranged in rows facing on a feedway and aligned along a gutter next to a walkway. A typical plan has two rows of stalls lengthwise with three alleys or service passages. Total barn width is 34 to 36 ft., and each stall $3\frac{1}{4}$ ft. to 4 ft. wide. One or more maternity pens, calf pens and feed rooms are included. Hay and bedding are stored in adjacent buildings or in an overhead loft; the milk room is generally attached to the barn by means of a short corridor. Stall barns in the colder areas should have insulated walls and ceilings, and power-operated equipment for ventilation, watering, feed distribution and manure removal. In warm-weather areas the barns are partly open, and cows are housed mainly for feeding and milking.

The loose-housing system is much the more flexible for varying herd size, it may be less costly and is well suited for saving labour and maintaining sanitation. The principal structure is a shed or shelter arranged so that the animals may move freely between the shelter and outside yard. Bedded floor area of about 50 sq.ft. is needed for each cow. Hayracks are placed to form a feeding area under shelter. Hay and bedding may be stored within the same open-type structure. Exercise yards should have 75 to 100 sq.ft. of space, usually paved, for each animal. The silo and silage feed trough should be accessible from the yard. Equipment and gates are placed so power manure loaders can be used to advantage.

The milking room or "milking parlour" is adjacent to the shelter area. Two or more milking stalls are elevated 30 in. above the operator's working space. Doors are arranged so cows can be brought in to be milked, held in the stall and sent back to the yard in an orderly manner. The arrangement should enable the operator to do the milking, care for the milk and control the doors all from one small alley with a minimum of walking. The milking room should be insulated, lighted both by windows and electricity, have smooth, washable surfaces and provision for heat in cold weather.

The milk room or milkhouse for market milk must meet code requirements as to surfaces, light, ventilation, hot water, wash vats and cooling equipment. A small room 8 by 10 ft. may qualify, however 12 by 14 ft. is usually more desirable. In the loose-housing system, the milking and milk-handling rooms are often combined in one structure.

Other buildings for dairying may include shelter and feeding

areas and separate pens for calves, growing heifers, dry cows and a herd bull. Bull pens or bull barns are less common on farms as artificial-breeding practices are adopted. (*See* also DAIRY INDUSTRY.)

Beef-Cattle Housing.—Beef animals do not require warm, enclosed shelters. Complete protection is provided only for young calves, cows at winter calving and young stock just going on full feed. Otherwise, open-front sheds, paved feed lots and facilities for feeding and removing manure are the main requirements. Adjustment may be necessary to give added protection in areas of heavy snowfall and more covered shelter if rainfall is heavy.

Cow herds for producing young stock need enclosed space for about 10% of the herd at one time, also maternity stalls and calf pens. For general livestock raising and cattle feeding, about 32 sq.ft. of shelter and 60 sq.ft. of paved yard are allowed for each full-grown animal. Feed-trough space is allowed at 30 in. per head, but only 10 in. of self-feeder trough and 20 in. of hayrack space are needed. Labour is saved by self-feeders for grain and hay, continuous feed bunks along fence lines, paved yards, manure removal with power scoops, automatic waterers and well-arranged gates and drives.

Almost any type of semiopen shelter having nine feet or more of headroom will serve for beef cattle. Trussed roofs are desirable to eliminate interior posts and partitions. Hayracks need to be under shelter; however, outside feeders are used for silage, grain and fresh-cut green forage.

Two typical building arrangements are: (1) sheds 20 ft. wide adjacent to one, two or three sides of a hay and feed storage barn; and (2) open-front sheds or multipurpose buildings facing on a barnyard, with ground-level storage for hay and bedding. Construction may be wood frame or metal on a masonry foundation, or a pole frame with lightweight covering. Some have masonry unit walls. In any case the lower walls to a height of from three to five feet should be of masonry or plank to protect against decay and damage.

Shelters for Sheep.—On the open range, structures for sheep include corrals, dipping vats, lambing and shearing sheds, etc. No attempt is made to shelter the flock as a whole. Farm flocks in mild climates need little housing. In moderate climates open sheds are satisfactory but in severe climates buildings are closed during storms. Floor space of 12 to 15 sq.ft., yard space of 30 to 40 sq.ft. and feed-rack space of 15 to 18 in. per ewe are required. At lambing time extra warmth may be obtained by setting up temporary lambing pens inside the building, covering them in case of cold weather. Dryness and ventilation without drafts are essential in buildings for sheep. Movable feed racks, grain troughs, partition and fence panels are used for quickly adjusting pen size to flock needs, setting up temporary lambing pens, temporary feed lots, controlling grazing area, etc. (*See* SHEEP.)

Hog Housing.—The principal hog-housing need is for the sow and litter for about eight weeks from birth to weaning. Young pigs require sanitary surroundings, temperatures above 50° F. for a few days and protection against being crushed by the sow. After weaning, breeding stock requires only reasonably clean, dry shelter and ample yard space, and fattening hogs gain rapidly and thrive with only minimum housing.

The two principal U.S. systems of hog housing are: (1) movable farrowing houses that can be relocated on clean ground each season; and (2) enclosed central-type houses which usually have concrete floors, smooth walls and insulation. A single-unit movable farrowing house may be no larger than 6 by 7 ft. for sow and litter. An A-shaped house is quite common; often the upper portion is made nearly flat to reduce headroom. The house may be built with or without floor, single walled and with burlap sacking instead of a door. Other house shapes are satisfactory if floor space of 42 to 64 sq.ft. is provided, and headroom is 3½ ft. or more. Movable houses are either prefabricated or home built from standard plans.

Multiunit houses with two, three and four pens are quite common. Two three-pen shed roof houses can be paired and connected temporarily to form six-sow units. Among the advantages claimed for movable houses are low cost, ease of handling, mobility and usefulness for small herds.

The fixed-in-place, central farrowing house is used mainly for herds of 12 or more sows; in cases where two or more farrowing seasons occur each year; and if the enterprise justifies a relatively high investment in structures and equipment. The typical house is one-story high, with an insulated ceiling and having a two-row arrangement of pens and a centre work alley in a 20 to 24 ft. width. Pens are 8 to 9 ft. long from wall to alley, and 6 to 8 ft. across. One or more feed and equipment rooms are included in the house. The more elaborate houses may be equipped with unit heaters, underfloor hot-water pipes or heat lamps over each pen and power fans for circulation. Ceiling heights should not exceed 7 or 7½ ft. Windows located in side walls or low in the roof should provide about two square feet of glass area for each pen. Each pen should have an individual watering trough, gates opening onto the centre alley and to an outside runway and guardrails on end wall and partitions to protect little pigs from being crushed.

A modern alternative to the pen is the farrowing stall. It confines the sow so that she may stand up or lie down but cannot move about and overlie her young. A space of about 12 to 18 in. on either side of the confinement stall provides room for the pigs to nurse, sleep or exercise. Heat lamps warm the pigs and help keep the space dry. After one or two weeks the farrowing stall may be removed.

Minor structures for hog raising include self-feeders, paved feeding floors, summer shades, watering devices, mineral boxes, loading chutes and breeding racks. These are needed with either the movable- or central-house system. Large-scale operators may combine both systems of housing on one farm.

Poultry Brooders and Houses.—Farm poultry houses are used for brooding baby chicks and maintaining laying flocks. A typical brooder house is a 120- to 160-sq.ft., wood-framed, wood-floored, movable structure on skids. Such a house will accommodate 300 chicks for six or eight weeks or until they no longer need heat. An electric or oil-fired brooder stove provides the necessary warmth. Windows in the south wall, insulation in walls and roof and air ducts for ventilation provide the best conditions for growing chicks.

Brooder houses for commercial flocks may be very large—40 by 200 ft. is not uncommon. They differ from small-farm types only

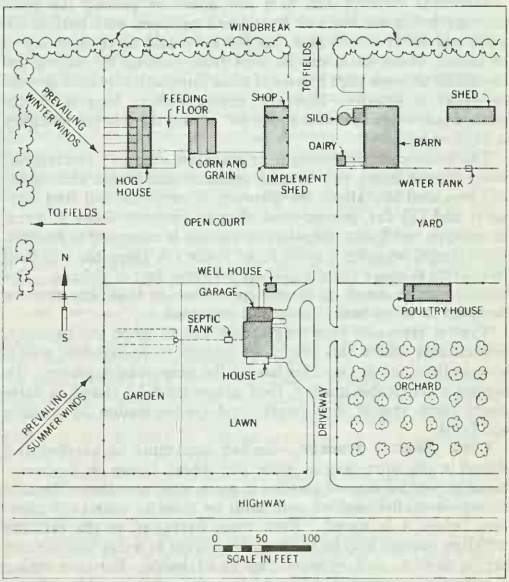


FIG. 2.—A LAYOUT OF FARM BUILDINGS IN THE NORTH-CENTRAL UNITED STATES

in size, construction details and equipment. The larger houses may have several brooder units, underfloor heat or heat lamps, automatic waterers and feeders and fan ventilation. One or more large doors are provided for access by tractor and equipment for removing litter. The houses are used until birds are ready for market or removal to range houses.

Laying houses are similar to brooder or broiler houses in size and construction. A 10 by 12 ft. house is adequate for 30 birds but a 20 by 20 ft. space for 100 hens is a typical unit size. Each 100-hen unit should have 20 nests, 80 linear feet of roost space, one to two waterers, a lighting device and 16 ft. of feed-trough length. Housing for any flock should allow a floor area of $3\frac{1}{2}$ to 4 sq.ft. per bird, and roosts, nests, waterers, lights, etc., in proportion to the requirements for 100 hens. Capacity can be increased and labour reduced by using automatic feeders and waterers and giving close attention to sanitation. For some special conditions, entire houses are equipped with metal cages each accommodating one or two hens.

House sizes range from 20 by 20 ft. up to 24, 30 or 40 ft. wide and 200 ft. or more in length. In the largest establishments, feed storage, egg room and utility space may be in a centre section, with laying-house wings in both directions. If land area is limited, houses may be two or three stories high. Construction varies somewhat with climate, from relatively open shelters to semi-enclosed with partial openings in the leeward wall and fully enclosed, insulated structures. Overhead insulation is often provided by a straw loft, consisting of $1\frac{1}{2}$ to 2 ft. of straw fill over a wood-frame, wire-mesh ceiling.

Summer-range shelters are used for growing chicks and replacement pullets. They are built on skids or runners, with light wood or metal framework, raintight roof with wide overhang and wire-netting enclosure. *See* also POULTRY AND POULTRY FARMING.

CROP STORAGE

Grain Storage.—Wheat, rye, oats, barley, soybeans, grain sorghum and shelled corn must be dried to about $12\frac{1}{2}\%$ moisture content for safe storage in farm-type bins in warm weather. Most grains are dry enough to store when harvested but artificial drying is necessary to reduce moisture in grain crops that are combined or otherwise harvested before they are quite dry.

Drying is accomplished in a few hours by passing the grain through drying machines or drying bins equipped with heating devices and power-driven fans that force warmed air through layers of grain. Moist grain can be kept from spoiling by forcing unheated air through large masses of grain intermittently over periods of weeks or months. However, drying without heat is accomplished only when the air is above 60° F. and the relative humidity is 75% or less.

The most common storages or granaries are: (1) rectangular, wood-framed bins; (2) circular prefabricated metal structures; (3) overhead bins above the driveway in corncribs and feed storages; and (4) flat, ground-level piles on concrete floors in warehouse-type buildings. Capacity of storage is measured in bushels. Each bushel occupies 1.25 cu.ft. of space. A given bin will hold four-fifths as many bushels as there are cubic feet of volume. The heaviest grains weigh 48 lb. per cubic foot, so that bins must be designed to carry heavy loads and pressures.

Typical farm-size bins range from 500 to 2,000 bu. capacity. Several bins within this size range provide more versatile, useful storage than one or two bins having the same total capacity. To maintain acceptable quality, food grains must be stored to safeguard them against dirt, insects and contamination by rodents and birds.

Corn (Maize) Storage.—Shelled corn must be handled and stored in the same way as grain like wheat, barley or soybeans. Since harvesting is most feasible at grain moistures above the safe storage level, field-shelled corn must be dried to near 12% moisture before it is stored. Even when harvested in the ear, the moisture content may be too high for storage in warm weather and drying down to 20% or below may be advisable. Ear-corn drying is generally accomplished by adapting the crib and adding ducts, temporary wall coverings, etc., so that large amounts of air—either cold or heated—may be forced through the crib.

In the principal corn-growing areas much of the crop is stored in the ear; *i.e.*, the kernels are not removed from the cob. Ordinarily the ears are not fully dry when harvested, but because of low winter temperatures little damage occurs until the coming of warm weather; during the intervening months the ears have a chance to dry if well stored. The common type of storage in the United States is a crib sided with wood slats spaced about one inch apart to permit ventilation by the wind; perforated clay or concrete-block walls are also used. The width of crib varies with the climate; in the principal growing areas cribs are 6 to 12 ft. wide with vertical sides 8 to 24 ft. high. A popular type of storage in the corn belt of the United States has a crib on each side of a driveway and grain bins above. A mechanical elevator fills both cribs and bins. A 27 by 40 ft. building with 11-ft. driveway, two cribs 8 ft. wide and 20 ft. deep, will store about 5,000 bu. of ear corn and 2,500 bu. of small grain or shelled corn. Because of the weight of ear corn (28 lb. per cubic foot) and its tendency to arch against walls and over crossbraces, walls must be well tied together with braces that can support safely a large part of the weight above.

Temporary cribs are either circular or rectangular in shape and built of snow fencing or wire mesh or of cribbed poles. Cribs that can be tightly closed are needed in warm regions where it is necessary to fumigate to control insects. For long-time storage it is best to shell the corn from the cobs when dry and store the shelled corn in tight bins. (*See* CORN; CROP DRYING AND PROCESSING; CROP-PROCESSING MACHINERY.)

Silos.—A silo is any type of structure or container that affords storage for large masses of high-moisture forage. The most common is the above-ground cylinder or tower silo, made of wood, concrete, masonry staves or blocks.

Tower silos vary from about 10 to 18 ft. in diameter and 30 to 50 ft. in height. Silage must be removed from the top at the rate of about two inches per day to prevent spoilage. For this reason the diameter is made proportional to the amount of silage needed. Height is limited by needed capacity, by the length of the feeding period or by practical considerations of cost and labour. A silo 12 ft. in diameter has 113 cu.ft. in each foot of height. Each foot vertically holds about 2.25 tons of silage weighing 40 lb. per cubic foot. This provides 754 lb. each day if two inches are removed, which is enough for 25 animals fed at the rate of 30 lb. of silage per day. A 12-ft. silo 36 ft. high will hold about 100 tons. (The average weight exceeds 40 lb. per cubic foot at depths greater than 14 ft.)

Silage under the heavy pressures found in upright silos puts a severe strain on the walls. Steel reinforcement is necessary in proportion to the height, as rods in mortar joints, embedded reinforcing in concrete and steel bands on wood or masonry staves. Tower silos have continuous or closely spaced access doors and a ladder.

A silo of unique design is prefabricated with a smooth, non-corroding wall of steel having a porcelain or fused-glass surface. It has an airtight top to reduce spoilage and a power-operated bottom unloader that makes the silage handling operation nearly automatic. This container is also suitable for storing high-moisture grain, shelled corn or ear-corn silage.

The trench silo is most suitable for storing large quantities of green corn or grass at minimum cost. The trench is cut into the ground on a gently sloping site. If made 8 ft. deep, 10 ft. wide at the bottom and 14 ft. at the top, a 60-ft. length gives a capacity of about 100 tons. Earth trenches tend to crumble and cave, so for best results the trench should be floored and the sides lined with four inches of concrete. A variation of the trench is a flat, ground-level bunker silo. It is similar to the trench with concrete floor, vertical or slightly sloping sides of concrete or planks, and open at one or both ends. Flat silos can be adapted for self-feeding by fitting a feeding gate across the end which is moved inward as the silage is consumed. Silage is sometimes stored in circular stacks supported by poles and slat fencing, or in long low ricks. Spoilage is high when temporary methods are used. The history of the development of silos and the use

of silage is discussed in the article ENSILAGE.

Hay Storage.—Outdoor stacks, overhead lofts and ground-level roofed-over areas have long been used for loose, uncut, air-dried hay. Weight is about four pounds per cubic foot and storage space is calculated at 500 cu.ft. per ton. Baling or chopping reduces storage space by one-half, doubles the weight per unit volume and facilitates handling. For these reasons, storage should generally be at ground level, either in low-cost sheds for baled hay or in silolike upright metal hay storages or pole-framed, wire-enclosed structures for chopped hay. For highest quality, legume hay is wilted and only partially dried in the field and air-dried under cover. The barn, loft or other storage then requires a system of air ducts and a power fan to prevent overheating and assure uniform drying. (*See* CROP DRYING AND PROCESSING; GRASSLAND.)

Storage for Fruits and Vegetables.—The cave or cellar is perhaps the most feasible structure for the home storage of fruit and potatoes and other vegetables. A typical cellar is built partially underground and the upper part is mounded over with earth to prevent freezing and provide fairly uniform conditions of temperature and humidity. Although concrete floor, walls and ceiling are recommended, the floor may be omitted and the ceiling made of logs or timbers treated with preservative. A room 8 ft. wide, 8 ft. high and 12 or more ft. long affords liberal storage and is useful also as a storm shelter. Tile drain, air vent, steps and a doorway are necessary.

Fruits and vegetables are sometimes stored in unheated basement space, insulated ground-level buildings with supplementary heat for cold weather or outdoor pits or mounds covered with straw, stalks, building paper and earth. Under such conditions, only short-time storage of several weeks or a few months is feasible.

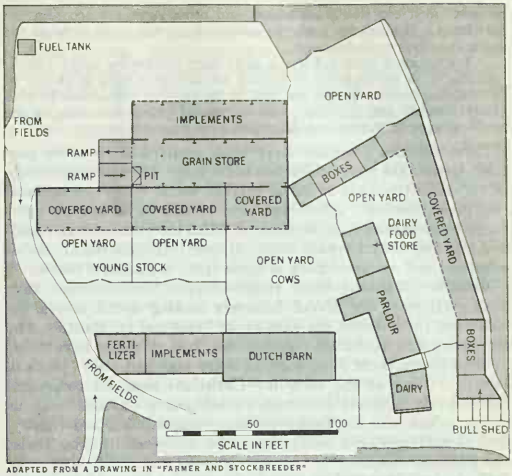
Ideal conditions are obtained only in buildings designed for storage purposes and equipped to maintain control of temperature, relative humidity and air circulation. The cost and labour necessary limit such storages to commercial enterprises or to large specialized farms. The buildings are generally insulated wood-frame structures set on lower walls of masonry. Equipment includes heating systems, refrigeration equipment, electric fans and handling devices such as elevators and conveyers. The buildings are constructed so that humidity in storage rooms can be maintained at about 85% to 90% and temperatures can be kept high enough to prevent freezing and low enough to minimize sprouting and deterioration. White potatoes and most other vegetables should be held at 60° F. for about ten days, then reduced to 50° F. for three-month storage and 40° F. for longer periods. Sweet potatoes (yams) are cured at 85° F., then held at about 55° F., usually in wood-framed, one-story buildings. Apples may be stored at or near 32° F. in well-ventilated storages. (*See* FRUIT FARMING: *Harvesting and Postharvest Practices.*)

Buildings for Tobacco Curing.—Tobacco "barns" are of two types, for air curing and flue curing respectively. Pole- or post-frame buildings are used for air curing. A barn 32 to 36 ft. wide, 48 or more feet long and having 20-ft. side walls has a capacity for three to four acres of tobacco. Vertical siding is used and about one-third of the wall surface is hinged to allow natural air ventilation in good drying weather. Artificial heat is supplied by coke stoves, oil or gas heaters or a commercial drying unit. Except for a small well-lighted stripping room, the entire space is used for hanging tobacco plants which are strung on four-foot sticks.

For flue curing, the typical building is 17 ft. 8 in. square with 14-ft. side walls. It is tightly built, insulated and fitted with air intakes at the bottom and an adjustable ventilator at the ridge. Because artificial heat is necessary, close attention needs to be given to fire safety, air circulation, humidity control and temperature regulation. Log walls are often used in low-cost barns.

BUILDINGS FOR MACHINERY AND SUPPLIES

Indoor storage of machinery affords protection from weather and animals, makes it easier to maintain a neat, uncluttered farmstead and provides a place for repair and maintenance work. The space is also useful for storing building materials, fertilizers, seeds and other supplies. Machinery-storage buildings should be free from interior posts or other obstructions, have headroom of 10 to 15 ft. over much of the area and doors that will accommodate the largest machines.



ADAPTED FROM A DRAWING IN "FARMER AND STOCKBREEDER"

FIG. 3.—ARRANGEMENT OF FARM BUILDINGS OF A TYPICAL BRITISH FARM

Concrete floors are desirable but not necessary. A shed with one side completely open affords fair protection; however, a fully enclosed building is preferable. Post-free construction is obtained by using arches, trusses or heavy beams to support the roof. Walls and roof may be metal or other thin material, or masonry walls with light roof frame and covering may be used. One common design has wood or metal arches spanning the width of the building. The framing members are attached to foundation or floor slab, and covered with any one of several materials.

The minimum practical storage building is about 12 ft. by 24 ft., which is one-car garage size. The two principal farm types are described as follows: (1) the "side-door" building, generally 20 to 32 ft. wide, which has a nearly continuous series of doors in one wall along the length of the building. The narrow width and numerous doors add to the cost if considerable machinery is to be stored. (2) The "end-door" drive-through type, 36 to 48 ft. wide and as long as needed, is best for ample capacity. Doors are located in each end and a centre driveway, kept free of all except wheeled vehicles, gives maximum convenience. Buildings of this type are adaptable to many purposes and are often used for baled hay, grain (with suitable bracing and bulkheads), cattle or sheep. *See* also AGRICULTURE; AGRICULTURE (ARTICLES ON).

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FARM COLONY or GROUP FARM, a joint operation of a large farm and some or all of its related enterprises by a group of individuals or families with common social or economic objectives. Such associations may be defined according to their methods of income distribution, as follows:

1. Joint cultivation association: individual farmers pool some of their productive resources, such as land, machinery, livestock and labour. Proceeds of their joint effort are divided on the basis of each member's investment in, and service to, the association.

2. Co-operative corporation farm: several individuals or families co-operatively own or rent a large farm and operate it as a single unit. Income is distributed on the basis of the value of labour contributed by each member.

3. Communal farm: a large farm operated on the principle that each

member must contribute his labour and other resources according to his ability. He benefits from the enterprise on the basis of what the group considers to be his needs.

4. Institutional farm colony: a large farm employing many people, operated by a government or private welfare institution in charge of determining policy. Wages are paid in the form of subsistence in kind (food, housing and clothing), cash or special grants according to the needs of each individual, as determined by management.

Farm colonies generally have been established to serve purposes beyond the mere production of income. They have been conceived as instruments of moral revival, social reform or national resources planning. Operations have tended to be heavily influenced by an ideology, on the basis of which the farms can be classified into four major types: religio-utopian, secular-utopian, socio-economic and welfare. Each of these types is discussed below.

Religio-Utopian.—Most religio-utopian farm colonies have been established by devout believers seeking moral revival by following, for instance, the example of Jesus and his apostles, who are reported to have lived together and "had all things in common . . . and parted them to all men, as every man had need" (Acts ii, 44–45). Some of the early lay Christians lived on communal farms, as do members of certain contemporary Catholic religious orders, which also emphasize celibacy, frugal living and charity. Communal farms have been operated for many centuries by Taoist and Buddhist monks.

During the 18th and 19th centuries, secular farm colonies with religio-utopian ideology were organized by several fundamentalist Protestant sects in the United States. Many of these groups originated during the late Reformation period in southern Germany. There, under the influence of Anabaptist preachers, small groups of disciples who wished to share a common life gradually formed compact communities. They migrated to North America, where cheap land and religious tolerance presented more favourable circumstances for establishing their "Kingdom of God" than did their native lands. Among these groups were the Ephrata community of German Seventh-Day Baptists, who settled in Pennsylvania (1732–1905); the Harmonist disciples of Father George Rapp, who founded the villages of New Harmony, Ind., and Economy, Pa. (1814–1905) (*see* NEW HARMONY); the Separatists at Zoar, O., (1819–98); and the followers of the mystic William Keil, who pioneered at Bethel, Mo., and Aurora, Ore. (1844–81). The Shakers, from England, established more than 20 farm colonies after 1778 in states east of the Mississippi. They believed in celibacy but replenished their ranks by adopting orphans and converting adults, so that there were a few scattered remnants in the second half of the 20th century. (*See* UTOPIAN COMMUNITIES: *Shakers.*)

The Amana society, with a membership of about 2,000 persons after mid-20th century, is established in several villages in eastern Iowa. Their ancestors landed in New York in 1842 as the "Community of True Inspiration," which had been founded in 1714 in Württemberg, Ger. The economically communistic principles of the society were abandoned in 1932, when it was transformed into a co-operative stock company. Members or their children are given preference in employment; all are entitled to free medical and dental service, free burial and, if necessary, support in old age by the society.

The Hutterian Brethren form the largest of the contemporary religious communal sects. About 400 migrated from Russia to South Dakota in 1874–77, to settle in three colonies. In the early 1960s they numbered about 13,000, living in about 115 colonies in western Canada (Alberta, Saskatchewan and Manitoba) and in South Dakota, North Dakota, Montana and Washington. The Hutterites emphasize economic self-sufficiency, supporting themselves through diversified farming and stock raising, and also engaging in carpentry, building, and electrical and machine-repair work, largely for their own use. There has been much change and mechanization in their income-producing activities, in contrast to the stability of their customs governing personal conduct, family relationships and community life. The latter have changed very slowly since 1528, when the early Hutterites were forced to flee Switzerland because of their belief in communal living, pacifism and Anabaptist protestantism. They settled in North America after an odyssey of centuries through temporary havens in Bohemia, Hungary and Russia.

During World Wars I and II, the pacifist convictions of the Hutterites were used as rationalization by some people in Canada and the United States to engage in acts of vandalism or to urge restrictive measures against the sect, which is strongly resistant to all pressures for assimilation. In 1944, the Alberta government passed the Communal Property act, which singled out the Hutterites for restrictions on the purchase of land and prohibited such purchases within a radius of forty miles of any existing Hutterite community. Legal obstacles to land purchase were also imposed in South Dakota in 1958. Yet a social and psychiatric study of the group from 1949 to 1954 showed that few Hutterites have ever been institutionalized in mental hospitals or jails, or have required public assistance. Other religio-utopian farm colonies, like those of the then polygynous Mormons in Utah (1840s) and the Oneida Perfectionists in Vermont and New York (1847–81), who advocated eugenics, were of U.S. origin. Many mushroomed into existence under the influence of revivalist preachers. About 67 other such short-lived farms were organized, mostly in the 19th century. (*See* LATTER-DAY SAINTS, CHURCH OF JESUS CHRIST OF; UTOPIAN COMMUNITIES.)

Among religious pacifists, group communal farm efforts are not uncommon. Many such colonies had a transitory existence in the United States and Great Britain in the decade before World War II. Foremost among them is the Bruderhof movement. In the late 1950s it had about 1,500 members of 20 nationalities in 11 communities in Paraguay, Uruguay, Germany, England and the United States. Since its founding in 1920 by a German pacifist philosopher, Eberhard Arnold, the movement has grown by attracting intellectuals seeking a sense of identification within an idealistic community. The group shares most of the beliefs and some of the practices of the Hutterites, but does not isolate itself from the larger society in which it lives. It favours higher education. The European and North and South American settlements, while widely separated geographically, have a common sense of identity and give each other mutual support. The members hope to become the focal point of a new order. They publish a bulletin, the *Plow,* in English, German, Spanish and Dutch.

Secular Utopian.—These farm colonies generally had a socialist ideology. Ethical concepts of the virtues of co-operation and neighbourliness also played an important role. Like the religio-utopians, they practised complete economic communism, but it was rationalized on the basis of secular expediency and a humanistic belief in the common good rather than on the basis of religious faith. Most of these colonies had a short life span; many broke up within a few months because of disagreement concerning their ideology and management. The leaders usually had a detailed theoretical program of action to eradicate what they considered to be the antisocial practices of their capitalist contemporaries. Many of the members, however, had not joined on the basis of any positive program, but were drawn together by a common protest and the hope of escaping from an imperfect world. Other such colonies experienced great difficulty because their members were largely of urban background—persons who had joined in response to urges to live a simple and creative life in the country but who lacked previous experience in agriculture and handicrafts. After the initial enthusiasm there would follow a gradual disillusionment during which many members left because of inability to do the work.

The English social philosopher, Robert Owen (*q.v.*), "fathered" 17 such colonies in the 1820s, among which New Lanark in England and New Harmony (*q.v.*), which he obtained from George Rapp, in the United States were the most famous. During the 1840s, some 40 U.S. group farms based their system on the writings of the French utopian socialist Charles Fourier (*q.v.*). The Brook Farm (*q.v.*) group in Massachusetts (1841–47) had many prominent members, including Ralph Waldo Emerson and Nathaniel Hawthorne. Seventy-five others are known to have existed, including the French Icarians, who migrated to the new world during the latter 19th century (*see* CABET, ÉTIENNE; NAUVOO); the anarchist New Llano group in Louisiana (1914–36); and the short-lived Sun-

rise community of urban Jewish workers in Michigan (1933–35).

Socioeconomic.—These colonies developed in response to an interest in economic and social efficiency rather than utopian ideology. They were essentially a 20th-century development, although an illustrious forerunner of this type of group farm was the communal colony of the Plymouth pilgrim fathers. During the 1930s, under the New Deal program of rehabilitating low-income farmers in the United States, joint-cultivation types of farm colonies and family-farm homestead projects were established. About 25 co-operative corporation farms were organized, all but one of which were converted in the early 1940s into individually owned farmsteads.

In England, the commissioner for special areas, in co-operation with local authorities and the ministry of agriculture, experimented with small homestead colonies to assist middle-aged men whose prospects for reabsorption into industry during the 1930s seemed remote. A number of central farms were set up, each with a warden in charge. After a year's training the men were transferred to small individual holdings. Subsistence homesteads, providing house and small garden plots for low-income industrial workers were also tried. By 1949, nearly 700 families had been settled on 19 estates of the land settlement association. A manager provided technical guidance, purchased supplies for the entire group and sold its products.

The American and English group-farming experiments were largely a depression phenomenon. They involved people who had little in common but their poverty and who lacked a philosophical identification with the idea of co-operation. Increased agricultural efficiency and mechanization of agriculture during and after World War II led to the virtual disappearance of government interest in further group-farm experimentation, with one noteworthy exception, in the Canadian province of Saskatchewan, after the Co-operative Commonwealth federation came into power. In 1945 the provincial government established a department of co-operation and co-operative development to encourage rural people in pooling their resources to attain greater economic efficiency and a higher standard of living as well as to facilitate the establishment of villages rather than isolated settlements on formerly virgin territory. The government has an educational program and provides credit. By the late 1950s there were more than a dozen such co-operative farms and about 175 associations owning farm machinery, producing fodder or trapping fur-bearing animals co-operatively. Some had been organized on provincial land by veterans of World War II; others were composed of neighbouring farmers or relatives who decided to pool their land and machinery.

The most spectacular use of farm colonies as an instrument of national reconstruction is found in Israel, where co-operative farm settlements have produced as much as 80% of the country's food annually. Israel's experiences have been closely studied by representatives of other countries, such as India, Burma, Ghana and Nigeria. Beginning in the late 19th century, Jewish migrants from Europe to Palestine often settled in farm colonies for reasons of economy, efficiency and safety, as well as sociability. Members generally shared a common ideology, such as socialist utopianism, ethical humanism or Jewish orthodoxy.

The main forms of modern co-operative settlements in Israel are:

1. Communal farms, called *kibbutzim*. They have from 60 to 2,000 members who work without pay and are supplied with individual housing, clothing, medical care and other personal needs. There are central dining rooms and kitchens, communal kindergartens and, often, children's dormitories. An increasing number of these settlements have established industrial enterprises. Since the foundation of the first one, Deganya, in 1910, some have become quite prosperous. Many are able to provide a good education for the children, maintain communal libraries and recreation buildings and give their members regular vacations. Especially since the establishment of the Israeli government in 1948, there has been a trend toward more privacy for member families, larger allowances for spending money, and private ownership of clothing and furniture.

2. The joint cultivation association, called *moshav ovdim*. These settlements are solely agricultural and range in size from 100 to 1,000 persons. They provide more privacy and individualism than is possible in a *kibbutz*. Members farm their own land, but use much of their machinery co-operatively and do most of their buying and selling on that basis. No property can be transferred to a new family without approval of the elected village council.

3. The co-operative corporation farm, called *moshav shitufi*. These farms combine the communal production of the *kibbutz* with the family ownership of a home and garden of the *moshav ovdim*. Agricultural and industrial resources are owned in common. Work and pay are adjusted to individual family circumstances. Each family in the *moshav shitufi* takes care of its own children and domestic services, such as food and laundry.

Farm colonies also were used to assist Jewish and other religious refugees outside Israel. At the beginning of the 20th century, the Jewish Colonization association established 19 family homestead projects in Argentina for victims of the Russian pogroms; by 1940 these supported a population of 27,000. Several hundred German refugee families were settled during World War II at Sosúa by the Dominican Republic Settlement association, financed by American philanthropists.

Large-scale voluntary mergers of small peasant holdings into joint cultivation associations and co-operative farms have occurred in Mexico, particularly during the presidency of Lázaro Cárdenas (1934–40). *Ejidos* (land-owning villages) were provided with liberal credit for the purchase of machinery, and were furnished with free technical advice. In India, the religious Bhoodan movement transformed parts of hundreds of villages into co-operative cultivation associations, dedicated to improvement in productivity, rural hygiene, education and social development. This movement was inspired by Vinoba Bhave, a follower of Mohandas Gandhi, who walked from village to village persuading landowners to donate part of their holdings to some of their landless neighbours.

Group farming has also been used as an instrument of Communist economic and social policy. In Russia, a number of peasant joint-cultivation associations (*tozes*) and communal farms, composed mostly of idealistic urban workers who wished to live together under a system without private property, were set up after the Revolution of 1917. These voluntaristic forms of association were abolished under Stalin's regime. Preference was given to state-managed mergers of private land holdings into large, nominally co-operative corporations, the *kolkhozy*. Peasants were increasingly pressured into joining. Under Stalin, *kolkhoz* managers had to be approved by the Communist party. Further central control over their operations was exercised at regional, state-owned machine-tractor stations, from which heavy farm machinery was rented and agricultural experts were assigned. Vast tracts of virgin land were also brought under cultivation by group farms under direct state control and ownership in the *sovkhoz* form of settlement.

The haste accompanying the forced collectivization of Russian agriculture resulted at first in a great loss of productivity and was accompanied by much suffering, particularly during the early 1930s. Conditions improved gradually, but peasant resistance to involuntary and total "co-operation" did not entirely disappear. After Stalin's death, the Soviet government gradually increased the degree of autonomy of agricultural producer groups. The *kolkhozy* were allowed to purchase machinery. Machine-tractor stations were gradually abolished. Peasants were allowed to cultivate small garden plots and to dispose of their products individually, on the open market.

The spread of Communism during and after World War II to eastern Europe and parts of Asia, especially China, was accompanied by forced collectivization of holdings of individual peasants. In Yugoslavia and Poland, after initial widespread organization of farm producer co-operatives by Communist functionaries, peasants were given some power to decide on the degree and kind of co-operation. As a result, most of the *kolkhoz*-type associations were dissolved. During the rebellion of October 1956 in Hungary, peasants dissolved about 2,500 of the 3,950 collective

farms that had been organized after World War II. Collectivization was pushed in Communist China in the late 1950s and the 1960s to facilitate control and mechanization of agriculture.

Welfare Group Farms.—These enterprises are operated by schools, mental hospitals, prisons, poor farms and orphan asylums for educational and rehabilitation purposes. They are under the direct supervision of the institution, with the welfare of the charges rather than farm production ostensibly being the primary objective of the operations. Before World War I such farm colonies were used on occasion to provide for permanently unemployed persons. However, the unemployment insurance systems developed in many countries after World Wars I and II proved to be a more satisfactory method of relief, although a few of the older rehabilitation colonies remained in operation.

Farm colonies, irrespective of their structure and ideology, provide a mechanism for reducing the isolation of rural existence and for promoting the mechanization and efficiency of production. They have been the object of considerable social and economic study, since they are generally planned on the basis of an explicit rationale and are small enough to be investigated with resources available to social scientists. Edward A. Norman established a research centre in this field, the Rural Settlement institute, later the Group Farming Research institute (1941–56). An International Council for Research in the Sociology of Cooperation was organized in 1953. It has headquarters in Paris and Milan, Italy, and publishes the *International Archives of Sociology of Cooperation.*

In addition to the references given above, related material will be found under CO-OPERATIVES.

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FARMER-LABOR PARTY, a minor U.S. political party representing the interests of small farmers and urban workers. The Farmer-Labor party of Minnesota—a state with a large Scandinavian population, politically oriented trade unions and a progressive tradition—grew out of the Nonpartisan league (*q.v.*), which had become active in that state in 1916. Farmer-Labor candidates were nominated as early as 1918, and in 1920 the party placed a ticket in the general elections but withheld active support from the national party (see *National Farmer-Labor Party*, below). In 1922 the Minnesota party elected a U.S. senator and two representatives. In 1923 the party became the Farmer-Labor federation and won the election of another senator, to fill an unexpired term; in 1930 its candidate Floyd B. Olson was elected governor of the state. He was re-elected in 1932 and 1934, serving until his death in 1936. In that year the federation gained control of all branches of the state government except the state senate, and elected five U.S. representatives and another senator. The federation supported Robert M. La Follette for president in 1924 and Franklin D. Roosevelt in 1932 and 1936.

A political force in one state only, the Farmer-Labor party was an example of a third party that became in fact, for a limited time and in a limited area, one of the major political parties. The election of Harold Stassen, a Republican, as governor in 1938, and his re-election for two successive terms, marked the beginning of the end for the party, which ceased to function as an independent party in 1944 when it joined forces with the Democrats to form the Democratic-Farmer-Labor party. Hubert Humphrey, U.S. senator from Minnesota, first elected in 1948, was instrumental in bringing about this coalition.

National Farmer-Labor Party.—This group was formed from the National Labor party in one of many attempts to unite small farmers, farm workers and urban trade unionists under one banner. In 1920 it nominated Parley P. Christensen for president and Max S. Hayes for vice-president, but, because it lacked finances and organization and failed to win the support of Progressives, Socialists, the Nonpartisan league or the Farmer-Labor party of Minnesota, it polled few votes. Capture of party control by militant trade unionists at the 1923 convention in Chicago alienated potential supporters, including the Farmer-Labor leaders; and the party disintegrated. The idea, however, persisted, as evidenced by the formation of the La Follette Progressive party in 1924.

The party's platform opposed monopolies, advocated the nationalization of public utilities, basic industries and banks, and denounced labour injunctions as usurpations of legislative power by the courts.

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FARMERS UNION, officially the National Farmers union and also known as the Farmers Educational and Cooperative union, was founded by Newt Gresham at Point, Tex., in 1902. Its early leadership and policies justify its being called the natural successor of the farmers' alliances of the 1880s and early 1890s. Initial success in controlling prices by not selling except for specified minimums led to rapid expansion of the union in the cotton states. To bolster this program it was necessary to limit production and ultimately add credit assistance based on crops stored in warehouses. Experience showed the importance of educating the farmers with reference to marketing, credit and tenure; these problems, together with co-operative enterprises, continued to be basic concerns of the union.

In the period from its organization until the mid-1920s the Farmers union was concentrated largely in the south and southwest. Beginning in the early 1920s leaders from the plains states became active and both membership strength and leadership in the Farmers union shifted from the south to the plains states. The union supported legislation to strengthen farmer co-operatives, increase credit available to farmers and increase farm prices. The National Farmers union became badly split in the 1930s on the issue of campaigning for specific office seekers. Those who favoured keeping education and the building of co-operatives as the major task of the union won control of the national offices. During the 1920s and the 1930s there were a number of reorganizations, especially in relation to the business enterprises sponsored.

Following a reorganization in the 1940s the National Farmers union developed a legislative program in support of an expanded program of supervised credit to low-income farmers, increased co-operative marketing, expansion of farm price supports at levels up to 100% of parity and production-control programs as needed to implement price supports.

In the mid-1950s plans were completed to develop potash deposits owned in New Mexico. Although only 24 states had active state Farmers unions, with a membership of about 300,000 farm families, a ten-year expansion program was launched to achieve the goal of an active state Farmers union with affiliated business services in all of the states. Profits from the potash fertilizer business were to be used to finance this expansion program.

The Farmers union from its earliest years differed from the American Farm Bureau federation (*q.v.*) and the Grange (*q.v.*) or National Grange of the Patrons of Husbandry in engaging in more informal co-operative activities with organized labour, in its greater emphasis on the problems of small farmers and in its advocacy of market reforms which often included greater government controls than the other farm organizations were willing to endorse.

Local Farmers unions are formed by ten or more male members.

Often the local unions are organized on township lines. The local unions form and support the county unions which in turn support the state unions. The state Farmers unions sponsor young people's educational and recreational programs. As in the case of the Farm bureau and the Grange, Farmers union locals usually have social and recreational programs for their membership and take an active part in community affairs. *See* also AGRICULTURAL ORGANIZATIONS.

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FARMINGTON, a city of San Juan county in northwestern New Mexico, U.S., at the confluence of the San Juan, Las Animas and La Plata rivers. Farmington was first settled in 1876 when Indian lands were opened to homesteaders, and was incorporated as a city in 1901. The region's first business was cattle ranching, but fruit growing was introduced in 1879 and soon there were flourishing orchards. A small rural town throughout the first half of the 20th century, its population was about 3,500 in 1950. The discovery of natural gas and commercial oil pools in the 1950s turned the city into an oil and gas centre. Pipelines were built to the Pacific coast, drilling operations were intensified and pumping plants were built. Economic growth also was accelerated by construction of Navajo dam, a bureau of reclamation irrigation project 40 mi. upstream on the San Juan river. By 1960 the population reached 23,786, an increase of 654% over the preceding decade. For comparative population figures *see* table in NEW MEXICO: *Population.* (O. R.)

FARM MACHINERY. Farm machinery includes power machines, tractors and field machines or implements and machinery used for saving labour about the farmstead. Specifically, a machine is a device used to transfer, transform or apply energy to do useful work. While machines include hand tools, such tools are not ordinarily considered in the general classification of farm machinery.

This article deals with the influence of farm machinery on agriculture and discusses developments in the use of power machinery in preparing the soil, planting, cultivating, harvesting and threshing. Additional information on specific kinds of farm machinery will be found in the articles CROP-PROCESSING MACHINERY; DAIRY INDUSTRY: *Dairy Machinery and Manufacturing Processes;* HARVESTING MACHINERY; PLANTING MACHINERY; SPRAYING AND DUSTING MACHINERY; TILLAGE MACHINERY and TRACTORS. *See* also AGRICULTURE; RURAL ELECTRIFICATION.

The development of farm machinery operated by tractors and electric motors puts the modern farmer in the capitalist class. On many modern farms the capital investment per worker is greater than the investment per worker in industry. The investment in machinery on U.S. farms, for example, increased 350% during the 20-year period preceding the second half of the 20th century. While farm machinery was not used as extensively in many parts of the world as in the United States, there developed a growing world-wide recognition that improvement in agricultural production required an increase in the use of machines.

The farmer is a director of both mechanical and electrical power. In the second half of the 20th century each farm worker in the U.S. had an estimated 40 h.p. at his command. In 1933 each worker commanded 33 h.p.; in 1920, 5.3 h.p.; and in 1870 only 1.6 h.p. During World War II the tractor power per acre was greater in England than in the United States.

Aside from speeding the farm work and reducing production costs, the use of tractors instead of animals for power on farms also released millions of acres for the production of food and fibre for humans instead of feed for work animals. Pasture areas so released made possible increased production of beef and other livestock. Timeliness, a most important factor in successful agricultural production, was made possible through the use of modern implements and machines powered by tractors.

During early colonial days in America, 85% to 90% of all workers were required to produce the food and fibre needed, meeting the demand less adequately than did slightly more than 10% of all workers in the second half of the 20th century. Wherever modern machinery was used, the agricultural worker was more efficient, an adequate food supply was assured and fewer workers were needed.

THE USE OF POWER

History.—The history of agricultural development is marked by advance in the efficient use of human labour through the use of machines and equipment designed, developed and improved to utilize animal and mechanical power.

The methods used by the American pioneers in tilling their small fields up to the end of the 18th century were little different from those of farmers in ancient Egypt, Greece and Rome. It was still the age of human power.

While animals had been used during the previous years, it was not until the beginning of the 19th century that the age of animal power began to advance. This resulted from the development of better plows, tillage tools, drills, planters and harvesting equipment designed to be drawn by animals. With the development during the first quarter of the 20th century of "big-team" hitches for pulling plows and combines, the use of animal power in the United States, particularly horses and mules, expanded until after World War I.

With the animal power and implements available, the farm labour required to produce a bushel of wheat was reduced from slightly less than three man-hours in 1830 to slightly less than one-half man-hour in 1896 and to one-fourth man-hour by 1930. This time was cut in half by the second half of the 20th century with tractor-operated equipment. With self-propelled machines, the time required was further reduced.

With the advent of the row-crop or general-purpose tractor, mechanical power had taken the place of horses and mules on most U.S. farms by the second half of the 20th century and was rapidly replacing oxen, horses, mules and water buffalo as power units on farms throughout the world.

Steam Engines.—Steam engines were first used as stationary power units, to take the place of treadmills (animal power) and windmills, to operate stationary machines such as grist and feed mills, wood saws and cotton gins. Later, self-propelled steam engines were used for operating stationary threshing machines that were moved from farm to farm. Many of these units were owned co-operatively by a group of farmers who organized a "threshing ring." Because of the heavy weight, such steam tractors never proved satisfactory as power units for drawing farm machines other than the huge plows of 10-, 12-, 16- or 18-furrow capacity used on the Great Plains.

Tractors.—The internal-combustion engine tractor had its beginning at the turn of the 20th century. The tractor was first developed as a dual-purpose machine—as a draft machine to take the place of teams of horses and other animals and as a stationary power source for operating shellers, threshers, grinders and other belt-driven machines. By the second half of the 20th century, farm implements and machines were designed as an integral part of the operating unit and were quickly and easily interchanged for the work at hand.

An outstanding contribution of the tractor industry was the development in 1935 of hydraulic-control equipment which literally lifts the implements by fingertip control, the implements being easily and quickly detached from or attached to specially designed hitch bars. An extension of the hydraulic system through a remote or "slave" hydraulic cylinder extended hydraulic control to the raising, lowering and adjusting of drawn equipment as well as integral or tractor-mounted tools.

Modern hydraulic-mechanical devices automatically control working depth of tillage implements, relieving the tractor operator of the need for shifting gears or making adjustments as the implement encounters surface irregularities or changes in soil texture. Tractor speed is maintained, with good uniformity in the tillage job.

PREPARING THE SOIL

Plows.—More power is required in the preparation of the land

for planting than in any other farm operation. The plow is the world-wide basic tool of agriculture. Use of oxen or horses to draw it was an outstanding contribution to the advance of agricultural production.

The plow was brought to Britain by the Romans. Some early horse-drawn plows were equipped with wheels and designed to be hitched to the horse's tail. This custom of hitching existed in Ireland as late as 1634, when an anticruelty law was passed prohibiting "plowing by the tayle."

A Dutch plow with a wooden moldboard was improved and patented as the Rotherham plow in England in 1730.

Early American statesmen were greatly concerned with the problems of agriculture. In 1788 Thomas Jefferson presented, as an original mathematical treatise, an account of the principle for constructing a moldboard plow, first to the Institute of France and afterward to the board of agriculture in England. Daniel Webster designed and constructed a large plow to be drawn by 10 or 12 oxen. The cast-iron plow was patented in the U.S. in 1797. It was found to be a good plow for use where the soil was sandy and stony.

As the American settlers moved westward, plowing the black prairie soils, high in organic matter, posed a special problem to the farmers who had cast-iron and iron-patched wooden plows. The ingenuity of John Deere, an Illinois blacksmith and plow maker of the 1830s, resulted in a new kind of plow which was made entirely of steel except for the braces, beam and handles. The one-piece share and moldboard of his first steel plow was cut from a mill-saw blade and shaped over a wooden form. This greatly improved plow not only made possible the effective plowing of the black prairie soils, but according to one writer "it cut by at least one-third the animal power needed to turn the soil."

Improvements of plows followed. Soft-centre steel for the moldboard was introduced in 1868; the three-wheel sulky or riding plows were followed by plows designed to be drawn by tractors, and later plows were mounted on tractors, which made plowing much faster, less laborious and often deeper than it was in the days of animal power.

Disk plows, developed toward the close of the 19th century, are used in hard dry soils, in soils that do not scour readily and where extremely heavy trash must be plowed under.

Harrows.—While the plow is the basic implement used in seedbed preparation, other implements have been devised for final preparation of the land to receive the seed. The branch of a tree was the first harrow. A wooden A frame with wooden teeth, and later iron teeth, was an improvement made during the first half of the 19th century. Steel-frame harrows with steel teeth and also a rotary type of harrow similar to the modern rotary hoe were developed in Norway during that period.

The disk harrow is second only to the plow as an implement for use in preparing a seedbed. It came into use in the late 1860s, but was not patented until 1877.

Other harrows have been developed for special uses in addition to seedbed preparation. Examples are the spring-tooth harrow, used for summer fallowing and weed control.

PLANTING AND CULTIVATING

In the early history of agriculture all the sowing of small grain was done broadcast. The farmers of China, India, Japan and Arabia, however, have drilled in their seeds from earliest recorded history. Information on primitive tools and methods used in planting and cultivating will be found in the article AGRICULTURE, PRIMITIVE.

Seeding Machines.—It is believed that the first seeding machine was developed and used by the Chinese about 2800 B.C. The Chinese drill of the middle of the 19th century resembled a wheelbarrow, with three small, hollow teeth about 28 in. in length which carried the seed from a box supported above the wheels. The Italians had a two-wheeled seeder around A.D. 1600.

Seed and manure drills were in use in England as early as 1649. Jethro Tull (*q.v.*), an English farmer and writer, perfected a machine drill about 1701 and described a drill for planting turnip seed in his *The New Horse Houghing Husbandry* (1731).

In the United States the first patents on a seeding machine were granted in 1799 but it was not until about 50 years later, in 1851, that the force-feed drill was patented. This drill was equipped with a device which controlled the rate of seeding.

Concurrently with this development, in 1848 drills were equipped with manure and seed colters or blades, acting independently of each other, which deposited manure at one depth and covered it, and deposited the seed at a shallower depth and covered it. Within a hundred years, tractor-drawn machines were developed to place commercial fertilizer in relation to seed for the most effective results. Often hitched in huge squadrons, these drills, drawn by a large tractor, could seed a strip 50 ft. wide.

American machines were available in the second half of the 20th century which in one operation prepared the seedbed with the mulch on the surface, planted the seed and placed the fertilizer. Drills and seeders accurately planted small grass and legume seed of all kinds along with the grain.

Corn Planters.—Row crops grown in hills of one or more plants are usually planted with a planter. The American Indian and the early settlers used a hoe to open a hole in which three or four kernels of corn were dropped and covered with the same tool.

The first American corn planter patent was issued in 1828. A forward step came in 1860 with the development of the cross-checking two-row planter, tripped by hand for checking as the planter crossed marks previously made in the field. The automatic check rower, tripped by a knotted cord placed across the field, was patented in 1875. The planter wire replaced the cord a few years later.

The first tractor-powered planters were the ordinary horse-drawn type adapted to be pulled by a tractor. They were supplanted with tractor-drawn two- and four-row equipment in the early 1930s. The speed and accuracy of these planters made it possible for the operator to control the time of planting, which played an important part in increasing corn yields.

In the second half of the 20th century equipment was introduced that could plant six, eight or more rows. Also planters could be equipped to do a fourfold operation: (1) plant the seed; (2) distribute fertilizer; (3) sow insecticides to kill ground-born parasites; and (4) apply chemical weed killers to kill weeds upon emergence through the surface.

Cotton Planters.—Cotton planters were not perfected as rapidly as corn planters. The first U.S. patent on a cotton planter was issued in 1825, and a one-mule improved planter was invented about 50 years later. The modern cotton planter is designed so that the plates which carry the seed in the hopper are interchangeable with plates designed to plant corn, sorghum and other seed. Multiple-row cotton planters have been perfected.

Special Planters.—Special planters were developed for planting sugar beet seed segmented to ensure more nearly the proper stand with minimum thinning. Potato planters, with automatic dropping mechanisms, eliminated the slow, laborious job of hand planting. These mechanical planters were designed to open the furrow, space and drop the seed pieces, properly place fertilizer and cover the fertilizer and seed at the proper depth.

Transplanting Machines.—Commercial gardeners and nurserymen who plant large quantities of plants and seedlings use transplanting machines. The essential parts of such a machine are a furrow opener, a water-supply tank, a hopper for fertilizer and blades for covering the fertilizer and forcing the soil about the plant.

Cultivating and Cultivators.—A crop is cultivated to promote growth of the plants and to destroy weeds which absorb moisture and plant food to the detriment of the crop.

To Jethro Tull, referred to above, is credited the development of what he called horse-hoe husbandry. Horse-drawn cultivators of different types came into general use early in the 19th century. An improved cultivator equipped with three colters, followed by a harrow, and with a wheel at the end of the beam to regulate the depth and to facilitate turning was invented in Scotland about 1818.

A U.S. patent was issued in 1856 for a straddle-row two-horse cultivator. Later, seats were added, and by 1870 a farmer with

two horses could cultivate as much as 15 ac. a day with a riding cultivator.

World War I accelerated the need for and use of multiple-row cultivators. Two-row horse-drawn cultivators were replaced first by two-row, then by four-row tractor-mounted cultivators. Larger multiple-row cultivators appeared in the second half of the 20th century to parallel the capacity of multiple-row planters.

Cultivators for special crops, including beets and beans, and for listed crops (crops planted in ridges) and crops on flat surfaces were developed. Rotary hoes are used for early cultivation of corn, cotton, soybeans, potatoes and small grain. This implement pulverizes the soil crust and destroys small weeds before the crop is large enough to be cultivated with a row-crop cultivator.

Weed and insect control through application of sprays and dusts became important as more was learned about insecticides and weed killers. Much of the loss caused by insect pests, plant diseases and weeds can be prevented through the use of spray material where proper equipment is available and when proved practices are followed. Spraying and dusting are done by custom operators and by individual farmers and orchardists. It became common in the U.S. for custom operators to use both ground machines and airplanes equipped with special sprayers and dusters.

HARVESTING

Sickle and Scythe.—The use of the sickle, a small, curved hand tool, for harvesting small grain dates back to 3000 B.C. The scythe, a larger hand cutting tool, was evolved from the sickle. In the second half of the 20th century both of these tools were still used for harvesting grain and grass in many parts of the world.

The cradle scythe was invented in Europe and was brought to America by the early colonists. The early cradle was a device for gathering the grain stems when cut and laying them in a swath for binding.

The grain stripper—a Gallic invention described by Pliny in the 1st century A.D.—is important as an attempt to lessen drudgery by using animal power. It consisted of a two-wheeled ox-propelled cart with a saw-toothed blade set across the open front to strip the heads, which fell into the cart.

Reapers.—Reaping machines developed gradually and simultaneously on both sides of the Atlantic. In America, where there had always been a labour shortage, development of great wheat-growing areas was impossible without machinery. The U.S. Civil War hastened this development.

In 1786 William Pitt of Pendeford, Eng., failed in his attempt to popularize a header with a revolving cylinder with rows of teeth which caught the heads and dropped them into a box.

The first English patent for a reaper was taken by Joseph Boyce in 1799. Invention followed invention, each adding features, until in 1822 Henry Ogle constructed a reaper that used a straight-edged knife blade as a cutter and employed a reel of revolving bars or arms, resembling the modern form, to push grain back upon a platform. Although Ogle's machine never became popular, his principle of the cutter and reel was adopted in all subsequent successful designs.

In 1826 Patrick Bell, a Scottish minister, invented a reaper with a shear-action cutter—movable blades cutting against stationary blades—a principle still in use.

Although the first U.S. patent was granted in 1803, no machine of importance was patented until 1822, when Jeremiah Bailey brought out a combination mower and reaper. The next invention worthy of mention was that of William Manning in 1831. His cutter bar reciprocated, that is, moved alternately from side to side, over guard teeth, as if anticipating designs used by Obed Hussey and Cyrus H. McCormick. Hussey and McCormick experimented with reapers simultaneously. McCormick had his at work by 1831, but Hussey was the first to secure a patent—on Dec. 31, 1833. Each machine utilized the principle of a reciprocating knife cutting against stationary guards or fingers. McCormick's machine employed a divider between cut and uncut grain and a reel to topple cut grain onto a platform.

Inventors then turned their attention to providing an automatic device to deliver the cut grain in a form suitable for binding. This brought the self-rake and the dropper. The self-raking reaper held the field from 1850 to 1870, when it was replaced by the harvester. A harvester included a special mechanism to handle and bind the cut grain into sheaves or bundles ready to be set up in shocks. C. W. and W. W. Marsh patented the first successful harvester in 1858. A canvas delivered the cut grain over the drive wheel to a box from which it was taken and bound by two men riding on the machine. This design set the pattern for future harvesters. However, a mechanical binding mechanism was still lacking. Because twine was very expensive, the first binders used wire, but damage to cattle resulted, so these binders were never popular. John F. Appleby made a successful twine binder which was put on the market in 1880 when twine was cheap enough to be used economically.

Thus the McCormick cutting principle, the Marsh frame and the Appleby binder were combined to produce the successful modern binder. The result was a grain binder that was still used successfully, though on a limited scale, in the second half of the 20th century.

The header, which merely clipped grain heads and elevated them into a wagon rack, was developed in the United States, Canada and Australia. The headed grain was usually stacked for threshing at a later date. Use of the header, along with the binder on a lesser scale, continued as standard harvest procedure throughout the Great Plains wheat areas of the U.S. and Canada until the grain combine became widespread early in the 20th century.

Windrower.—The header's more modern counterpart was the self-propelled or tractor-drawn windrower which cut the standing grain and laid it in a windrow atop the stubble. Separating and cleaning were done by the combine harvester equipped with an attachment to pick up the windrow in place of the regular cutting platform. The practice of windrowing was followed in the Great Plains of the U.S. and Canada, where the grain was cured in the windrow to protect it from late-season weather and pest damage.

Threshing or Thrashing Machines.—Threshing or thrashing is the separation of grain or other plant seeds from their husks or pods. Until the middle of the 19th century the chief methods were flailing by hand or treading by animals on a threshing floor. The modern methods employ either the drawn-type or self-propelled combine harvester, which harvests the ripened seeds and threshes them in one operation.

The first step in the mechanization of threshing came in the 17th century when fanning mills were developed for winnowing. Andrew Meikle, a Scotsman, in 1786 built a threshing machine which combined the blow of the flail (*q.v.*) with the rubbing action of the threshing floor, the prototype of present-day threshers, in which beaters were fastened to a revolving drum forcing the grain against the ribs of a sparred concave sieve placed below the drum.

Probably the best known of the early American machines was developed by Hiram and John Pitts of Winthrop, Me., to combine the threshing, separating and winnowing processes in a single machine. Eventually the combine replaced the stationary thresher.

Combines.—The development of a combine (that is, a combination harvester and thresher) was concurrent with the development of the reaper, the binder and the threshing machine. A U.S. patent was issued to Samuel Lane on a combined harvester on Aug. 8, 1828. The first combine to be built was patented by H. Moore and J. Hascall of Michigan in 1836, but its use was abandoned because of climatic conditions. Later it was taken to California and used successfully in 1854.

The first combines were drawn by horses; later by steam and internal-combustion tractors. The self-propelled combine was introduced about 1908. This was a significant advancement because it made the combine more maneuverable and more efficient. The self-propelled model could go into a field without running down part of the crop on the first round. Modern self-propelled combines literally put one man in complete command of his harvest.

The combine, although originally built to harvest wheat and oats, is used to harvest many other crops, including legume and grass seeds, beans, sorghum grains and corn.

Corn Harvesters.—Many types of corn harvesters have been

developed. The sled cutter, one of the early attempts, cut the stalks, which were put in shocks by the operator. Corn binders were developed later. Husker-shredders are used to remove the ear from the stalk, husk it and shred the stalk for feed and for bedding. The corn picker was developed for use where the stalks were left in the field. By mid-20th century more than 90% of all corn grown in the corn belt of central U.S. was harvested with the picker.

A shelling attachment (introduced in late 1950s) for the two-row corn picker enabled the grower to harvest his crop as shelled corn or ear corn. A corn attachment for the self-propelled combine had entered the corn-harvesting field in 1954. The corn attachment picked the ears and passed them on to be shelled and cleaned in the separator. Because of the high moisture content of the corn when harvested by either of these methods, a drying and storage problem was created, which was solved by installing crop driers either on the farm or at the grain elevator.

Haying Machinery.—Hay has always been an important crop where livestock is raised. The tractor-mounted mower, the tractor-mounted rake and pickup baler have taken the place of the sickle, scythe, hand rake and pitchfork in the modern production of the hay crop.

About 1930 proposals for a hay conditioner or crusher attachment for a mower were developed. The purpose of crushing the green hay was to reduce the time required in curing or drying. Several U.S. manufacturers produce this type of machine. Other hay machinery includes various types of rakes, tedders, loaders, balers and forage harvesters of several types. The latter machine may be used to cut and chop a green crop and deliver it into a wagon or truck to be stored as ensilage, dried artificially for hay or fed (green) to stock in the feed lot. It may be used, also, to pick up and chop windrowed field-cured hay for storage in barn or stack. With a row-crop attachment, it is used to harvest standing row crops, such as corn, for ensilage.

Special machinery and equipment are found on farms that produce large amounts of hay. Sweep rakes and hay stackers eliminate much hard labour during the hay harvest. Automatic pickup balers permit one man to do a job formerly done by several. In the late 1950s an attachment was devised for the automatic baler which would toss small bales directly into a wagon drawn behind the baler, further reducing the labour and time required in harvesting. While the handling of loose hay in barns has been done with forks and slings, the chopped hay and bales are handled with blowers and mechanical elevators and barn conveyers.

Crop Driers.—Much progress was made in the development of farm crop driers during the second quarter of the 20th century. These units are designed to dry grain and hay with heated or unheated air. The various types of driers and their uses are discussed in CROP-PROCESSING MACHINERY.

Cotton Harvesters.—The perfection of mechanical cotton harvesters led to the complete mechanization of cotton production in some areas.

Machines for stripping mature bolls of cotton from the stalks were developed during the last half of the 19th century. These strippers were not used to a great extent until 1940, and largely at that time in Texas and Oklahoma, where stormproof cotton, which is stripped or snapped in a once-over operation, is the principal type grown. With a stripper, one man did the work of 20 men snapping by hand. While a bale of cotton was harvested with a stripper in 30 minutes, it took one man about 40 to 50 hours to harvest a bale by hand.

In open-type cotton, which cannot be stripped, the bolls open wide as they mature to expose the cotton fibre for easiest plucking or pulling. The mechanical cotton picker draws the lint from open bolls and leaves the unopened bolls for a later picking. After many years of field testing, the cotton picker was produced commercially in 1941. As a result, large areas of cotton were mechanized in west Texas, Arizona and in southern California, where open-type cotton is raised.

Other Crops.—Other crops are harvested and handled mechanically. Potato diggers were first available in 1886. Few were used until 50 years later. By 1940 machines were in use that dig, clean, grade and bag the potatoes in one trip across the field. Peanuts, sugar beets, sugar cane and castor beans are harvested with machines designed for the particular crop. These crops were largely mechanized in certain areas by the second half of the 20th century.

See also references under "Farm Machinery" in the Index volume.

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FARM MANAGEMENT consists of making and executing all of the decisions necessary to the economic operation of a farm. Farm management policy decisions include choice of farming practices, what and how much to produce, the allocation of available resources for production, the size of the farm operation, and the purchase or rental of land or other additional resources. Farm management executive decisions concern timing of operations and day-by-day modification and implementation of plans to meet the constantly changing conditions of farming.

This article treats of examples of major types of farm management situations ranging from a two-acre rice farm in Japan to a large rubber plantation in Indonesia, indicates the nature and objectives of farm management and considers the many interrelated factors involved in management decisions. In practice, farm management requires the integration of information from many fields in agriculture. The survey article on AGRICULTURAL ECONOMICS describes the economic environment of farm management with respect to public policy, prices, marketing, and economic institutions; the institutional arrangements regulating farm land and farm leases are discussed in LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS (*see* also LAND REFORM; FARM TENANCY; SMALL HOLDINGS; MÉTAYAGE SYSTEM). The articles on SOIL; PLANT BREEDING; WEED, and various aspects of weather as well as those on specific crops and livestock tell of the physical and biological framework within which decisions are made. *See* also AGRICULTURE; AGRICULTURE (ARTICLES ON).

MAJOR TYPES OF FARM MANAGEMENT SITUATIONS

The great range of farm management problems may best be seen from several specific examples. On a typical 200 ac. Corn Belt farm in the United States, for example, the labour force typically is the equivalent of two full-time men; the farmer, with a capital investment of $65,000, must concern himself with credit management—how much to borrow, what to rent, what terms to use and so on; because the favourable physical conditions provide a wide range of options in combining enterprises, he must decide on his crop rotation and the extent to which he will sell corn for cash, feed hogs or fatten cattle. These decisions will vary as he weighs the differing risks of these different efforts, evaluates varying price relationships and considers efficient use of his machinery and his own knowledge.

On a typical Great Plains wheat farm in the United States with 700 ac. of land, half in fallow, half in wheat, the farmer's greatest problem may well be how to deal with problems of price and weather risk. Though government price support programs have

taken much of the price risk out of his farming, the weather risk is real. With a total investment of $80,000, annual cash expenditures of $5,000, and the value of production ranging from nothing to $10,000 or $15,000 depending on weather, this farmer must weigh his risks very carefully.

In western Europe the typical family farmer, who has less land than is economic with modern machinery and buildings and standards of education and training, must be concerned particularly with technical improvements to raise yields of crops and livestock at low cost, with adjustments to his choice of products, as conditions change, and with the gradual acquisition of more land through amalgamations of farms.

Farm Management.—In agricultural economics farm management is considered a fourth factor of production along with land, capital, and labour. Although it is the central resource around which a farm plan must be built, management is difficult to evaluate in most farm situations, for it is virtually impossible to distinguish between results of the farmer's activities as worker and as a manager, or to determine at the end of the year how much he has earned for managing and how much for use of the capital, labour, and often land that he has supplied to the business. Many studies of farm records, however, indicate high rewards for good management. There is a wide range, for example, in financial returns of farmers in the same area with similar land resources and markets, but with different levels of management. (J. E. Ws.)

A typical farmer in northwestern India with a labour force of two men and eight acres of land must be particularly concerned with weather and insect risk and securing at least enough income for subsistence. He must farm carefully to see that his meagre living continues and must weigh carefully any technical recommendations made to him. His methods have not changed for generations, partly because few workable innovations have been offered him, and partly because of his conservatism. The future availability of improved services may eventually provide scope for decisions that can raise his production and income.

The rice farmer in Japan faces problems of allocation of his labour between his two-acre rice farm and various off-farm job opportunities. On his farm he must weigh the value of new seed varieties and fertilization practices and consider the possibility of reorganizing his farm and labour to allow the growing of a third crop in the annual cycle.

The manager of a large rubber plantation in Indonesia must worry about the larger political problems of expropriation. He also is concerned with the merits of pulling old trees out and replacing them with higher yielding varieties, receiving a larger income later but foregoing income while the new trees come into bearing. Complex problems of discounting are involved and he also faces problems of labour management and marketing.

On a large market garden, or vegetable farm, in the Lea Valley near London the farmer must make decisions concerning a very large capital investment, including glasshouses, or greenhouses, packing sheds, an irrigation system, and washing and grading machinery. He also must worry about timing his production and anticipating and matching market specifications.

A rancher with hundreds of acres in the pampas of Argentina or the western United States must make a difficult management decision in choosing between higher present income from carrying larger numbers of cattle and allowing his range to deteriorate from overgrazing, or lower present income with smaller numbers and the capital value of his land maintained for a longer period. His decision will be conditioned by his present income, the standard of living he wishes to enjoy, his debt situation, and his appraisal of future price relationships and opportunities.

Thus, the character of the world's agriculture is shaped by literally millions of farmers facing a nearly infinite variety of situations as they attempt to maximize their satisfaction with a set of decisions and actions suited to their objectives and conditions. Future agricultural progress depends on changing the environment within which farmers make decisions and aiding them in adapting their decisions to this new environment. In the presently low income agricultures of the world, expanded research, improved supply facilities and enlarged market opportunities will open a much wider area for farmer decision-making. The extent to which a myriad of farmers modify managerial decisions in response to these changes will determine whether or not an improved diet can be provided to the world's expanding population.

THE NATURE AND OBJECTIVES OF FARM MANAGEMENT

Like other forms of business management, farm management is an exercise in applied economics. It is concerned with economizing the use of resources in order to achieve certain desired ends. Individual farm incomes and the total volume of the world's agricultural production are greatly influenced by farm management decisions.

Farm management is distinguished from management of most other types of enterprise by the fact that in farming there is less control of the business environment. Because weather, insect and disease incidence, price and other factors change sharply, randomly and continuously, the outcomes of many farm management decisions are uncertain. These influences condition not only individual decisions, but also general attitudes towards decision-making. Even in a generally traditional, subsistence economy such factors as family size, availability of land, water conditions and even tastes change over periods of time. Farm operations must accordingly be constantly adjusted.

In a modern commercial agriculture, the changes brought about by research, capital formation, advertising and other developments further the importance of the farmer's decisions.

The great variability of the physical and biological conditions of agriculture generally make it impossible to generalize farm management decisions over a wide area. They must be specific to sets of conditions which vary significantly even from one small field to another. This is an important factor favouring a relatively small size of business in agriculture as compared with the industrial sector of the economy.

The farmer is usually assumed to be aiming at maximum returns in relation to the factors of production that he controls—his own management, labour, land and capital. Since, however, so many farms are operated as family enterprises, other factors often influence management decisions, including the way the farmer uses his labour and the kinds of work he must do, the time he devotes to leisure and other activities, the importance he attaches to immediate as compared to future income, and other personal and family goals. Hence, two farmers in quite similar situations and with equivalent ability may manage their farms quite differently due to differences in their values and objectives.

MANAGEMENT DECISIONS

Use of Available Resources.—Farm management decisions and results are conditioned by the relative proportions in which the various production resources—basically land, labour and capital, plus technology and management—are available. Many areas of Asia and some parts of Africa and Latin America are characterized by high population densities and very small farms. This greatly restricts the earning potential of the farmer. In Japan and a few other areas of the world, however, farm incomes are substantial, and are increasing despite very small farms. As the result of agricultural education and research and provision of services by the government the Japanese farmer has been able greatly to increase his agricultural production and income. Indeed, through capital improvements and technical advances allowing double and triple cropping and much higher yields per acre, a typical farmer is able to wrest a value of production from two acres of land nearly ten times greater than that which a rice farmer in West Bengal, India, wrests from a similar two acres.

Combinations of Production Factors.—Many farm management decisions are concerned with the intensity with which the various factors of production are used. For the farmer in a technologically backward situation these decisions are largely con-

cerned with the quantity of labour to use on a given piece of land. He may choose to expend a great deal of labour, carefully preparing the seedbed, weeding with utmost care, carrying large quantities of manure to the land and so on. The decision will depend on the productivity of his labour and on the relative values he attaches to his leisure time and to the extra product he will get. Generally, as he applies more and more labour to a given piece of land, the principle of diminishing returns will come into play, providing him with less and less return for each additional unit of labour. Eventually, the value of added production will be less than the value of that labour used in some other way. Because farmers vary in how they weigh these matters, differences arise in the apparent care with which they farm.

In a technologically modern agriculture, questions of the combination or intensity of use of factors of production arise over a much wider range. The farmer must decide not only how much labour to use per acre, but how much to spend on insecticides, fungicides, and weed killers, how much feed to give per head of livestock, how much capital to invest, and so on. These decisions are influenced by the same principle of diminishing returns.

The final decision regarding intensity will also be influenced by the physical and economic conditions the farmer faces. For example, the response to varying amounts of fertilizer will be different on different soils, even from field to field within the same farm. The cost of capital to invest in fertilizer will vary from one farmer to another and even the farmer's ability in applying the fertilizer will influence the response and hence the amount it pays him to put on his fields. Thus, even if they have set the same basic objectives, farmers will differ in their decisions from one situation to another.

Conservation.—In farming as in any business, management decisions effect both present income and future income. But in farming the choice of practices may increase present income not only at the expense of future income but also at the cost of permanent destruction of land or other assets. In many parts of the world soil erosion is a constant and real problem. Sometimes the farmer's need for immediate income drives him to decisions and practices which he knows will result in long term destruction of his soil. In other cases, he acts in ignorance of the results of his actions or of conservation practices. It is often to society's advantage to teach the farmer conservation methods, to alleviate the pressures which prevent his acceptance of such measures, and to undertake direct governmental measures for conservation, such as large-scale programs of flood control.

Product Combinations.—Another important set of farm management decisions concern choice of the combination of activities or enterprises. Climate, soil and topography play an obvious role in restricting choices. Economic factors also play a role. Areas close to market are more likely to produce bulky, perishable products like milk than are areas distant from market. The availability and quality of farm-to-market roads and other public and private services are important conditioning factors.

In some areas the farmer may have little choice of products. This tends to be the case in the dryland wheat areas of the United States, Canada, and the Soviet Union. In other regions physical and economic conditions may throw open a wide range of possibilities, making decisions difficult and complex. The Corn Belt of the United States epitomizes this situation. In such areas fluctuating price relationships may change the most profitable combination from time to time. Opportunities to match such changes, however, may be restricted or delayed if substantial capital is tied up in specialized machinery or if a change would mean entering a new enterprise at a disadvantage.

Risk and Uncertainty.—Farmers the world over make their decisions in an environment of great uncertainty and risk. Weather is highly variable from year to year. This not only influences crop yields and income but also the choice of crops and the intensity of use of factors of production. Some parts of the world are much more subject to weather risk than others. In the dry wheat areas of the world the rainfall varies from year to year around the critical minimum necessary to make a crop. In the monsoon climates of Asia similar uncertainty occurs concerning the timing of the rains and their effect on crop production. In such high risk areas farmers tend to be conservative, choosing the less risky crops and keeping down their cash expenses—for fertilizer, for example.

Another form of risk faced by farmers is price risk. Historically, the prices of agricultural commodities have fluctuated more widely than many other prices. Like the weather, this uncertainty tends to encourage conservatism. Crops with widely fluctuating prices are grown more sparingly than other crops. Farmers also are careful about investing in fertilizer and other inputs requiring cash costs that may not be recovered in a low price market.

A final form of risk is technical risk—whether new techniques will succeed under a particular set of conditions. New seeds, fertilizers, farming practices and machinery are constantly presented to the farmer but it can never be certain whether a new idea will be profitable on a given farm until it has been tried on that farm. In countries with well-developed agricultural research and extension facilities this risk can be reduced substantially. But even at best, the farmer takes a risk in these decisions. In many countries this risk is very high indeed, and is yet another reason for conservatism. Many farmers in the world have found that their chances of physical and economic survival are greatest if they keep to the ways of their forefathers. But in the modern world innovation and change are required to maintain a competitive position, and the farmer is favoured who minimizes risk by carefully judging the applicability of innovation to his situation.

Professional Management.—Farmers' management decisions have traditionally been based on observation of their own and their neighbours' experience. Historically, there have been occasional cases of systematic record-keeping and farm management analysis. And, tracing back at least to the Roman, Cato, there have been wise rules of thumb for farm management. The growing complexity of farming has created a need for specialists in farm management for research and teaching in agricultural institutes and universities, in adult education programs and in farm extension and other public and private agencies and services.

In commercial farming and plantation regions many land owners employ professional managers to plan and supervise operations by hired labour or tenants. In both Great Britain and the U.S. there are societies of professional farm managers, which publish journals and sponsor meetings. They have established high professional standards and codes of ethics in the fields of farm management, farm appraisal, and farm credit. Universities and research organizations have collected data concerning farm management and have developed and adapted a considerable body of theory and applied diverse methods of analysis, many of a very sophisticated nature, to problems of farm management. (*See* also AGRICULTURAL EDUCATION AND RESEARCH.)

Sources of Information for Decisions.—The farmer draws information for his management decisions from three primary sources. Public and privately maintained experiment stations supply reports on their research through publications, county agents or agricultural advisers and various other channels. Farm management specialists help adapt such information to various farm conditions but each farmer must appraise it in relation to his own conditions.

The farmer also learns from the experience of other farmers. Colleges and research stations may systematically collect such information and organize it to present to farmers.

The third primary source of information is the farmer's own farm operations and observations. The modern farmer keeps detailed records that allow him systematically to analyze and learn from his past decisions. Professional help in farm record keeping and analysis is often available.

Techniques of Analysis.—Many different techniques are used in the systematic analysis of information concerning farm management. Decisions concerning the combination of enterprises or practices often have a very complex basis. The farmer requires data concerning input requirements and probable outputs for all the likely alternatives. These data can be analyzed by preparing budgets in which the various resources to be used and their costs

are compared with the outputs and their values. The budgets may be for part of the farm business, but more commonly a change in one part of the business has so many ramifications that a budget for the whole farm must be prepared. Farm planning services which are being rapidly expanded in many countries of the world emphasize the systematic preparation of budgets for individual farms or sets of farms.

Budgeting can be greatly systematized by mathematical techniques and the use of high speed computers where large numbers of alternatives are involved. Public and private agencies occasionally provide computing and interpreting services of this type. The technique is, of course, like any other technique, no more accurate than the underlying data; in addition, because mathematical programming is mechanical it is less likely that an error in judgment or data will be caught in the manipulation process.

For decisions regarding intensity of use of inputs of fertilizer, labour, and other factors of production the farmer is particularly interested in the relationships between particular inputs and the output of crops or livestock. These relationships may be compared by tabulating data for output when different levels of input are used. Mathematical formulas can describe more complex interrelationships than simple graphs or tables, but they often require modification in application to the varying conditions of different farms.

Farm Size.—The size of farm businesses is a question that has many political and cultural aspects, as well as important implications for farm management. In the actual business of agricultural production, the complexity of management and the necessity of day-to-day decisions over varied conditions give considerable advantage to the family-size farm and explain much of its persistence in a world of large scale business in most other enterprises.

With economic development the non-farm sector of an economy eventually expands sufficiently to allow a decline in the proportionate number of people in agriculture, and an increase in the size of farms. This in turn entails difficult decisions in adapting methods, labour and equipment to larger operations, and in managing capital and credit problems on a new scale.

In the highly commercialized agricultures of the world, farm size and capital investment have been rapidly increasing. The average size of labour force per farm has not. Mechanization has allowed one man to handle more and more land and livestock. This has greatly increased the capital requirements per man and created many new management problems as well as opportunities.

In many aspects of agriculture other than direct production, very substantial economies of large scale operation arise. It would not, for example, pay the individual farmer to carry on experimental research. Thus research organizations have been developed to serve many farmers. Likewise many educational, marketing and credit services are commonly operated on a large scale. Because of the economies of these facilities, comparison of large scale farms that have these services with small scale farms that do not, are usually favourable to the large scale operation. This is the case when tropical plantations complete with research organizations, marketing and financing facilities are compared with typical smallholders. The comparison is less favourable to the plantations when both the plantations and the smallholders have access to these facilities.

State farms and collective farms are often formed in an attempt to achieve economies in the services supplied to farmers, to speed the spread of knowledge about new technologies and to establish control over farm production. Often collective and state farms as well as cooperative farms run into severe difficulties in day-to-day management decisions because of the removal of the labour force from the active decision-making process. There is also a substantial problem of supervising large labour forces on such farms. Collective and cooperative farms seem to work best when the labour force is particularly dedicated to the aims of the farm through religious or other motives as in the 18th and 19th century utopian farm colonies in North America and the 20th century *kibbutzim* in Israel (*see* FARM COLONY). For details of collectivization under Communism *see* articles on specific countries, as UNION OF SOVIET SOCIALIST REPUBLICS: *The Economy: Agriculture.* (*See* also PEASANT MOVEMENT.)

Vertical Integration.—Economies of scale and coordination of farm services are also achieved through various forms of vertical integration of one or more processing and marketing functions with production. Contract farming provides an example: the farmer contracts with the processor of his commodities to deliver his production to that processor. In some cases the processor takes over a considerable portion of the management function, instructing the farmer as to variety of crop to grow, time of performing various operations and quantities of various inputs to use. The processor may also provide credit. Similar types of integration may be provided for by supplying agencies—by feed companies, for example—as well, and cooperatives throughout the world provide many examples of vertical integration. Advances in marketing and increased specialization in production have pressed farming arrangements in this direction.

The Role of Government.—Government may play a substantial role in setting the environment within which farm management decisions are made. The government-sponsored agricultural research and extension programs are examples of activities which enlarge the scope for decision-making by farmers. Price setting by government may reduce the area of decision-making by farmers, although frequent shifts in government price policy may in fact introduce a whole new area of decision-making to farmers. At the extreme, governments may determine the quantities of supplies available to farmers and even set the acreage to be planted to various crops. Such actions greatly reduce the scope of farm management.

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(J. W. ME.; JN. R. R.)

FARMSTEAD ARRANGEMENT, U.S. The farmhouse and farm service buildings along with their associated yards, pens, lots and lanes comprise the typical United States farmstead. Normally the farmstead is located on the land that is being farmed. In pioneer times it was customary to select a site near running water and a stand of timber.

Today the favoured farmstead site is well drained, close to fields and pastures, accessible to power lines and on a good road leading to markets, churches and schools. An area of between five and ten acres which is naturally elevated or sloped gently to the east or southeast is desirable.

The relative position of the various elements comprising a farmstead is influenced by several independent factors. A well-balanced arrangement is a compromise between the limitations inflicted on the site by nature, by the character of the main farm enterprises, by the danger of fire and by the requisites of pleasant farm living.

Natural Influences.—The most unalterable factors in farmstead arrangement are those imposed by nature. They include prevailing winds, sunlight, drainage and natural views.

Prevailing winds are considered in planning the farmstead layout. Feed lots require locations where their associated structures can shield workers and livestock from winter winds and where summer air currents will not carry barnyard odours to the farm home. An evergreen windbreak on the north and west sides of the farmstead can shelter the whole area. But it is important not to obstruct air movement immediately around the farmhouse and near structures utilizing natural ventilation for crop drying. To reduce the chances of fire, major structures are placed out of the line of the prevailing winds.

Sunlight also is a factor in planning farmstead arrangement. In addition to giving light, the sun will provide heat and have a sterilizing value in livestock buildings that are oriented to admit a maximum amount of sunlight in the winter. Buildings like corncribs, two-row farrowing houses and stanchion dairy barns need to have the sun on both the east and the west sides. Consequently, they are usually located with the long axis north and south. Poul-

try houses generally face south with most of their windows on that side.

All areas of the farmstead need good natural surface drainage; the farmhouse occupying the best-drained site. Traffic areas between service buildings and lots also require especially good drainage. A building arrangement that follows the contour of the land will facilitate maintenance. Grading can sometimes redeem a site that would otherwise be impractical.

The farmhouse is located where advantage can be taken of views toward naturally attractive features. The best natural view is often of a small lake, a patch of woods or a permanent pasture. Windows in the living portion of the farmhouse are then oriented toward these natural views, and service buildings and lots are kept away from this part of the farmstead.

Major Farm Enterprises.—Farmstead arrangement is strongly affected by the type of business enterprise for which the farm is suited. While general-purpose farms need a variety of buildings and related lots to accommodate multiple enterprises, more specialized farms need facilities for only one or two.

For efficient chore operations cash-grain farms mainly require storage structures, which are located where they can be conveniently filled and emptied. Shelters for farm machinery are common to most types of farms. They require locations that permit equipment to have ready access to fields by lanes, and where there is ample turning space. A site relatively near the house is suitable, especially if a shop for repairing machinery is incorporated.

Specialized enterprises like dairying require a group of related buildings or integrated units for storing feed and roughage, for housing and exercising livestock, for milking and for preparing milk. Where the major enterprise is feeding cattle and hogs, sheds are arranged about a feed centre which stores roughage, grain and supplements and provides equipment for processing rations.

By the second half of the 20th century many advances had been made in the development and application of automatic equipment for processing feed and distributing it to livestock on the farm. (*See* CROP-PROCESSING MACHINERY.) Electric power assisted by electronic controls have made possible accurate metering, blending, grinding and conveying of feed and roughage with a minimum of hand labour. Mechanical feed-conveying equipment affects farmstead arrangement by allowing wider latitude in locating livestock-feeding areas in relation to the feed-processing centre than do systems depending on gravity for distribution. Later expansion of the enterprise also is easier where mechanical systems have been incorporated.

A farm service yard is an open area that provides access to the principal buildings, lots and lanes to fields. It reduces the need for entry of farm machinery to livestock lots and the open space helps to prevent the spread of fires.

Farm Living Values.—An important but less tangible influence on farmstead arrangement is the value of attractive appearance to the farm family and the community. The farmhouse and the more attractive buildings are placed where they are readily seen from the public road. The more undesirable views are screened off by buildings and plantings. Deep yards or permanent pastures usually are located next to the public road, keeping the farmhouse 125 ft. or more back.

Unification of the farmstead as a whole helps to improve its appearance. An evergreen windbreak forms a backdrop that gives unity to the over-all setting, as do roof colours and architectural features that are repeated. Ornamental fences and landscape plantings also contribute to the interrelated appearance of buildings and lots.

Trends in Farmstead Arrangement.—In the second half of the 20th century the average size of farms in the United States increased through consolidation of smaller units. Thus the functions of two or more old sets of buildings often have had to be coordinated. On livestock farms one procedure has been to concentrate feed processing at the most centralized set of buildings and use self-unloading wagons to distribute the feed to other centres.

As farms continue to become more specialized, building arrangements reflect this change by further concentrating chore activity centres and by using more automatically controlled equipment. *See* also FARM BUILDINGS; FARM MANAGEMENT.

See Keith H. Hinchcliff *et al., Planning Your Farmstead* (1954); W. A. Foster and Deane G. Carter, *Farm Buildings*, 4th ed. by Deane G. Carter, ch. 3 (1954). (K. H. HF.)

FARM TENANCY. Tenancy is one of three major means of organizing agricultural units of production throughout the world. The other two major means are owner operatorship and group or communal tenure, including state ownership. Further discussion of the history and development of the different forms of land tenure and agricultural organization in various lands throughout the world will be found in the article LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS. The article MÉTAYAGE SYSTEM deals with the cultivation of land for a share of the produce. *See* also FARM COLONY; FARM MANAGEMENT; AGRICULTURAL ECONOMICS; LANDLORD AND TENANT; and articles on individual countries and on the continents.

Farm tenancy arises when landowners cannot or do not wish to operate their land and when farm operators cannot afford or do not wish to own the lands they operate. Thus, under tenancy, landowners contribute their lands and various amounts of operating capital and management while tenants contribute their labour and various amounts of operating capital and management. The returns from this pooling of land, labour, capital and management are shared by landlords and tenants in various ways.

In western Europe and in North America the usual means of using agricultural lands is through the individual farmer who is either a tenant or an owner-operator. In Africa, in parts of Mexico under the *ejido* system, parts of the middle east, China and the U.S.S.R., various forms of communal and tribal tenures are in practice (*see* FARM COLONY; LAND TENURE, PRIMITIVE).

In areas where land has been alienated to individuals, usually some of these individuals have gained ownership of more land than they could cultivate. Sometimes this occurred as an outgrowth of the feudal structure which characterized the society of Europe in medieval times and of Japan, for example, before the Meiji restoration of 1868. Sometimes it was the result of large Spanish and Portuguese grants of land in newly conquered areas of the new world; grants which still influenced the ownership of land in the second half of the 20th century in Latin America and the southwestern United States. Sometimes it was the result of the appropriation of apparently unoccupied lands in Africa which, in reality, were under some form of tribal tenure and shifting agriculture. In India and Pakistan many landlords originally gained their property as a result of the British delegation of tax-collecting rights, which gave rise to the zamindar and ryotwari systems which were in the process of being eliminated in the second half of the 20th century.

In other areas, such as Burma, tenancy has arisen because unstable agricultural prices and low price levels forced many small cultivators to mortgage their lands to moneylenders who eventually gained control when the borrowers defaulted. But in other instances tenancy has arisen because individuals with capital wished to invest in agricultural land and were willing to combine their land with the labour and management ability of some other individual who had little capital.

Regardless of how it arose, farm tenancy in the modern world serves to combine the land resources of the landlord and the labour resources of the tenant into a single operating unit. Under proper conditions this can be economically as efficient as owner-occupancy, as has been demonstrated in the United Kingdom and in the midwestern United States. But when the landlord has too much power —perhaps because of competition for land, credit monopoly or outright intimidation—there may be an arbitrary transfer of income to the disadvantage of the tenant, and there is no incentive for proper cultivation. Under such conditions, poverty ensues, tenants may come to be considered as an inferior social class and many abuses appear.

TENANCY THROUGHOUT THE WORLD

Probably tenants and their families constitute as many as two-fifths of the world's people engaged in agriculture. Thus, around

750,000,000 people live and work on other people's land. There are wide differences in the extent of tenancy throughout the world. In the second half of the 20th century tenancy varied from 65% of all farmers in England and Wales and 77% in Scotland to 5% in Denmark and 5.4% in western Germany. Tenants made up 53% of all farmers in India and 40% of the total in Formosa. On the other hand, in parts of Thailand tenants were as few as 5% of the total number of farmers. Care should be taken not to associate operator-ownership too closely with a high level of living. Many of the owner-operator farmers in the areas of southeast Asia were heavily in debt and held their land only because moneylenders did not care to take title to the land for themselves.

Within individual countries there were great differences in the extent of tenancy and therefore national averages might be misleading. In the Philippines, for instance, farm tenancy varied from less than 2% of all farmers in the mountain section of Luzon to over two-thirds of all farmers in central Luzon.

Tenancy Improvement.—Governments in both the more advanced and the underdeveloped nations, especially after World War II, showed great interest in improving conditions of tenancy. In the United Kingdom the Agricultural Holdings act of 1948 spelled out tenant rights, giving greater security to tenants. A French law passed in 1946 guaranteed the tenant the right to renew his leases even against the will of the landlord, and provided for compensation if he left. In Brazil the civil code provided that the term of the lease must cover the harvesting of the first crop. In Japan the law of Oct. 1946 provided security for tenants and set maximum levels of rent. In Formosa rents were limited and minimum conditions of tenancy prescribed by legislation. In India the Bombay Tenancy and Agricultural Lands act of 1948 provided comprehensive minimum standards for tenancy contracts. Other Indian states, including Hyderabad, Surashtra and West Bengal, passed tenancy legislation.

Properly framed and administered, improved farm-tenancy arrangements in underdeveloped areas offer an important foundation upon which to build a more productive agriculture. Improved tenancy conditions can offer security, fair returns, assurance of future returns for present investments, improved levels of living and the social and political independence of individuals prerequisite to first-class citizenship.

Providing Security.—Paramount in tenure-improvement measures are adjustments favouring security of tenure wherever insecurity is a serious problem. Fortunately, there are several remedial adjustments which are available and which have been used successfully by particular countries. These adjustments include: (1) written lease provisions; (2) a minimum lease term; (3) a minimum termination notice and automatic renewal; (4) restrictions on transfers of leased land; (5) heritability of leases; (6) permanent occupancy and use of rights; and (7) compensation for disturbance.

In an increasing number of nations, tenancy agreements had to be written and meet certain minimum requirements, as was the case, for instance, in the Netherlands and Sweden. In some of the less developed areas, similar regulations were effectively implemented. In Japan, under the agrarian reform measures following World War II, all tenancy contracts had to be written.

In an effort to lengthen the tenant's planning horizon many nations established a minimum period for an agricultural lease. In the United Kingdom the length of the contract runs for the lifetime of the tenant so long as he practises "good husbandry" and wishes to continue to cultivate his holding. In Belgium the minimum period of lease is nine years. In the Netherlands individual parcels without buildings must be rented for a minimum of 6 years, while farms must be rented for a minimum of 12 years, with, however, provision for adjusting the rent every three years. In the Philippines the tenant has lifetime security of tenure under the Landlord-Tenant Relationships act of 1954, subject to fulfilling statutory requirements. In India the minimum length of time is from five to ten years in different states, and generally the tenant may not be evicted except for default in rent payments, bad cultivation techniques or resumption of the land by the landlord for his own use. In Mexico the interest of the tenant in any event continues until he harvests standing crops or picks ripening fruit. In Formosa the minimum period of lease was set at six years, and could be renewed if the tenant desired unless the landlord took back the land for his own cultivation.

Farm and Home Improvements.—Closely allied to the problem of providing security of tenure is the matter of making farm and living improvements on rented lands. Since rented lands are owned by someone other than the operator, and since improvements made on that land usually become the property of the landowner, tenants have little incentive to make improvements which become the property of someone else.

The adjustments usually considered are: (1) compensation for unexhausted value of improvements; (2) compensation for dilapidations; (3) longer-term leases; (4) kind and amount of rental payments.

Perhaps the most highly developed and formal system of compensation is found in the United Kingdom, under the provisions of the Agricultural Holdings act of 1948. Under this act, the tenant has a statutory right to compensation of three general sorts: (1) for long-term improvements; (2) for medium-term improvements; and (3) usual improvements necessary for good husbandry (*see* also LANDLORD AND TENANT).

Provisions for compensation similar to those in the United Kingdom are found in France, the Netherlands and commonly throughout western Europe. But such measures were also being adopted in other countries. In India, for example, several states recognize the right of the tenant to make improvements and claim compensation for them if forced to quit his holding.

Implementing Improvements.—The activities of the Food and Agriculture Organization of the United Nations in providing technical assistance and sponsoring regional land-problem seminars in Campinas, Braz., Bangkok, Thailand, and Salahuddin, Iraq, may be cited as important measures to implement tenancy improvements. Under the leadership of FAO, concerted efforts by the United Nations agencies have been made to assist member governments in their tenancy-improvement efforts. The United States government has contributed to this end by providing land-tenure technicians for various countries such as Japan, the Philippines, South Korea and Vietnam. (*See* also LAND REFORM.)

THE UNITED STATES

History.—The history of farm tenancy in the United States begins in the colonial period of the 17th and 18th centuries. Most colonists came to America in search of freedom and land. Settlers in the New England colonies, for the most part, owned the land which they farmed. However, colonies to the south of New England were settled by proprietors with large land grants. Proprietors in the middle Atlantic colonies rented their holdings to tenants and attempted to collect quitrents from the tenants. Terms of the "durable lease" or "incomplete sale" under which these tenants occupied land provided for annual rents in the form of dues and services to the landlord. The landlord retained the option of collecting one-fourth of the sale price or recovering full title to the land at three-fourths of the market price.

The quitrent system hung together for two centuries mainly because few landlords collected the dues and services. Never popular with the occupiers, many of whom came to America to escape European feudal land practices, the system was finally thrown off by the antirent rebellions during the 1840s. Except in the plantation areas of the south, most individual landlords owned only one rented farm after the middle of the 19th century.

With almost unlimited free land to the westward to be had largely for the effort of settling, most colonists refused to tolerate unsavoury tenancy conditions in the colonies and early states. However, some farmers preferred the comforts, safety and improvements of the settled areas over the frontier, and they rented farms in the older areas. As many as one-third of the farms were rented in a New Jersey county as early as 1843. Although state- and nationwide statistics on farm tenancy were not obtained until 1880, farm tenancy existed throughout the early development of the nation. At the time of the first nationwide agricultural census, including detailed farm tenure data, in 1880, 25.6% of all farms

were reported being operated by tenants who rented all their land from landlords. Subsequently, the proportion of all farms in the U.S. operated by tenants was 28.4% in 1890, steadily increasing to 35.3% in 1900, 37% in 1910, 38.1% in 1920 and 42.4% in 1930. It dropped to 38.7% in 1940, to 26.8% in 1950 and continued to decline in the second half of the 20th century. Tenancy was most prevalent in the midwestern and southern states. For example, in Iowa 38.4% of all farmers were tenants who rented 42.7% of the state's farmland. In addition, 15.9% of the state's farmers rented part and owned part of the land they operated.

Over the years, farm tenancy in the United States arose from a combination of factors. Young farmers without sufficient capital and management experience rented land from owners desiring to retire from active farming. Nonfarmers who acquired land through inheritance or as a hedge against inflation rented their land to farmers without land of their own. During the depressed 1930s many farm owner-operators lost ownership of their farms through foreclosures and excessive debts coupled with low prices for farm products. These farmers became tenants. A study in Iowa revealed that nine of every ten tenants expected eventually to own the land they operated and these farmers regarded tenancy as a means toward farm ownership.

Lease Types.—Farm tenants pay their landlords a share of the products or cash or a combination thereof as rent for the use of land. Of the more than 1,000,000 farm tenants in the U.S. in the second half of the 20th century, 28% paid a share of the crops only, 23% were sharecroppers, 14% paid a share of the crops and in addition some cash rent, 14% paid cash rent only, 9% paid both shares of livestock and crops and the remaining 12% paid various combinations of the above as rent.

Thus, the most prevalent kind of rent was a share of the crops only. These renters are called crop-share tenants. They usually furnish all the labour, machinery and part or all of the operating capital and own the livestock. Crop-share tenants usually pay one-fourth to one-half of the crops as rent to the landlord.

Sharecroppers, the next most prevalent lease type, were most common in cotton- and tobacco-producing areas (*see* SOUTH, THE). The tenant, or sharecropper, usually furnished the labour only; the landlord furnished machinery, power, seed, fertilizer and other elements of production in addition to the land and improvements. The tenant, or sharecropper, received a share of the crop as a wage for his labour.

Sharecrop-cash tenants are similar to crop-share tenants and differ only by paying some cash in addition to a share of the crops as rent.

Cash tenants pay cash only as rent to the landlord. These tenants pay all operating expenses and receive all returns from crops and livestock. They hire the land from the landlord for a specified amount of cash as rent. This kind of rent was diminishing in importance in the second half of the 20th century.

Livestock-share tenants pay a share of both the livestock and crops produced as rent. Under the livestock-share lease, the tenant furnishes his labour, the landlord furnishes his land and everything else is furnished by landlord and tenant jointly. Livestock-share leases, usually on a 50-50 sharing basis, are common among parents and children. This arrangement is an important means whereby parents retire and their children take over operation of the home farm. However, nonrelated tenants and landlords also use this arrangement quite often. The livestock-share lease, most prevalent in the livestock-producing areas of the middle west, was growing rapidly in proportion to other kinds of leases.

Lease Problems and Improvements.—Three major problems plagued leasing arrangements throughout the nation. First, most farm leases were for only one year without automatic renewal, which did not provide the tenant family sufficient certainty of expectations to enable them to become a vital part of the community or to use the farm resources in the most productive manner.

Second, farm leases were influenced largely by past customs and often failed to encourage changing technological improvements in agriculture.

Third, rent payments frequently did not reflect the relative productivity of resources contributed by landlord and tenant, respectively. Changes in prices and costs were not readily reflected in rentals, which lagged behind price and cost changes.

Improvements in farm leases include longer-term leases or annual leases with automatic-renewal provisions unless one party notifies the other party four, six or nine months ahead of the end of the lease year. Another improvement is compensation to tenants for unexhausted value of improvements made by the tenant if and when the tenant quits the farm before receiving full benefits from the improvements. The amount of compensation may be determined by the remaining benefits of the improvement at the time the tenant leaves the farm. These remaining benefits may be based upon the original cost of the improvement, replacement cost or productive value. The original cost method is most frequently used, although it fails to reflect price changes and does not necessarily represent productive value. Still another involves making the division of income between landlord and tenant reflect more accurately the productivity of the resources each contributes. Further improvements include provisions for the use of fertilizers, rotation, weed-, insect- and disease-control measures, conservation improvements and other improved farming practices. Finally, leases should be in writing in order to minimize disagreements over their provisions. (J. F. T.)

FARNABY, GILES (*c.* 1565–1640), English composer of virginal music and madrigals. Sir John Hawkins (d. 1789) says that Farnaby came of the same family, originally of Truro, Cornwall, as the schoolmaster and scholar Thomas Farnaby, but it is not known whether he was born before or after their removal to London. Like his father he was a citizen of London and a member of the Joiner's company, and the fact that a cousin, Nicholas, was a virginal maker suggests that Giles's activity as a musician may have had the same beginning. This would also explain why the composer of one set of fresh but rather unimportant canzonets (1598) and a number of psalm settings should rank with the greatest keyboard composers of his day. Not that Farnaby was without academic training—he graduated as bachelor of music at Oxford university in 1592; but his marked disregard for the current conventions of written counterpoint (consecutive fifths occur quite frequently in his canzonets) points to the virginal player rather than the church-trained organist. Of the 54 pieces by him in the Fitzwilliam virginal book, the most individual are such short and intimate ones as "His Dream" and "His Rest," but his larger sets of variations exploit a vein of brilliant virtuosity scarcely inferior to that of John Bull.

His son Richard (born *c.* 1590) is represented by four pieces in the same collection.

See E. H. Fellowes (ed.), "Canzonets to Foure Voyces," *English Madrigal School*, vol. xx (1922); J. A. Fuller-Maitland and W. Barclay Squire (eds.), *Fitzwilliam Virginal Book* (1899). (J. J. N.)

FARNBOROUGH, THOMAS ERSKINE MAY, 1st BARON (1815–1886), clerk of the British house of commons, historian and writer on parliamentary procedure, was born in London on Feb. 8, 1815, and was called to the bar at the Middle Temple in 1838. His *Treatise on the Law, Privilege, Proceedings and Usage of Parliament* (1844; 16th ed., 1957) is a standard work on the subject, and has itself influenced parliamentary procedure. Sir Erskine May (he was created knight commander of the bath in 1866) was examiner of petitions for private bills (1846), taxing master of the house of commons (1847), assistant clerk (1856) and clerk of the house of commons (1871–86). His *Constitutional History of England . . . 1760–1860* (1861–63) was revised in later editions by its author. He died in London on May 17, 1886, a few days after his elevation to the peerage.

FARNBOROUGH, an urban district in the Aldershot parliamentary division of the county of Southampton (*i.e.*, Hampshire), Eng., 33 mi. S.W. of London by road. Pop. (1961) 31,911. It is mainly residential, but is famed as the site of the Royal Aircraft establishments and has important military and other establishments. A display of civil and military aircraft is held annually by the Society of British Aircraft Constructors. The parish church of St. Peter includes portions of its Norman predecessor and has a wooden belfry at the west end. On the north wall are some 12th-14th century murals.

Above the east side of the main road is Farnborough hill mansion, now a convent but for some time the residence of the former empress Eugénie of France, who built St. Michael's Roman Catholic church in 1887 to receive the remains of her husband, Napoleon III, and her son Louis, the prince imperial; she too was buried there.

FARNE ISLANDS, a group of 17 main islets with smaller rocks and reefs, about 80 ac. in extent, lying 1½ to 6 mi. off the N.E. coast of Northumberland, Eng. They are composed of dolerite, which has resisted the action of the waves, and are a part of the Whin Sill. The largest island, Inner Farne or House, is 16 ac. in extent and has precipitous cliffs up to 80 ft. in height; the other principal islets are Staple, Brownsman, North and South Wamses, Longstone and Big Harcar. The whole group belongs to the National trust and is preserved as a bird sanctuary, for myriads of sea birds breed there. On Inner Farne a small 14th-century chapel stands on the site of the hermitage to which St. Cuthbert (*q.v.*) retired from the priory at Lindisfarne between 676 and 684. He was with difficulty persuaded to leave Farne on his appointment to the bishopric of Lindisfarne and returned to it to die in 687. Longstone lighthouse was the home of the heroic Grace Horsley Darling (*q.v.*) who, with her aged father, the keeper, rescued survivors of the "Forfarshire" which was wrecked on Sept. 7, 1838, on the Harcars. Near the southwest point of Inner Farne is the powerful Farne lighthouse.

FARNESE, an Italian family which ruled the Parma duchies from 1545 to 1731. Originating in upper Lazio, the family soon became famous through its statesmen and its soldiers, among them Pietro, consul of Orvieto *c.* 1100 and commander of the papal cavalry; Pier Nicola, defender of Bologna in 1361; Piero, who distinguished himself in the Pisan war in 1363; and Ranuccio il Vecchio (the Old), one of the most celebrated *condottieri* of his time, who commanded the Florentines against Milan in 1424 and later was Pope Eugenius IV's captain against the Colonna. In the 15th century, moreover, the Farnese won great power thanks to an adroit matrimonial policy; of Ranuccio's sons, Gabriele Francesco married Isabella Orsini, while another, Pier Luigi, married Giovanella Caetani.

Of this latter union was born Alessandro (1468–1549), the future Pope Paul III (*see* Paul). His illustrious name and his vast culture (he had been a pupil of Pomponio Leto), as well as the love affair of his sister Giulia with Pope Alexander VI, assured his rapid rise at the Roman court. A cardinal from the age of 25, he was elected pope on Oct. 13, 1534, after a compromise reached by the French and the imperial parties. In the prevailing spirit of nepotism, Paul III, at the consistory of Aug. 19, 1545, detached Parma and Piacenza from the papal dominions and erected them into duchies.

Pier Luigi (1503–47), the first duke, was Paul's son by a woman whose name is unknown. He carried out a vigorous and efficient internal policy in Parma and Piacenza. He instituted a supreme council of justice and a ducal chamber, ordered a census of the population, reduced the Valtarese to submission and curbed the power of the feudal lords. In his foreign policy he maintained an ambiguous attitude toward the Holy Roman empire, and the resentment of Charles V probably favoured the conspiracy of the nobles who assassinated Pier Luigi at Piacenza on Sept. 10, 1547.

Pier Luigi's second son, Ottavio (1524–86), had been married to Charles V's natural daughter Margaret (*q.v.*) of Austria in 1542, but when Ottavio succeeded to his father's title Charles V caused Piacenza to be occupied and gave the Valtarese, Bardi and Compiano to Giulio Landi, one of the conspirators. Even Paul III himself was not sure whether to keep the Farnese state alive or not. Ottavio, however, having refused to surrender Parma to the Holy See, reacted with energy and ability to his difficulties and finally became reconciled with Charles V's son Philip II of Spain, who at the treaty of Ghent (1556) gave Piacenza back to Ottavio, though keeping a garrison there. Ottavio, who made Parma his capital instead of Piacenza, continued his father's work of internal consolidation and the struggle against the feudal lords. He harshly repressed a conspiracy in 1582 and subdued the Valtarese again.

Pier Luigi's eldest son, Alessandro (1520–89), had been created cardinal at 14. A patron of scholars and artists, it was he who completed the magnificent Farnese palaces in Rome and at Caprarola. His younger brother Orazio married Diane (*q.v.*) de France, natural daughter of Henry II, and was killed at Hesdin in 1553.

The third duke, Alessandro (1545–92), Ottavio's son, was the most distinguished male member of the Farnese family (*see* the separate article Farnese, Alessandro). Educated at the court of Madrid, where he had been sent as a hostage according to a clause in the treaty of Ghent, he followed a career of arms and after his father's death continued in command of the Spanish forces in Flanders because Philip II would not agree to his return to Parma, of which he was duke only in name.

Alessandro was succeeded in 1592 by his son Ranuccio I (1569–1622), who had been regent since 1586. In 1612 Ranuccio ferociously repressed a conspiracy of the nobles, which was provoked by a further diminution of the privileges of the local feudatories but was abetted by the Gonzaga dukes of Mantua and perhaps also by the house of Savoy. The conspiracy may well have been part of a vast scheme against the Spanish preponderance in Italy, as the Farnese were Spain's most faithful allies. Ranuccio is remembered also for his constitutions of 1594 reforming the structure of public administration, and for the control that he exercised over education.

Ranuccio's son and successor Odoardo I (1612–46), ambitious and impulsive, wanted to alter the basic principles of the Farnese policy. He joined the anti-Spanish league during the Thirty Years' War and equipped an army at great cost to himself and with disastrous consequences, as the duke of Modena deserted the league and invaded the duchy of Parma. In 1637, therefore, Odoardo had to sign a peace and to renounce the French alliance. A few years later (1640) he quarreled with Pope Urban VIII over the Farnese fief of Castro, in Lazio, on which Urban's Barberini nephews had designs. The fief was confiscated, war broke out and in 1642 Odoardo was excommunicated. Then Venice, Tuscany and Modena formed an antipapal league to protect Parma, and France also intervened in Odoardo's favour. Peace was concluded on the basis of the *status quo ante*, at Venice on March 31, 1644.

Odoardo's eldest son, Ranuccio II (1630–94), who succeeded him in 1646, inherited a heavy burden, the effects of which became obvious chiefly in the reopening of the Castro question. In 1649 Pope Innocent X accused the Farnese of the murder of an ecclesiastic and seized the fief; the duke declared war, but was utterly defeated at Bologna (Aug. 13). Abandoned by France and by Spain alike, he had to agree to pay a ransom to redeem Castro, which was finally taken from him in 1666 on the ground that payments were in arrears. Ranuccio, however, secured Bardi and Compiano for himself (1682). He also founded the public archives (1678) and instituted tariffs to protect local industries. Even so, the situation of the duchy remained on the whole precarious, one of the reasons being the continual passage of troops during the War of the Grand Alliance.

Francesco (1678–1727), Odoardo's brother and his successor in 1694, attempted to save the fortunes of the state and of the dynasty, now in utter decadence, by his economic and diplomatic initiative, but his only important success was the marriage of his niece Elisabetta (*see* Isabella) to Philip V of Spain in 1714, which enabled him to pursue a plan for an anti-Austrian league in Italy.

The last Farnese of the male line was Antonio (1679–1731), duke from 1727. On his death his widow, Enrichetta d'Este, was supposed to be pregnant but proved not to be so. Parma and Piacenza passed to Don Carlos (the future Charles III of Spain), Philip V's eldest son by Isabella, as it had already been agreed at the treaties of London (1718), of The Hague (1720) and of Seville (1729)—but not without protests and counterclaims by the papacy and by the Holy Roman empire.

A collateral branch of the Farnese, called the branch of Latera, founded by Bartolomeo, son of Pier Luigi Farnese and Giovanella Caetani, had died out in 1668.

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FARNESE, ALESSANDRO (1545–1592), duke of Parma from 1586, the statesman and general who governed the Spanish Netherlands for 21 critical years, was born in Rome on Aug. 27, 1545, the son of Ottavio Farnese, duke of Parma from 1547 (*see* FARNESE), and Margaret of Austria, natural daughter of the Holy Roman emperor Charles V. At the end of 1556 Alessandro was sent, more or less as a hostage, to the court of Philip II of Spain, then at Brussels in the Netherlands (whence he accompanied Philip on his visit to England); and in 1559 he was taken to Spain. He thus became acquainted with Don John of Austria (*see* JOHN [Don, 1545–1578]), Philip's half brother. Margaret of Austria, however, had in 1559 been made regent of the Netherlands; and in 1565 Alessandro returned there for his marriage, in Brussels, to the Portuguese infanta Maria. After this he was allowed to return to Parma. Bored with inactivity, he obtained permission to join Don John and took part in the battle of Lepanto in 1571. He then served with Don John in Italian campaigns till the end of 1574. Finally, late in 1577, he was summoned to the Netherlands to reinforce Don John, now regent there for Philip of Spain. For the revolt with which the Spaniards were confronted *see* NETHERLANDS, THE: *History*.

Farnese's presence contributed much to Don John's victory at Gembloux (Jan. 31, 1578); and on Don John's death (Oct. 1) Farnese was appointed regent in his place. His first major success was the treaty of Arras (May 1579), whereby the Catholics of Hainaut, Artois and Douai seceded from the rebellion and reaffirmed their allegiance to Spain. Farnese could now proceed against the Union of Utrecht, to which William the Silent, prince of Orange, and the rebellious provinces adhered. He took Maastricht in June 1579, Tournai in Dec. 1581. After campaigns against the French pretender François, duc d'Anjou (*see* ALENÇON, DUCS D'), in 1582–83, he then reduced Ypres, Bruges and Ghent in 1584. Then he turned to his major enterprise, the siege of Antwerp. To prevent the town's being relieved by sea, he had a bridge constructed across the Scheldt, from Calloo to Oordam. This was completed on Feb. 25, 1585; and on Aug. 17, worn out by the blockade, Antwerp capitulated. The southern Netherlands were now Spanish again.

His father's death (1586) made Alessandro duke of Parma, but Philip retained him as regent in the Netherlands. Despite his successes against the earl of Leicester (sent from England to help the Dutch), the most notable of which was the capture of Sluys in Aug. 1587, Parma was hampered in his plans for subjugating the rest of the Netherlands by Philip II's determination to conquer England. Parma was instructed to conserve his troops and to marshal a fleet of transports which would cross the channel protected by a fighting fleet from Spain. The failure of this design, in 1588, is the story of the Armada (*q.v.*).

After this, Parma's energies were further diverted from continuous operations against the Dutch by events in France, where Henry III's *coup d'état* against the pro-Spanish Guises (1588) had been followed by the accession of the Protestant Henry IV to the royal title (1589). Moreover, the Spanish treasury could no longer send money regularly for the payment of Parma's army. He had to pledge his own jewels for this in 1590 and also to suppress a mutiny. He led 15,000 men into France in Aug. 1590 to the relief of Catholic Paris, which Henry IV was besieging. He outmaneuvered Henry and saved Paris, then had to retreat at once to the Netherlands. Likewise, in 1591, he had to interrupt a campaign against Maurice of Nassau in order to relieve Rouen. He died at the abbey of St. Vaast, near Arras, in the night of Dec. 2–3, 1592. After a magnificent funeral in Brussels, he was interred in Parma, with the single word "Alexander" for epitaph. One of the greatest soldiers of his time, he had also been an astute diplomat. His soldiers' excesses, for instance at the sack of Maastricht, and his condonation of attempts on the life of William the Silent are blemishes on his reputation.

See L. van der Essen, *Alexandre Farnèse*, 5 vol. (1933–37).

FARNHAM, a market town and urban district in the Farnham parliamentary division of Surrey, Eng., 38 mi. W.S.W. of London by road. Pop. (1961) 26,934. Area 14.1 sq.mi. Farnham lies in the valley of the River Wey, whose northern and southern slopes rise to 600 and 500 ft. respectively above sea level. Aldershot camp is 3 mi. N.E. Farnham castle, on a hill north of the town, was, until the creation of the diocese of Guildford in 1927, the palace of the bishops of Winchester; in that year it became the residence of the bishop of Guildford and is partly a retreat house. The castle was first built by Henry of Blois, bishop of Winchester and brother of King Stephen. It was razed by Henry III but rebuilt by the bishop of Winchester. In 1567 and 1569 Bishop Horne entertained Queen Elizabeth I there.

Farnham was garrisoned for Charles I, suffered during the Civil War and was demolished in 1648. George Morley, bishop of Winchester, restored the episcopal palace within its walls (1662–84). The park of 300 ac. was acquired by the urban council in 1930. The parish church of St. Andrew is a transitional Norman and Early English building with later additions. It was formerly a chapel of ease to Waverley abbey (2 mi. S.E. of Farnham), the earliest Cistercian house in England, founded in 1128 by William Giffard, bishop of Winchester. William Cobbett (*q.v.*) was born in the parish and is buried in the churchyard. The mansion of Moor park was the residence of Sir William Temple (d. 1699) and his wife, Dorothy Osborne (d. 1695). There Jonathan Swift worked as Temple's secretary (1689–94). Esther Johnson, Swift's "Stella," also lived in the house, her mother being employed by Lady Giffard, Temple's sister.

By the time of the Domesday survey the manor of the bishop of Winchester at Farnham was as large as most of the king's estates. Farnham's position at the junction of the Pilgrims' way and the road from Southampton to London was important. In 1205 it had bailiffs, and in 1207 it was a mesne borough under the bishop of Winchester. In 1247 the bishop granted the first charter, giving, among other privileges, a fair on All Saints' day.

Henry Cardinal Beaufort is said to have confirmed the original charter in 1410, and in 1566 Bishop Horne granted a new charter. In the 18th century the corporation, a close body, declined, its duties being performed by the vestry, and in 1789 the one survivor resigned and handed over the town papers to the bishop. Farnham sent representatives to parliament in 1311 and 1460. It early became a market of importance and was famous in the late 17th and early 18th centuries for wheat and oats. Hop-growing has been carried on in the neighbourhood since 1597.

FARNWORTH, a municipal borough (1939) of southeast Lancashire, Eng., lies 9 mi. N.W. of Manchester. Pop. (1961) 27,502. Farnworth was originally settled in Saxon times. The first mill was erected in 1676. During the 19th century large-scale industrial development took place. The town's open spaces include Central and Darley parks. Market street, the principal shopping centre, is on the main road between Bolton and Manchester and there are two railway stations. The chief industries are cotton spinning and weaving, rayon weaving, textile finishing and general engineering. (T. HI.)

FARO, the southernmost city of Portugal and the capital of a district of the same name, is an Atlantic port 327 km. (203 mi.) S.S.E. of Lisbon by road. Pop. (1960) 19,094. It is on the Lisbon-Vila Real de Santo Antonio railway, and an airport was constructed in the 1960s. Through its harbour are exported fish, wine, local spirits, fruit (almonds, figs and other dried fruits), cork, baskets and sumac. The mineral resources of the district, which include tin, lead, antimony and auriferous quartz, are little developed, but agriculture is more advanced. Faro was recaptured from the Moors in 1249. It was sacked by the English in 1596 during the Spanish occupation and suffered severe earthquakes in 1722 and 1755.

The administrative district of Faro (area 1,958 sq.mi.; pop. [1960] 312,509) coincides with the ancient kingdom and province of Algarve (*q.v.*). It is popular with tourists because of its mild climate, its many fine beaches (Rocha, Albufeira, Monte Gordo) and scenery, and its towns which show their years of Moorish occupation. Of these, Monchique has medicinal springs and baths. This land of fishermen and sailors was important in Portuguese history. Henry the Navigator chose it as a base, and from ports near Faro sailed the first expeditions in the age of discovery. Close by are the Roman ruins of Milreu (Ossonoba).

FARO, one of the oldest of all gambling games played with cards, supposedly named from the picture of a pharaoh on French playing cards imported into Great Britain. It was enjoined by specific mention in English law as early as 1739. A favourite of highborn gamblers throughout Europe in the late 18th and early 19th centuries, Pharaoh was the game at which the young Count Rostof, in Tolstoy's *War and Peace*, lost a fortune. In the United States a writer in 1894 termed it "unquestionably entitled to be called the national American card game." A commonplace in U.S. gaming rooms, especially in the west, until about 1915, the faro bank (marked traditionally by a picture of a tiger as an advertisement outside the house, whereupon playing faro was known as "bucking the tiger"), by 1925 had all but vanished. Faro later continued to be a fixture at licensed gambling houses in Nevada.

The Layout.—In faro a shuffled 52-card pack of playing cards is placed face up in a dealing box. Bets may be placed only against the house. The 13 cards of the spade suit, representing the ranks of all suits, are enameled on a cloth, or layout, on which the bets are placed. A bet may be placed on any rank to win, or (by coppering the bet, that is, placing a copper counter on the chips) to lose; or, by the manner in which the chips are placed on the layout, may cover several ranks.

The Play.—The dealer takes one card from the box. This card, called soda, is not used. The next card taken from the box loses (the house pays the amount of any coppered bet placed on this rank and takes in bets placed on this rank to win). The next card (left showing in the box) wins, and the house pays the amount of any bet placed on that rank to win. The removal of one card and exposure of the next constitute a turn on which bets are settled. Then the dealer removes the exposed card from the box, puts aside another card, which loses, and leaves exposed another card, which wins. The casekeeper keeps on display a running record of which cards have been played and which are still to come, for reference of all players. The last card in the box (called in hock), like soda, does not count.

When cards of the same rank appear in the same turn, and so both win and lose, the house takes half of each bet on that rank, whether to win or to lose. This is called a split. When only three unplayed cards remain in the box, players are invited to call the turn, the house paying 4 to 1 (against odds of 5 to 1) to any player guessing correctly the exact order in which these cards will appear. If the last three cards include a pair (called a cathop) the house pays 2 for 1 to anyone who calls the order.

Stuss is a variant of the game in which the cards are dealt from a pack held face down in the dealer's hand, not from a dealing box, and when a split occurs the house takes all the bets on that rank, instead of only half of them.

See A. H. Morehead *et al.*, *The New Complete Hoyle* (1956).

(A. H. Mo.; F. Hs.)

FARQUHAR, GEORGE (1678–1707), was the only British dramatist of any comic power at the beginning of the 18th century, and he infused a new element into the old dramatic form. He was born, the son of a clergyman, in Londonderry, Ire., and was entered as sizar at Trinity college, Dublin, but he preferred to spend his energies as an unsuccessful actor at the Smock Alley theatre in Dublin. Having almost fatally wounded a fellow actor in Dryden's *Indian Emperor* by failing to distinguish between a rapier and a foil, he abandoned his stage career and went to London to write comedy, encouraged by the actor Robert Wilks, with whom he had acted in Dublin.

His first play, *Love and a Bottle*, was produced at the Drury Lane theatre in 1699 and, being well received, was followed in the same year by *The Constant Couple* and in 1701 by its sequel, *Sir Harry Wildair*. In Feb. 1702 there appeared his adaptation of Fletcher's *The Wild Goose Chase*, which he named *The Inconstant*, and in December, *The Twin Rivals*. No further plays apart from *The Stage Coach* (1704), a farce translated from the French in which he collaborated with Pierre Motteux, appeared until 1706. He may have spent the time in soldiering, since the earl of Orrery had given him a commission in his regiment, but at all events it is certain that in 1703 he married a Yorkshire woman whom he mistakenly believed to have a fortune. Some of his letters had appeared in 1701 in Abel Boyer's collection of *Letters of Wit*, and in 1702 he issued *Love and Business in a Collection of Occasionary Verse and Epistolary Prose*, which contained his "Discourse Upon Comedy," a somewhat schoolboyish scourging of academic critics.

His plays up to this point were not much more than spirited variations on the theme of Colley Cibber's *Love's Last Shift*, in which libidinous young men have their fling for four acts and unconvincingly reform in the fifth. They have, however, freshness, wit and a lively human sympathy. He enjoys his fools rather than despises them. His real contribution to the drama came with *The Recruiting Officer* (1706) and *The Beaux' Stratagem* (1707), which he completed on his deathbed. He died on April 29, 1707, a few days after its successful production at the Haymarket theatre.

His achievement in these two last plays was the introduction of Elizabethan verbal vigour and love of character into the ethos of Restoration plays of sexual conflict. He stands out from his contemporaries for sheer originality of dialogue and a sense of the stage based upon his practical theatrical experience. He had the Irishman's gift of using an acute and mocking critical spirit to reveal the falsity of common social assumptions, and, since these do not much vary, his plays still have pungency, as has been proved more than once by 20th-century revivals of his final play. It is usually said that he, with Sir John Vanbrugh, helped to destroy Restoration comedy by a "luscious" treatment of sex; it is more accurate to say that he helped to destroy it by discarding its outworn themes in favour of contemporary actualities.

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FARRAGUT, DAVID GLASGOW (1801–1870), U.S. admiral who won fame as a Union commander during the Civil War, was born on July 5, 1801, near Knoxville, Tenn. At New Orleans he formed a close friendship with Capt. David Porter of the navy, who adopted his young namesake and put him in the navy in 1810. Farragut went to sea the next year on board the U.S.S. "Essex" with Porter, who took every opportunity to throw responsibility on the boy. Farragut commanded a prize with ability when only 12 years old, served with credit in the "Essex's" desperate fight with H.M.S. "Phoebe," and returned to the United States to go to school. The next few years were devoted alternately to service afloat and to school. He learned French, Italian and Arabic. Before he was 20 he was already an accomplished officer. In 1823 the navy department placed Commander Porter in command of a squadron to destroy the pirate strongholds in the West Indies. Farragut accompanied Porter, and active service ashore and afloat may be said to have completed Farragut's education. He had even had practice in handling a steamer and in 1824 was in command of the U.S.S. "Ferret." Routine service followed for many years.

The Civil War opened in the spring of 1861, and in Dec. 1861 he was assigned to command the West Gulf blockading squadron, with orders to enter the Mississippi river and capture New Orleans. The strategic plan of the administration for the reduction of the seceding states assigned a great role to the navy. While the armies in the field were to oppose the Confederate forces, the task of the navy was to cut the hostile armies from their sources of supply overseas, for which they expected to pay by exporting cotton. The first step of the navy was to establish a blockade of the coast from the Chesapeake to the Rio Grande. By the end of 1861 this blockade was becoming fairly effective, but munitions of war landed in Mexico were finding their way along the Red river and the Mississippi to Confederate armies. The second great strategic operation of the navy was to seize control of the Mississippi and stop the supply of foodstuffs and munitions coming from the southwest. An army in conjunction with a flotilla of river craft undertook this task from the north, while Farragut with the same purpose moved from the open sea against New Orleans, the metropolis of the south, where success would

secure him a valuable base for subsequent advance. The war department believed that the forts on the river below the city should be reduced by mortar fire before attempting to thrust wooden ships past them, but Farragut carried out his own bolder plan of running by them in the dark and was completely successful on April 24, 1862. His position above the forts cut them off from the city. Troops from the transports outside could land almost under his protecting batteries and the result was the surrender of the forts and the city. Against Farragut's opinion, the department insisted on his proceeding farther up the river, but the time was inopportune and nothing important was then accomplished. But the following year, when Grant's army was occupied before Vicksburg, Farragut greatly aided him by passing the heavy works at Port Hudson below the Red river and stopping traffic along that stream. Vicksburg fell in July 1863 and the Mississippi was soon in Federal control to the great loss of the Confederate armies fighting in Tennessee and Virginia. Farragut now turned his attention to entering Mobile bay, where he expected an army from the north to meet him and so to cut off another great slice from the Confederacy, but the troops were employed elsewhere. Mobile bay was formed by a long sandspit enclosing a large inlet. It was defended by several forts, of which the strongest was Ft. Morgan at the end of the spit close to the channel. A line of mines obliged ships to pass close to Ft. Morgan, and, besides, the heavy ironclad "Tennessee" covered the approaches. Farragut had to wait till he had monitors to pit against the "Tennessee," and on Aug. 5, 1864, he entered in two columns, the monitors leading and the wooden frigates following, each with a gunboat lashed to her port side. Farragut in the "Hartford" held the second place in his column. The leading monitor, "Tecumseh," in her anxiety to engage the "Tennessee," crossed the mine field and was blown out of the water. The "Brooklyn," leading the wooden column, stopped: the line drifted in confusion while the tide swept all upon the fort. This was the great moment of Farragut's life. Disaster was imminent. With instant decision he shouted "Damn the torpedoes" to the hesitating "Brooklyn," and swung his own ship clear of her and headed across the mines which had just been fatal to the monitor. The mine cases rattled against the bottom but none exploded and the fleet followed on and anchored triumphantly above the fort. Then the "Tennessee" came out from the shelter of the fort and after a hard fight, in which the wooden ships repeatedly rammed her, she was reduced to impotence and surrendered. The forts were now isolated and surrendered one by one, Ft. Morgan waiting till the troops lying outside in transports had landed their siege guns and brought them into action. Farragut's health now forbade further active service. His work was over. He had been made rear admiral in 1862, vice-admiral in 1864 and admiral in 1866. In 1867 he went to Europe and paid a round of ceremonial visits to the seaports of the great powers. He died at Portsmouth, N.H., on Aug. 14, 1870. (W. L. R.; X.)

FARRANT, the family name of several English musicians active in the period between 1550 and 1650; their careers, identities and relationships (if any) are confused. The earliest and most distinguished as a composer, RICHARD (*c.* 1530–80), was a gentleman of the Chapel Royal from 1552 until his appointment in 1564 as master of the choristers at St. George's, Windsor; this post entailed the annual presentation of a play before the queen, and some of his music for these survives as well as anthems and a service. In 1569 he was reappointed to the Chapel Royal, retaining both posts until his death in 1580. Two organists and composers named Farrant were employed at Salisbury cathedral. JOHN the elder, almost certainly at Bristol from 1570 to 1571, was appointed master of the choristers at Salisbury in 1571 and organist in 1578. In 1592 he left for Hereford but resigned his post there in the following year. The younger JOHN (1575–1618), his son, was born at Salisbury and held the post of organist there from 1598 until his death. A John Farrant was organist of Ely cathedral (1567–72) but nothing further is known of him. The John Farrant described in Adrian Batten's organ book (*c.* 1638) as organist of Christ church, Newgate, in London, is probably distinct from these three. DANIEL, a viol player, was in the royal service from 1619 until the Commonwealth; he died before 1660. He may be identical with, or more probably the son of, the royal violinist of the same name mentioned in state papers in 1607. (J. J. N.)

FARRELL, JAMES THOMAS (1904–), U.S. writer known especially for his detailed fictional explorations of the lower middle class Irish on the south side of Chicago, where he was born, Feb. 27, 1904. Educated in parochial schools and at The University of Chicago, he supported himself at various jobs before becoming established as a writer. In his writing Farrell attempted to present and analyze honestly and painstakingly social groups and what he called "social structures," in a modified version of early 20th-century naturalism. Of more than 30 volumes of fiction he published, the titles are fairly evenly divided between the novel and the short story, though his exhaustive analysis of a section of American urban life required the expanded scope of a linked series of novels. The most famous of these was the first, a trilogy describing the life of "Studs" Lonigan in a deteriorating middle-class section of Chicago (*Young Lonigan*, 1932; *The Young Manhood of Studs Lonigan*, 1934; and *Judgment Day*, 1935). The style followed both social and speech idioms with scrupulous consistency and the work revealed the hero's decline in terms of the decline of the milieu. Subsequently, Farrell drew from one of the lesser figures of his trilogy, Danny O'Neill, for five novels (1936–54); a third hero, Bernard Clare (or Carr), was the subject of another trilogy (1946–52). These sequences—the first in particular—were likely to stand as Farrell's major achievement.

Of his nonfiction, *A Note on Literary Criticism* (1936) is important for its criticism of the Marxist view of literature; *Reflections at Fifty* (1954) is a volume of reminiscences.

See Joseph Warren Beach, *American Fiction, 1920–1940* (1941); Wilbur Merrill Frohock, *The Novel of Violence in America* (1950); C. C. Walcutt, *American Literary Naturalism* (1956). (F. J. HN.)

FARRIERY, the shoeing of horses and other ungulates with nailed rims of iron. The craftsman so engaged is called a farrier, or blacksmith. Since farriers learned to treat wounds and diseases of horses, farriery came to include the veterinary art.

Both tools and methods of farriery differ somewhat between continental Europe and the English-speaking lands. The continental farrier has an assistant to hold the animal's foot, whereas the British or North American farrier works alone. Knives and files are used to clean and pare the hoof. A shoe of appropriate size, heated until it is red, is then usually held against the hoof so that charring will show any remaining irregularities of the hoof surface that should be removed. The shoe is then exactly fitted, shaped and attached with six or eight nails.

See also VETERINARY SCIENCE: *History*. (L. T. W.)

FARRUKHABAD, a city, district and *tehsil* in the Allahabad revenue division of Uttar Pradesh, India. The city is near the west bank of the Ganges, 77 mi. N.W. of Kanpur. It forms a joint municipality with Fatehgarh, the military and administrative area to the southeast; pop. (1961) 94,591. Farrukhabad is a junction of the North Eastern (metre-gauge) and Northern railways: the former connects northwest to Mathura and southeast to Kanpur, and the latter connects Farrukhabad southward with Shikohabad (70 mi.) on the Delhi-Allahabad main line. The city is linked by road with the Grand Trunk route to the south. Manufactures include printed calico and curtains, quilt cloth, metal vessels, gold lace, tents, sugar and tobacco. There are cold-storage plants for potatoes, which are distributed in large quantities. Farrukhabad was founded in 1714 by Mohammed Khan, nominal Mogul governor who established his independence in the area for about 30 years.

FARRUKHABAD DISTRICT (1,645 sq.mi.; pop. [1961] 1,295,071) is a flat alluvial plain in the middle Doab (*q.v.*). It is watered by the Ganges, which crosses the north of the district, and by its tributaries the Kali Nadi (Kalandar), Isan and Arvind. The Kanpur branch of the Ganges canal passes through the south of the district. The main products are rice, wheat, barley, millets, pulses, cotton, sugar cane, tobacco and potatoes. The last two, together with watermelons, cotton prints, perfume and saltpetre, are the district's main exports.

Farrukhabad district contains many ancient sites, including those of Kannauj (*q.v.*), Sankasya (or Kapitha) and Kampil.

Sankasya, represented by the modern village of Sankisa (1,134) 8 mi. W. of Farrukhabad, is mentioned in the Hindu epic *Ramayana* (*c.* 4th century B.C.). It became a famous Buddhist pilgrimage city and it was believed to be the place where Buddha descended from heaven after three months. Several mounds probably mark the sites of ancient Buddhist stupas or relic mounds and a monastery. The existing village stands on a great mound of ruins known as the Fort. Close by, on another mound of bricks, stands a medieval temple of Bisari Devi; and 400 ft. north of this temple there is the capital of an Asokan column (3rd century B.C.), bearing the figure of an elephant. Outside these monuments the earthen ramparts of the ancient city make a circuit of about 3.5 mi.

Kampil is mentioned in the *Yajurveda* and in the later epic *Mahabharata* (*c.* 2nd century B.C.) as the capital of the quasi-legendary kingdom of southern Panchala. The modern village (2,000), 24 mi. N.W. of Farrukhabad, is near an old course of the Ganges, beside which stand rows of ancient temples. There are also three Jain temples dedicated to the sage Neminath. (B. Sr.)

FARS (formerly Farsistan), an *ostan* (province) of southwestern Iran. It is bounded southwest and south by the Persian gulf and the general governorship of Bandar Abbas, northwest and north by Khuzestan and Isfahan and east by Kerman. Pop. (1961 est.) 1,230,336; area 57,401 sq.mi. The province is almost filled by a succession of ridges, mostly of limestones (the prolongations of the Zagros range), running in a southeast-northwest direction and intersected by plains. The whole system drops in steps from a central axis of elevation at the Kuh-e Dinar (14,276 ft.) toward the south, southeast and northeast.

Climatically Fars may be divided into the *garmsir* and the *sardsir* (the warm and the cold regions). The *garmsir* extends up to about 2,500 ft. and is humid along the coast and in the western foothills but dry in Laristan. Date palm and other delicate fruits besides grain, rice, cotton and tobacco grow in the *garmsir*. Settlement is sparse and the region is largely used by tribes for winter pasture. The plains of the *sardsir* (Marv Dasht, Bazeh [Bayzah], Shiraz, Fasa, Darab) are the main centres of cultivation. They are watered by rivers or strong springs and mostly form closed basins with salty lakes (Maharlu, below Shiraz, and Bakhtegan [or Neyriz] fed by the joint rivers Kor and Sivan [Polvar]). The plains and plateaus of the *sardsir* gradually merge into the interior deserts. Most ranges in the *sardsir* and the transitional zone (2,500–4,500 ft.) were originally clad in oak forest which suffered heavy destruction. Still higher are the summer pastures.

The most important tribes are the Kashgai (Qashqai) of Turkic origin and speech, the Khamseh of Arab and Turkic stock, and the Lak who gave Persia one of its most benevolent rulers, Karim Khan Zand (1750–79). Agriculture and the raising of flocks are the main occupations of the province; carpet weaving and other traditional crafts are also carried on. Modern industrialization (sugar refining, cement) is slow. Shiraz (*q.v.*), famous for its poets and its wine, is the chief city and the capital of the province. Other centres are Kazerun, Lar, Jahrum, Borazjan and Bushire in the *garmsir;* and Neyriz, Fasa, Abadeh, Ardakan and Firuzabad in the *sardsir* or the transitional zone. Bushire is the seat of the governor of the Gulf Ports subdivision of the *ostan*. Shiraz and Abadeh are on the main road from Bushire to Teheran.

Fars, the ancient Persis (*q.v.*), settled since Neolithic time, has played a prominent part in Persian history. It was the heart of the Achaemenid and the Sassanid empires which left many noble traces (Pasargadae, Firuzabad, Persepolis [*qq.v.*] and Naksh-e Rostam). During the Arab, Seljuk and Mongol conquests, alien tribes obtained a foothold in Fars. Resultant quarrels and misgovernment together with the deterioration of the natural endowment and repeated calamities led to the impoverishment and even abandonment of fertile areas. Rehabilitation and development has been undertaken, but Fars has lost much of its importance by the decline of Bushire and its trade because of competition of Khorramshahr and Bandar-e Shahpur, the railway ports of Khuzistan. (H. Bo.)

FARTHING, formerly the smallest English coin, equal to one-fourth of an English penny. (Anglo-Saxon *feórtha*, fourth, +*ing*, diminutive.) The first farthings were struck during the reign of Edward I and were of silver. Elizabeth I struck only silver three-farthing pieces. The copper farthing was first introduced in the reign of James I, a patent being given to Lord Harington of Exton in 1613 for the issue of copper tokens of this denomination. Properly, the copper farthing dates from Charles II, who also issued a tin farthing, with a central copper plug and an inscription on the edge, *Nummorum famulus 1684* ("the lowest of the coins 1684"). Queen Anne issued no farthings, though patterns were prepared.

COURTESY, THE ROYAL MINT
REVERSE OF BRITISH FARTHING SHOWING WREN

In 1860 the copper farthing was superseded by one of bronze. In 1842 a proclamation was issued giving currency to half-farthings, but these were demonetized in 1869. The traditional "Britannia" was displaced from the farthing reverse in 1937 by the wren. Farthings became obsolescent after World War II and were demonetized on Dec. 31, 1960. (C. H. V. S.)

FARUK I (Farouk) (1920–1965), king of Egypt from 1936 to 1952, was born in Cairo on Feb. 11, 1920. The son of King Fuad I (*q.v.*), he succeeded his father in May 1936 and took over the powers of a council of regency when he came of age on July 29, 1937. Educated in Egypt and in England, he married, in 1938, Farida, daughter of an Egyptian judge. The marriage was dissolved in 1948. In 1951 he married Narriman, daughter of another Egyptian subject. There were three daughters by the first marriage and a son by the second. Soon after his accession Faruk took up his family's quarrel with the dominant Wafd party and his father's personal distaste for its leader, Mustafa al-Nahas Pasha. To this he added an almost equal dislike for the British ambassador, Sir Miles Lampson. A combination of his father's Italophile sympathies and the suspicion that the Axis powers might win the war led him to retain in his entourage persons who maintained contact with the enemies of Great Britain in World War II. Accordingly, on Feb. 4, 1942, the British ambassador presented himself at the royal palace with some display of military force and confronted Faruk with the alternatives of abdication and summoning Nahas Pasha to form a government. The king summoned Nahas Pasha and it was not until Oct. 1944 that he again felt strong enough to dismiss the Wafd. In 1948 the unsuccessful Palestine campaign damaged Faruk's standing in the eyes of his people; still more so the widespread suspicion that people close to him had been involved in the corruption connected with the purchase of arms to which the Egyptian military failures were attributed. There followed the military revolution of July 1952 that compelled Faruk to abdicate (July 26). After his abdication he lived in exile in Europe. He died in Rome on March 18, 1965. *See* also Egypt: *History*. (H. S. D.)

FASCES in ancient Rome were bundles of elm or birch rods from which the head of an ax projected, fastened together by a red strap and symbolizing the power to scourge and decapitate. They were the insignia of official authority, probably Etruscan in origin and dating from the regal period when they represented the plenary authority of the kings, carried by the lictors (*q.v.*), who attended the magistrates with *imperium* (supreme authority), in the left hand and on the left shoulder before the magistrate or, at his funeral, reversed and behind the bier. They were lowered before the sovereign people and superior magistrates. The consuls, who had 12 *fasces*, removed the ax within the city in recognition of the right of appeal from them to the people, but retained it outside. Dictators had 24, praetors 6 (2 in the city), legates 5 and, although they had no *imperium*, priests and Vestal Virgins 1; censors had none. The emperor at first had 12 but after Domitian, 24. A victorious general who had been saluted as *imperator* by his soldiers decorated his *fasces* with laurels, a prerogative that was later monopolized by the emperor. The higher municipal magistrates also had *fasces*, usually two.

In Italy from 1919 the *fasces* were adopted as the emblem of the Fascist party, which took its name from them.

BIBLIOGRAPHY.—T. Mommsen, *Römisches Staatsrecht*, vol. 1, pp. 373 ff. (1887); and for illustrations, A. M. Colini, *Il fascio littorio* (1932).
(T. R. S. B.)

FASCISM is the name of a political attitude which puts the nation-state or the race, its power and growth, in the centre of life and history. It disregards the individual and his rights, as well as humanity, in the exclusive interest of the nation. As a political technique it follows the lead of totalitarian bolshevism as a single-party state with strict regimentation of all aspects of national life. The name fascism was first used by the movement started by Benito Mussolini in March 1919. Later on it became the general name for similar movements in other countries, among which German National Socialism (*q.v.*) was the most prominent. The Italian word *fascismo* is derived from the Latin *fasces*, "bundles," denoting in ancient Rome a bundle of rods with an axe, borne before Roman magistrates as a symbol of authority.

Among the intellectual forerunners of fascism were two Frenchmen, Georges Sorel and Charles Maurras, and an Italian, Vilfredo Pareto. Pareto, an economist and sociologist, developed a cyclical theory of social change and of the rise of new elites. Georges Sorel, the theoretician of revolutionary syndicalism, emphasized the creative role of violence in history. His doctrine of direct action was firmly opposed to mediation and compromise, which he regarded as signs of the decadence of the *bourgeoisie*. Through direct action in the spirit of violence, a new social elite was to lead the proletariat into a new epoch of history and civilization in opposition to plutocracy. His Italian followers applied his theory of a heroic proletariat not to a class but to the Italian nation, which they regarded as a proletarian nation in relation to the western plutocratic democracies. Charles Maurras was the father of "integral nationalism" in France. He opposed the ideas of the French Revolution, emphasized the precedence of French national self-interest before all other considerations and stressed foreign policy as the foremost field of activity of the state. His newspaper *L'Action française* had little influence in France except under the Pétain regime. Its Italian counterpart, *L'Idea nazionale*, struck much deeper root in Italian soil.

The origins of the fascist movement in Italy are to be found both in the wave of disillusionment and at the same time in the exacerbated nationalism which swept Italy after 1918. Even before World War I Enrico Corradini had propagated a doctrine of extreme and belligerent nationalism, which had fanned enthusiasm for the Libyan war of 1911 and for imperial expansion. The poet Gabriele d'Annunzio had exalted in verse and prose not only the mission of a victorious Italy, but also the love of danger, adventure and war. In the military coup by which he with a legion of black-shirted followers gained possession of Fiume in Sept. 1919, and during the 16 months in which he as *duce* ruled the city, D'Annunzio introduced a constitution foreshadowing the "corporative state" and all the rites, salutes, allocutions and mass shouts which later became characteristic of the fascist movement. Mussolini himself before 1914 had been a leading member and editor of the Italian Social Democratic party, but he had always represented the tendencies of revolutionary syndicalism with their emphasis upon direct action and enthusiastic will. Against the attitude of his party, Mussolini supported Italy's entrance into the war in the fall of 1914; on Nov. 15 he founded his own newspaper, the *Popolo d'Italia*, in Milan, which called itself an organ of combatants and producers and carried the social revolutionary motto by Blanqui, "Who has steel has bread," and Napoleon's saying, "The revolution is an idea which has found bayonets." Mussolini's first famous editorial bore the characteristic title "Audacity."

In the social unrest and moral confusion which followed the war of 1914–18, Mussolini founded the Fasci di Combattimento on March 23, 1919, in Milan. The new group had no definite program; at first Mussolini was still a revolutionary syndicalist who preached the expropriation of the land, the mines and all means of transportation. It was not until the beginning of 1921 that he allied his group openly with the propertied classes, with the landowners and the industrialists. But whatever his sociological affiliations, he was moved throughout by a fierce nationalism and by the love of violence and adventure.

When he ran in Milan for a parliamentary seat in the elections of Nov. 16, 1919, he got less than 5,000 votes out of 346,000. But the deep social unrest prevailing in Italy in 1920 gave Mussolini a chance, and though the danger of any bolshevist or socialist success had entirely faded by the end of the year, Mussolini and his squads of violent young men appeared to the frightened upper classes as a guarantee of security. Thus, with the army conniving, Mussolini's followers set for themselves the task of "restoring order" and breaking up the socialist and progressive movements and organizations. With a boastful ruthlessness, with the proud sacrifice of all ethical scruples to success, the local *squadristi*, under the leadership of men such as Dino Grandi, Balbo, Roberto Farinacci and others, set out for the conquest of power in the name of youth against what they called "the tottering parliamentarism" of the "senile" and undecided liberals. The lack of resistance on the part of the government, the army and the police emboldened the fascists, who had formed themselves into the National Fascist party in Nov. 1921.

In the following year Mussolini completely abandoned his original socialist, antimonarchist and anti-Catholic program. He had no definite doctrine to offer. "Our program is simple: we wish to govern Italy. They ask us for programs, but there are already too many. It is not programs that are wanting for the salvation of Italy, but men and will power." On Oct. 28, 1922, the famous "march on Rome" was staged. Though the Fascists and the Nationalists were outnumbered in the Italian parliament by ten to one, and though with some show of resolute action the Fascists could easily have been stopped, the king refused to sign the proclamation of the state of siege which his government had prepared, and on Oct. 29 invited Mussolini to form the new government. Though the new prime minister at first accepted a coalition cabinet and preserved some of the forms of the liberal state, within a very few years all the trappings of parliamentarism were gone, all other parties outlawed, all civil liberties and constitutional guarantees suppressed and a full dictatorship established. The process was accelerated by the reaction of the country and of the civilized world to the murder of the socialist deputy Giacomo Matteotti in June 1924, on the eve of his exposure of the graft and corruption of the Fascist party. Highest Fascist officials were alleged to have been implicated in the murder. In his effort to save his regime from the outraged feelings of the country, Mussolini established a totalitarian order in which the state was completely identified with the Fascist party, which in turn was identified with its leader. Though he professed to fight bolshevism, he successfully adopted its methods, without, however, being able to carry them, in the different climate of Italy, as far as they were carried in Russia and later on in Germany. The different *squadristi* organizations had been reformed on Feb. 1, 1923, as the Milizia Volontaria per la Sicurezza Nazionale.

Fascism in its beginnings was not a doctrine and had no clearly elaborated program. It was a technique for gaining and retaining power by violence, and with an astonishing flexibility it subordinated all questions of program to this one aim. But it was dominated from the beginning by a definite attitude of mind which exalted the fighting spirit, military discipline, ruthlessness and action and rejected contemptuously all ethical motives as weakening the resoluteness of will. Fascism is power politics and *Realpolitik* in their most naked form; all theoretical considerations are subservient to what is regarded as the "inexorable dynamics" of the factual situation. Ultimately everything depends upon the ever-changing decisions of the leader, decisions which cannot be discussed, but are blindly obeyed and immediately executed. Thus fascism could present itself in a given situation as a bulwark of the social order against social revolution, against Marxism and the proletariat, and could in a different situation become the propagandist and spearhead of a proletarian world revolution against conservatism and wealth, against *bourgeoisie* and capitalism.

With its stress upon the irrational, upon instincts and activism, fascism insists upon the "iron logic of nature" which will always make the strong prevail over the weak, the more resolute over the irresolute, and thus aims at educating the nation to develop its

strength, courage and resolve, and by these means to ensure its victory. All fascist activity is devoted to this preparation for what it regards as the inevitable and beneficial struggles which form the life of nations. Fascism, therefore, repudiates above all the idea of peace and harmony. "War alone brings up to their highest tension all human energies and puts the stamp of nobility upon the peoples who have the courage to meet it. Fascism carries this antipacifist spirit over even into the lives of individuals. It is education for combat." These words by Mussolini are amplified by his famous statement that "War is to the man what maternity is to the woman. I do not believe in perpetual peace; not only do I not believe in it, but I find it depressing and a negation of all the fundamental virtues of man." Therefore, to continue in Mussolini's words, "The whole nation must be militarized. . . I consider the Italian nation in a permanent state of war." The creed of fascism is heroism, the praise of audacity and danger, devotion and sacrifice for the nation and its necessary wars.

Fascism regards itself as a rejection, a complete and uncompromising denial of the principles of liberalism and democracy, as elaborated and realized in the British, American and French revolutions of the 17th and 18th centuries. It is a return to an authoritarian order, based upon the subordination of the individual and the inequality of caste and rank. The liberty of the individual is denied in favour of the state, the inequality of men is proclaimed as immutable and beneficial. The "bourgeois" achievements which liberalism had secured from the time of the English revolutions of the 17th century on have not only been abandoned but derided and combated. From the beginning fascism acted as the implacable enemy of democracy and of the rights of man. Society is to be built strictly upon a hierarchical order: the leaders are not to be elected, nor are they to be responsible to the people; on the contrary, the people are responsible to the leaders whose appointment depends only upon those above them. Military discipline and blind obedience are to permeate the whole of civilian life. One of the famous slogans of fascism was *credere, obbedire, combattere* ("have faith, obey, fight"), and another was *Mussolini ha sempre ragione* ("Mussolini is always right").

The 18 years of the Fascist regime from 1922 to 1940 were devoted to the military preparation of the Italian nation for a coming struggle for what was regarded as the mission of the Italian people, the rebirth of the Roman empire. To this goal the economic life of the country was completely subordinated. Fascist economy, like communist economy, can be regarded as a permanent war economy. The authoritarian and centralized pattern of political life found its replica in the new economic institutions. Fascist inefficiency in Italy did not allow, however, the full realization of governmental goals. Much of the *stato corporativo* (*see* CORPORATE STATE) remained in the blueprint stage.

The basic law of April 3, 1926, established six main economic sectors, within which capital and labour were represented by national confederations of employers and employees. The professions were organized in a separate national confederation. However, civil servants, government officials of all kinds and teachers were placed under the direct control of the secretary of the Fascist party, because their employer was, directly or indirectly, the state. The economic corporations, too, were not regarded as independent agencies but as instruments of public administration dependent upon the will of the head of the government. With the approach of the Abyssinian War of 1935–36 the control of all economic activities by the party was intensified. This control apparently did not increase the efficiency and productivity of the Italian economy, either in the outright military field or in the nominally civilian areas. The Italian military debacle in World War II revealed the glaring inefficiencies and insufficiencies of Fascist economics. The standard of living and the real wages of the Italian workers and farmers remained extremely low in comparison with other European countries throughout the 20 years of the Fascist regime. Nevertheless, the Fascist leadership did not cease painting a picture of coming Italian grandeur for the benefit of the Italian masses. The cult of the Roman empire and of its expansion was stimulated in every possible way.

In a speech before the senate on March 30, 1938, Mussolini painted a glowing picture of Italian armed strength and military preparedness. Italy, he declared, could raise an army of 9,000,000 men, of whom 5,000,000 were first-line fighters, ready to hurl themselves, under his personal direction, against any enemy. According to him, this army was amply supplied with the most modern instruments of destruction which would enable it to break through the stoutest defenses in conformity with the fascist maxim that the war must be decided within a few months. The powerful navy was principally composed of recently launched vessels which were to be used with boldness and decision. The air force was equal to any and would rain death and destruction on enemy territory. The quick success of Italian arms in any struggle would be guaranteed by ample reserves of supplies and by the fact that Mussolini himself would assume command of the operations.

When Italy, greedy for conquest, entered the war in 1940 to deal the deathblow to the British empire and its idea of liberty, the sordid reality, the inefficiency and corruption of Fascism were quickly revealed. The Italian armies and navy were everywhere ignominiously defeated, and Mussolini's regime was overthrown by the king in Italy in July 1943. It was saved by the Germans for a temporary existence as a Fascist republic in northern Italy. But the Anglo-U.S. advance put an end to it in the spring of 1945; Mussolini died an ignoble death at the hands of partisans.

In many ways fascism can be regarded as an exaggerated and even absolutized nationalism which entirely obliterates both individualism and humanity. The nation becomes the supreme arbiter, its service the one supreme duty. Only actions, thoughts and sentiments which help to increase the power of the nation can be called good. This absolute devotion to the nation—not to a nation which is governed by ethical rules of divine or of rational origin, but to one which is an end in itself and which is entirely identified with the fascist party and its leader—becomes the guiding principle of all education in fascism.

This education is not confined to the schools alone nor to the youth organizations of the fascist party; like bolshevism in Russia, it determines everything printed in the press and in periodicals, heard over the radio, presented on the screen or stage, so that it ultimately colours every thought and every sentiment of the people. This kind of indoctrination works especially well because no other information or critical attitude or independent inquiry is ever allowed to reach the people. Fascism leads also to a complete destruction of all free cultural and intellectual intercourse with other nations.

But fascism is not a national attitude in the sense that it would be confined to certain nations. Though it is true that fascism finds a much better soil for its growth in the cultural and social traditions of certain nations, it represents a general attitude which can be found everywhere. Its rise was facilitated by the growing complexity of life in the age of masses and machines and by a feeling of disillusionment and cynicism in the postwar generation after 1914. Democracy, which has grown up in the last 300 years, represents, with its emphasis upon individual responsibility and individual decisions, the most difficult societal system, requiring a definite human maturity. Fascism can in many ways be regarded as an escape from this difficulty into the irresponsibility of following a leader who deprives the masses of their liberty and maturity but promises them social security and economic progress. Fascism, however, was in such complete opposition to the trends of the 18th and 19th centuries that its emergence found democracy completely unprepared for the heavy and decisive blows which its implacable enemy intended to deal it, through propaganda, terror and war. Thus it happened that fascism, which in the 1920s seemed confined to Italy, became in the 1930s a world-wide movement which put democracy not only on the defensive but into mortal danger.

Mussolini could say in 1934, "Since 1929 fascism has become not merely an Italian phenomenon, but a world phenomenon." On Oct. 25, 1932, he had assured his audience at Milan of the coming world leadership of fascist Italy. "Today, with a fully tranquil conscience I say to you, that the twentieth century will be the century of fascism, the century of Italian power, the century during which Italy will become for the third time the leader of mankind."

In that Mussolini was at least partly wrong, because the following years proved very quickly that even in the case of a world-wide victory of fascism the leadership would not fall to Italy, but to Germany, which in 1933 joined the ranks of the fascist powers and very quickly dwarfed Italy in importance.

Fascist principles had become accepted by 1936, to a varying degree, by the governments of Austria, Hungary, Poland, Rumania, Bulgaria, Greece and Japan. In most of these countries fascist parties were formed which imitated not only the doctrinal concepts of the Italian and German movements but also many of their external symbols, though every country had its peculiar national tradition expressed. Thus, while the Italian fascists donned black shirts and the Germans brown, the fascists in Hungary donned green shirts and used the cross and arrow instead of the fasces or swastika. In some of these countries the local fascist brand was a product of popular movements, not created by the government. This was the case in Rumania, where a young lawyer, Corneliu Zelea-Codreanu, founded in 1927 a Legion of the Archangel Michael for the Christian and racial renovation of Rumania, which later developed into the terrorist organization of the Iron Guard and, when disbanded by the government, constituted itself as a party, Totul pentru tara ("Everything for the fatherland"). Though this party had fought enthusiastically for a pro-German orientation of Rumanian policy, it was nevertheless sacrificed by the Germans to the needs of the hour and succumbed in bloody and tormented internal strife. Similarly, a full-fledged fascism came to power in Greece under the leadership of Gen. Joannes Metaxas, who on Aug. 4, 1936, inaugurated the "third Hellenic civilization" with its symbol, the Spartan salute. The warlike virility of ancient Sparta and the imperial splendor of Byzantium were to be revived.

But the most important gain achieved by fascism outside of Italy and Germany was the fascist conquest of Spain. The civil war started by Gen. Francisco Franco from Spanish Morocco on July 17, 1936, ended with the victory of the insurgents in March 1939. By a decree of Aug. 4, 1939, Franco assumed "in its entire plenitude the most absolute authority. The Chief is responsible only to God and to History." During World War II Spain supported, as far as its economic misery and backwardness permitted, the other fascist powers. In July 1942, when fascist victory still seemed probable, Franco asserted that totalitarianism had "amply demonstrated its superiority" over democratic institutions. The Spanish fascist party, the Falangists, revived the dream of the great Spanish empire of the golden century, which had attempted to impress its civilization upon the whole world and which had ruled in the Americas and in the Pacific.

The victory of fascism in Spain seemed to bear witness to the growing international strength of fascism and to the apparent weakening of democracy. Thus, fascist attitudes and movements could even infiltrate the democracies. Fascist propaganda was relentlessly active, not only in Europe but throughout the western hemisphere. People were induced to believe in the "breakdown" of capitalism and in the inevitable upsurge of the "wave of the future." The German and Italian governments devoted special efforts to the organization of citizens of German and Italian descent abroad, and tried to teach them to put their loyalty to their racial origins above their loyalty to the country whose citizens they were. Fascist influence was very strong in France, but relatively weak in Britain.

In the United States the great number of fascist-type groups, the competition of presumptive leaders and their division into Protestant and Catholic groups prevented the formation of a strong fascist organization. This failure is explained by the habitual Republican or Democratic preferences of most citizens, the strength of popular optimism as to the future (reinforced for many by the efforts, if not always the success, of the New Deal in coping with the depression) and the insulating effects of the federal system, most notably upon Huey Long's "share-the-wealth" movement in Louisiana. A further factor was the strong traditional attachment of most U.S. citizens to the U.S. constitutional system. In Latin America the Integralista movement in Brazil was the outstanding example of a fascist party. In Asia a number of superpatriotic terrorist organizations of young officers and students tried to stamp out the influences of western liberalism in Japan and to bring Japan back to the military virtues and disciplines of the old order. Thus, by 1939, fascism had gained a rapidly growing strength over a wide geographic area.

The strength of fascism in the international scene was much increased by the close co-operation of the leading fascist powers. From 1936 on, Germany and Italy entered into a number of political, cultural, economic and military agreements, and in 1937 this "axis" was extended to include Japan. While the fascist countries co-operated closely and formed their own "League of Nations" in the so-called Anti-Comintern pact which was later joined by Spain and Hungary, the democratic nations did not co-operate, and instead of strengthening the League of Nations as a bulwark against aggression, allowed it to disintegrate. Thus the world became safe for the aggression of fascist powers.

After 1938 the German form of fascism, known as National Socialism, became so predominant that it impressed its peculiar character upon all other (and even upon the older) forms of fascism. This is especially true of the acceptance of anti-Semitism by Italian and even Japanese fascism. Japan has no Jews and practically has never had any Jewish problem. The number of Jews in Italy was insignificant; they had been completely assimilated into the national life, had participated prominently in all Italian national movements and wars, and many of them from the beginning had belonged to the Fascist party, had been for years in Mussolini's inner circle. Official Fascist sources had repeatedly declared anti-Semitism an absurdity. But in 1938 Italian fascism suddenly accepted the German racial theory.

In May 1939 Italy and Germany concluded an outright defensive and offensive military alliance. The Soviet-German agreement of Aug. 1939 forced a reorientation in fascist propaganda. Until then fascism had always insisted that its official arch enemy was communism, and National Socialism especially had reserved its most violent diatribes for "Jewish communism," of which Moscow was regarded as the seat and centre. Now the propaganda against communism ceased entirely; National Socialism laid a new emphasis on its own proletarian revolutionary character which explained and made possible its understanding with communism. The attacks on "Jewish communism" were replaced by even more vitriolic attacks on "Jewish capitalism" and democracy, which was sometimes called plutocracy, the heart of which seemed to be first London and then Washington.

The year 1939, with the conquest of the Czechs and Poles by Germany, gave the National Socialists also an opportunity to apply their fascist theories of racial inequality to other peoples than the Jews.

In the war which broke out in Sept. 1939 between Germany on the one hand and Britain and France on the other, fascists and communists not only collaborated against Poland, but joined in the denunciation of France and Britain as imperialist plutocracies and as responsible for the war. Later, Pres. Franklin D. Roosevelt was singled out by fascists and communists as a warmonger. On Sept. 27, 1940, Germany, Italy and Japan concluded, in Berlin, a formal fascist alliance with the intention of imposing "the new order" of fascist authoritarianism upon Europe, Asia and Africa. The new pact denied any hostile intention against the Soviet Union; in fact it was followed by a pact of friendship and neutrality between Japan and the U.S.S.R. in April 1941. During that year the attacks against the United States became more and more violent. On Oct. 23 the *Stampa* of Turin, one of Italy's best-known newspapers, depicted Secretary of State Cordell Hull and President Roosevelt as "throbbing with rage as they use phrases from the ghetto from which the latter has descended."

The fascists tried to prepare for the easy conquest of the democracies by undermining their understanding of the situation and by breaking or mollifying their will to timely action. The most refined technique of propaganda was coupled with a strategy of terror to produce the desired disintegration of the democracies. Since the time when the Spanish insurgents declared that the conquest of Madrid, which was then still in the hands of the republican government and which was being attacked by four columns moving

toward the city, would be helped by a "fifth column" of Franco sympathizers within the city, the expression has been frequently used to designate the conscious and more often unconscious helpers of totalitarian penetration into the democracies. Fascist propaganda was ingenious in sowing disunity and distrust among the democracies, fulminating against "British imperialism" in the United States, against "Yankee imperialism" in Latin America, and warning the British of U.S. "intention" to liquidate, and partly inherit, the British empire. Depending upon the audiences for which it was destined, fascist propaganda raised doubts about democracy equally from the rightist as well as from the leftist point of view.

Though the fascist powers succeeded in conquering a large number of countries, they could in no way quench the spirit of national resistance. Small groups, succumbing to anti-British and anti-Semitic propaganda, everywhere co-operated with the Germans. Thus in France the defeat of June 1940 gave a reactionary group under Marshal Pétain, Pierre Laval and Admiral Darlan the chance of seizing power. Democracy in France was officially abolished, the achievements of the French Revolution abandoned and vilified, the famous symbols, "liberty, equality, fraternity," discarded in exchange for a mixture of the old French pre-Revolutionary order and an imitation of the German-Italian fascist models. In Norway a Major Vidkun Quisling established, with German help, a pro-German, anti-British government. Only in Poland were the Germans unable to find any "Quislings" or collaborators. The heroic uprising in Warsaw in Aug. 1944 under General Bor marked the climax of the spirit of resistance, which made itself felt in all countries overrun by the fascist alliance.

Fascism, which started in the early 1920s as a movement of purely Italian national significance, had entered at the beginning of the 1940s the struggle for world domination, so as to make the 20th century a fascist century. But its plans miscarried. World War II, started by the fascist great powers, ended in complete defeat for them.

Fascism survived the defeat of World War II only in Spain and in Argentina. In the German Federal Republic and in Japan the foundations of democracy were successfully laid, and one could hardly speak of a rebirth of fascism. The situation in Italy was different. Attempts at the revival of fascism were made, first in 1946 by Guglielmo Giannini, who founded a newspaper and organization called *L'Uomo qualunque* ("The Common Man"), and later and more successfully by the Movimento Sociale Italiano. In the 1950s fascist attitudes gained in influence in France, especially in connection with the war in Algeria. A racialist policy recalling fascist attitudes was followed in the Union of South Africa when the elections of May 26, 1948, brought the Herenigde Nasionale party, the Reunited National party, under the leadership of Daniel Malan to power. It was mainly because of the government's racial policy (known as apartheid) that the union withdrew from the Commonwealth of Nations in 1961 (under the leadership of Prime Minister H. F. Verwoerd) and became the Republic of South Africa.

The stronghold of fascism in the western hemisphere was Argentina. There, in June 1943, a group of army officers who were deeply impressed by German National Socialist military achievements seized power. This group called itself G.O.U., Grupo de Oficiales Unidos ("Society of United Officers"). The three initials were also understood to stand for *gobierno, orden, unidad,* "authoritarian government," "order" and "national unity." The dominant figure among these officers was Juan Perón. On Oct. 17, 1945, he seized power, and the "glorious October seventeenth" was declared a national holiday in 1951. On Feb. 24, 1946, Perón was elected president of the Argentine republic. He tried to win over the masses, the *descamisados,* the "shirtless ones," to whom he promised far-reaching social reforms and a relentless fight against capitalism and Yankee plutocracy. He accused North American imperialists of wishing to dominate Latin America and presented his own system as a true democracy of social justice. He was supported by his wife, Eva Perón, who was the head of the María Eva Duarte de Perón Welfare foundation. Her death on July 26, 1952, weakened his hold on the people in spite of the proud slogan, *Perón cumple,* "Perón accomplishes things." He was overthrown in Sept. 1955 by the armed forces. The legacy which he left was similar to that which Mussolini had left in Italy—widespread corruption, a profoundly shaken economic position and a rapid rise in the cost of living.

See also references under "Fascism" in the Index volume.

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(H. Ko.)

FASHION: *see* DRESS.

FASTI, a term connected with the Roman *dies fasti,* or days of the month on which it was allowable under divine law (*fas*) to transact legal business, first denoted the list of court days in Rome, corresponding in English law to "lawful days." The announcement of *fasti* was taken over from the priests in 304 B.C., when Gnaeus Flavius (*q.v.*) exhibited an official list in the forum. About 187 B.C. M. Fulvius Nobilior set up an annotated form of *fasti.* Then Roman antiquarians turned to the problems of general chronology, on the basis of material in the archives, and refined on the details of the civic year. Interesting fragments of such a pre-Caesarian calendar survive from the *fasti* of Antium (Anzio) of about 70 B.C. The reform of the Roman calendar by Julius Caesar in 46 B.C. led to the wide publication of *fasti.* Fragments of *fasti* set up in many places under the early empire show lists of years with the names of consuls and local officials, details of special festivals and priestly colleges, and the anniversaries of noteworthy events, along with the calendar itself. Ovid in *Fasti* describes the festivals of the first six months of the Roman year.

The lists of consuls (*fasti consulares*) were accompanied by records of triumphs (*fasti triumphales*), and a notable example survives in the fragments of the Capitoline *fasti* which were set up on the triumphal arch of Augustus in the forum in the late 1st century B.C. These *fasti* preserve important evidence for Roman chronology; but, despite their official form, they represent only the results of antiquarian research. The early material probably came from the *Annales Maximi,* a collection of records published *c.* 123 B.C.; thus, although one may assume the existence of records before 300 B.C. it is not certain that they were kept in reliable chronological order. *See* also ANNALISTS.

For the texts *see* A. Degrassi (ed.), *Inscriptiones Italiae,* vol. xiii. 1 (1947); *Fasti Capitolini* (1954); *Inscriptiones Latinae Liberae Rei Publicae,* vol. i (1957). In general: E. Pais, *Fasti Triumphales Populi Romani* (1920); T. R. S. Broughton, *Magistrates of the Roman Republic* (1951–52).)

(A. H. McD.)

FASTING. To fast means to go without food and drink, usually, though not always, for reasons of religion. Abstention from food may be complete or partial and of long or short duration.

Times.—In most religions and cultures, particular times are proper for fasting. Fasting existed in prehistoric cultures, and it is practised among many modern primitive peoples. A specified time is usually appointed for the fast, the times most commonly

set aside being before the harvest, in the spring or winter, before the hunt, before initiation ceremonies or before religious or magical rites. Fasts also are frequently observed on the occasion of a death or when a deity is believed to have been angered.

Fasting at special times is also characteristic of the world's great religions. Among the Jews, the Day of Atonement is observed as a day of fast (*see* JEWISH HOLIDAYS: *Yom Kippur*). In memory of the Lord's death, the early Christians kept a fast on Friday, and a relic of this fast survives today. For Good Friday, the annual commemoration of Christ's death, the fast was extended first to 40 hours, then to 40 days, the period known as Lent (*q.v.*). For Muslims the entire month of Ramadan (*q.v.*) is a period of penance and fasting.

Motivation.—Motivations for fasting are so varied that, even though in its external form (abstention from food) the practice exhibits a basic pattern of uniformity, it is difficult to categorize them. For convenience's sake, three broad divisions can be made: magical, ethical and religious. These divisions are not mutually exclusive; often one of the three predominates, and one of the others is present in a lesser degree. The faster whose motive is magic attempts to gain ascendancy over nature by using the fast as a secret or magic hold over the natural powers. He whose motive is ethical intends to strengthen the moral fibre either of himself or of the community. The person who fasts for religious motives acknowledges his dependence upon his creator and by his fast worships the maker of heaven and earth.

Magical Fast.—Primitives give various reasons for fasting. Some foods are considered dangerous, others are holy (tabu); some people fear demons connected with certain foods, others propitiate deities before a sacrifice. In animistic religions, in which natural occurrences or objects of nature are considered to influence events, a fast in honour of, for example, the lord of the storm, is predominantly magical and only incidentally religious in its motivation. That is to say, less attention is paid to worshiping the god than to forcing him to act on behalf of his devotees. However, religious observance and social patterns in these societies are so closely interconnected that it is not always possible to discern whether the context of a fast is magical, religious or even, on rare occasions, ethical. The so-called *jejunium propheticum* ("prophetic fast") is difficult to categorize; it is a commonplace among shamans and tribal priests, who appear to fast in order to induce visions. Indeed, there are times when none of these motives is present. For example, among some tribes of North American Indians the ability to go without food or water for a protracted length of time was admired and envied as revealing powers of endurance.

Ethical Fast.—A purely ethical fast would be one undertaken in the spirit of what William James, in *Talks to Teachers on Psychology and to Students on Some of Life's Ideals*, calls "heroism in little unnecessary points." He who practises such asceticism will reap the reward of standing "like a tower when everything rocks about him, and his softer fellow-mortals are winnowed like chaff in the blast." An outstanding example of one who fasted not for personal but for community benefit was Mahatma Gandhi, whose fasts were undertaken primarily in atonement for the violent excesses of those who followed his own nonviolent opposition to the British government of India. As a side effect they brought moral pressure to bear on opposing or dissident factions, forcing them to act for the good of the community.

Religious Fast.—In the Judaeo-Christian world, fasting is considered an exercise of the virtue of religion. There are three main reasons for fasting, the same reasons as those for any other penance: (1) to gain control over the body and its sense appetites; (2) to raise the mind to thoughts of God and to prayer; (3) to offer satisfaction for offenses given to God. Self-control is basic to any asceticism, making it possible to turn the mind more easily to thoughts of God, to address him directly in prayer and to become more closely united to him. This close union, another way of saying "love of God," is an essential fruit of the religious fast. If it is lacking, the fast has failed.

Practice.—Observance of fasting in modern times is far less severe than it was in ancient days. In the last century before the Christian era, the Pharisees, a sect of Jews who were intent on observing not only the Mosaic Law but the extra practices recommended by the rabbis as well, introduced the observance of two fast days each week. In the course of a year in the 20th century only nine fast days are recognized by the different groups in Jewry, and of these, only one, Yom Kippur, is observed by all groups. The early Christians fasted on Friday, to commemorate the death of the Lord; later Wednesday and Saturday were added. A relic of this practice remains in the present-day quarterly observance of Ember days (*see* EMBER DAYS AND EMBER WEEKS). The 40-day Lenten fast in preparation for Easter once had a counterpart before Christmas, the Advent fast. The severities of the ancient fasts, particularly as they were practised by the hermits of the desert in the 3rd and 4th centuries, belong to the past in western civilization. Since these excesses inflicted bodily damage that rendered a person less able to lead a normal life in the service of God, they were abandoned in favour of less severe penitential practices, which had the advantage of keeping the body and its sense appetites under control without crushing either. Some of the austere religious orders, as the Carmelites, Carthusians and Cistercians, practise more rigorous fasting than the ordinary believer is expected or desired to do, but even among these it is not carried to the point of physical harm.

Those fasts that involve complete abstention from food are easily described. The Muslim during the month of Ramadan takes neither food nor drink in the daytime—that is, when it is light enough to distinguish a black thread from a white one. For the Jews, Yom Kippur is a 24-hour fast from sundown the day before till sundown of the day itself. Tishah b'ab, a fast observed by some groups of Jews in commemoration of the two destructions of the Temple, is also a 24-hour fast; all the others are of 12 hours' duration.

Those fasting practices that involve partial abstention or abstention from certain foods only are more difficult to describe. The Jewish dietary laws (*see* KOSHER) are an example of abstention from certain foods. Roman Catholics practise abstention on all Fridays of the year (except when they fall on Holy Days of Obligation and national or regional holidays), on Ash Wednesday and on the vigils of the Immaculate Conception and Christmas, no meat or soup or gravy made from meat being eaten. Days of abstinence in the Eastern Churches are much more numerous (totaling around 150), and other foods, including fish, eggs, milk and cheese, also are forbidden. The Roman Catholic days of fast include all the weekdays of Lent, the vigils of Pentecost, the Immaculate Conception and Christmas, and the Ember days. This fast is enjoined on all Catholics over 21 and under 59 years of age. Only one full meal is eaten each day; two other meatless meals, sufficient to maintain strength, may be taken according to the faster's needs, but together they should not equal another full meal. On a fast day meat may be taken at the principal meal, except on the days of abstinence referred to above. Eating between meals is not permitted for one who is fasting, but liquids, including milk and fruit juices, are allowed. The Eastern Churches observe periods of fasting during Advent; from Trinity Sunday to SS. Peter and Paul; and for two weeks before the Assumption.

A third type of fast kept by Roman Catholics is the one observed out of reverence before the reception of Holy Communion. Pope Pius XII in 1957 changed the earlier regulation, which demanded complete abstention from all food and drink from midnight until the sacrament was received, in order to enable Catholics to receive the Holy Eucharist more frequently. The new law demands that the communicant abstain from solid food and alcoholic beverages for three hours and from other liquids, except water, for one hour before the reception of Communion. Nonetheless, Pius XII urged those who were able to follow the old rule to continue to do so.

In churches of the Anglican Communion practices of fasting and abstention generally coinciding with those of the Roman Catholic Church are commonly but by no means universally observed. The observation of the more important fast days is specifically commended by the Book of Common Prayer but details of the observances are left to the discretion of the ecclesiastical authorities.

The Protestant churches for the most part leave the question of

fasting to the individual church member; each is to determine for himself whether he shall fast, and how. Some Lutherans, for example, urge that a fast be kept before partaking of the Lord's Supper but leave the method of keeping it to the devotion of the faster. One notable exception to this reluctance to set down norms for fasting is the fast day recommended by the Latter-day Saints on the first Sunday of each month; two meals are omitted on that day, and the money saved in so doing is expected to be used to help the needy. *See* also references under "Fasting" in the Index volume.

See J. Hastings (ed.), *Encyclopaedia of Religion and Ethics,* two articles on "Fasting" and several on "Fasts and Festivals" in different cultures and religions; "Abstinence" and "Fasting" in F. L. Cross (ed.), *The Oxford Dictionary of the Christian Church* (1957). (T. A. He.)

FASTOLF, SIR JOHN (1380–1459), a career soldier who fought and made his fortune in the second phase of the Hundred Years' War. The name Falstaff replaced that of Sir John Oldcastle (*q.v.*) in Shakespeare's *Henry IV Part I* when the play was printed in 1598; but Fastolf bore little resemblance to the character who bore the name Falstaff there, in *Henry IV Part II* and in *The Merry Wives of Windsor* (as Richard James pointed out in 1625); and Shakespeare's version in *Henry VI* of him in his proper name and person is equally libelous. Of Yarmouth burgess and Norfolk petty gentry stock, Fastolf seems early to have entered seigneurial service, first possibly with the duke of Norfolk and later with Thomas of Lancaster (afterward duke of Clarence). His marriage (1409) to a rich widow of baronial family, Millicent Scrope *née* Tiptoft, raised his income from the £46 a year of his inheritance by an annual £240. But it was in the wars after 1420 that his fortune was effectively made. Booty, ransoms, the baronies of Sillé-le-Guillaume and of La Suze-sur-Sarthe, other lands, captaincies and high offices in France inflated his prestige and swelled his income; he was able by buying land in England to increase his revenue there by 1445 to over £1,000 a year and still have capital for investment, building, "improvements" and conspicuous waste.

Knighted probably some time in 1415, Fastolf was created banneret on the battlefield of Verneuil in 1424 (when he took 20,000 marks sterling in plunder) and became a knight of the Garter in 1426. At the battle of Rouvray or "the Herrings" (1429) he saved a provision train on its way to the besiegers of Orléans. Accused of cowardice at the battle of Patay in the same year, Fastolf was able to justify his conduct in the 1440s. About 1440 he finally returned to England.

His income from land in France had already declined from over £675 a year after a revolt (1435) in the Pays de Caux; but his possessions there were still worth a clear £401 in 1445. After the loss of Normandy in 1449–50 they were worthless. But Fastolf had not done badly. Though he had at times bought unwisely and brought the tribulations of disputed titles on his head and on those of his servants in the law, his estates at least gave him the consolations of local grandeur.

Like other war magnates he lived as splendidly as his condition and his income allowed. A fine castle was built at Caister in Norfolk, and this and other houses were filled with furnishings, books and plate; his wardrobes with fine clothes and jewelry; and his servants indulged fruitfully in literary arts. As his age lengthened so did his temper shorten; and the irascible and suspicious old man encountered in the *Paston Letters* (*q.v.*) is the one best known today. His suspicion was not groundless; childless, he intended his possessions for pious works; but before his death at Caister on Nov. 5, 1459, the vultures were circling and in the end his property was split up among them. The largest share went to the Paston family; but the eventual administrator of his will, William Waynflete, bishop of Winchester, salvaged a part for his new Magdalen college in Oxford.

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FAT, the name given to certain animal and vegetable products that are oily solids at ordinary temperatures and are chemically distinguished as being combinations of glycerol (glycerin) and various fatty acids. (*See* Oils, Fats and Waxes.) Fat is a normal constituent of animal tissue, being found even before birth; it occurs especially in the intramuscular, abdominal and subcutaneous connective tissues. (*See* Adipose Tissue.) In the vegetable kingdom fats occur in the seeds and fruits and sometimes in the roots. *See* Biochemistry: *Fats and Amino Acids;* Nutrition: *Fats;* Obesity; *see* also references under "Fat" in the Index volume.

FATALISM, the attitude of mind which accepts whatever happens as having been bound or decreed to happen. Such acceptance may be taken to imply belief in a binding or decreeing agent; and the development of this implication in ancient Greek and Roman mythology, with its personified Moirai, Fata or Parcae, is discussed in the article Fate. Fatalism in its relation to later modes of thought is the subject of this article.

Fatalism may be described loosely as synonymous with determinism, but it is useful to make a distinction. Whereas determinism (*q.v.*) can be represented as compatible with moral responsibility, fatalism properly understood would reduce practical ethics to nothing but the advice that we should resign ourselves indifferently to the course of events. Strict fatalism, therefore, is not to be sought in the major Christian controversies arising from differences between Augustinian and Pelagian, semi-Pelagian or Molinist doctrine on free will, on grace and on predestination (*qq.v.*), wherever the notions of merit and of guilt (sin) retain any sense of actuality. Among Christians, indeed, the Quietists, with their uncritical reliance on inspiration, may be regarded as having in practice approached more closely to the fatalistic norm of behaviour than any of the commonly recognized partisans of determinism, as Calvinists, Jansenists, etc.

Primitive Islam taught that everything is ruled by the decree of almighty God; but influence from pre-Islamic fatalism in Arabia and fatalistic doctrines in Iranian religion (especially Zervanism) soon changed this tenet into belief in an inexorable fate (kismet, *nasib*), and submission to the will of God became resignation to fate's decree.

The common confusion between "fate" and "chance" can be removed by linguistic analysis. The proposition "it happened by chance" means that there appeared to be no intrinsic necessity for a coincidence, and this is obviously different from saying that something happened of necessity, by fatal design. Misunderstanding arises only when the proposition is put into the form "chance caused it to happen," which is admissible colloquially but is nonsensical if taken literally. The calculation of probability (*q.v.*) is an attempt to introduce an element of fatal order into the field of chances.

FATA MORGANA or Morgan le Fay, fairy enchantress of Arthurian romance. Her origins are uncertain; various theories link her with a Celtic Muirgen (seaborn), Morrigan, the Irish war goddess and Modron (from the Celtic divinity Matrona). She is first named in *Vita Merlini* (*c.* 1150) by Geoffrey of Monmouth as skilled in the arts of healing and changing shape, one of nine sisters, rulers of Avalon (*q.v.*) where the wounded Arthur is taken. The 12th-century *Roman de Troie* refers to her as a fairy who hated Hector for his rejection of her love. Her healing powers are mentioned by Chrétien de Troyes in *Erec* (*c.* 1165), where she appears for the first time as Arthur's sister and also as the fairy-mistress of Guigomar, lord of Avalon. These two traditions of healing and hostility due to frustrated love are further developed in 13th-century prose romance where her relations with her brother Arthur seem strangely ambiguous. In the prose *Lancelot* often called the Vulgate cycle, in the *Huth Merlin* and hence in the *Morte Darthur* of Sir Thomas Malory, which was based largely on those sources, Morgan, thwarted in love, stirs up trouble between Arthur and Guinevere; yet she comes finally as a beneficent figure for the dying Arthur. This emphasis on the hostile aspect of Morgan is characteristic of the prose romances' distrust of fairies and enchanters as possessors of diabolical knowledge. Morgan's magic powers are explained as learned from books and from Merlin, and even her role as healer of Arthur in Avalon is par-

tially christianized. In the *Mort Artu* (a branch of the Vulgate cycle) and in Malory, although Morgan bears Arthur magically away, he ends in a Christian tomb. The tradition of a living Arthur, tended by Morgan in Avalon, continued to appear, however, in several 13th- and 14th-century texts, sometimes associated with Sicily. A trace of this localization (probably due to Norman influence), survives in the use of the term Fata Morgana to denote a mirage frequently seen in the Straits of Messina, consisting of an apparent vertical elongation of an object situated on the opposite shore (*see* MIRAGE).

See also ARTHURIAN LEGEND; MERLIN.

See L. A. Paton, *Studies in the Fairy Mythology of Arthurian Romance* (1903); *Arthurian Literature in the Middle Ages*, ed. by R. S. Loomis (1959). (E. M. K.)

FATE. The idea of fate as an impersonal force that absolutely predetermines all events was, to the ancient world as it is to the modern, a philosophical or theological conception rather than a popular notion. For Greece, the nearest approach to such an idea was the concept of an "allotment" (*moira, moros, aisa*), made to an individual either by the gods together or by Zeus alone: it was now and then almost identified with Zeus. The individual could not escape the portion of misfortune contained in it, though, according to the *Odyssey*, he might increase this through his own folly, as Aegisthus did by deliberate neglect of a divine warning. Patroclus (*Iliad* xvi. 845) says that his death is due to Zeus and Apollo, but four lines later blames "cruel *moira* and the son of Leto" (Apollo). Again, the *Iliad* states that it was the *moira* of Achilles to die soon after he had killed Hector. But he had his choice, for he might have preferred to stay quietly at home, in that case to enjoy a long but inglorious life. There might be a *moira* for a whole nation, at least in post-Homeric belief. Persia, according to Aeschylus, was apparently to conquer in Asia but to meet misfortune overseas—a doom foolishly precipitated by Xerxes. On occasion the "allotment" was personified. In Homer, a man must undergo "such things as Moira (Aisa) span upon the thread of his birth," in which connection he sometimes mentions the Clothes (Spinners). Often the plural form *moirai* is found. The Moirai were conceived as very old women (though art does not represent them so). From the time of Hesiod onward they were even given individual names—Clotho (Spinner), Lachesis (Allotter) and Atropos (Inflexible). Some fanciful persons, much later, assigned different tasks to the three: the holding of the distaff to Clotho, the spinning to Lachesis and the cutting of the thread to Atropos. But fundamentally the Moirai belonged to folk belief; their primary function was to assist at a birth and then and there to determine the career of the child, as the Moires still do in modern Greece.

The Romans identified their obscure native deities the Parcae with the Moirai, and, evidently under the influence of Greek myth, pluralized their *fatum*, the "spoken" decree of the gods. Tertullian mentions *Fata scribunda*, Fates who write, presumably, the child's destiny. The phraseology is archaic, and the idea of writing seems to be Etruscan, not native Latin. The identification of the Parcae with the Moirai rested on a very doubtful etymology deriving *Parcae* from *pars*. This use of *fata* had an interesting development. When the neuter gender became extinct in spoken Latin, its plural came to be thought of as a feminine singular; hence Italian *fata*, French *fée*. The Fates had become a fairy. *See* also ANANKE; FATALISM; NORNS. (H. J. R.)

FATEHPUR, a town and district in Uttar Pradesh, India. The town lies in the Doab (*q.v.*) between the Ganges and Jumna rivers. It is a municipality and the district headquarters. Pop. (1961) 28,323. Fatehpur is connected by rail with Kanpur (48 mi. N.W.) and Allahabad (73 mi. S.E.). The Grand Trunk road also passes through it while other roads lead to Rae-Bareli, Banda, Ghazipur and Hamirpur. Tombs of Abdus Samad Khan and Baqar Ali Khan and a mosque are buildings of historic interest.

Fatehpur was founded in the 15th century by the Pathans but afterward it came under the sway of the Moguls. In 1736 it was overrun by the Marathas before being retaken by Pathans of Fatehpur. In 1753 it was conquered by the nawab of Oudh, and in 1765 made over to the Delhi emperor; later it was restored to the nawab's dominions. Finally in 1801 it was ceded to the East India company by the nawab.

FATEHPUR DISTRICT (1,625 sq.mi.; pop. [1961] 1,072,940) is rectangular in shape and is bounded by the Ganges on the north and Jumna on the south. Along these rivers there is much *khadar* (broken land) which is unfit for cultivation. A ridge running parallel to and about 5 mi. S. of the Ganges serves as a watershed for the area. Except for the *khadar* and this ridge the rest of the land is level, gently sloping toward the southeast. The climate is of monsoon type and the average annual rainfall is 36 in. The soil is alluvial and fertile except for tracts, mostly in the middle of the area, which are impregnated with saltpetre. More than 60% of the total area is under cultivation and most of the population is engaged in agriculture. The main crops are rice, wheat, barley, millets, cotton, sugar cane and oilseeds. (M. N. K.)

FATEHPUR-SIKRI, a town in Agra district, Uttar Pradesh, India, 26 mi. S.W. of Agra city, was founded by Akbar (*q.v.*) in the 16th century. Pop. (1961) 9,980. The site was deemed auspicious after Akbar's visit to the hermit Salim Chishti (d. 1572), who foretold the birth of his three sons, of whom Salim became the emperor Jahangir. As a token of thanksgiving Akbar built Fatehpur-Sikri and personally directed the building of a mosque and tomb for Chishti, to which were gradually added magnificent buildings enclosed in a battlemented red sandstone wall with nine gateways. Although Akbar's favourite residence, it ceased to be a capital after 1588 and was abandoned because of inadequate water supply. It was a Muslim foundation, but strong Hindu influences can be seen in the palace of Akbar's wife with its blue enamel roof, in the Hawa-Khana with western Indian decorative elements and even in Chishti's tomb of white marble with mother-of-pearl inlay and windows outlined by intricate marble tracery. There the elaborate cornice brackets show clear Hindu influence. Also noteworthy are the houses of Miriam and Birbal, the latter with exuberant carving and an unusual roof, and the Diwan-i-Khas (private audience hall) with a single central pillar whose capital bears the ends of four diagonally radiating pillars to form a platform for the emperor and ministers. The symmetrical Jamma Masjid (great mosque) has a fine façade; its southern entrance, the Buland Darawaza (gate of victory), is one of India's greatest architectural achievements. The rose-weathered sandstone was soft when quarried and very apt for the carvers' skill; the whole site preserves the artistic conception of a great emperor. (A. H. CE.)

FATHERS OF THE CHURCH. The Fathers of the Church are the great bishops and other eminent Christian teachers of the early centuries who were conspicuous for soundness of judgment and sanctity of life and whose writings remained as a court of appeal for their successors, especially in reference to controverted points of faith or practice. In their writings the Christian tradition came to terms, partly by absorption, partly by protest, with Greco-Roman culture and philosophy. A list of Fathers begins with the Christian writers of the 1st century whose writings are not included in the New Testament; where it ought to end is a more difficult point to determine. Perhaps the balance of opinion is in favour of regarding Gregory the Great (d. 604) or the Venerable Bede (d. 735) as the last of the Latin Fathers and John of Damascus (d. *c.* 750) as the last of the Fathers of the Greek Church. A more liberal estimate includes Johannes Scotus Erigena or even Anselm or Bernard of Clairvaux in the West and Photius in the East. The *abbé* J. P. Migne, editor (1844–66) of the great collection of both Latin and Greek patristic writings, carried his Latin patrology down to the time of Innocent III (d. 1216) and his Greek patrology to 1472; but, while this large extension of the field is much to the advantage of his readers, it undoubtedly stretches the meaning of *patrologia* far beyond its natural limits. For ordinary purposes it is best to make the patristic period coterminous with the life of the ancient catholic church. In the West the church enters the mediëval stage of its history with the death of Gregory, while in the East even John of Damascus is rather a compiler of patristic teaching than a true Father. In

the East, however, there is no such definite break as that marked in the West by the rise of scholasticism in the 12th century.

A further question arises. Are all the Christian writers of a given period to be included among the Fathers, or only those who wrote on religious subjects and of whose orthodoxy there is no doubt? Migne, following the example of the editors of *bibliothecae patrum* who preceded him, swept into his collection all the Christian writings that fell within his period. But he is careful to state on his title page that his patrologies include the ecclesiastical writers as well as the Fathers and doctors of the church, and an ecclesiastical writer is not necessarily orthodox. It is clear that in the circumstances the terms Father, patristic and patrology must be used with much elasticity, since it is now too late to substitute for them any more comprehensive terms.

By the Fathers, then, is understood the whole of extant Christian literature from the time of the apostles to the rise of scholasticism. However the lower limit of this period may be interpreted, the literature it embraces is immense. Some method of subdivision is necessary, and the simplest and most obvious is that which breaks the whole into two great parts, the ante-Nicene and the post-Nicene. This is not an arbitrary cleavage; the Council of Nicaea (A.D. 325) is the watershed that actually separates two great tracts of Christian literature.

The ante-Nicene age yields priceless records of the early struggles of Christianity; from it have survived specimens of the early apologetic and the early polemic of the church, the first essays of Christian philosophy, Christian correspondence, Christian biblical interpretation. In these products of the 2nd and 3rd centuries there is much that was not surpassed by any of the later patristic writings.

Yet the post-Nicene literature, considered as literature, reaches a far higher level. Both in East and West, the 4th and 5th centuries form the golden age of dogmatic theology, of homiletic preaching, of exposition, of letter writing, of church history and of religious poetry. Two causes may be assigned for this fact. The conversion of the empire gave the members of the church leisure and opportunities for the cultivation of literary taste, and gradually drew the educated classes within the pale of the Christian society. Moreover, the great Christological controversies of the age tended to encourage in Christian writers and preachers an intellectual acuteness and a precision of thought and expression of which the earlier centuries had not felt the need.

Ante-Nicene Literature.—Ante-Nicene patristic literature begins with the group of writers of the late 1st and early 2nd century known as Apostolic Fathers. Like the New Testament writers, Clement of Rome, Ignatius of Antioch, Polycarp of Smyrna and pseudo-Barnabas dealt in letters with the moral and dogmatic problems of the church. Modern editions of the Apostolic Fathers usually also include fragments of a work by Papias; the allegorical visions of the *Shepherd of Hermas;* and four examples of literary forms later important—the *Didache* (a rather puzzling church order), the *Martyrdom of Polycarp,* the charming apology called the epistle *To Diognetus,* and the *Martyrdom of Polycarp.* (*See* also Apostolic Fathers.)

The apologists, defenders of the life of the church against its persecutors and of its faith against rival beliefs, belong largely to the later 2nd century. Justin Martyr is perhaps the greatest as well as one of the first. Among others are Athenagoras of Athens; Tatian, a pupil of Justin who repudiated his master's sympathy with Greek philosophy; and Minucius Felix, whose dialogue is probably the first literary product of Latin Christianity. Irenaeus of Lyons, though not generally classified among the apologists, represents the church's clearer definition of its tradition against the speculations of the Gnostics.

In the early 3rd century Tertullian of Carthage, austere to the point of a rigorism that ultimately led him into the Montanist heresy, formulated Latin Christian thought, while Clement of Alexandria represents a mystical and cultured Greek Christianity. (*See* also Apologists, Early Christian.)

From the genius of Origen, Clement's successor as head of the catechetical school at Alexandria, an allegorist, biblical critic, mystic and apologist, derives nearly all later Greek Christian thought, orthodox and heretical. Meanwhile at Rome Hippolytus continued the work of Irenaeus; his *Apostolic Tradition* (identified by 20th-century scholars as a source of later church orders) is a priceless record of liturgy and life in the early 3rd-century church. Practical problems of conduct and order predominate in the works of Cyprian, bishop of Carthage from 249 to his martyrdom in 258.

Besides these great figures there were many other ante-Nicene Fathers whose works are now lost or preserved only in fragments. Modern discoveries have added such items of interest as the 2nd-century *Paschal Homily* of Melito of Sardis and the *Didascalia Apostolorum,* a 3rd-century Syrian church order; with Hippolytus and the *Didache,* this is the basis of an extensive later literature. Even the age of the great persecution of Diocletian produced such significant work as the Latin apologies of Arnobius and Lactantius Firmianus, and in the East the work of Methodius of Olympus on ascetic ideals (*The Banquet of the Ten Virgins*).

Post-Nicene Literature.—The literary output of the post-Nicene church can be only briefly summarized.

Greek.—Athanasius dominates the period of the post-Nicene controversy. In the generation after 360 Greek theology finds its classic expression in the Christian Platonism of the Cappadocian Fathers, Basil of Caesarea, his brother Gregory of Nyssa and their friend Gregory of Nazianzus. Antioch produced John Chrysostom, the great preacher of practical Christianity, and the exegete Theodore of Mopsuestia, whose literalism inspired the later Nestorians. Cyril of Alexandria, with his emphasis on the unity of Christ, similarly inspired the Monophysites, though his own theology was accepted at the Council of Ephesus (431) and, in combination with that of Antioch and Rome, at Chalcedon in 451. The Chalcedonian doctrine of God and man united yet unconfused in Christ was developed and expounded in the 6th century by Leontius of Byzantium (whose position is close to the moderate Monophysitism of Severus, patriarch of Antioch from 512 to 518), in the 7th by Maximus the Confessor and in the 8th by John of Damascus. Meanwhile monasticism and mysticism developed their own literature, a striking example of the latter being the anonymous 5th-century writer known as pseudo-Dionysius or Dionysius the Areopagite.

Latin.—In the West, Hilary of Poitiers and Ambrose of Milan worked out the statement of orthodox doctrine in Latin. Other high points in Latin Christian literature are the biblical scholarship of Jerome, the poetry of Prudentius and the monastic handbooks of Johannes Cassianus. But all are put in the shade by the massive work of Augustine, whose writings on faith and practice are the point of departure for all later Western Christian thought. His immediate successors are Leo of Rome, the doctor of the incarnation as Augustine was the doctor of grace, and the Augustinians and anti-Augustinians of the last days of Roman Gaul. Sixth-century Christian philosophy is represented by Boethius, who began the revival of Aristotle that was to dominate medieval thought; poetry by Venantius Fortunatus; and monastic guidance by Cassiodorus and Benedict—the latter's rule, unpretentious in form, codifies brilliantly centuries of experience. Caesarius of Arles early in the century and Gregory the Great at its end are preachers of primarily pastoral concern.

Syriac and Other.—Some of the Fathers who wrote in Syriac (who must be distinguished from Greeks whose writings happen to be preserved in that language) suggest the possibility of a Christian literature related to Semitic rather than to Greek culture. The apologist Bardesanes wandered off into Gnostic speculations; but among his orthodox successors in the 4th century were the practical-minded Aphraates, "the Persian sage," and the more mystical and poetic Ephraem Syrus, deacon of Edessa. Later Syriac writers mainly adapt Greek theology when they get beyond practical and devotional topics, although in the 6th century the Nestorian Narsai and the Monophysite Philoxenus of Mabbug display considerable vigour. The literature of the Armenian and Georgian churches is mainly of interest because of the translations preserved in those languages. In Egypt the Coptic-speaking Christians had their own straightforward tradition, though content to take their theology from the Greek patriarchs of Alexandria, first

Athanasian and later Monophysite. The *Sayings of the Fathers* of the desert combine ascetic piety with a peasant's common sense, but the only major original writer in Coptic was the rigorist Abbot Shenute of Atripe (d. 451). Later Coptic literature is mainly biographical, legendary and homiletic; the Church of Ethiopia developed these interests further, and also preserved a great mass of ancient Christian writing of all kinds.

Study and Influence of the Fathers.—In historic Christianity the Fathers possess an authority which the Council of Trent stated in the cautionary phrase "that no one should venture to interpret Sacred Scripture contrary to the unanimous consent of the Fathers." For some Christians this formulation hardly seems adequate, since on disputed points the Fathers are rarely unanimous. They are, however, generally characterized by a disciplined intellectual enthusiasm and a sense of balance; even their occasional one-sided denunciations rest on an ultimate confidence in the harmony of faith and reason, of revelation and philosophy, of the divine and the human in Christ and the Christian. Tertullian, an apparent extremist, cried, "What has Athens to do with Jerusalem?", but he employed Stoic ideas and the tools of Latin style. *In toto* the Fathers represent the main tradition of Christian belief and practice in the period when the apostolic teaching took shape in the great creeds of Christendom and the decisions of the general councils. All the major Reformers, notwithstanding their insistence on the unique authority of Scripture, wholeheartedly appealed to the Fathers as representatives of the teaching of the undivided church; thus the English canons of 1571 laid down as a standard for preachers "what is agreeable to the doctrine of the Old and New Testaments, and what the Catholic Fathers and ancient Bishops have gathered from that doctrine."

Modern study of the Fathers began with the interest of the Christian Renaissance in Christian classics. In the Reformation period both Catholics and Protestants used them as an armory; but the massive scholarship of the 17th and 18th centuries rose beyond this and produced a number of basic critical editions, especially those of the French Benedictines. Migne's impressive *Patrologiae cursus completus* (217 volumes of the Latin Fathers and 162 of the Greek), is a collection of reprints, not always accurate, and it is gradually being replaced by sounder editions, notably in the two great series the "Vienna Corpus" (*Corpus scriptorum ecclesiasticorum latinorum*, 1866–) and the German *Griechische christliche Schriftsteller der ersten (drei) Jahrhunderten* (1897–). The great series of *Texte und Untersuchungen zur Geschichte der altchristlichen Literatur* begun by O. von Gebhardt and Adolf von Harnack in 1882 is typical of the learned research devoted in modern times to patristic writings. A valuable expression of widespread interest has been the participation of hundreds of scholars of all confessions in the patristic congresses held at Oxford after 1951. The accumulated labours of scholars since the time of Erasmus have laid a sound foundation for study of this extensive literature, of such significance for those interested in the history of religion or in classical Christian teaching and practice.

See also biographies of the more important Fathers.

BIBLIOGRAPHY.—In addition to the series mentioned above, the *Corpus Scriptorum Christianorum Orientalium* (1903–) and the *Corpus Christianorum* (1955–) should be mentioned; the latter replaces Migne with new editions or selected reprints. Pending the completion of the *Patristic Greek Lexicon* (1961–), ed. by C. W. Lampe, the *Greek Lexicon of the Roman and Byzantine Periods* of *E. A. Sophocles* (1887) is still helpful. For patristic Latin the 17th-century classic of C. F. du Cange, *Glossarium ad scriptores mediae et infimae latinitatis* (current reprints are from the 10-vol. edition of 1883–87), yields for most practical purposes to A. Souter, *A Glossary of Later Latin to 600 A.D.* (1949), and J. F. Niermeyer, *Mediae Latinitatis Lexicon Minus* (1954–).

Individually or in series, works of the Fathers have been translated into many modern languages. English readers have been well served by the Oxford *Library of the Fathers*, 43 vol. (1839–81), and the two series commonly referred to as the *Ante-Nicene and Post-Nicene Fathers* (properly *Ante-Nicene Christian Library* and *Select Library of Nicene and Post-Nicene Fathers*). They have been supplemented or replaced by *Ancient Christian Writers* (1946–), *The Fathers of the Church* (1947–) and more selectively in the *Library of Christian Classics* (1953–). The fullest guide to patrology is O. Bardenhewer, *Geschichte der altchristlichen Literatur*, 5 vol. (1902–32); good briefer treatments in B. Altaner, *Patrologie* (1955; Eng. trans. 1960), and J. Quasten, *Patrology* (1950–). W. Smith and H. Wace (eds.), *Dictionary of Christian Biography*, 4 vol. (1877–87), is still useful. For more popular introductions *see* Robert Payne, *The Fathers of the Western Church* (1951), and *The Holy Fire: the Story of the Fathers of the Eastern Church* (1957); E. Routley, *The Wisdom of the Fathers* (1957); Anne Fremantle, *A Treasury of Early Christianity* (1953); Robert R. Williams, *A Guide to the Teachings of the Early Church Fathers* (1960). (E. R. Hy.)

FATHOM, a measure of length, being the distance from the tip of one middle finger to the tip of the other, when the arms are stretched out to their widest extent. This length has been standardized to a measure of six feet, and as such it is used mainly in sounding (*q.v.*) as a unit for measuring the depth of the sea.

FATIGUE, a condition of impairment, resulting from prolonged mental or physical activity or both, usually removable by rest. The term is used ambiguously, sometimes referring to the organic state of exhaustion or lowered energy following work; sometimes to the feelings of tiredness or boredom experienced at such times; and often to the decline in efficiency of performance during a continuous work session. S. H. Bartley used the term fatigue for the lowered feelings and the term impairment for the organic tissue changes.

Research in pilot fatigue and in combat and operational fatigue in World War II and the Korean War led to a broader use of the term to describe the effects of factors other than work, such as sleep loss, fear and emotional strain, cold and high altitude, or sheer ennui from immobility and endless waiting with nothing to occupy the mind. In industry, it is realized that fatigue symptoms can result from a wide range of factors, such as low morale, frustrated drives, poor working environment or unsatisfactory socio-economic status.

Through all these meanings of fatigue there runs a common thread, but research fails to show any close correspondence between changes in organic state, subjective feelings and performance level. Thus a worker may suffer considerable deterioration in his feelings even though his output remains high. Attempts to find an organic decrement to parallel closely the decrement in the output of workers have been successful only in grossly muscular types of performance. Hence, fatigue must be considered a complex, mutually independent group of deteriorative changes that are ordinarily reversible (*i.e.*, overcome by adequate rest and change of activity) but that in extreme cases can cause irreversible organic damage or severe mental disturbance.

Measurement of Fatigue.—Because of its complex nature, fatigue must be measured from three different angles: the subjective, the physiological and the objective.

Subjective.—The first of these is difficult to do accurately, even though it is by far the most significant for the worker himself, because it is concerned with his own feelings of discomfort, satiation, pain and weariness. To measure these qualitative changes, the worker rates himself, at stated intervals during the work session, on a feeling-tone scale, indicating the degree of his tiredness at that moment. These ratings are plotted on a graph to show the course of development of subjective fatigue. Investigators agree in finding a much more rapid decline in feelings than in output of work; but in the long run those persons who show the greatest deterioration in feelings also show the largest drop in efficiency.

Physiological.—On the physiological side, fatigue is measured by changes in the energy exchange rate of the body, called the metabolic rate. This can be done by recording pulse, blood pressure, temperature and breathing; or by analyzing the products of metabolism, such as the amount of carbon dioxide expired from the lungs in relation to the oxygen intake, or the quantity carried off through the blood stream of such waste products as lactic acid, phosphorus, cholesterol, creatinine, or glandular secretions such as the 17-ketosteroids from the adrenal cortex. These methods yield reliable results when gross muscular work is involved, but the changes accompanying predominantly mental or sedentary work are small and difficult to measure reliably. This type of work yields increases in metabolic rate up to 28%, but part of this must be attributed to the muscular and emotional components of the task. All mental work is accompanied by tensions in the

small muscles in and about the head and neck, and even in the larger skeletal muscles of posture. Much of it also involves emotional strain, with resulting use of extra energy by the glands and smooth muscles controlled by the autonomic nervous system. Muscle tensions are measured by recording electrical action currents directly from the muscles.

Emotional tension is reflected in a changed resistance of the skin to a weak electric current passed through it and can be recorded with a galvanometer.

Objective.—Fatigue is measured from the objective or functional side in one of two ways: either by analyzing the worker's performance to determine the output in successive periods of a continuous work session, or by testing his efficiency periodically in some brief activity other than the set task. After 1950 researchers used the critical flicker fusion rate rather widely for this purpose. This is the speed at which a disk consisting of alternate black and white sectors must be rotated to be seen as a uniform gray surface by the observer. Fatigue lowers this rate. When it is desired to study muscular fatigue in a limited part of the body, an ergograph is used, such as the finger ergograph invented by Angelo Mosso (1890). This permits the subject to pull his finger repeatedly against a known weight, recording the extent of each pull until exhaustion is reached. The resulting record, called an ergogram, typically shows a short period of maximum output, followed by a slow decline, which is accelerated toward the end. The breakdown occurs in a very few minutes, depending on the weight pulled. More complex tasks, using the whole body, show a less rapid decrement and may even undergo an improvement for a time, called warming up.

Mental tasks show a similar declining output curve, but rarely does complete exhaustion occur; frequently an equilibrium is reached, at which level work can go on indefinitely. Mental workers actually obtain short involuntary rests at frequent intervals, called blocks, of which they themselves may not be aware. This may indicate the operation of an automatic protective mechanism of the nervous system. It is not the difficulty of the mental task in the usual sense that determines the severity of the fatigue decrement but rather its sameness, continuity and uninterestingness. Some psychologists prefer to distinguish this type of decrement from genuine fatigue, calling it satiation or boredom. They point out that it is not a real capacity change, merely a weakening of motive.

Fatigue in Industry.—Although occasional studies of fatigue in industrial workers were made as early as 1893, it was not until World War I, when industry was called upon to meet excessive production demands, that systematic research was begun. Typical of the agencies set up for this purpose is the Industrial Fatigue Research board of Great Britain. Studies of a wide variety of determinants of efficiency have been made. Although increased production is a major objective in such research, the health and welfare of the worker have not been ignored as ends in themselves. Attention has been directed to ways of alleviating fatigue and improving morale.

Studies fall into two general categories, those concerned with causal factors in the work itself, and those having to do with the worker's environment, both physical and social, at work and outside.

Length of Work Day and Rest Pauses.—When attempts have been made to add extra hours to the work day or work week, as was tried in England as a war emergency step, with schedules up to 60 hours per week, the long-run effects were detrimental; a return to previous schedules was soon made. Apparently a work day of 8 hours and a work week of 40–44 hours are optimal. Next in importance to length of day are the frequency and length of rest pauses. If pauses are short, they must be more frequent, especially in heavy work. As to the manner in which the rest is spent, it depends on the task. With physical tasks, the rest time is best spent in complete relaxation. With light tasks or mental work, however, there is some profit from change of posture, light entertainment, conversation or a "coffee break."

Too long a break may make resumption of work harder, because it necessitates warming up to the task again. Often the recuperative effect of a change of task is nearly as beneficial as a rest.

Methods of Working.—Sometimes the nature of the task is less important than the manner in which it is performed. Time and motion study, begun by F. W. Taylor, has revealed many ways of reducing energy expenditure through analysis of the manner in which tasks are performed.

Industrial physiology, by concentrating attention on the physiological cost, has contributed much to the reduction of fatigue while maintaining output at a maximum. An important problem in all repetitive work is that of monotony and its dulling effect on attention. With the rapid growth of automation after 1950, new problems in fatigue of this type arose. Workers who formerly performed active manipulations came to act as mere observers or checkers, and the problem of maintaining alertness at a maximum became acute. In this type of work boredom sets in, sensory acuity is reduced and attention wanders, with serious consequences to efficiency.

Work Environment.—Chief among the factors in the work setting causing accelerated onset of fatigue are inadequate lighting, too weak or improperly diffused to avoid glare or eliminate shadows; excessive amounts of noise, creating nervous tension; and poor atmospheric conditions. The latter includes such special factors as temperature, humidity, ventilation and air circulation. Workers can endure reasonably high temperatures if humidity is low, and even the discomfort from excessive humidity combined with heat can be lessened if the air is in rapid circulation. Stale air is depressing, but becomes less so when adequately circulated. When temperatures rise to above 100° F., however, with humidity constant, fatigue onset occurs twice as fast as in temperatures between 40° and 80°. Excessive heat produces rapid pulse, inadequate blood circulation, cramps, heat stroke and exhaustion. Some relief is gained by increasing chloride intake. In certain industries the atmosphere is contaminated by fumes or toxic dust; this adds to worker fatigue by undermining physical health, thereby increasing accident rates.

General Environment.—Industrial psychologists have found that fatigue and boredom of workers are importantly related to social factors, such as the amount of recognition received from management, irritations from supervisors or fellow workers, and financial or other personal worries not having a direct relation to the job. One of the studies frequently quoted in support of this is that of Roethlisberger and Dickson, performed at the Hawthorne plant of Western Electric company. This study, which was planned to determine the effects on output of periodic rest periods during the work day, demonstrated instead the stimulating effect on workers of being given special recognition by management. The workers chosen for the study were placed in a special room and given special attention with reference to lunches and other details, in order to maintain controlled conditions. As a result, their production improved, regardless of whether they were given rest periods or not. L. Hornstra (1955) considers fatigue a psychosomatic expression of partial frustration. It is lessened to the degree that work is satisfying and congenial, and even when the task itself is disagreeable the situation as a whole may be satisfying provided needs are being met through performance of the task.

See also PSYCHOLOGY, APPLIED: *Industrial Psychology.*

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(A. G. Bs.)

FATIGUE OF METALS is the progressive change of structure and mechanical properties of metals produced by frequently repeated or fluctuating loading. Specifically, the term is applied to the progressive deterioration of the cohesion of metals as a result of which fracture is produced by the repetition of stress cycles of maximum intensity appreciably lower than the stress intensity that would cause fracture upon a single application.

The majority of mechanical failures of structural and machine parts occurring in operation can be attributed to fatigue. A num-

ber of fatal accidents to airplanes were found to be the result of fatigue, mainly of wing spars; the accidents in 1954 involving two of the early Comet jet airliners were attributed to fatigue failures in the pressure cabin. Thus in the design of aircraft, particularly long-range transport planes with expected service lives exceeding 30,000 flying hours, structural fatigue has emerged as a major design problem.

The physical appearance of a fatigue fracture is significantly different from that of a fracture produced by a single load application. Moreover, fatigue fractures occur suddenly, without noticeable permanent deformation, and thus apparently without preliminary warning, unless the surface of the repeatedly stressed part is kept under careful observation for incipient and growing cracks.

The characteristic appearance of the fracture surfaces indicates the progressive nature of the transcrystalline fatigue-failure mechanism: a smooth zone of brittle separation, showing clam-shell markings (traces of the fatigue crack at various stages of growth), starts from one or several local faults, usually located at the surface, and spreads gradually inward until the remaining cross section fails, producing a separation surface of coarse crystalline appearance. The smooth portion of the separation surface is frequently discoloured by oxidation, particularly when the fatigue cracks take years to grow to critical size.

Historical Survey.—Fatigue fractures were observed and reported as soon as metals were used under conditions of repeated or fluctuating stress. The first published report (Germany, 1837) referred to fractures observed in steel cables used in mine hoists. In 1842 the problem emerged in England in connection with failures in locomotive axles, and was discussed in 1849 and 1850 in a series of meetings of the Institution of Mechanical Engineers. In 1849 the so-called Iron Commission, appointed "to inquire into the application of iron to railway structures," published its report containing an investigation (by H. James and D. Galton) into the behaviour of cast-iron bars subjected to pulsating bending strains; in this investigation the concept of an endurance or fatigue limit was first established; below this limit fatigue does not exist.

Between 1858 and 1870 the results of an extensive series of classical experiments on iron and steel subjected to repeated axial, torsional and bending stresses were published by A. Woehler, a German engineer.

The term fatigue was introduced into the engineering literature in 1854 in a paper by F. Braithwaite in the *Proceedings* of the Institution of Civil Engineers, following a suggestion of Joshua Field, fellow of the Royal society, then president of the institution. The term is used with respect to repeated stressing due to mechanical forces (mechanical fatigue), to repeated transient temperature forces caused by temperature cycling in machine parts operating at elevated temperatures (thermal fatigue) as well as to noise from jets or other sources (acoustic fatigue).

The volume of fatigue research has increased considerably since 1870: first in connection with the development of locomotives and rolling stock of increasing weight, leading to increasingly severe fatigue effects in rails and bridges; later in connection with the development of heavy machinery (marine engines, turbines), as well as with the use of high-strength steel in automobile construction; and, finally, in connection with the use of lightweight alloys in the construction of airplanes, as well as the use of high-temperature alloys for heat exchanger and other machine parts subject to elevated temperatures, including nuclear reactor parts, most of which are subject to thermal fatigue.

The application of the metallurgical microscope in the study of the structural changes in metals produced by repeated stresses initiated a new phase of research. The classical work, between World Wars I and II, on microstructural changes under repeated stresses, by H. J. Gough, provided the first basic knowledge concerning the micromechanism of fatigue and laid the foundation for subsequent research work aided by improved microscopic techniques and the development of the electron microscope.

Many of the important but very complex engineering problems, such as the effect of the dimensions of the stressed parts, the accumulation of damage under variable stress amplitudes, the effect of combinations of various types of stress, the effect of residual stress fields, etc., are still largely unsolved, with the result that engineering design for fatigue relies heavily on empirical safety factors and large-scale prototype testing.

Micromechanism of Fatigue.—Two stages can be distinguished in the progress of fatigue: (1) that of initiation of damage, ending in the formation of submicroscopic cracks; and (2) that of growth of microscopic and macroscopic cracks. Such distinction attempts to delimit the stage of propagation of an optically resolvable crack from the stage preceding its visual identification. The latter is closely related to the heterogeneous plastic glide under repeated stressing which differs significantly from that produced by a single stress application.

The effect on the crystal structure of rapid cyclic stressing is a sharp concentration of glide processes in widely and fairly regularly spaced glide bands ("striations") observable on the polished metal surface, which tend to grow steadily in width and in intensity. It is within the most pronounced striations that fatigue cracks are initiated at an early stage of repeated stressing, and along which they subsequently propagate. The concentration of slip into striations may be due to the development, with increasing number of applied stress cycles, of localized elevated temperatures.

That localized thermal softening has a significant effect in the initiation of fatigue cracks is suggested by the observation within the striations of heat stains in certain metals and of recrystallization, polygonization, diffusion and precipitation in other metals and alloys. (*See* also ALLOYS.)

Surface Effects.—*Corrosion and Fretting Fatigue.*—The initiation of fatigue damage at or near surfaces of cyclically stressed parts is the cause of the pronounced surface sensitivity of fatigue performance. Any effect that impedes the slip or blocks it before it reaches the surface impedes or delays the process of crack initiation and thus increases the fatigue life. The creation of very thin surface layers subject to high-intensity compressive residual stresses resulting from the elastic restraint on enforced volume expansion of this layer imposed by the unstrained core is particularly effective.

The volume expansion may be produced by forcing foreign particles into the atomic lattice near the surface (carburizing, nitriding, cyaniding), or by cold-working the surface layer (shot-peening, cold-rolling). Similarly, changes produced in the surface by mechanical polishing and grinding are highly effective in increasing the fatigue life. (*See* SURFACE HARDENING; IRON AND STEEL INDUSTRY: *Steel Metallurgy.*)

Surface effects are particularly significant when the stress gradients are steep, with the maximum stress intensity at the surface coinciding with the residual compression (bending, torsion, roots of notches).

Fatigue life is reduced by any mechanical effect that induces premature localized slip in the surface, such as tool marks and other accidental defects, as well as drill holes and grooves. It is also sharply reduced by surface damage resulting from the effects of a corrosive medium, particularly when the corrosive action is simultaneous with the repeated stressing (corrosion fatigue); in general the corrosive effect of fluids on metal surfaces is amplified by fatigue stressing. Most wetting fluids, without necessarily being chemically corrosive (for instance distilled water), reduce the fatigue life of many metals in comparison with their fatigue life in air; however, surface damage by chemical corrosion (for instance in sea water) accelerates this effect considerably. Even air is corrosive with respect to fatigue: tests in vacuum suggest a slight increase of fatigue life with decreasing pressure.

Surface damage inducing fatigue cracking is also caused by relative motion of the cyclically stressed surface with reference to other metal surfaces in rubbing contact with it. The rapidly developing friction heat and surface oxidation produces "fretting fatigue" which is characteristic of fatigue failures in bearings, grips and particularly riveted or bolted connections of cyclically stressed structures.

Statistical Aspects.—The number N of stress cycles of amplitude S that is sustained prior to fracture (fatigue life) increases

as the amplitude decreases. The form of the relation between S and N (Woehler diagram or S-N diagram) depends on the type of stress (tension, torsion, bending or combined stress), the geometry of the stressed structural part (local concentrations of stress), the range of the repeated stress cycle (difference between maximum and minimum stress) and the mean (sustained) stress on which it is superimposed, as well as on environment (temperature, corrosive atmosphere, radiation). It is limited, on the one hand, by a minimum stress amplitude, the "fatigue limit" S_0, which decreases with increasing N, on the other, by a minimum number of stress cycles, the "minimum life" N_0, which increases with decreasing S. Fatigue fractures do not occur unless the stress amplitude S is larger than S_0, and the number of its repetition N larger than N_0.

The fatigue life N associated with a specified stress amplitude S or with a sequence of variable stress amplitudes is a highly statistical variable, probably because the micromechanism of fatigue damage is closely related to local imperfections of the surface and of the crystal structure. Depending on the degree of control imposed on the conditions of repeated stressing and on the geometry and surface conditions of the stressed part, as well as on the environment, the fatigue life under relatively well-controlled, nominally identical conditions is subject to a range of variation (ratio between the maximum and minimum values) of about five to ten; the range increases with increasing number of tests.

The prediction of the fatigue life on the basis of tests or observations is, therefore, subject to considerable error, and the characteristic relation between S and N cannot be definitely specified. To every combination (S, N) the numerical probability P (between zero and one) that this combination will in fact produce fracture, or the probability $l = (1\text{-}P)$ that it will not produce fracture must be attributed. The S-N relation is thus a three-dimensional S-N-P or S-N-l relation, and the fatigue life is represented by the "mortality function" $P(N)$ or the "reliability function" $l(N)$ expressing, respectively, the probabilities of fracture P or of survival l at different values of N. The functions are limited by the minimum life N_0 for which $P(N_0) = 0$ or $l(N_0) = 1$; as N_0 tends toward infinity, S_0 tends toward the true endurance limit. The S_0-N_0 diagram below and along which survival is certain thus delimits the range of fatigue under constant stress amplitudes.

Prevention of Fatigue.—The large majority of mechanical service failures in modern engineering practice are the result of fatigue. Therefore, the importance of adequate fatigue design can hardly be overestimated. While selection of fatigue-resistant rather than high-strength metals and the improvement of their fatigue performance by surface treatment are of considerable importance, the most significant preventive factor is the careful design of even the smallest structural detail so as to avoid sharp re-entrant corners, abrupt changes of sections and other sources of intense stress concentration, as well as sources of fretting fatigue.

See also MATERIALS, STRENGTH OF; METALLURGY; METALLOGRAPHY.

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FATIMA (FATIMA BINT MOHAMMED THE PROPHET) (*c.* 606–632), daughter of the prophet Mohammed by his first wife, Khadija, was born in Mecca. She married her cousin 'Ali ibn Abi Talib (*see* ALI), a devoted follower of Mohammed, and their sons, Hasan and Husain (*see* HASAN AND HUSAIN), became the only male perpetuators of Mohammed's line.

This Family of the House of Mohammed was hounded by misfortune. Fatima and 'Ali were the losers whenever they clashed with 'A'isha, the favourite wife of Mohammed. Both felt that they were deprived of their inheritance by Abu Bakr (*q.v.*), the first caliph.

Fatima died in Medina shortly after Mohammed, but her memory has been kept alive through the tragic history of her family and descendants, many of whom were massacred for political reasons in 680 at Karbala, Iraq.

As Fatima's family failed politically, disappointed followers, the Shi'a, endowed its members with great moral virtues, religious insight and, finally, with divinity. In this process the role of Fatima "the virgin" is curiously similar to that of the Virgin Mary in Roman Catholicism. She is accorded a high place of honour in heaven. Her symbol, "the Hand of Fatima," is frequently displayed in religious processions.

Fatima's husband and sons became the first Imams or spiritual leaders of Shi'ite Islam, which still expects the return of one of their descendants as the divine Mahdi who shall rule on earth. Sunnite, or orthodox, Islam also venerates the Family of the House but absolutely refuses to endow any of them with a divinity denied even to Mohammed.

Several Shi'ite dynasties claimed descent from Fatima. The most important was the Fatimid caliphate (909–1171; *see* FATIMIDS) of north Africa, Egypt and Syria, which withstood the crusaders but succumbed to Saladin.

See Henri Lammens, *Fatima et les Filles de Mahomet* (1912); Peter Hagop Mamour, *Polemics on the Origin of the Fatimi Caliphs* (1934). (N. A.)

FÁTIMA, a village and sanctuary in Santarém district, central Portugal, about 18 mi. E. of Leiria by rail, on the tableland of Cova da Iria. The sanctuary is dedicated to the Virgin Mary, and the celebrations held there on the 12th and 13th of each month from May to October are attended by great numbers of pilgrims.

On May 13, 1917, three young peasant children, Lucia dos Santos (or Abóbora) and her two cousins, Francisco and Jacinta Marto, saw a vision of a lady while tending sheep at a spot now marked by a small chapel. In accordance with her promise, the vision was repeated on the 13th of each month until October, except for August when the children were at Valinhos pasture (near Aljustrel, the village of their birth), where they saw the lady on Aug. 19. The lady revealed herself on Oct. 13 as the Lady of the Rosary and asked for a chapel to be built for her there. After initial opposition the visions were accepted as the appearance of the Virgin Mary by the bishop of Leiria on Oct. 13, 1930. In the same year, papal indulgences were granted to pilgrims and devotion in other ways was also favoured. The content of the devotion consists of frequent recitation of the rosary, works of mortification for the conversion of sinners, devotion to the Immaculate Heart of Mary, the consecration of Russia to the Immaculate Heart, prayer for world peace and a communion of reparation by the faithful on the first Saturday of each month.

The first national pilgrimage to Fátima took place in 1927 and the basilica was begun in 1928 and consecrated in 1953. With a 213-ft. tower surmounted by a 7-ton bronze crown and a crystal cross, it is flanked by hospitals and retreat houses and faces a vast square in which is the little Chapel of the Apparitions. The celebrations include the blessing of the sick and a torchlight procession in which the crowned image of the Virgin of Fátima is carried. Numerous cures have been reported, though publicity for them has not been sought.

See C. C. Martindale, *The Message of Fatima* (1950).

FATIMIDS, the name of an Arab dynasty called after Fatima (*q.v.*), daughter of the Prophet Mohammed, from whom and her husband, Ali, they claimed descent. They rose as leaders of the Isma'ili movement, which was secretly organized in the 9th century for the sake of overturning the Abbasid caliphate. Very little is known of the early leaders of the secret period of the movement, who resided in Salamiyah in Syria. The founder of the territorial might of the dynasty, usually known as 'Ubaydullah (though his official name was 'Abd Allah), left Salamiyah (in consequence of inner conflicts within the movement), and betook himself to North Africa, but was imprisoned by the ruler of Sijilmassa in 905. The head of the Isma'ili mission in north Africa, Abu 'Abd Allah al-Shi'i, succeeded in capturing the whole of the province of Ifriqiya (modern Tunisia and eastern Algeria) from the Aghlabids, vassals of the Abbasid caliphs of Baghdad, and entered their residence

Raqqada (near Kairouan) in March 909. In May he led an army westward, put an end to the Rustamid dynasty in Tahert, and thence proceeded to Sijilmassa, where he released 'Ubaydullah. 'Ubaydullah entered Raqqada in triumph, and, under the style of al-Mahdi, was proclaimed the rightful caliph, or imam (the title preferred by the Shi'ites, to whom the Isma'ilis also belonged).

'Ubaydullah and his successors claimed to have descended from the line of the imams of the family of Ali; different genealogical trees, however, were put in circulation by the Isma'ilis themselves. Their enemies pronounced these claims as false and asserted that the founder of the dynasty, and of the Isma'ili movement, was an impostor, called 'Abd Allah ibn Maymun al-Qaddah, who used Shi'ism for his own selfish and nihilistic aims.

The reorganization of Isma'ilism by 'Ubaydullah led to inner tensions, symptoms of which appear in the murder of Abu 'Abd Allah al-Shi'i by 'Ubaydullah in 911, and in risings (finally suppressed) among the Berber tribes which had brought about the triumph of the dynasty in north Africa.

'Ubaydullah did not lose sight of the aim of Isma'ilism, which was not the establishment of a local kingdom but the gaining of the universal caliphate. After defeating his internal enemies, he immediately turned his attention to the east and organized an expedition to Egypt (913–914), which, however, was unsuccessful; nor did a second expedition (919–920) fare much better. In 921 he transferred his residence to a new capital named after him Mahdia, where he died in 933.

The reign of his successor, al-Qa'im, was mainly memorable for the uprising of Abu Yazid, a leader of the Kharijite sect, who was, however, supported also by the orthodox Sunnis who resented the imposition of Shi'ism as the official religion of the state. Abu Yazid occupied Kairouan in 943, and the next year laid siege to Mahdia. After about ten months, however, he was compelled to raise the siege. In May 946 al-Qa'im died at Mahdia and was succeeded by his son al-Mansur. Al-Mansur pursued Abu Yazid who was retreating to the west, and captured him, mortally wounded, in 947. At the end of the war al-Mansur transferred his capital to a suburb of Kairouan which was named al-Mansuriyya after him. He died in 953.

Al-Mansur was succeeded by his son al-Mu'izz. His authority was acknowledged over the greater part of the region now constituting Morocco, Algeria and Tunisia, as well as Sicily. In the years 958–959 he sent his general Jawhar westward to reduce Fez and other places where the authority of the Fatimid caliph had been repudiated; after a successful expedition Jawhar advanced to the Atlantic. The Fatimid imam, in addition to being the ruler of extensive territorial dominions, was also the leader of the followers of Isma'ilism outside his realm, though after its earlier successes, the expansion of the movement had begun to decline by the middle of the 10th century (partly owing to internal dissension).

When Kafur, the ruler of Egypt, died, al-Mu'izz thought the moment opportune for a fresh invasion. His general Jawhar succeeded where the generals of the founder of the dynasty had failed, and conquered Egypt in 969. Three years later al-Mu'izz resolved to transfer the centre of the Fatimid power to Egypt, and he entered Cairo (Al Kahirah), the new capital founded by Jawhar just to the north of the old (Al Fustat), in Aug. 972, leaving behind in north Africa as his lieutenant general Yusuf ibn Ziri.

Though the conquest of Egypt was not the goal of Fatimid aspirations, but a step toward universal rule over the Islamic world, in fact their expansive power spent itself with the conquest. In spite of the fact that Egypt, as north Africa before, was the headquarters of a missionary organization working in different parts of the Islamic world in favour of the Fatimids, the rest of the history of the Fatimid dynasty (lasting for *c.* 200 years) is mainly that of a territorial empire consisting of Egypt and its outlying provinces. For the internal history of this period *see* EGYPT: *History: Medieval Period.* In external affairs and in the relations of the dynasty with Isma'ilism the most important developments are described below.

Under al-Mu'izz and his son al-'Aziz (976–996) the momentum of the conquest of Egypt was sufficient to carry the Fatimid armies into Syria, most of which remained in their hands till the second half of the 11th century. In the second half of the 10th century their sovereignty was acknowledged in the distant province of Sind, governed by Isma'ili missionaries. The reign of al-Hakim (996–1021) is memorable from the point of view of religious history through the rise of the Druze sect (*see* HAKIM, AL-; DRUZE). The reign of al-Zahir (1021–36) was followed by that of al-Mustansir (1036–94), the first half of whose reign was marked in Egypt by a virtual collapse of government. Of the vassal realms, north Africa was lost through the defection of the Zirids to Sunnite orthodoxy and Sicily through the advance of the Normans. On the other hand, Yemen was gained to the Fatimid cause by the rise of the Isma'ili dynasty of the Sulayhids, and in the east there was a recrudescence of Isma'ili propaganda. Egypt, meanwhile, was reorganized by the strong hand of the vizier Badr al-Jamali.

The choice of a successor on al-Mustansir's death, a choice made by the great vizier's son and successor al-Malik al-Afdal, proved fatal for the Isma'ili movement. Al-Musta'li (1094–1101), whom he put on the throne, was not accepted by the Isma'ilis in the east, who severed their connection with the Fatimids and formed an independent movement (*see* ASSASSIN). Another schism occurred after the death of al-Amir, al-Musta'li's son (1101–30): the Yemenite Isma'ilis did not acknowledge his successors in Egypt (al-Hafiz, 1130–49; al-Zafir, 1149–54; al-Fa'iz, 1154–60; and al-'Adid, 1160–71). Having lost the allegiance of the Isma'ilis abroad, the Fatimid rulers at home in Egypt had only a shadow of authority, which was in fact wielded by their viziers. Thus it meant very little to the population when, in 1171, Saladin (*q.v.*), a figure representative of the Sunnite revival and the champion of Islam against the crusaders, deposed al-'Adid (who died shortly afterward) and proclaimed the legitimacy of the Abbasid caliph.

Subsequent conspiracies which aimed at placing on the throne a member of the Fatimid family proved abortive. *See* ISMA'ILISM.

See also references under "Fatimids" in the Index.

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FATTY ACIDS or ALIPHATIC CARBOXYLIC ACIDS, a class of compounds of carbon, hydrogen and oxygen that are important in industry and in biochemistry. Fats and fatty oils are formed in chemical reactions in which fatty acids and glycerin take part. The many derivatives of fatty acids are prepared by modifying the hydrocarbon chain or by utilizing the reactions of the carboxyl group.

See BIOCHEMISTRY: *Fats and Amino Acids;* CARBOXYLIC ACIDS; HYDROGENATION; OILS, FATS AND WAXES: *Hydrogenation;* SOAP; *see* also references under "Fatty Acids" in the Index.

FAUCHILLE, PAUL AUGUSTE JOSEPH (1858–1926), French authority on international law, born at Lille, on Feb. 11, 1858, studied law in Paris. His doctorate thesis, *Du blocus maritime* (Paris, 1882), remains a classic of international comparative law. He was responsible for the second edition of Henry Bonfils' *Manuel de droit international public* (1898), which he was subsequently to expand till it became the monumental *Traité,* 4 vol. (1922–26). He established, under the auspices of the University of Paris, the Institut des Hautes Études Internationales in 1920.

Fauchille died at Fontenay-aux-Roses (Seine) on Feb. 9, 1926.

FAULHABER, MICHAEL (1869–1952), German Catholic churchman and prominent opponent of the Nazis, was born at Heidenfeld on March 5, 1869. He studied philosophy and theology in Würzburg and Rome and was ordained a priest in 1892. He was a lecturer at the University of Würzburg (1899–1903) and professor of theology (Old Testament) at the University of Strasbourg (1903–10), subsequently serving as bishop of Speyer (1911–17) and archbishop of Munich and Freysing (1917–52). He was created a cardinal in 1921. Faulhaber collided early with the Nazis, whose neopaganism was repugnant to him, and he played a part in causing the failure of Hitler's *Putsch* in 1923. Ten years

later, with the Nazis in power, he delivered to vast throngs his famous sermons entitled *Judaism, Christianity, and Germany* (translated by George D. Smith, 1954). He emphasized that the teachings of the New Testament were but a logical sequel to those of the Old, and that exceptions taken to the latter were basically exceptions to the moral law in general. He added that the German tribes had become civilized only after they had been converted to Christianity and that Christian values were fundamental to German *Kultur*. Throughout these sermons, as well as those which were to follow until the collapse of the third *Reich*, there runs a thread of vigorous criticism of Nazi theories and Nazi practices which the cardinal repeated in communications to the government. An attempt on his life was made in 1934, and his residence was attacked in 1938.

He died in Munich on June 12, 1952.

Cardinal Faulhaber's book *The Women of the Bible* appeared in English in 1938 (new ed. 1955). Among his other publications was *The Moral Teachings of the Gospels* (1936; *Die Sittenlehre des Evangeliums*). (F. A. Hs.)

FAULKNER (FALKNER), **WILLIAM** (1897–1962), U.S. author, winner of the 1949 Nobel prize in literature, was born on Sept. 25, 1897, at New Albany, Miss., into a family with deep southern roots. He was, among other things, an aviator in World War I, a student at the University of Mississippi, a postmaster, a Hollywood writer, a farmer and, in his later years, a lecturer at the University of Virginia; but for the greater part of his life he made his home in Oxford, Miss., where he died on July 6, 1962.

After false starts as poet (*The Marble Faun* [1924]) and novelist (*Soldiers' Pay* [1926], *Mosquitoes* [1927]), Faulkner discovered his métier with his third novel, *Sartoris* (1929), the first in a series of works, laid in "Yoknapatawpha" county, Miss., on the past, present and future of the south. The "saga" includes, most notably, *The Sound and the Fury* (1929), *As I Lay Dying* (1930), *Light in August* (1932), *Absalom, Absalom!* (1936), "The Bear" (in *Go Down, Moses, and Other Stories* [1942]), and *Intruder in the Dust* (1948).

Divided into four sections, the first three of which are given to the streams of consciousness of three brothers in the Compson family—Benjamin, an idiot; Quentin, a Harvard student who commits suicide; Jason, a mean-spirited storekeeper—*The Sound and the Fury* chronicles the decay of a patrician family. *As I Lay Dying*, another stream-of-consciousness novel which moves kaleidoscopically through 15 minds, recounts the bizarre odyssey of the poor-white Bundrens, who, after awaiting the death of Mrs. Bundren, journey against all odds 40 mi. to bury her. *Light in August* counterpoints the stories of Lena Grove, placidly walking across the south in search of the father of her unborn child, and Joe Christmas, who, uncertain of his colour, vacillates between white and black, finally to be lynched as a Negro. *Absalom, Absalom!* is an impressive record of the rise and fall of the plantation dynasty of Thomas Sutpen, whose career before, during and following the Civil War becomes a symbol of the race-contorted history of the south.

"The Bear," one of Faulkner's most powerful stories and a key to his central themes, celebrates the initiation into manhood of Isaac McCaslin through the hunting of an animal at once legendary, symbolic and superbly actual, and at the same time treats movingly the problem of interracial relations. *Intruder in the Dust* combines the story of the Negro Lucas Beauchamp charged with the murder of a white man, the maturing of the boy "Chick" Mallison who helps exonerate Beauchamp in a rather crudely contrived detective yarn, an overwrought plea by Chick's uncle Gavin Stevens for southern autonomy, and the analysis of "not a racial outrage but a human shame." Outside the Yoknapatawpha series, Faulkner's most ambitious work was the 1955 Pulitzer prize novel, *A Fable* (1954), a modern rendering of Passion week in which the Unknown Soldier of World War I, as the latter-day Christ, speaks against the corruption of the world's leaders and for the faith of the mass of humanity.

Dealing with all levels of southern society, Faulkner saw the south as doomed by its sinful exploitation of land and man. U.S. readers first found Faulkner's experimental style prolix, turgid and unnecessarily obscure, and his characters excessively brutal. But the nightmare world which these readers came to accept as a set of symbols for personal and social disintegration more readily impressed European readers, to whose violently changing lives and societies Faulkner addressed himself with particular force both naturalistically and symbolically. Emphasizing the presence of the past, the power of doom, and the value of endurance, Faulkner transcended his region and his country to speak to the world.

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(J. PT.)

FAULT. In geology, a fault is a dislocation in the rocks of the crust of the earth. The fault plane or surface is a fracture along which the rocks on opposite sides have slipped past each other. Most, if not all, earthquakes are due to movement along faults. Faults range in size from those that are detected only under the microscope to others that are many hundreds of miles long. In some instances, the movement is distributed over a fault zone composed of countless individual faults that occupy a belt hundreds of feet wide.

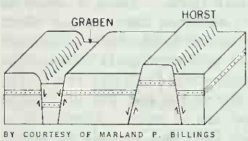

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FIG. 1.—GRABEN AND HORST

Origin.—Faults are due to compressional or tensional forces that cause fracturing in the earth's crust. Thrust faults are the result of compressional forces where the easiest relief is upward. Strike-slip (wrench or lateral) faults are similarly due to horizontal compression, but in such cases the easiest relief was in a horizontal direction at right angles to the compressional force. Gravity faults, also called by some geologists normal faults, are often considered to be the product of horizontal tension in the crust, but this tension may be the result of vertical compressional forces acting from below.

Classifications and Examples.—A gravity fault or normal fault is one in which the hanging wall has gone down relative to the footwall (the block above the fault plane or surface is called the hanging wall; the block below is called the footwall, fig. 4); such movement involves lengthening of the crust of the earth at right angles to the strike of the fault.

Gravity faults are found throughout the world. In the Great Basin province of Utah and Nevada, such faults bound many of the mountain ranges on one or both sides. The mountains have been uplifted relative to the adjacent valleys many thousands of feet along these faults. One of the best examples is that along the west side of the Wasatch range of Utah. The Teton range of Wyoming is bounded on the east by a large gravity fault. A block that has dropped relatively downward between two gravity or normal faults dipping toward each other is a graben (fig. 1). The Rhine graben of Germany, bounded on both sides by gravity faults, is 180 mi. long and 20 to 25 mi. wide. A block that has been relatively uplifted between two gravity faults that dip away from one another is a horst (fig. 1). A tilted block that lies between two gravity faults dipping in the same direction is a tilted fault block.

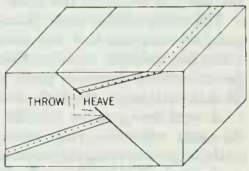

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FIG. 2.—THRUST FAULT

A thrust fault (fig. 2) is one in which the hanging wall has gone up relative to the footwall; it involves a shortening of the crust of the earth at right angles to the strike of the fault. Some thrust faults are folded generally after displacement along them has ceased. Thrust faults with an initial low angle of dip and a net slip measured in miles are often referred to as overthrusts (fig. 3).

One of the best known thrust faults in North America, the Lewis overthrust, is found along the east side of the Rocky mountains in Glacier national park of Montana. Along this thrust

ancient Pre-Cambrian rocks have been thrust eastward over younger Cretaceous rocks for at least 10 mi. Large thrust faults are also characteristic of the Appalachian region in the so-called Valley and Ridge province of Virginia and Tennessee.

Along the Moine overthrust in the northwest highlands of Scotland the Moine schists have been thrust northwestward for at least 15 mi. Thrust faults along which the movement is tens of miles are common in the Alps. Many overthrusts have been folded and deeply eroded. In places erosion may cut so deeply that in a circular or elliptical area the footwall block is completely surrounded by the hanging wall block; this is called a window (fig. 3). Elsewhere, an isolated mass of the hanging wall may be completely surrounded by the footwall; this is known as a klippe or thrust outlier (fig. 3).

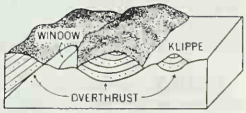

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FIG. 3.—OVERTHRUST SHOWING WINDOW AND KLIPPE

In another group of faults the dip is essentially vertical and the movement is largely horizontal. Such faults are called strike-slip faults, wrench faults or lateral faults. Along a series of faults trending northwestward in California, the northeast block has been displaced southeasterly relative to the block southwest of the fault. During the San Francisco earthquake in 1906 the maximum movement along the San Andreas fault was 21 ft. The total movement along this fault during the last few millions of years appears to have been several tens of miles. Another large fault of this type is the Great Glen fault that extends northeast-southwest across Scotland from Inverness to Oban. Along this fault the block to the northwest has moved southwesterly 65 mi. In the South Island of New Zealand the northeasterly trending Alpine fault is a strike-slip fault along which the displacement is many tens or even hundreds of miles.

Movement Along Faults.—In describing movement along faults the intersection of the fault plane with the surface of the earth is called the fault trace (fig. 4). The trend or direction of the fault trace is called the strike and is defined by the angle the trend makes with a north-south line. Faults may be vertical, horizontal or inclined at any angle. Although the angle of inclination of a specific fault tends to be relatively uniform, in some instances the inclination may differ considerably from place to place. The angle of inclination measured from the horizontal is called the dip (fig. 4). The angle of inclination or deviation from the vertical is called the hade.

The walls of the fault plane in many instances are smoothly polished and marked by scratches called slickensides. These scratches indicate the direction in which the two blocks on opposite sides of the fault plane have moved relative to each other. In some instances, the rocks along a fault plane have been crushed to a very fine-grained claylike substance known as fault gouge. In other cases the fragmental rock is relatively coarse-grained with fragments ranging from an inch in diameter to many feet; such material is known as fault breccia (*q.v.*) or crush breccia.

In general, the displacement of the blocks on the opposite sides of the fault plane must be considered in relative terms; the absolute movement relative to some datum, line or plane such as sea level, is generally unknown. The movement along a fault may be rotational, in which the blocks rotate relative to one another, or translatory, in which no rotation is involved.

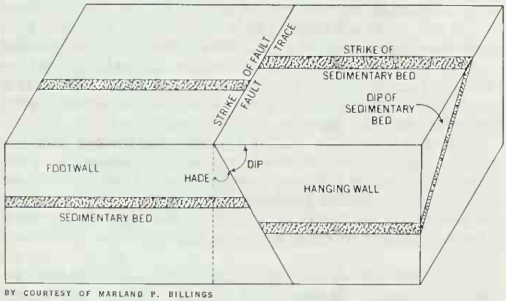

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FIG. 4.—TERMINOLOGY APPLIED TO FAULTS

Although it is clearly recognized that a rather elaborate terminology is necessary to describe the relative movements along faults and the effects on the disrupted strata, complete unanimity of definition has not been achieved. The most common terminology and the one adopted here is a modification of the terminology advocated by a committee of the Geological Society of America in 1912.

The net slip is the total displacement; it is the distance measured on the fault surface between two formerly adjacent points situated on opposite sides of the fault plane (ab of fig. 5). The inclination that the net slip makes with a horizontal line in the fault plane is called the pitch or rake (angle cab of fig. 5). To describe the net slip quantitatively, it is necessary to give its pitch, the amount of the displacement and the direction of the relative movement. The strike slip, measured in the fault plane, is the horizontal component of the net slip (bd of fig. 5).

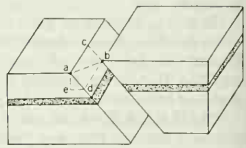

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FIG. 5.—TERMINOLOGY APPLIED TO MOVEMENT ALONG FAULTS: (AB) NET SLIP; (BD) STRIKE SLIP; (CB) DIP SLIP; (AE) VERTICAL SLIP; (ED) HORIZONTAL SLIP

The dip slip is the component of the net slip measured directly down the dip of the fault plane (cb of fig. 5). The vertical slip is the vertical component of the net slip; it is a measurement of the relative vertical movement along the fault plane (ae of fig. 5). The horizontal slip is the horizontal component of the dip slip; it is a measurement of the relative movement of the two blocks toward or away from each other (ed of fig. 5).

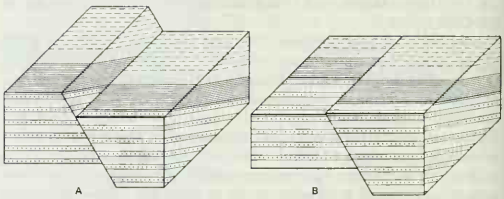

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FIG. 6.—EFFECT OF FAULTING ON DISRUPTED STRATA, (A) BEFORE EROSION; (B) AFTER EROSION

Effect on Disrupted Strata.—The apparent movement of a fault may be very different from the actual movement. Thus, in fig. 6 (A), the hanging wall has moved down relative to the footwall. But when the left-hand block has been eroded to the level of the right-hand block (fig. 6 [B]), their relation suggests that the right-hand block moved forward relative to the left-hand block. Of course, this might actually have been the case, and a solution of such problems is possible only if some other planar feature, such as a dike or an older fault, has also been displaced by the fault. The throw and heave are measured in a vertical section at right angles to the trend of the fault plane (fig. 2). The throw is the vertical component of the apparent movement in such a section; whereas the heave is the horizontal component. Many geologists define throw and heave differently; defining throw the same as vertical slip and heave the same as horizontal slip (as defined above).

For discussion of faults in relation to the occurrence of gas and oil *see* FORAMINIFERA; GEOPHYSICAL PROSPECTING; MINE PROSPECTING AND DEVELOPMENT. *See* also GEOLOGY; EARTHQUAKE.

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FAUNUS, an Italian rural deity, the bestower of fruitfulness on fields and cattle. As a herdsmen's god he was identified with Inuus, the fertilizer of cattle. His identification with the god worshiped at the Lupercalia (*q.v.*) is controversial. He is above all a woodland deity and identified with the sounds of the forest; thus he is called Fatuus ("the speaker") and has a female counterpart, Fatua or Fauna, either his daughter or wife, allegedly identical with the Bona Dea (*q.v.*). He is sometimes prophetic (as in the *Aeneid,* vii), and as Incubo has charge of nightmares and buried treasure (*cf.* fairies, pucks, etc.). He is identified with the Greek Pan (*q.v.*) and under this influence may be pluralized: fauni, woodland spirits conceived as satyrs (*q.v.*). Rationalizing mythologists made him an early king of Latium, the son of Picus and father of Latinus. He had two festivals (Faunalia): on Dec. 5 in the country, an occasion of gaiety and spirited dancing (Horace, *Carmina,* iii, 18); and an urbanized form on Feb. 13 (Ovid, *Fasti,* ii, 193 ff.), which took place at the temple of Faunus in Rome.

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FAURE, FÉLIX (1841–1899), sixth president of the third French republic, was born in Paris on Jan. 30, 1841, the son of a small furniture maker. He made a fortune as a tanner and merchant at Le Havre and was elected to the chamber of deputies in Aug. 1881. He sat in the centre, interesting himself chiefly in matters concerning economics, railways and the navy. Between 1881 and 1888 he was four times undersecretary for the colonies. In 1893 he was made vice-president of the chamber. In May 1894 he obtained cabinet rank as minister for the navy under Charles Dupuy. On Jan. 17, 1895, Faure was rather unexpectedly elected president of the republic on the resignation of J. P. Casimir-Périer. His fine presence and his tact on ceremonial occasions rendered the state some service, as when he received the Russian emperor Nicholas II in Paris in 1896 and returned his visit in 1897, after which meeting the momentous Franco-Russian alliance was publicly announced. The latter days of Faure's presidency were embittered by the Dreyfus affair, which he was determined to regard as *chose jugée.* On Feb. 16, 1899, he suddenly died in his study at the Élysée palace during an interview with his mistress Mme Steinheil (*née* Marguerite Japy).

See A. Dansette, *Histoire des présidents de la République* (1953); J. Chastenet, *Histoire de la IIIe République,* vol. iii (1955).

FAURÉ, GABRIEL (URBAIN) (1845–1924), French composer who made a most important contribution to the music of the late 19th and early 20th centuries. He excelled not only as a song writer of great refinement and sensitivity but also in every branch of chamber music. He wrote over 100 songs including the well-known "Après un rêve" (*c.* 1865) and "Les roses d'Ispahan" (1884), and the two song cycles "La Bonne Chanson" (1891–92) and "L'Horizon chimérique" (1922). Above all, he enriched the literature of the piano with a number of highly original and exquisitely wrought works, of which his 13 nocturnes, 13 barcarolles and 5 impromptus are perhaps the most representative and best known. He was not instinctively attracted to the theatre, as were so many of his contemporaries in France, although he wrote incidental music for several plays, including Maurice Maeterlinck's *Pelléas et Mélisande* (1898), as well as two so-called "lyric dramas," *Prométhée* (1900) and *Pénélope* (1913), which contain much fine music. He wrote little for the orchestra, but the *Requiem Mass* for solo voices, chorus, orchestra and organ, composed in memory of his father and first performed at La Madeleine in Paris in 1888, is certainly one of the works by which he will always be remembered, exhibiting as it does his ability to achieve an emotional effect with the strictest economy of means.

Fauré was born at Pamiers (Ariège) on May 12, 1845. From 1855 to 1865 he studied at the École Niedermeyer in Paris, where he came under the influence of C. Saint-Saëns, who gave him piano lessons and introduced him to the music of Liszt and Wagner. In 1896 he was appointed organist at La Madeleine and professor of composition at the Paris conservatoire. In 1905 he succeeded Théodore Dubois as director of that institution and remained in office until ill health and deafness obliged him to resign in 1920. He died in Paris on Nov. 4, 1924.

As a teacher Fauré had a great influence, and his composition classes were attended by almost every French composer of note of the generation that succeeded him, including Florent Schmitt, Maurice Ravel, Roger J. J. A. Ducasse (Roger-Ducasse) and Charles Koechlin, to name only a few. His teaching, however, was anything but academic, and he had little sympathy with the upholders of tradition for tradition's sake, of whom his predecessor at the Paris conservatoire had been a typical example. Under Fauré's direction the conservatoire took on a new lease of life.

Although he never concealed his respect for the consecrated forms of music, Fauré, in his creative work, delighted to infuse into those forms a peculiar mélange, all his own, of harmonic daring and a most candid freshness of invention. This quiet and unspectacular revolution prepared the way for the more sensational innovations of the modern French school. One of the most striking features of his style was his fondness for daring harmonic progressions and sudden modulations, invariably conducted with supreme elegance and a deceptive air of simplicity. His music has all the traditional French qualities of clarity and craftsmanship and seems to reflect in a high degree the refinements of the civilization in which his art was nourished.

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FAURIEL, CLAUDE CHARLES (1772–1844), French scholar and writer who played a considerable, though unspectacular, part in the revival of historical and literary studies in France after 1815. He was born at St. Étienne on Oct. 21, 1772, and received a good education in the Oratorian colleges of Tournon and Lyons. Republican by conviction, he served in the army before becoming private secretary to the minister of police, Joseph Fouché (*q.v.*), in 1799 and then, three years later, resigned the post when affronted by the ambition of Bonaparte. About this time his first literary efforts—some articles in the *Décade philosophique* (1800)—won the approval of Mme de Staël, and he contracted with Mme de Condorcet a liaison which lasted until her death in 1822. His friendship with François Guizot procured for him, after the July revolution in 1830, the chair of foreign literature at the Sorbonne, and in 1836 he was elected to the Académie des Inscriptions. He died at Paris on July 15, 1844.

Fauriel was a reluctant writer and an unreliable historian, but his undoubted scholarship and particularly his tenure of office at the Sorbonne were largely responsible for the subsequent development of the study of comparative literature in France. His publications include *Chants populaires de la Grèce moderne* (2 vol., 1824–25), a work serving the causes of poetry and Greek independence and the first to bring Fauriel before a wide public; *Histoire de la Gaule méridionale sous la domination des conquérants germains* (4 vol., 1836), the only completed section of a projected general history of southern Gaul; *Histoire de la Croisade contre les hérétiques albigeois* (1837), a translation of a provençal poem on the Albigensian crusade; and two posthumously published works—*Histoire de la poésie provençale* (3 vol., 1846; Eng. trans., 1860) and *Dante et les origines de la langue et de la littérature italiennes* (2 vol., 1854).

Fauriel's *Mémoires* were found with the papers of Mme de Condorcet and were published by L. Lalanne under the title *Les Derniers Jours du Consulat* (1886; Eng. trans., 1885).

See also J. B. Galley, *Claude Fauriel* (1909).

FAUST (Faustus), the name of a magician and charlatan of the 16th century who has become famous in legend and literature. The real Faustus died *c.* 1540, but the scanty references to him in contemporary sources suggest the possibility that there were two men (Georgius and Johann) using that surname. In 1507 it is known that a certain Georgius Sabellicus, calling himself Faust Junior, the chief of necromancers, the second magus, palmist, astrologer and so on, obtained toward the end of Lent the post of schoolmaster at Kreuznach, Ger., through the good offices of Franz von Sickingen, "a man very fond of mystical lore." He

grossly abused the trust placed in him by indulging in "the most dastardly form of lewdness" with the boys and fled from punishment, as is reported in a letter from Johannes Tritheim, abbot of Sponheim monastery, near Kreuznach. Two years later, on Jan. 15, 1509, a certain Johannes Faust *"ex Simern"* was granted the degree of B.A. by the faculty of theology in the University of Heidelberg, and the university matriculation records show that he was placed first on the list of 15 and duly paid his fees. According to Conrad Mutianus Rufus, canon of St. Mary's church, Gotha, in Sept. 1513 Georg Faust, "the demigod of Heidelberg," was heard bragging and boasting in an Erfurt inn. The account book of the bishop of Bamberg records that on Friday, Feb. 10, 1520, Dr. Faust received ten gulden for casting the bishop's horoscope. Kilian Leib, prior of Rebdorf in Bavaria, says that on June 5, 1528, a Georgius Faustus of Helmstedt claimed to be the commander and preceptor of the knights of St. John at Hallestein, on the borders of Carinthia. Only ten days later, on June 15, 1528, the records of Ingolstadt show that Dr. Georg Faust was banished from the town as a soothsayer; and Dr. Faust, "the great sodomite and necromancer," was refused a safe conduct by the city of Nürnberg on May 10, 1532. On June 25, 1535, "the famous necromancer" Dr. Faust was in Münster, where, as reported in the *Waldeck Chronicle,* he prophesied accurately that the bishop would recapture the city that evening. Finally, "the philosopher Faust" seems to have prophesied accurately early in 1540 "a very bad year" for the Venezuelan expedition, according to Philipp von Hutten, who met his death on it.

This is the last mention of Faust while he was still alive. He appears to have been fairly well known and widely traveled, probably not without education, but with an evil reputation. All the observers are agreed about this; but opinions were divided about his prowess in magic. The humanists, and Tritheim in particular, scoffed at his claims and derided him as a braggart. The famous classical scholar Joachim Camerarius (1500–74) speaks of his "juggler's tricks"; and Philipp Begardi, a physician in Worms, said that his promises were great and so was his fame, but that his deeds were "very petty and fraudulent." The contemporary demonologists, with the exception of Augustin Lercheimer and Johannes Wier, who showed him up as a trickster in *De praestigiis daemonum,* ignored Faust almost completely, and no serious history of magic has ever included him among the noted practitioners. But the Reformed clergy, Luther and Melanchthon among them, strengthened the widespread and popular belief in the diabolical powers of "the famous necromancer." A Swiss Protestant pastor, Johannes Gast, who had once dined with Faust in Basel, declared in his *Sermones conviviales* (1548) that the dog and horse with him were demons and that the wicked sorcerer had finally been strangled by the devil. Faust himself, by referring more than once to the devil as his *Schwager* (crony or "brother-in-law"), probably gave rise to this flight of fancy which brought him into line with a perdurable tradition. From time immemorial those who were credited with supernatural powers were also rumoured to have died violent or mysterious deaths; and the legend of Faust as it developed thereafter was the 16th-century Lutheran version of the myth of the magus, among whose earliest known representatives were the Persian magi.

The sages and mages of antiquity were greatly revered and believed to be of divine origin, but they were also greatly dreaded because of their mysterious power, and from the earliest times magic was abused in the hands of charlatans and evil-intentioned practitioners. Magicians as a class were already losing caste under the Roman empire when Christianity precipitated their downfall by claiming a monopoly of miracles; and the church's striking declaration *Habet diabolus Christos suos* ("The devil has his own Christs") effected a revolution in public opinion which transformed the pagan deities into demons and their priests into devil worshipers. The mighty magus of ancient times was reduced to the status of a black magician, a downfall that was symbolically and dramatically represented in the legend of Simon Magus (*q.v.*). On the other hand the legend of Theophilus of Adana, who, in order to regain the office from which he had been deposed, agreed to serve the devil and gave him a sealed denial of Jesus Christ, first brought into prominence the notion of an infernal pact, which had been admitted by St. Augustine and other fathers of the church and which derived from Jewish incantation ceremonies. Mariolatry saved Theophilus from the consequence of his bargain; but a species of diabolatry (belief in the almost unlimited power of the devil), which flourished among the early Lutherans, spelled eternal damnation for Faust, and all the more so because he had recourse to magic in order to satisfy his craving for knowledge. This was evil in itself according to the anti-humanistic tendency of the Reformed Churches. The *Sturm und Drang* writer Friedrich Maximilian von Klinger later deliberately identified the hero of his sombre novel *Fausts Leben, Taten und Höllenfahrt* (1791) with Johann Fust of Mainz, the reputed coinventor of printing, who died in 1466; and both he and Heinrich Heine declared that the confusion had arisen in the popular mind because of superstitious fear of the dissemination of knowledge.

It may seem strange that such a shady and relatively obscure sorcerer as Faust should have become the representative black magician of his age rather than his far more famous contemporaries, Tritheim, Agrippa von Nettesheim, Paracelsus and Nostradamus, who were also involved in occult speculations and practices and were also suspected of commerce with the devil. But Faust attained to posthumous fame because of his first biographer, the anonymous author of the first *Faustbuch,* published by Johann Spies in Frankfurt-on-Main in 1587. The book is of unequal merit; for bookmaking of the crudest kind underlies the collection of magical feats which forms its nucleus. These tales, taken from Lercheimer and other demonologists, had been told about the ancient magi and retold in the middle ages and later about such reputed wizards as Virgil, Merlin, Simon Magus, Gerbert (Pope Silvester II), Albertus Magnus, Roger Bacon, Zyto and many more. They were now attributed to Faust, baldly and badly narrated and still further disenchanted by the clodhopping humour shown at the expense of Faust's dupes. Disenchantment also spoils the evocation of Helen of Troy, a devil disguised as a wanton, doll-like minx; but the genuinely poetic idea which summons her up from Hades to ensure Faust's damnation set Christopher Marlowe's imagination aflame and is one of the reasons why the legend put on immortality. The other is to be found in the intense conviction of the author, a God-fearing, devil-fearing Lutheran, of the truth of the tale he was telling. His descriptions of the nether regions and of the fearful state of mind of his heart-hardened hero have spiritual intensity and are still impressive, as can be seen from Thomas Mann's highly effective use of many such passages verbatim in his *Doktor Faustus* (1947). Moreover, in the creation of Mephostophiles (for whose name, of which this was the original form, he was also responsible), the author attained to such realism in his presentation of the savage, embittered, remorseful and yet ruthless fiend as to inspire unquestioning belief.

The book ran like wildfire through Europe. It was translated speedily into Low German, Danish, Dutch, English and French, and, somewhat later, into Polish and Czech, while revised and augmented editions, one of them in rhyme, followed on each other's heels in Germany. Its career was halted there by the appearance in 1599 of Georg Rudolf Widmann's *Faustbuch,* which dislocated and swamped the sadly diminished tale with a spate of learned and sermonizing commentaries and further disfigured it by retelling it with a rabidly anti-Catholic and anti-Semitic bias. This version was re-edited in 1674 by Johann Nikolaus Pfitzer and cut into little bits by Christlich Meynenden in 1725 to form a popular chapbook, by which time the original Spies version was forgotten.

But it had served its turn; for the Elizabethan prose translation by "P. F., Gent." in 1592 or earlier inspired Christopher Marlowe's *The Tragicall History of D. Faustus* (published 1604), in which the tragic power and passion latent in the original attained a summit unsurpassed in Faustian literature. Marlowe, who followed his source closely, took over a good deal of the farcical element and introduced a comic subplot, thus admitting elements of decay into the tragic organism which, decomposing the legend with a speed almost equal to the swiftness of its flower-

ing, brought it finally to the compost heap with William Mountfort's *The Life and Death of Doctor Faustus, With the Humours of Harlequin and Scaramouche* (1697) and John Thurmond's pantomime *Harlequin Doctor Faustus* (1724). It underwent a similar but less radical deterioration in Germany, where English strolling players presented Marlowe's drama early in the 17th century. German versions soon supplanted the probably mangled English text and, to judge by the playbills and accounts which have survived, sensationalized it with many spectacular effects, introduced some indigenous elements and diversified it with a great deal of clowning. Faust dramas of this kind were enacted for 200 years on the popular stage; and the puppet-play texts, many of them still extant, suggest that on the whole the Marlovian scheme was adhered to in the booths, as well as on the boards. The puppet plays themselves, streamlined and artless, with some tense and moving scenes, allowed a large part to Casper the clown; but, however much shortened Faust's part might be in consequence, his tragic end was often floodlit with poetry, and his eternal damnation was never in doubt.

This fact had to be taken into account by the fabricators and editors of the extremely lucrative magical manuals circulating at the time. With a view to increasing sales, they used Faust's name on the title page and sometimes in the body of incantation ceremonies deriving ultimately from Akkadian-Chaldean inscriptions through the Greco-Roman papyri and Jewish rituals; and in order to reassure prospective purchasers of these various so-called Faustian *Höllenzwänge* ("harrowings of hell"), they either wrote preambles showing how the dangerous bilateral pact with the devil could be avoided or they ignored the subject and concentrated on the unilateral pact which constrained the spirits to obedience without any bodily or spiritual harm to the exorcist. The great Faustian ritual classic *Magia Naturalis et Innaturalis* (in the Weimar grand-ducal library and well known to Goethe) went even further. After giving the text of the unilateral pact, it also communicated the wording of a bilateral pact, with the soul of the exorcist at stake, and then gave the religious ceremony to be performed in order to break the agreement. Exceedingly pious in tone, these manuals were in great demand during the 17th and 18th centuries, when it was believed that with their help buried treasure could be located and raised; and they popularized the notion that infernal pacts could be renounced by the grace of God.

But the name of Gotthold Lessing is the first great name associated with the salvation of Faust in literature. The desire and pursuit of knowledge appeared to this enlightened rationalist as one of the noblest instincts of the human mind, and he left a scheme and some scenes pointing toward the hero's reconciliation with God. Published in 1784, they had great influence; and from then onward the innumerable Faustian authors have been divided into two camps: the traditionalists and the salvationists. Even before the appearance in 1808 of Goethe's *Faust,* part i, with its promise of salvation in the prologue, several dramatists had attempted to realize this ideal; and others continued to do so both before and after the publication of his *Faust,* part ii, in 1833, although the awe-inspiring conclusion to this masterpiece of modern literature should have discouraged his successors. For it is more than salvation to which Goethe's Faust attains in the final act, which is an apotheosis of the hero as a representative of striving and seeking humanity, who may spend a lifetime erring but will be redeemed by the active pursuit of knowledge and truth. Goethe is unique in having solved the seemingly insoluble problem of grafting a humane and rationalistic ethic onto the dire assumptions of the legend; but the introduction of love interest into the cosmic conflict with the appearance of Gretchen diminished its grandeur in Faustian literature as a whole, although this is not nearly so much the case with the tragic traditionalists, on some of whom Don Juan and Byron have left their mark. None of them can hold a candle to Marlowe; but there are works of real interest, power and beauty among them. Klinger's and Thomas Mann's contributions have already been mentioned. To them should be added: Adelbert von Chamisso, *Faust, Ein Versuch* (1804), Christian Grabbe, *Don Juan und Faust* (1829), Nikolaus Lenau, *Faust: Ein Gedicht* (1836), Woldemar Nürnberger, *Josephus Faust* (1847), Heinrich Heine, *Doktor Faust: Ein Tanzpoem* (1851) and Paul Valéry, *Mon Faust* (1946). None of these poets has been able to accept Goethe's optimistic conclusion; and Lenau and Valéry, in particular, have stressed the dangers inherent in the notion of attaining to absolute knowledge with its correlative power. In their works the annihilating instinct of mankind faces the incorruptibility proclaimed by Goethe; and the fear of the Faustian spirit of insatiable scientific inquiry has been given modern expression.

See also references under "Faust" in the Index volume.

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FAUSTINA, ANNIA GALERIA (known as THE YOUNGER) (d. A.D. 176), daughter of the emperor Antoninus Pius and the elder Faustina, cousin and wife of the emperor Marcus Aurelius, accompanied her husband in the Danube wars, receiving the title *mater castrorum* ("patroness of the army"), and in his tour of the eastern provinces after the revolt of Gaius Avidius Cassius in 175. She died suddenly during this journey in 176; divine honours were accorded her, and a new alimentary foundation for educating daughters of the poor was established in her memory. Ancient writers accuse her of infidelity and disloyalty, probably unfairly; her husband loved and admired her.

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FAUSTUS, SAINT, OF RIEZ (*c.* 400–*c.* 490), bishop of Riez, France, and one of the chief exponents of Semi-Pelagianism, was born in Roman Britain about the year 400. He and probably his family went to southern Gaul in the first years of the 5th century. Faustus joined the newly founded monastic community on the Îles de Lérins, of which he became the third abbot about 433. After some 20 years as abbot, Faustus was elected bishop of Riez in the Basses-Alpes and from then on played a leading role in the ecclesiastical life of 5th-century Gaul. He died about 490. Although he was liturgically venerated as a saint before the 19th century in Riez (Sept. 28), this cultus has completely disappeared.

Faustus was a significant theologian and a celebrated preacher. His sermons, many of which were reworked and used by Caesarius (*q.v.*) of Arles, can still be found attributed to other names in the sermon collections gathered in 16th-century France. As a theologian, Faustus in his two books *De gratia* gave the final form to the Gallic anti-Augustinianism today called Semi-Pelagianism. For Faustus, grace was indeed necessary for true virtue and salvation, but he conceived grace as something extrinsic to man, which was rendered operative through man's own natural initiative toward salvation (*credulitatis affectus*). Without naming Faustus but citing his very words, the second Council of Orange (529) rejected Faustus' doctrine.

Faustus' works were printed by J. P. Migne, *Patrologia Latina,* vol. lviii, 523–557, and A. Engelbrecht, *Fausti Reiensis opera,* in the series "Corpus Scriptorum Ecclesiasticorum Latinorum." vol. xxi (1891).

See G. Weigel, S. J., *Faustus of Riez* (1938). (G. Wl.)

FAUVISM, the name given to a vigorous, short-lived phase in the modern art movement. In the first years of the century the influences exerted by Paul Cézanne, Vincent Van Gogh and Paul Gauguin became apparent in the work of individual painters. At the 1905 Salon d'Automne in Paris several young artists, led by Henri Matisse, offered the first collective expression of these new influences. Vivid in colour to the point of violence, their pictures compelled attention and provoked scandalized protests. In the same gallery a small bronze in the Italian Renaissance manner prompted Louis Vauxcelles, the critic, to describe it as "a Donatello

among the wild beasts" (*chez les fauves*)—from which the epithet Fauvism was coined.

Typical of the Fauvist manner was an exultant handling of brilliant pigment. Imitative colour was rejected. Colour, instead of light and shade, was used to illuminate the picture surface; and colour shapes were related, rather than contained, by flowing lines. Each separate element was exploited to intensify the expressiveness of the whole. At first paint was applied in a pointillist style, later in areas of flat decorative colour. The main influences which still permeated the movement were the acutely personal vision of Van Gogh, the rich bold designs of Gauguin and the prevailing taste for oriental and primitive art.

BY COURTESY OF MADAME MARGUERITE DUTHUIT

PORTRAIT OF MADAME MATISSE KNOWN AS "PORTRAIT WITH A GREEN STRIPE" BY HENRI MATISSE, 1905. IN THE STATENS MUSEUM FOR KUNST, COPENHAGEN, DEN.

Fauvism evolved no creed and proposed no program. It sprang up among a group of burning enthusiasts, all of whom endorsed similar aesthetic theories and technical innovations without submerging their individualities. Outstanding in the movement were Henri Matisse, Georges Braque, Charles Camoin, André Derain, Kees Van Dongen, Raoul Dufy, Othon Friesz, Henri Manguin, Albert Marquet, Jean Puy and Maurice de Vlaminck. Outside France leading painters who revealed Fauvist tendencies were Ernst Ludwig Kirchner, Erich Heckel, Fritz Bleyel, Karl Schmidt-Rottluff (founders of a parallel German movement called *die Brücke*, "the bridge") and two Russians, Alexei von Jawlensky and Wassily Kandinsky. Though by 1908 Fauvism had lost its momentum as a unity, its liberating influence, having paved the way for Cubism, was clearly apparent in German Expressionism and in the later free forms of abstract Expressionism (*see* EXPRESSIONISM).

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(F. W. W.-S.)

FAVART, CHARLES SIMON (1710–1792), French dramatist and one of the creators of French *opéra comique*, was born in Paris, Nov. 13, 1710. After his father's death he carried on his business as pastry cook, meanwhile writing librettos for light operas. He became stage manager of the Opéra Comique in 1743, and in 1745 married Marie Duronceray, a singer and actress. She attracted the attentions of Maurice de Saxe, Favart's patron, who used his power over them both to make her his mistress. Favart's best play, *Les Trois Sultanes* (1761), is a comedy based on a similar triangular situation. Here song and dance play a less important part than in Favart's other works, the best of which is *La Chercheuse d'esprit* (1741). Favart became director of the Opéra Comique in 1758.

He died in Belleville, May 12, 1792. His *Mémoires et correspondance littéraires, dramatiques et anecdotiques* (1808) throws light on the writer and his times.

See A. Font, *Favart. L'opera-comique et la comédie-vaudeville au XVIIe et XVIIIe siècles* (1894); A. Iacuzzi, *The European Vogue of Favart* (1932).

(D. Ks.)

FAVERSHAM, a market town, river port and municipal borough in the Faversham parliamentary division of Kent, Eng., on a creek of the Swale, 9 mi. W.N.W. of Canterbury by road. Pop. (1961) 12,983. It is a limb or a corporate member of the Cinque port of Dover. The Early English church of St. Mary of Charity (restored in 1754) has some remains of frescoes (*c.* 1305) on one of the columns and 14th-century paintings in the chancel. A brass commemorates King Stephen, whose remains are said to have been transferred at the Dissolution to a tomb in the Trinity chapel from the Gluniac abbey which he founded. Matilda, his queen, and their son Eustace were also buried in the abbey. The fragment of the outer gateway that remains forms part of the house wherein Thomas Arderne (Arden) was murdered in 1550. This event is the theme of *The Lamentable and True Tragedie of M. Arden of Feversham in Kent*, one of the earliest English domestic dramas. Faversham's grammar school was founded in 1527, forfeited at the Dissolution and restored by Elizabeth I in 1576. The original building (1587) still exists.

Traces of Roman settlement have been found, but the town (Favreshant in Domesday Book) owed its early importance to its situation as a port on the Swale near Watling street and to being surrounded by fertile country. In 811 it was called the king's town "of Fefresham" and a witenagemot was held there under Athelstan. In 1086 it was assessed as royal desmesne and a market held. When King Stephen founded the abbey in 1147 he endowed it with the manor and hundred of Faversham, which caused many disputes between the abbot and men of Faversham concerning the abbot's jurisdiction.

Faversham was probably a member of Dover from the earliest association of the Cinque ports, certainly as early as Henry III, as shown by a charter of 1252. All the liberties of the Cinque ports were granted to the barons of the town in 1302. The governing charter till 1835 was that of Henry VIII, granted in 1545 and confirmed by Edward VI.

Faversham creek is navigable up to the town for vessels up to 300 tons. The shipping trade is considerable, chiefly in oils, timber, agricultural feeding stuffs and fertilizers, both coastwise and from continental ports. The oyster fisheries were formerly managed by a very ancient guild, the Company of Free Dredgermen of the Hundred and Manor of Faversham, but since 1929 by the statutory company. Hops and cherries are largely grown in the neighbourhood. Brewing, brickmaking, the quick freezing and canning of fruit and vegetables and the grading and packing of apples and pears are carried on. There are a shipyard and light engineering works in the town, also large oil depots.

FAVORINUS (fl. 2nd century A.D.), skeptical philosopher and sophistic rhetorician of the Roman empire, whose life, as he said, was remarkable because "being a Gaul, he lived as a Greek; being a eunuch [an androgyne], he was sued for adultery; and, being in dispute with the emperor, he suffered nothing." Born in Arles, he is known to have lived in Rome, in Athens, in Corinth and in Ephesus and to have been highly esteemed for his learning and for his eloquence. Plutarch, Herodes Atticus and Aulus Gellius were his friends; Polemo of Laodicea, his bitterest rival. Falling into disfavour with the emperor Hadrian, he appears to have retired to comfortable exile in Chios until the end of the reign.

Favorinus wrote philosophical discourses, declamations, a *Miscellaneous History* and memoirs. His serene discourse *On Exile* was printed by M. Norsa and G. Vitelli from a Vatican Greek papyrus in 1931. Editions of Dio Chrysostom (*q.v.*) include two orations (xxxvii and lxiv) now usually ascribed to Favorinus: the *Corinthiaca*, an outstanding specimen of rhetorical exercise in the Asianic style; and *On Fortune*. Only fragments remain of his other works; the historical ones are collected by C. Müller, *Fragmenta historicorum Graecorum*, iii (1849).

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FAVRE, JULES GABRIEL CLAUDE (1809–1880), French statesman, a resolute opponent of Napoleon III and a negotiator of the Franco-German peace treaty of Frankfurt (May 10, 1871), was born in Lyons on March 21, 1809, and was an advocate by profession. From the time of the revolution of 1830 he declared himself a republican. After the revolution of 1848 he was deputy for the Loire *département* in the constituent assembly and, for a few weeks, deputy minister for foreign affairs. Elected to the legislative assembly of 1849 by the Rhône *département*, he tried with Victor Hugo and others to organize an armed resistance in the streets of Paris to the *coup d'état* of Dec. 2, 1851. After this he withdrew from politics, resumed his profession and

in 1858 distinguished himself by his defense of Felice Orsini, the would-be assassin of Napoleon III.

Elected deputy for Paris in 1858, Favre was one of "the five" who gave the signal for the republican opposition to the empire. In 1863 he became the head of his party, and began denouncing the Mexican expedition and the occupation of Rome. These speeches, eloquent and incisive, won him a seat in the Académie Française in 1867. With Louis Adolphe Thiers he opposed the declaration of war against Prussia in 1870. At the news of the defeat at Sedan he demanded from the legislative assembly the deposition of the emperor.

On Sept. 4, 1870, in the government of national defense, Favre became vice-president under Gen. L. J. Trochu and minister of foreign affairs, with the onerous task of negotiating peace with victorious Germany. He proved to be less adroit as a diplomat than he had been as an orator and committed several irreparable blunders. His statement on Sept. 6, 1870, that he "would not yield to Germany an inch of territory nor a single stone of the fortresses" was a piece of oratory which Bismarck countered, at the Ferrières meeting on Sept. 19, by his declaration that the cession of Alsace-Lorraine was the indispensable condition of peace. Favre also arranged for the armistice of Jan. 28, 1871, without knowing the situation of the armies and without consulting the government at Bordeaux. Finally, he neglected to inform Léon Gambetta that the army of the east (80,000 men) was not included in the armistice, with the result that it had to retreat to neutral Switzerland.

Elected deputy to the national assembly on Feb. 8, 1871, in six different constituencies when his part in the armistice negotiation was not yet known, Favre was sent by Thiers to conclude the final peace with the Germans. He withdrew from the ministry, discredited, on Aug. 2, 1871. He remained in the chamber of deputies, but took no part in active politics. He was elected senator on Jan. 30, 1876. He died at Versailles on Jan. 19, 1880. He had published *Le Gouvernement de la défense nationale*, three volumes (1871–75), explaining his role in the events of 1870–71. After his death his family published a collection of his speeches in four volumes (1881).

See Maurice Reclus, *Jules Favre* (1912). (Ad. D.)

FAVUS (Tinea Favosa), a highly contagious fungus disease of the scalp, occurring occasionally also on other parts of the skin and in the nails. It is endemic among the poor population in many areas of eastern and southeastern Europe and in the middle east. It is uncommon in western Europe and in the United States. Favus is caused by the invasion of the skin and the hair usually by the fungus *Trichophyton schoenleinii* (though other species may also be responsible), leading to the formation of hard, cup-shaped, sulfur-yellow crusts. In contrast with other fungus diseases of the scalp, favus may irreparably destroy the hair follicles. Unsightly permanent spotty baldness and scarring often occur in the involved areas. Treatment with griseofulvin usually produces good results.

See also Skin, Diseases of. (Rd. B. S.; X.)

FAWCETT, HENRY (1833–1884), English radical statesman and economist who overcame blindness to follow an active political career and was especially successful as postmaster general, was born at Salisbury on Aug. 26, 1833, the son of a successful businessman. He was educated at King's College school, London, and at Peterhouse and Trinity hall, Cambridge. He was seventh wrangler in 1856, and was elected to a fellowship at his second college. He also entered Lincoln's Inn in 1854. His brilliant prospects were much affected when he was blinded by a shooting accident in 1858. Nevertheless he fished, rowed, skated, walked and rode, and entered into the social life of Trinity hall. He was a friend and follower of J. S. Mill, whose economic doctrines he popularized with clarity and success. Fawcett was elected to the chair of political economy at Cambridge in 1863 and held the professorship till his death.

Fawcett was already known in political circles as an advanced radical, and after some false starts became member of parliament for Brighton in 1865. In 1867 he married Millicent Garrett (*see* Fawcett, Dame Millicent Garrett). As a thoroughgoing radical, he was looked at askance by the Whigs. He was a severe critic of the Liberal government of 1868–74; he protested against the limited scope of the elementary education bill; and it was his opposition that secured the defeat of the Irish Universities bill in 1873 and precipitated a government crisis. He lost his seat at the next general election, but became member for Hackney in April 1874. He took a keen interest in Indian finance, in the rights of women and in the preserving of commons and open spaces; and he joined with the Gladstonian Liberals in opposing Disraeli's eastern policy.

When the Liberal party returned to power in 1880 Gladstone offered Fawcett a place in the new government as postmaster general (outside the cabinet). Fawcett accepted, and showed he was a most capable head of a department. To his readiness in adopting suggestions, and his determination to push business through instead of allowing it to remain permanently in the stage of preparation and circumlocution, the public was mainly indebted for five substantial postal reforms: the parcel post, postal orders, sixpenny telegrams, the banking of small savings by means of stamps, and increased facilities for life assurance and annuities. In connection with these two last improvements, Fawcett helped in 1880 to draw up a pamphlet, *Aids to Thrift*, of which about 1,250,000 free copies were distributed. He died at Cambridge on Nov. 6, 1884.

In the great affliction of his youth Fawcett bore himself with a fortitude which it would be difficult to parallel. The kindness evoked by his misfortune, a strongly reciprocated family affection, a growing capacity for making and keeping friends—these and other causes tended to ripen all that was best in a strong but somewhat stern character. His acerbity passed away, and in later life was reserved exclusively for official witnesses before parliamentary committees. Frank, helpful, conscientious to a fault, absolutely honest and a stanch friend, he was a man whom no one could help liking.

See Leslie Stephen, *Life of Henry Fawcett* (1885). (M. R. D. F.)

FAWCETT, DAME MILLICENT GARRETT (1847–1929), leader of the movement for women's suffrage in England, was born at Aldeburgh, Suffolk, on June 11, 1847. She was the seventh of the ten children of Newson Garrett, a radical shipowner who ardently supported the long efforts of his eldest daughter, Elizabeth, to enter the medical profession. At 20 Millicent married Henry Fawcett (*q.v.*). His blindness and the perfect sympathy between them led to the closest interdependence of their activities.

Mrs. Fawcett began to work for women's suffrage immediately after her marriage. Her first speech on the subject was made in 1868; after that speech she and another woman were referred to in the house of commons as "two ladies, wives of members of this house, who have disgraced themselves by speaking in public." Yet from the first the movement had distinguished supporters, among them J. S. Mill, Charles Kingsley, John Morley and Sir Charles Dilke.

The 50-year campaign for women's suffrage put a heavy strain on Mrs. Fawcett, and revealed her invincible tenacity, practical wisdom and unfailing humour. Almost every year a women's suffrage bill was introduced into the house of commons, only to be blocked or defeated. Every year's work meant a growing volume of meetings, petitions, processions and press campaigns. Mrs. Fawcett became president of the National Union of Women's Suffrage Societies in 1897. When the militant suffragist movement began in 1905 she, while opposed in principle to its methods, never criticized; she simply went on working on her own line.

Mrs. Fawcett was always passionately patriotic. During the South African War, the government sent her to investigate the concentration camps for Boer women and children. The report she produced vindicated (her opponents said whitewashed) their administration. The outbreak of World War I was the heaviest blow of her political life. Immediately the whole strength of her organization was turned to efforts for "sustaining the vital forces of the nation." In Jan. 1918 the national change of heart toward women's claims, for which her patient work had paved the way,

was consummated by the passing of the Representation of the People act, enfranchising about 6,000,000 women. A year later, her national union having become the National Union for Equal Citizenship, she retired from active leadership. She had been made a dame of the British empire after the war, and died in London on Aug. 5, 1929. Among her many writings were a novel, *Janet Doncaster* (1875); *Some Eminent Women of Our Time* (1889); *Life of Queen Victoria* (1895); *Women's Suffrage* (1912); *The Women's Victory—And After* (1920); and *What I Remember* (1924).

See Ray Strachey, *Millicent Garrett Fawcett* (1931). (M. A. H.)

FAWKES, GUY (1570–1606), English conspirator, famous for his part in the Gunpowder plot (*q.v.*), was a member of a prominent Yorkshire family. His early religious training was in the Anglican faith, but after his father's death in 1579 and his mother's subsequent marriage to a Roman Catholic, he was converted to Roman Catholicism. His religious zeal, as well as his adventurous spirit, led him to leave England in 1593 and enlist in the Spanish army in the Netherlands, where he won a reputation for great courage and cool determination. He remained with the Spanish army until April 1604.

Meanwhile in England a small group of disgruntled Catholics led by Robert Catesby (*q.v.*) was formulating plans to blow up the parliament building while the king and his chief ministers were present. Since the plotters were well known and easily recognizable, they needed the assistance of a person with military experience who had been away from England for some time. The plotters decided upon Fawkes, and early in April 1604 Catesby sent his cousin Thomas Winter to the Netherlands to enlist Fawkes's services. Without being informed of the details of the plot, Fawkes returned to England and was soon brought into the conspiracy. He took the name John Johnson and posed as a servant when the plotters rented a house abutting upon the parliament building. Fawkes, disguised as a porter, stood sentinel while the other conspirators attempted to dig a subterranean passage to a point directly under the chamber of the house of lords. When this project was abandoned and the conspirators rented an adjoining cellar which extended under the parliament building, Fawkes was given the task of planting the explosives. He brought in at least 20 barrels of gunpowder, placed several iron bars upon them to increase the impact of the explosion, and then concealed these instruments of destruction with a covering of faggots and coals.

The gunpowder was, of course, never exploded. The government learned of the plot before parliament met, and Fawkes was arrested on the evening of Nov. 4, 1605. At first he refused to name his fellow conspirators, but after being tortured on the rack he revealed all. He was tried before a special commission on Jan. 27, 1606, was found guilty, and was executed opposite the parliament buildings four days later. The scheduled date of the plot, Nov. 5, Guy Fawkes day, is celebrated in England with fireworks and the burning of "guys." (R. C. Jo.)

FAYETTEVILLE, a city of northwestern Arkansas, U.S., the seat of Washington county, is located in a circle of hills, part of the beautiful Ozarks. The home of 13 governors and Archibald Yell, the first congressman from Arkansas, and a historic stop on the Overland Mail route, Fayetteville is the site of the University of Arkansas (established 1871). There was no settlement there when the city was staked as a site for the county seat in 1828. The city was first named Washington Courthouse, but changed to Fayetteville, after Fayetteville, Tenn., in 1829. It was incorporated in 1836, received a city charter in 1859, which was abolished by act of the legislature in 1867; was reincorporated as a town in 1869; and in 1906 again became a city. The town acquired an educational reputation through its early schools, especially Sophia Sawyer's Female seminary (1839) and Arkansas college (1852–62). The latter, destroyed during the Civil War, was the first degree-granting college in Arkansas.

Within 30 mi. of both the Missouri and Indian territory borders, Fayetteville suffered severely during the Civil War. The battle of Pea Ridge (March 7–8, 1862) was fought in neighbouring Benton county, and the battle of Prairie Grove (Dec. 7, 1862) was fought just 10 mi. west of town. After the battle of Fayetteville (April 18, 1863) the town was held by Federal troops until the end of the war. The dead of these battles are buried in Fayetteville's National and Confederate cemeteries.

While industry exists, Fayetteville is primarily a residential community. For comparative population figures *see* table in ARKANSAS: *Population.* (W. J. LE.)

FAYETTEVILLE, a city of North Carolina, U.S., the seat of Cumberland county and one of the state's oldest and most historic towns. The city is 50 mi. S.S.W. of Raleigh on the west bank of the Cape Fear river at the head of navigation, 120 mi. from the ocean. The town is located in a region noted for its production of cotton, tobacco and other crops. For more than a century this area was the centre of the nation's naval stores industry, the chief products being tar and turpentine. After 1870 this industry declined and finally disappeared. Textiles and lumber are the largest industries. Others include tobacco sales warehouses, food processing, cotton seed, fertilizer, furniture, brick and stone. It has had a council-manager form of government since 1949.

Highland Scots established the original settlement there in 1739 and named it Campbellton. A few years later other Highlanders founded the village of Cross Creek, one mile northwest of Campbellton, where they found two creeks which met and immediately separated, thus giving the appearance of crossing. In 1783 the two settlements united and were incorporated as Fayetteville, the first community so honouring the marquis de La Fayette. Fayetteville served as the state capital from 1789 to 1793. There on Nov. 21, 1789, the second state ratifying convention approved the constitution of the United States, which had been rejected the previous year at Hillsboro. By 1820, with a population of approximately 3,500, Fayetteville was second only to Wilmington in size and commerce. It was the centre of the state's "wagon trade" and in the 1850s was the eastern terminal of the longest plank road ever built in the United States. Gen. William T. Sherman occupied the town in March 1865.

Points of interest include the Market House (built in 1838), which houses a public library and historical museum; the armory of the Fayetteville Independent Light infantry, organized in 1793; the State Teachers' College for Negroes (founded in 1877 and one of the earliest schools of its kind); and many monuments and old halls and houses. About 10 mi. N.W. of the city are Ft. Bragg and Pope air force base.

For comparative population figures *see* table in NORTH CAROLINA: *Population.* (H. T. L.)

FAYRFAX, ROBERT (1464–1521), English composer, called by Anthony à Wood "the prime musician of the nation," was born at Deeping Gate, Lincolnshire, on April 23, 1464. Nothing is known of his career until 1497, when he was granted the first of a series of benefices by way of reward for his services as a singer and composer. He is referred to as one of the "Gentlemen of the King's Chapel," a position he held until the year of his death. Since Chapel Royal duties were of an occasional nature, Fayrfax was able to settle at St. Albans, Hertfordshire, where he directed the choir and played the organ at the abbey from 1498 onward. He gained the degrees of bachelor and doctor of music at Cambridge in 1501 and 1504 respectively, and wrote a five-part motet, *Aeterne laudis lilium,* for Elizabeth of York, who visited St. Albans in 1502. The work submitted for his Cambridge doctorate was the Mass *O quam glorifica,* based on a hymn melody for Vespers of the Assumption.

Fayrfax was made a "poor knight" of Windsor in 1514, and so received an extra pension; his position was such that frequent requests were made for the provision of music destined for court entertainments. On every New Year's day from 1516 to 1519 he was paid considerable sums of money for copying or composing books of songs and anthems. His greatest hour came in June 1520, when he was called upon to take charge of the Chapel Royal musicians when they accompanied Henry VIII to his meeting with Francis I at the Field of Cloth of Gold. Fayrfax died at St. Albans on Oct. 24, 1521.

The Masses by Fayrfax are based on antiphons such as *Regali ex progenie* (Nativity of the Blessed Virgin Mary), *Tecum*

principium (Christmas) and *Alloquio dulcis,* the first word of whose fifth line—"Albanus Domini laudans mirabile nomen"—gives the Mass its title and shows it to be in honour of St. Alban. The music of Fayrfax, which was published by the American Institute of Musicology (1960), proves him eminently worthy of the praise bestowed on him during his lifetime. (D. W. ST.)

FAYYUM, AL (EL FAIYUM), a province (governorate) of upper Egypt, occupies a great depression of the Western desert about 60 mi. S.W. of Cairo. Area 691 sq.mi.; population (1960) 839,000. The capital is Al Fayyum; the other principal towns are Sinnuris, Ibshaway and Itsa. The Fayyum oasis is separated from the Nile valley eastward by a gravelly ridge penetrated by the Bahr Yusuf, which occupies a former channel for the Nile floodwaters and is canalized to provide irrigation. The whole basin is below sea level (maximum depth 174 ft. below), including smaller but arid depressions to the south and southwest, such as Gharaq and the Wadi ar Rayyan (280 sq.mi.). In the northwest lies Birkat (lake) Qarun (85 sq.mi.); its surface is 148 ft. below sea level and its greatest depth about 15 ft. The modern lake is a remnant of the lake of Moeris (*q.v.*), formed during the Pleistocene when the Nile (60 ft. higher than today) breached the separating ridge. Fertile sediments and lacustrine clays thus floor the depression; it differs from oases dependent upon springs by its system of irrigation canals fanning from the Bahr Yusuf.

More than 400 sq.mi. of Al Fayyum is cultivated, the principal crops being cereals, cotton, grapes, olives and figs of exceptional quality. Rose trees are numerous, and much of the attar of roses of Egypt is manufactured there. There is an excellent local breed of sheep, Fayyum chickens are noted for plumpness and the lake of Qarun, although brackish, abounds in fish. Industries include wool and cotton spinning and weaving, leather tanning and cigarette manufacture. Mounds north of Al Fayyum town mark the site of Arsinoë, earlier Crocodilopolis, where was worshipped the sacred crocodile kept in the lake of Moeris. Ruins of ancient settlements abound, especially near the lake. (A. B. M.)

FAYYUM, AL (EL FAIYUM), also called Madinat al Fayyum, a town of upper Egypt and capital of the province of Al Fayyum, lies about 55 mi. S.S.W. of Cairo on the southeast side of Al Fayyum depression, where the Bahr Yusuf irrigation channel debouches from the Lahun gap to water the whole province. Pop. (1957) 89,448. Al Fayyum is the largest town in the depression and profits from the isolation of the province from the Nile valley and from its site as the focus of irrigation and routeways. It is the market and distribution centre for merchandise passing between the province and the Nile valley, with which it is linked by standard-gauge railway at Al Wasitah (Wasta) and by main roads to Al Jizah (Giza) (55 mi., N.N.E.) and Bani Suway (Beni Suef) (27 mi., S.E.). Within the province, Al Fayyum is the centre of a network of narrow-gauge railways and roads. Its industries are mostly connected with agriculture: cotton ginning, wool and cotton spinning and weaving, dyeing, tanning and cigarette manufacture. The history of Al Fayyum goes back at least to the 12th dynasty and a series of towns has existed on or near the site, including Crocodilopolis of the Greeks and the Ptolemaic Arsinoë, whose remains lie just to the north. (A. B. M.)

FEAST AND FESTIVAL, as the terms are used in religion, are essentially synonymous ("festival" being the adjective form used also as a noun), properly describing an anniversary that is observed with rejoicing; "feast" is thus the opposite of "fast" (*see* FASTING). More generally, "feast" and "festival" also are applied to all such annual ceremonies and are not confined to those observed with rejoicing. This article deals only with festivals in early religions and in modern non-Judaeo-Christian religions. The feasts of the Christian liturgical year are described in the article CHURCH YEAR, and in many separate entries such as EASTER; CHRISTMAS; etc. Jewish festivals are discussed in the article JEWISH HOLIDAYS. The word holiday ("holy day") in the purest sense also means a religious festival, but it has come to be used to describe any day on which a community or individual is relieved from the obligation of work, and hence has a largely secular connotation; secular holidays are discussed in the article HOLIDAY.

Major religious feasts and festivals, with few exceptions, are annual. The religious year not only represents a span of time but is also a representation of sacred events of the past eternally recurring. Just as the Christian year beginning with Advent is a re-enactment of sacred events, the year in other religions also presents a sacred cycle. Among historic religions, the cyclic recreation of time is most explicit in the Zoroastrian New Year. The unrestrained character of most New Year festivals represents cyclic chaos before creation, and is most pronounced in primitive religions, though it survives in the Hindu *holi* and similar rites.

Festivals have an educational and social as well as religious character. In primitive cults having no written records, seasonal recital of mythology at festival time serves the function of transmitting traditional lore within the tribe. Festivals bind a religious group into a unity transcending family and local ties. Muslims of Arabia and Indonesia come into a socioreligious relationship despite separation by common observance of the festival associated with the fast of Ramadan. Continuity between living and dead is maintained by communal offerings at festivals, and the cosmic order underlying social order is maintained by honouring the gods. Unity of "denominations" within religions, such as Shivites in Hinduism or Shi'ites in Islam, is secured by sectarian observances. The solidarity of the Greek or Mesopotamian city was celebrated by festal worship of the local deity, while larger political solidarity was preserved by subordinating local festivals in the context of a great national calendar. In primitive religions the festivals of the village deity perform the same role.

Great feast days recapitulate the history of religion in any given place: the pre-Christian cult of the dead in northern Europe survives in All Saints' day; the Thai New Year includes older primitive and Hindu aspects incorporated into the later Buddhist celebration, and the Sikh festival of *hola* is an adaptation of the older Hindu *holi.*

Primitive Religions.—The religious and social or tribal aspects of festivals cannot be separated, all activities being endowed with a religious or at least traditional character. In the Fiji Islands the inauguration of a new chief is celebrated as the recreation of the world. In the Trobriand Islands the *baloma,* or spirits of the dead, are invited to join in harvest festivities. After dancing and feasting, they are dismissed. In this way the cooperation of the spirits with the living is assured. Among many groups, including Indian tribes of British Columbia, the entire social structure is transformed at festival times, religious ceremonial being performed by secret societies embracing the entire tribe rather than by usual social units. Initiation into manhood involves whole tribes in public festivities. Beginning of hunting, fishing or plowing seasons, first-fruit and harvest, and totemic gatherings are the commonest occasions for festivals in primitive societies.

Mesopotamia.—The cultures of the Tigris-Euphrates valley from the 4th millennium B.C. to the Persian conquest in the 6th century B.C. displayed great continuity in religion. The central idea underlying festivals was that man was created for *dullu,* service of the gods, and that such service would assure man's well-being. Heaven was an exact counterpart of earth, the gods having human characteristics. Worship included feeding, washing and entertaining images. Daily service by priests was climaxed by great seasonal festivals. New Year (Akitu) in spring was the only festival celebrated continuously in all periods. Lasting from the 1st to the 10th of Nisan (March/April), it included a recounting of the Epic of Creation, public penance by the king for any misdeeds affecting the state, and divination of prosperity for the coming year. The king then assumed the role of Tammuz, the vegetation god, and was married to the goddess Ishtar, thus assuring divine rule. The midsummer festival of Tammuz was widely celebrated. In addition to these, each temple had its own local calendar. The temple in which festivals were celebrated included a large court through which worshipers would pass, deposit gifts and hear liturgies. The role of the worshiper was passive, priests performing all cultic acts. (*See* also BABYLONIA AND ASSYRIA: *Religion.*)

Egypt.—The Egyptian cultus bore some external resemblance

to the Mesopotamian. Most festivals were celebrated by priests alone. On a few great festivals, however, images of gods were fed and entertained by being carried in procession. The "coming forth" of Min, the fertility god, was typical. The statue was carried in public by priests together with lettuces, Min's sacred plant. The image was placed on a throne and offerings presented. Dancing and feasting accompanied such "comings forth." The greatest festivals were observed by towing barges bearing portable shrines along the Nile. The festival of Opet in which the god Amon was towed by the king's barge from Karnak to Luxor lasted as long as 27 days. At the Feast of the Valley Amon was towed to the graves of the kings to pour libations. Festivals in honour of the dead with offerings and lights were held at the beginning of each year.

The purpose of these and most Egyptian festivals was to celebrate and maintain the continuity of the living, the dead and the gods. Later cults included that of Osiris (*q.v.*), which spread to the Greek world. This included annual performances or religious dramas which developed into the well-known Hellenistic mysteries. After Osiris' coming forth in procession to be killed by his mythological foe, several days of mourning were held before his rising, which was celebrated with general festivity by his devotees. Mystery cults with their dramatic celebration embodied an element of personal devotion and offered salvation by identification of the devotee with the god which was not found in the official cult, the influence of which declined in Hellenistic times. (*See* also EGYPT: *History: Ancient Religion;* MYSTERY.)

Greece.—Festivals of ancient Greece were local in origin, each city-state having its own calendar. The feasts of the country dweller were agricultural and chthonic, the gods of the Olympic pantheon being honoured in cities. The great festivals of 5th-century Athens, the influence of which extended to the rest of Greece, were the Dionysia and the Panathenaea (*qq.v.*). Processions, such as that portrayed on the frieze of the Parthenon, were a prominent feature of each festival. Public feasts were held, the citizens being entertained at the expense of the city. Drama, particularly tragedy, and games were parts of celebrations. Sparta's chief feast was the Hyacinthia. The festival of Soteria (deliverance) was held at Delphi. Festivals were observed with civic holidays which became secularized in later times. The religious meaning of the official cults declined in Hellenistic times, and mystery cults imported from Egypt and Asia Minor rose in importance. Festivals of these cults were celebrated only by initiated devotees. The mysteries of Osiris mentioned above were typical. (*See* also AGRIONIA; APATURIA; BUPHONIA; CARNEIA; DELIA; DAPHNEPHORIA; DEMETRIA; DIASIA; ANTHESTERIA; DELPHINIA; PYANOPSIA; THARGELIA; THESMOPHORIA.)

Rome.—The official cult of Rome included festivals for most of the gods of the pantheon. The oldest cult was the domestic worship of the hearth, which was elaborated into the cult of the vestal virgins who tended the hearth fire of the state. As the Greek pantheon was romanized, Greek characteristics of celebration were adopted. The festival of Mars (*q.v.*), the war god, was distinctively Roman, however. Celebration included a war dance by priests, running and rapid dancing being methods of instilling martial power. The feast of Saturn (*q.v.*) resembled a Greek harvest feast. Social distinction was forgotten, and all restrictions relaxed; thus the Saturnalia became associated with all forms of licence.

All festivals of the official calendar were civic holidays, and keeping the feasts was required by patriotism. The civil character of religion after the establishment of the empire became more pronounced, and imported mystery cults and Christianity answered actual religious needs. The cult of the Great Mother of Asia Minor, Cybele, and of Mithra, an Iranian deity, were popular. The great festival of Cybele was kept at the beginning of spring when the goddess was borne in procession to music. The story of the goddess seeking the body of her dead lover, and of the revival of Attis, was related. The mourning and rejoicing paralleled that of the Osiris cult of Egypt. (*See* also AMBARVALIA; BACCHANALIA; LECTISTERNIUM; LUPERCALIA.)

Northern Europe.—Festivals of pagan Germanic, Celtic and Slavic peoples were seasonal and observed with feasting and drinking, often to excess. They were generally celebrated in sacred groves. Four great seasonal festivals were kept: autumn (harvest), winter (Germanic *Yule*), spring and midsummer. At Germanic festivals sacrificial animals were eaten. According to the *Ynglinga Saga,* Odin ordained autumn sacrifices to celebrate a good year, *Yule* for growth and summer for victory. Among Saxons the dead were commemorated at autumn, while winter commemorations were common in Scandinavia. Celtic festivals were solar in character, chief among them being Samhain (Nov. 1) and Beltane (*q.v.;* May 1). On these days bonfires were lighted to represent the waning and waxing sun, and worshipers danced around the flames to acquire the power of the sun. These were essentially fertility rites. The May queen and May king of Beltane have survived in folk custom. At these times household fires were rekindled. Feb. 1 and Aug. 1 were also celebrated. Among Slavs the summer and winter solstices were major festivals. Popular pagan festivals were assimilated to saints' days after Christianization. St. John's eve (June 23) assumed characteristics of older midsummer festivals, and the Germanic cult of the dead was associated with All Saints' day. Ceremonial bathing at midsummer among pagan Slavs was reinterpreted as baptism.

Iran.—The festivals of ancient Iran have survived in the Parsee (Zoroastrian) community of Bombay, composed of refugees from Islamic invasions of the 8th century. Of the character of festivals in ancient times little is known, most information coming from Arab narratives of the middle ages. Each month of the Zoroastrian year had one sacred day (*yasan*) in honour of one of the *Amesha Spentas* (beneficent spirits) and *Yazatas* (angels) of Ahura Mazda. The great Parsee festivals are Nauruz (New Year), the feast of Mihrajan (Mithra), the 6th of Fravartin and the 11th of Din, birth and death days of Zoroaster. There are also six seasonal feasts celebrating the creation of heaven, water, earth, trees, animals and man, each lasting five days. The last also commemorates the dead, a platform being erected in each home to bear flowers and fruit for the dead. Nauruz is also the feast of Ahura Mazda and the traditional day of creation, the celebration of which represents an annual re-creation of time. Ritual fire, the devotional centre of the Parsee temple, is rekindled.

Islam.—The great festivals of Islam are limited by tradition to two celebrated in conjunction with two of the "five pillars," or religious obligations, of Islam; pilgrimage (*hajj*) and the fast of Ramadan (*q.v.*). Few festivals other than these have developed, and such as have are shunned by the more orthodox. Cults of saints exist among mystical brotherhoods (dervish orders) and in the sectarian faith of Iran and parts of India (Shi'ism). Mohammed's insistence on the equality of believers, however, discouraged a multiplicity of saints' days. The radical break of Islam with earlier Arab paganism excluded older folk festivals from the calendar. The nomadic character of early Muslim life and the desert ideal of simplicity has been a deterrent to extravagant celebration such as that of Hinduism where local traditions are strong.

The pilgrimage which each Muslim is to perform at least once in life unless prevented by illness begins on the 8th of Dhu 'l-Hijja, the last month of the Muslim year. Having performed preliminary devotions, the pilgrim sets out from Mecca for the Mount of Mercy (Jabal ar-Rahma) about nine miles distant. On his return two days later, sacrifices are offered in the wayside village of Mina. The "great festival" (*'id al-kabir* or *'id al-adha;* Turkish *Qurban Bairam,* "Sacrifice Bairam") is celebrated throughout the Muslim world for three days beginning on the day of sacrifice in Mina. New clothes are worn, friends visited and gifts exchanged. The communal prayers are of a more archaic and solemn form than usual. The other major festival follows the fast of Ramadan, the ninth month. During this month no food is eaten from sunrise to sunset. During the first three days of the following month, Shawwal, the "little festival" (*'id al-saghir* or *'id al-fitr,* "Festival of Fast-Breaking"; Turkish *Küchük Bairam*) is celebrated. Graves are visited and decorated on both festivals. (*See* also BAIRAM; RAMADAN.)

While orthodox (Sunnite) Islam does not sanction other feast days, sectarian (Shi'ite) Islam and the mystical Sufi tradition

have introduced others such as the *maulid* (birthday) of the Prophet, first celebrated in 1207. Festivals of saints (*wali*) preserve primitive traits and are celebrated at local sanctuaries. The feast of Nebi Musa (Moses) is observed at a shrine near Jericho. Birthdays of founders of dervish orders regarded as saints by members of the brotherhoods are observed. The chief festival in Shi'ite Islam is the 10th of the month of Muharram, which commemorates the death of Husain, son of the caliph 'Ali, regarded by Shi'ites as the legitimate leader of the faithful and successor of the Prophet. His sanctuary at Karbala in Iraq is a place of pilgrimage, where a passion play depicting his death is performed (*see* HASAN AND HUSAIN). Among other Muslims, this day is remembered as the traditional day on which Adam and Eve were expelled from the Garden, and on which Noah left the ark. Other lesser days include *Lailat al-qadr* ("Night of Power") and the 15th of Sha'ban, which, while not an official New Year, is kept with festivities resembling New Year celebrations. Such local unofficial festivities are often overladen with local superstitions.

Holy days of other faiths have been assimilated to popular Islamic usage. The day of *'ashura'* (10th of Muharram) was the original fast day in imitation of the Jewish Day of Atonement before Mohammed prescribed the entire month of Ramadan. The Coptic Easter is observed by Egyptian Muslims, though naturally without its Christian meaning, and the Zoroastrian New Year (Nauruz) is observed in Iran. None of these, however, is sanctioned by orthodoxy.

All festivals are movable, the Muslim calendar consisting of a year of lunar months totaling 354 days. After 33 years, festivals are celebrated in all months of the western calendar. This removes the great feasts from the influence of non-Islamic seasonal rites, despite persistence of local customs in some unofficial celebrations. New Year festivities, prominent in other religions, have a minor role in Islam.

Buddhism.—Since Buddhism originated not as a popular religion but as a monastic order, the earliest festivals were associated with the monastic calendar and initiation into the *Sangha* (order) The first popular festivals commemorated events in the life of the Buddha. Buddhism, originating in the 6th century B.C. in India, spread rapidly throughout eastern Asia, but became extinct in its own homeland by the late middle ages. Thus festivals vary with country and sect, and have assimilated characteristics of various cultures. The festive calendar of northern (Mahayana) Buddhism, which recognizes several mythological Buddhas, Bodhisattvas and sectarian founders, is more complex than that of the southern (Theravada) school, where these figures are unknown.

Southeast Asia.—Festivals of Thailand illustrate the celebrations of the Theravada. Influences from pre-Buddhist indigenous and Hindu sources are prominent. Trut, or New Year (March/April), is of a mixed character. Buddhist monks exorcise ghosts from the vicinity and are presented with gifts. Oblations are made to various gods of Hindu origin. As people meet, water is playfully thrown by one on the other. Gambling, usually frowned upon, is permitted for the three-day festival. The main religious festival is Wesak (Pali Vishakha-puja), celebrated on the full moon of the month Vishakha (April/May), commemorating the birthday, enlightenment and death of the Buddha. Lasting for three days, it includes distribution of food and alms, decoration of dwellings with garlands and lanterns, and offerings of flowers to Buddha images. Captive birds are released in memory of the Buddha's compassionate nature. Other festivals include those at the beginning and end of the *vassa*, or rainy period, from June to October, when monks remain in the monastery. This is the traditional time for taking vows. The Magha-puja festival celebrates the Buddha's exposition of the *patimokkha*, or rule of monastic discipline. At the royal temple 1,250 tapers are lighted to commemorate the exposition to a like number of original monks. Festivals in Burma and Ceylon follow the Thai pattern. Lesser festivals are associated with pilgrimage sites such as the temple containing the relic of the Buddha's tooth in Kandy, Ceylon.

Tibet.—Festivals in Mahayana lands vary greatly. In Tibet the birthdays of Padmasambhava (8th century A.D.), founder of Buddhism in Tibet, and Tsoń-k'a-pa (14th century), founder of the dominant sect, are celebrated in addition to events in the life of the Buddha. New Year (February) is celebrated with feasting, visiting and a relaxation of monastic discipline. The chief festival is sMon-lam (supplication), following the three-day New Year. Special religious observances are held for 11 days. Festivals of the various Bodhisattvas ("gods" of northern Buddhism) are also held. A feature of most Tibetan festivals is the propitiation of demons, a vestige of the Bon religion of pre-Buddhist days. This is prominent in the "Procession of the Thunderbolt" (Phurba, Sanskrit Vajra), an annual expulsion of demons from the country. This and most other major festivals are celebrated with fairs and masked plays.

China.—Specifically Buddhist festivals include the Buddha's birthday, when images are taken from temples, bathed and clothed, and legendary birthdays of various Mahayana figures, notably Kwan-yin, Bodhisattva of mercy; Mi-li Fo (Maitreya Buddha); and O-mi-to Fo (Amida Buddha). On these days fairs are held near temples with theatrical performances.

Japan.—All sects join in celebrating the Buddha's birthday with floral offerings. Each of the sects observes the birthday of its founder and favourite Mahayana Buddha, these celebrations often exceeding those of the historical Buddha in elaborateness. Thus the sects of Zen, Shin, Shingon, Nichiren, Jōdo and others have their own calendars. Theatrical performances using classical dance forms are often given. One of the oldest festivals, Urabon-E, with elaborate temple dances re-enacts the story of Moggaliputta, the disciple of Buddha who saved his mother from hell by his offerings to the *Sangha*.

Jainism.—Like Buddhism, Jainism arose as a monastic movement in the 6th century B.C., but has not spread beyond India. Major festivals are associated with the monastic year. They are restrained in character, Jainism being intensely ascetic. The eight days of Pajjusana in August is a period of penance. During these days the birthday of Mahavira, founder of the Jain order, and the giving of the *Kalpa Sutra*, an important scripture, are celebrated with processions. Other festivals include an adaptation of the Hindu Diwali, and legendary birthdays of the 23 *tirthankaras*, predecessors of Mahavira, the last of a series of saviours. The strict sect of Digambaras observes the bathing in milk of the huge statue of the *tirthankara* Gommateshvara in Mysore several times each century.

Hinduism.—Festivals of contemporary India are derived from the sectarian Hinduism of the period after the writing of the Puranas (*c.* 4th century A.D.). Ancient festivals were mostly seasonal and observed with sacrifices described in the Vedas. The "four month festivals" were celebrated at the end of winter and at the beginnings of the rainy season and autumn. The Ashvamedha (horse sacrifice) was the most elaborate Vedic festival. Probably a spring fertility rite in origin, it was celebrated by a king who wished to claim universal sovereignty. A horse was let loose for a year to wander, protected by a royal guard which claimed for the king all land covered. At the end of the year, it was returned and sacrificed amid much feasting and unrestrained celebration. Vedic festivals were similar to those of other early Indo-European peoples, but as the Aryan invaders were absorbed by indigenous Dravidian peoples, these festivals fell into disuse and were replaced by those of medieval Hinduism.

Modern festivals are mostly connected with the worship of the great gods Shiva, Vishnu (generally in form of one of his avatars or incarnations) and Shakti. Many are associated with a place of pilgrimage sacred to a deity. Seasonal festivals, as *holi*, are celebrated by all sects and are popular, not sectarian, in origin. Some festivals are common to northern India, others to the south where Dravidian culture is strong. Many are purely local and are observed with fairs.

Holi, perhaps least religious in character, has features of a fertility rite. It is celebrated for five days in March/April with bonfires, unrestrained street dancing and processions. Red powder is thrown by celebrants on each other, and images of gods are borne in decorated cars. In Orissa the spring festival is associated with the Dolayatra (swing festival) in which images of Krishna, an avatar of Vishnu, and his consort Radha are ceremonially

entertained in a swing. A seasonal festival restricted to the Dravidian south is Pongal, or the boiling of new rice. This is celebrated for three days and is the traditional Tamil New Year. In Bengal the New Year is marked by the worship of the Ganges.

Sectarian festivals are numerous among the devotees of Vishnu, since that god has several avatars. He is worshiped at Puri in Orissa as Jagannath (Juggernaut; *q.v.*), or lord of the world, his image being pulled in an immense car by devotees at the Rathayatra festival (June/July). Prayers, offerings, dancing and bathing are performed and religious narratives read. A Krishna festival of the Maratha country is the Rasayatra commemorating the dancing of the god with the cow-maids (*gopi*) of legend. The birthday of Krishna is celebrated in August/September and that of Rama, another avatar, is celebrated in March/April. In all festivals the image is bathed, clothed and entertained according to ritual prescription (*puja*) and Puranas are read.

Shiva has no avatars, and so his calendar is simpler. The 14th day of each lunar period is especially sacred, and that of Magha (January/February) is observed as the Shivarati festival.

The great festival of Shakti (called also Durga and Kali), consort of Shiva worshiped as a deity in her own right in Bengal, is the Durga-puja. Celebrated in September/October, it is a time for family reunion and social gathering as well as religious observances. Animal sacrifices, virtually unknown elsewhere, are offered in Calcutta.

Purification by bathing is a feature of most Hindu festivals. This is particularly evident at those observed at places of pilgrimage located at confluences of rivers.

Other major festivals include Dashara (worship of the Ganges), Lakshmi-puja (goddess of wealth), Sarasvati-puja (goddess of knowledge) and Diwali, celebrated at night with lights. Birthdays of traditional sages and founders of sects are also celebrated.

Hindu festivals have spread to the predominantly Buddhist lands of southeast Asia and Nepal. They are preserved unmixed with other types in Bali. (*See* also HINDUISM: *Festivals.*)

Sikhism.—Festivals of Hinduism have been adapted by Sikhism, a monotheistic faith founded in the Punjab in the 16th century by the Hindu reformer Nanak. The orgiastic Hindu *holi* has been refined and the red powder thrown is allegorized as *sat nam* ("true name"; *i.e.*, of god), the name having been changed to *hola*. The Sikh calendar also includes festivals of the *gurus*, or teachers, and of martyrs.

China.—Popular Chinese religion is an amalgam of Confucian, Taoist and Buddhist beliefs imposed on a background of more primitive folk belief. Great Confucian festivals such as the imperial sacrifices at solstices and equinoxes are no longer observed. Confucianism as a state religion having collapsed with the fall of the empire. Specifically Buddhist (*see* above, *Buddhism*) or Taoist festivals are observed only by a small percentage of the population, though each religion has had a profound influence on popular festivals. The carnival spirit of later Taoism is particularly evident. Festivals associated with temples, Buddhist or Taoist, are local in spirit and usually accompanied by fairs and theatrical performances. The specifically religious motivation is secondary to the social character of the holiday.

The great festivals are seasonal. New Year is celebrated officially for a month beginning in late January or early February. It is preceded by an expulsion of demons and by theatrical performances. Offerings are made to gods of hearth and wealth, and to ancestors. The spring festival (Ch'ing-ming) is observed with sweeping of graves and rekindling of hearth fires. Ceremonial meals at ancestral tombs and family reunions mark the festival, which usually coincides with Easter. Before the rise of Buddhism in China, the festival had an agrarian fertility quality which has been displaced by the commemoration of the dead. The Feast of the Souls in August and the winter festival in November also commemorate the dead. The midautumn festival, like New Year, is a festival of the living and gay in character. An altar is built out-of-doors and "moon cakes" are offered to the "old man in the moon." This is a family festival, and the role of women is prominent. In addition to these seasonal festivals, each temple may have its own patron deity whose birthday is celebrated. Such festivals are rooted in village life.

Japan.—Shintō, the ancient religion of Japan, was obscured by the introduction of Buddhism in the 6th century A.D., though it survived as a popular nature religion, particularly in rural areas, and in mixed form with Buddhism. The revival of Shintō and its purification from Buddhist elements began in the 17th century, but was completed only with the Meiji restoration of 1868. The present form of festivals is therefore recent, though elements of celebration are ancient. Purification is a prominent feature of all Shintō festivals. Ceremonial bathing, food and cloth offerings and waving of "purification wands" with recitation of ritual formulas (*norito*) are modes of ritual. New Year is celebrated with ceremonial house cleaning, giving of presents, presentation of cakes to household shrines, and offerings of rice to sources of household water. Many Shintō festivals are observed at local shrines.

After 1945 and the disestablishment of Shintō as the state religion, the religious meaning of the festivals diminished, though they remain as legal holidays. "Sect Shintō," a generic term covering various cults of modern origin, observes birthdays of sect founders as well as days of patron deities. (*See* also SHINTŌ.)

Traditional Festivals and Modern Thought.—The growth of modern nationalism and the impact of western civilization, leading to either religious reform or secularism and an attendant decline in the value of tradition, has diminished the meaning of many festivals. This is particularly true of China, Japan and to some extent India. While in Muslim lands religious observances re-enforce political unity and, internationally, Islamic solidarity, traditional piety has diminished. In China the spring festival has been perpetuated under communism, though without religious overtones. Modern Hindu philosophy and religious reform have resulted in a calculated neglect, on the part of the educated classes, of traditional festivals rooted in Puranic lore. As modern trends modify traditional beliefs, festivals are reinterpreted, secularized or discarded in many cases.

See also references under "Feast and Festival" in the Index volume.

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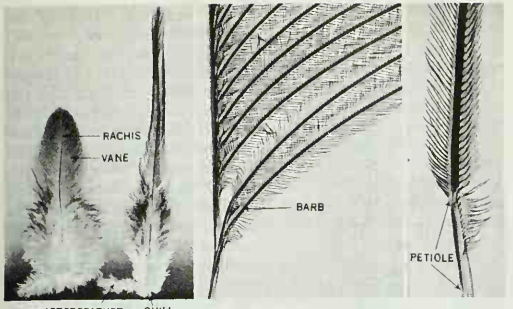
FEATHER. Birds are covered in large part with specialized epidermal structures called feathers that are found in no other group of animals. They are supposedly evolved from the scales of the reptilian ancestors of birds, and are composed entirely of horny substances called keratins.

General.—*Function of Feathers.*—Definitive adult feathers, of three basic types, associated with certain functions, are admirably engineered to be lightweight yet strong. The contour feathers (including the flight and tail feathers) define the body outline and serve as aerodynamic devices; filoplumes (hair feathers) and plumules (down feathers) are used principally as insulation, to conserve body heat. Colours and patterns in feathers serve as protective coloration or for sexual display.

Uses of Feathers by Man.—Feathers provided quills for writing as early as the 6th century, and from that time until steel pen points were introduced in the 19th century they served as the principal writing implements of civilized communities. Quills from crows were especially desirable for making fine lines. For ordinary script, quills from the swan were preferred to those from the goose, but the latter's quills were used more extensively. Only the five outer wing feathers (primaries) were considered suitable for writing, especially those from the second and third follicles.



(A, B) F. R. LILLIE AND H. WANG; (C, D) FROM F. R. LILLIE AND H. WANG, "PHYSIOLOGICAL ZOOLOGY," 1941

FIG. 1.—CONTOUR FEATHERS FROM BROWN LEGHORN CAPON: (A) BREAST FEATHER; (B) SADDLE FEATHER AS SEEN FROM THE VENTRAL SURFACE (A AND B REDUCED); (C) DORSAL VIEW (ENLARGED) OF PORTION OF LEFT VANE OF BREAST FEATHER SEPARATED FROM CENTRAL RACHIS; (D) VENTRAL VIEW (GREATLY ENLARGED) OF COMPLETELY DETACHED BARB FROM LEFT VANE IN C

Moreover, preference was given to those from the left wing because they curve outward and away from the writer. Quills obtained from living birds in the spring proved to be best for writing purposes. Quills from the eagle, owl, hawk and turkey have also been used as writing instruments.

Because of their elasticity, lightness, softness and ability to resist matting, feathers have been used extensively as stuffing for beds, cushions, etc. Goose contour and down feathers, when plucked in the spring from living birds, proved to be most satisfactory for this purpose, although feathers from other aquatic birds (swans, ducks) were likewise used. Feathers of domestic fowl are not too satisfactory for this purpose because they lack the requisite softness. The down of the eider duck has a tendency to mat, and has been used more frequently as stuffing for quilts and as insulation for articles of clothing.

Feathers do not appear to have been used much in Europe for ornamental purposes until the close of the 13th century. During the reign of Elizabeth I feathers began to occupy an important place as headdress ornaments for women. Ostrich feathers were in particular demand for this purpose, especially those of the male, whose long tail and wing feathers are pure white and whose remaining contour feathers are jet black. Most in demand have been feathers of the South American ostrich, *Rhea americana;* the marabou feathers obtained from the storks *Leptoptilos dubius* and *L. javanicus* of India and from *L. crumeniferus* of Africa; the aigrettes of the heron; and the feathers of the various species of birds of paradise and of numerous species of hummingbirds.

FROM F. R. LILLIE AND H. WANG, "PHYSIOLOGICAL ZOOLOGY," 1941

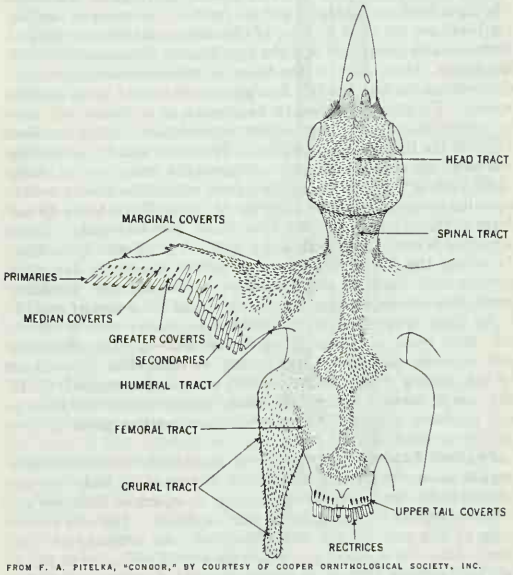
FIG. 2.—DORSAL VIEW OF BREAST FEATHER OF BROWN LEGHORN CAPON DISSECTED AFTER POTASSIUM HYDROXIDE TREATMENT, SHOWING LATERAL COMPONENTS OF THE RACHIS STRIPPED FROM THE CENTRAL COMPONENT (REDUCED)

Quills of various sizes are also used as holders for sable and camel hair brushes used by artists. Feather brushes and dusters are made from the wing feathers of domestic fowl and other birds. Increasingly, feathers are used in the preparation of artificial flies for fishing purposes.

Since the past indiscriminate hunting of birds for feathers has almost eliminated some species, restrictions are now enforced by the conservation agencies of many governments. To be accurately informed on his country's restrictions on the taking and using of bird plumage, a person should contact the governmental departments concerned (*see* also WILDLIFE CONSERVATION).

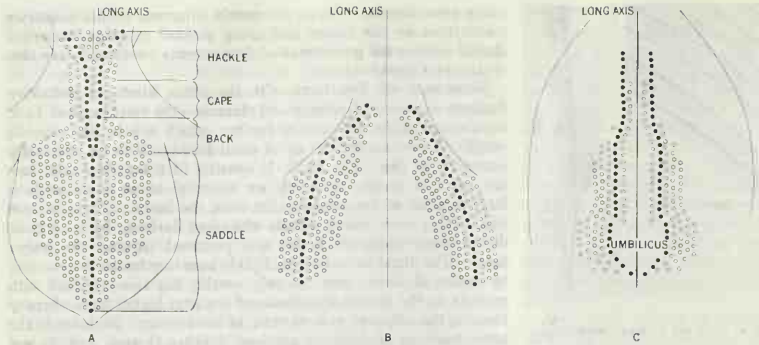
Structure of Feathers.—Of the three kinds of definitive feathers—contour, filoplume and plumule—the most familiar (and most complex) is the contour feather, which will be described in detail. A contour feather of an adult bird tends to be bilaterally symmetrical (fig. 1[A, B]). It consists of a tapering axial rod, the shaft or rachis, to which are attached at an acute angle a large number of tapering parallel rods, the barbs. These in turn (fig. 1[C]) carry many minute elongated barbules both on their distal (away from the body) and proximal (toward the body) faces. The distal barbules (fig. 1[D]) bear tiny hooklets (hamuli) by means of which they not only overlap but also interlock with grooves on the proximal barbules of the next higher barb, thereby forming the coherent web, or vane, of the feather. Barbules in the basal portions of feathers are long delicate threads and do not bind successive barbs together; consequently this part of the feather is fluffy.

The outer surface of the feather is called dorsal, the inner one ventral. The fibrous wall of the rachis encloses a centre composed of air-filled supporting vesicles of microscopic size; thus the rachis combines strength with lightness. Continuous with the rachis basally is the hollow quill, which is inserted in a pit in the skin, the follicle. The cavity of the quill is subdivided by a series of horny concave partitions that represent the remains of pulp caps that formed during development of the feather. At the junction of quill and rachis is a ventral pit, the superior umbilicus, through which projects the fluffy afterfeather (fig. 1[B]). The degree of development of the afterfeather is highly variable not only in different birds but also in different areas of the same bird. In the cassowary and emu the afterfeather is equal in length and size to the main feather; in other birds it is usually much shorter and narrower than even the fluffy portion of the main feather. In fowl it is well developed in unspecialized contour feathers, but is practically absent, or represented only by a few barbs, in flight and tail feathers. If the afterfeather is coloured, its colour pattern is a mirror image of that in the corresponding portion of the



FROM F. A. PITELKA, "CONDOR," BY COURTESY OF COOPER ORNITHOLOGICAL SOCIETY, INC.

FIG. 3.—DORSAL VIEW OF FEATHER TRACTS OF A SCRUB JAY. (LESSER COVERTS, NOT DRAWN HERE, WOULD BE DIRECTLY ANTERIOR TO THE MEDIAN COVERTS)



FROM A. HOLMES, "FEATHER FOLLICLES: ORDER OF ORIGIN," 1935, IN "AMERICAN JOURNAL OF ANATOMY"

FIG. 4.—DIAGRAMMATIC ARRANGEMENT OF FEATHERS IN DOMESTIC FOWL: (A) DORSAL TRACTS; (B) BREAST TRACTS; (C) VENTRAL RIDGE TRACTS. OPEN CIRCLES INDICATE PAPILLAE ARISING IN ORDER ON EITHER SIDE OF THE PAPILLAE OF THE ORIGNAL TRACTS (BLACK CIRCLES)

main feather. The quill possesses a terminal opening, the inferior umbilicus, which encloses the feather papilla responsible for the formation of this feather and subsequent feathers.

The manner in which the barbs are attached to the rachis becomes evident upon dissection of the feather following treatment with 5% potassium hydroxide solution (fig. 2). The barbs, remaining attached to each other, separate as a unit from each side of the feather except at the apex. Such dissections reveal that the lateral surfaces of the rachis are actually composed of flattened barb bases called barb petioles, bent at an obtuse angle from the free portion of the barbs, overlapping one another serially and bound firmly to the central part of the rachis by keratin fibres. Each petiole carries an extension of the series of proximal barbules, which latter thus appear in the intact feather to arise from the rachis itself.

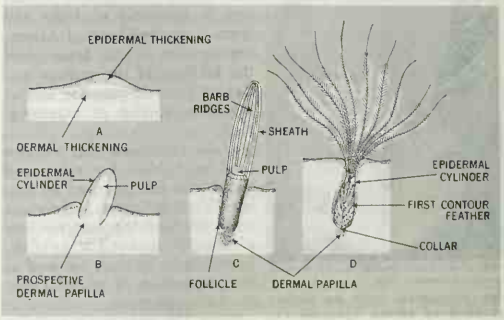
The type of feather described above is called a contour feather because collectively such feathers define the form of the body. The flight feathers (remiges) and tail feathers (rectrices or steering feathers) are the most striking of the contour feathers because of their size and special use in flight (*see* FLIGHT [NATURAL]). The filoplumes, which arise at the bases of contour feathers, are inconspicuous hairlike feathers bearing a small tuft of barbs at their apexes. Filoplumes appear to be present in all birds, but only in certain species do they project beyond the contour feathers (*e.g.*, on the thighs of cormorants). Plumules, usually completely concealed by contour feathers, are generally scant, but in many birds, such as gulls and ducks, they form a thick, insulating undercovering comparable to the underfur of seals. Their barbs do not form coherent vanes, but are long, loose, soft and fluffy. Their structure is much simplified, and a rachis may be entirely lacking. In herons the tips of the plumules disintegrate into a fine scaly powder that becomes distributed over the plumage, providing protection against wetting and giving it a peculiar sheen; accordingly these specialized down feathers are called powder down. All three types of definitive adult feathers—contour, filoplume and plumule—are known collectively as teleoptiles, in contrast to the nestling down feathers, which are called neossoptiles. In the case of contour feathers the same feather follicle that eventually produces a teleoptile first produces a nestling down feather and one or more juvenile feathers.

Feather Tracts (Pterylae).—In most birds contour feathers are not uniformly distributed over the surface of the body, but are located in feather tracts (pterylae) (fig. 3) separated from one another by regions of almost naked skin (apteria). The only exceptions to this rule are the ostrichlike birds, the penguins and the South American screamers, in which the even distribution of plumage has probably been secondarily acquired. Feather tracts differ in their arrangement (called pterylosis) in different species and hence are useful in classification of birds.

The wing tract includes the flight feathers proper (remiges) and their coverts (tectrices). The remiges include: (1) the primaries, arising from the hand and attached to its skeleton; (2) the secondaries, arising from the forearm and attached to the ulna; and (3) the tertials (when present), arising from the upper arm and attached to the humerus. The coverts comprise on the upper surface of the wing the greater, median, lesser and marginal coverts. The greater coverts cover the bases of the remiges; the others overlap in ascending order (toward the leading edge of the wing) with decrease of size. The spinal (dorsal) tract extends the whole length of the bird, excepting the head, along and on each side of the spinal column. In fowl (fig. 4[A]) this tract may be subdivided from the front to the back (though it is not separated by apteria) into the regions of the hackle, the cape, the back and the saddle; each region is distinguished by the form and pattern of its constituent feathers. On the ventral surface of the bird are the breast tracts (fig. 4[B]), which are paired, extending from the neck backward in diverging pterylae. Between the breast tracts is a ventral tract (fig. 4[C]), running along either side of the midline around the region of the umbilicus and meeting in front of the anus. The tail tract includes the tail feathers (rectrices) and their coverts. In addition, there are to be distinguished the head tract, the humeral tract (scapulars), the femoral tract and the crural tract.

Development of Feather Tracts and Feathers.—*Feather Germs.*—Feather germs begin to form in the skin of bird embryos during incubation. In the chick embryo the initial steps in their formation can be seen as early as at 6½ days of incubation. Each feather germ arises as a localized hillock that protrudes beyond the skin level (fig. 5[A]); each hillock consists of a condensed dermal or mesodermal core covered by thickened epidermis. Initial feather germs arise at definite places within each feather tract and then other feather germs appear, arising at equal distances from one another along longitudinal and diagonal co-ordinates, thus forming intricate geometrical patterns within each tract. By the 10th or 11th day all feather germs have appeared within each tract, and the tracts attain their definitive outlines. Each feather germ in the embryo gives rise to a feather follicle in the adult.

Intricate operations on chick embryos, sometimes involving

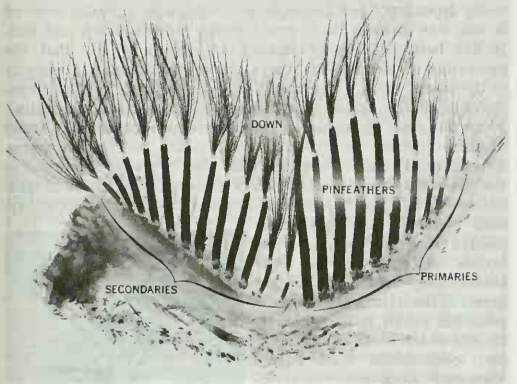


FROM "MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY," VOL. 5; USED BY PERMISSION OF MCGRAW-HILL BOOK CO., INC.

FIG. 5.—DIAGRAMMATIC DEVELOPMENT OF THE DOWN FEATHER: (A) DERMAL THICKENING; (B, C) FORMATION OF EPIDERMAL CYLINDER; (D) DOWN FEATHER BEING PUSHED UPWARD BY DEVELOPING CONTOUR FEATHER (ENLARGED)

transplantation of tiny blocks of mesoderm from the future thigh region to the future shoulder region, have demonstrated conclusively that the mesoderm controls the location of the feather tracts and the number and distribution of feather germs within the various tracts, as well as their time of appearance, orientation and other characteristics. Moreover, thigh mesoderm can induce formation of thigh-type feathers in the apteria of the shoulder region where feather germs would not appear normally.

Nestling Down.—Each feather germ lengthens by basal growth to form a tapering cylinder that slopes posteriorly (fig. 5[B]). The inner portion of the epidermal wall of this cylinder becomes thrown into parallel folds or ridges of uniform height that extend



FROM R. L. WATTERSON, "PHYSIOLOGICAL ZOOLOGY," 1942

FIG. 6.—VENTRAL VIEW OF A CLEARED WING OF NEWLY HATCHED BARRED PLYMOUTH ROCK CHICK SHOWING LOCATION OF PRIMARY AND SECONDARY FEATHERS AND THE RELATIONSHIP BETWEEN PINFEATHERS AND DOWN FEATHERS. ALL FEATHERS EXCEPT THE FLIGHT FEATHERS HAVE BEEN REMOVED (ABOUT NATURAL SIZE)

longitudinally and that protrude into the mesodermal core, which latter has now become the richly vascularized and nutritive pulp (fig. 5[C]). Each epidermal ridge forms one barb with its two rows of incipient barbules (a barb-vane). At the base of the feather germ the inner portion of the epidermal cylinder does not become thrown into folds but remains of uniform thickness to form the calamus or base of the down feather.

Thus the nestling down feather is a radially symmetrical structure (fig. 5[D]) and exhibits basically the same structure in all feather tracts. During these events the base of the feather germ sinks progressively into the skin, thus surrounding itself with an epidermal-lined tube, the feather follicle.

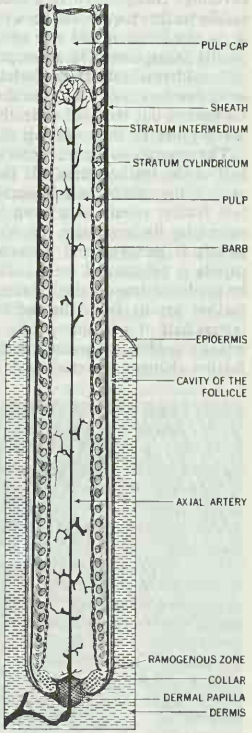
Juvenile Feathers.—Below the level of the calamus the feather germ begins to form the apex and progressively more basal levels of the juvenile feather; as the juvenile feather lengthens, it forces the down feather out of the mouth of the follicle (fig. 5[D]). The outermost cells of the epidermal cylinder form the feather sheath surrounding both the down and juvenile feathers. In fig. 6 the sheaths are shown broken from the down feathers, as a result of drying and friction after hatching, but still enclosing the developing juvenile feathers, at this stage called pinfeathers.

After the bird hatches, development of the juvenile feathers continues. As in the formation of the down feather, the wall of the epidermal cylinder is divisible into an outer sheath (stratum corneum) and an inner portion (stratum intermedium and stratum cylindricum). The inner portion becomes thrown into longitudinal barb-vane ridges that protrude into the mesodermal pulp (fig. 7). The stratum intermedium of each ridge forms the distal part of one barb-vane of the juvenile feather, whereas the stratum cylindricum separates the developing barb-vane from the pulp (*see* fig. 10) and is concerned with formation of pulp caps, which keep the pulp from drying. Meanwhile the base of the epidermal cylinder becomes markedly constricted to form the inferior umbilicus. The constricted region of the pulp, as well as the region of pulp immediately above and below this constriction, becomes highly fibrous and is called the dermal papilla. The latter structure continually proliferates cells, which are added to the base of the growing pulp. Moreover the epidermal cylinder becomes markedly thickened in the region of constriction and immediately above this region, to form the collar. The latter is a zone of cell division and continuously contributes cells to the base of the elongating epidermal cylinder, making possible basal growth of the sheath, of each barb-vane ridge, of the rachis and of the stratum cylindricum. The barb-vane ridges then have the appearance of sprouts arising slightly diagonally from the edge of the collar (*see* fig. 8). As formation of the feather is completed from the tip downward, the pulp is resorbed at intervals, leaving behind one pulp cap after another formed by the stratum cylindricum.

The apex of the sheath ruptures, releasing the tip of the feather. By the time keratinization is complete throughout the entire length of the epidermal cylinder, the pulp is resorbed down to the level of the dermal papilla. The juvenile feather is then complete.

Adult and Replacement Feathers.—Eventually the juvenile feathers are lost (molted), leaving denuded dermal papillae behind. Thereupon each collar proliferates a layer of epidermis over the papilla, thus reconstituting a feather germ; the latter then begins the task of forming the next feather, either another juvenile feather or an adult feather. Once this feather is completely formed, it, too, will be lost through accident, molting or perhaps plucking. In any event, the collar again proliferates a layer of epidermis over the denuded dermal papilla, and the reconstituted feather germ begins to form another feather. The new feather will be exactly like its predecessor (providing regeneration of an adult feather is concerned and providing the physiological condition of the bird remains unchanged). Thus fig. 7 may be used to illustrate development of a juvenile, adult or regenerating (replacement) feather.

Differences in Development.—The development of juvenile and adult feathers is more difficult to visualize than that of nestling down feathers because of the formation of the rachis and the application of the bases of the barbs (barb petioles) to the sides of the forming rachis, thus resulting in the formation of a bilaterally, rather than a radially, symmetrical feather. This difference in development may be visualized most readily if the feather cylinder is slit lengthwise, halfway between dorsal and ventral surfaces, and then spread out flat on a slide with the pulp surface facing the observer (fig. 8). Such a preparation is called a split-feather preparation. At the base of this illustration are shown the growing zone of the epidermal cylinder, the collar and the barb-vane ridges (dark parallel oblique lines), which appear to arise as sprouts from the edge of the collar. The rachis arises as a rather massive outgrowth of the dorsalmost edge of the collar. As the barb-vane ridges lengthen



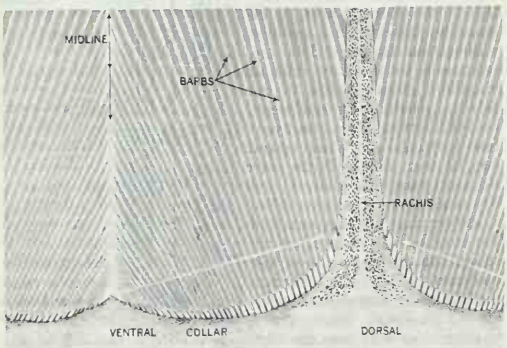
FROM F. R. LILLIE, "BIOLOGICAL REVIEWS," 1942

FIG. 7.—LONGITUDINAL SECTION THROUGH THE DEVELOPING PINFEATHER IN ITS FOLLICLE (ENLARGED)

progressively, by addition of cells from the collar, their bases approach the rachis progressively from each side (white arrows) until they fuse with the lateral surfaces of the rachis and with each other, their growth by addition of cells basally thereupon terminating. The apex of each subsequent barb-vane ridge forms adjacent to the midventral line; by the time the full length of the barb-vane ridge is attained, its base has moved dorsally and upward on the rachis. The ridge therefore extends obliquely across half the circumference of the epidermal cylinder. As these feather elements become keratinized and the sheath ruptures, the inner portion of the epidermal cylinder breaks apart in the midventral line, and the barb-vanes on the two sides of the rachis assume their definitive positions as illustrated in fig. 1.

Many intricate and instructive operations have been performed on the feather germ inside the feather follicles of adult birds. If the dermal papilla is completely removed from a follicle, that follicle cannot form another feather. But if the dermal papilla is removed from the base of a follicle, denuded of its epidermal covering and then transplanted into a slit in the epidermal wall of a follicle that has lost its dermal papilla, the latter follicle will initiate development of a feather. If the dermal papilla is removed from a follicle, denuded, rotated 180° and replaced in the follicle in its new orientation, it will initiate development of an inverted feather whose ventral (or inner) side will be outermost. Even more striking experiments involve transplantation of feather papillae between different feather tracts; for instance, between breast and saddle tracts. The breast feather (fig. 1[A]) is distinctly different in form from a saddle feather (fig. 1[B]). An intact breast feather papilla (dermal papilla plus its epidermal covering) transplanted to a saddle follicle from which the intact saddle feather papilla has been removed will form a *breast* feather in its new location, and vice versa. But, a denuded breast feather papilla transplanted to an empty saddle follicle will cover itself with epidermal cells from the latter and will form a *saddle* feather in its new location. Thus the dermal papilla initiates feather germ formation, but the kind of feather that results from this stimulus is controlled by the epidermis that actually forms the feather.

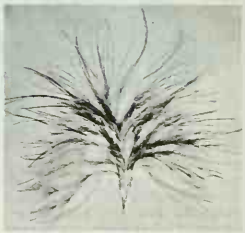
The capacity to form a rachis seems to be restricted to the dorsal half of the feather germ. If the dorsal half is removed and discarded, the ventral half is unable to form a rachis; the resulting tuft feather resembles a down feather of a newly hatched chick, except for its larger size (fig. 9). If the ventral half of a feather papilla is removed and discarded and a dorsal half of another papilla is substituted for it, twin feathers facing each other will be produced from a single follicle. Moreover, a lateral half of a feather papilla from the saddle tract can be combined with a lateral half of a feather papilla from a breast tract and grown in either a saddle or a breast follicle. The composite papilla forms a feather chimera (mosaic) with one half exhibiting characteristics of a saddle feather, the other half, of a breast feather. Thus the feather papilla lends itself admirably to the types of interventions practised by experimental embryologists.



FROM F. R. LILLIE, "BIOLOGICAL REVIEWS," 1942

FIG. 8.—INTERIOR VIEW OF THE BASE OF FLATTENED SPLIT CYLINDER OF A BREAST FEATHER OF A BARRED ROCK CAPON (GREATLY ENLARGED) (*see* TEXT)

Colours of Feathers.—Many feathers owe their colour to the deposition in their cells, during formative stages, of minute granules of melanin pigment formed by specialized cells called melanocytes. The cell bodies of these pigment cells are located in the portion of each barb-vane ridge adjacent to the pulp (fig. 10[B]) and extend long, narrow processes peripherally toward the forming barbule cells, upon or into which they deposit pigment granules. Later these melanocytes contribute pigment granules to the barbs as well, whereupon, depleted of their granules, they die. Melanocytes of each breed of chicken or species of bird produce pigment granules of a specific size, shape and colour. Feather colours directly dependent upon their content of pigment granules received in this way include black, gray, brown, reddish-brown and buff. It has been possible to demonstrate experimentally that the precursors of melanocytes, the colourless melanoblasts, originate in the neural crest, a region of the embryo that is located dorsolaterally to the neural tube (source of spinal cord and brain). From this point of origin they migrate throughout the body, many of them entering the epidermis of the skin and feather germs. Experimental tests demonstrate that they are already present in the epidermis of wing buds of chick embryos by 80 hours of incubation. It has been further demonstrated that when these embryonic pigment cells are transplanted from embryos of coloured breeds to embryos of white breeds, they invade the feather germs of the latter where they deposit the colour pattern characteristic of the donor. For example, melanoblasts from Barred Plymouth Rock embryos transplanted to White Leghorn embryos form their characteristic barred pattern (alternating black and white transverse bars) in White Leghorn feathers.



F. R. LILLIE AND H. WANG

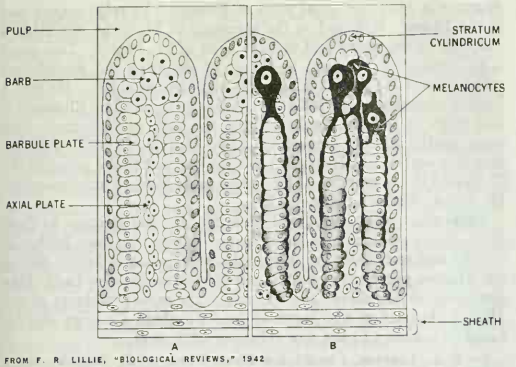
FIG. 9.—TUFT FEATHER FORMED FROM VENTRAL HALF OF FEATHER GERM (ABOUT NATURAL SIZE)

Feathers of white breeds have little or no pigment because the melanoblasts that invaded them during developmental stages die before they can form functional pigment cells (fig. 10[A]). White feathers can be produced in skin transplants taken from normally pigmented breeds by preventing the entrance of the migrating melanoblasts into the skin. Actually the white colour is due to reflection of light by means of the physical structure of feathers; in coloured breeds this structural effect is masked by pigment.

In addition to white certain other colours are called structural colours. They likewise occur because of structural peculiarities of the cells constituting the feather. Frequently structural colours are modified by the presence of melanin granules. This is the cause of the noniridescent blue colour of some feathers, and is likewise the explanation for the iridescent colours, the colours that seem to change as the bird moves. In the case of noniridescent blue certain cells of the barbs are modified structurally, whereas iridescent colours are due to modifications of the barbule cells.

Certain pigments deposited in feathers are not contained in special pigment cells. This group of pigments, the carotenoids, occurs naturally in the food of many birds. Carotenoids and their decomposition products are carried through the circulation in the pulp to the epidermal cells that will become the barbs and barbules, and are at first in solution in the fats in these cells. When the cells undergo keratinization, these pigments become transformed into flakes that become evenly distributed in the keratin. Such flakes are responsible for the yellow, orange and bright red colours of plumage, especially of the ornamental feathers and of the colourful plumage of males of many migratory song birds.

Sexual Differences in Plumage.—In many birds the plumage of the male differs markedly from that of the female; *i.e.*, the plumage exhibits sexual dimorphism of form, and often of colour.



FROM F. R. LILLIE, "BIOLOGICAL REVIEWS," 1942

FIG. 10.—ARRANGEMENT OF CELLS WITHIN BARB-VANE RIDGES AS SEEN IN TRANSVERSE SECTIONS THROUGH THE FEATHER CYLINDER IN CAPONS: (A) WHITE LEGHORN: (B) BROWN LEGHORN (GREATLY ENLARGED)

For example, in Brown Leghorn fowl the male possesses long, drooping, lacy golden feathers in the saddle tract, whereas the corresponding feathers of the female are short, round-tipped and stippled. It has been demonstrated experimentally that the female type of plumage in this breed is due to production of an ovarian hormone. This hormone apparently suppresses development of the cock type of plumage since, upon removal of the ovary, the genetic female forms typical male-type plumage. Castration of the cock, though, does not modify its plumage however fundamentally it may alter other sex characteristics. Injection of ovarian hormone either into normal males or into females from which the ovary has been removed causes formation of plumage of the female type. Especially interesting experiments were performed on breast feathers of castrated male Brown Leghorns. An area of feathers was first plucked, and regeneration of the male type of feathers (black) allowed to begin. Then daily injections of ovarian hormone were given for several days, as a consequence of which the basal regions of the forming feathers became salmon-coloured; *i.e.*, developed the colour typical of female breast feathers. Injections were then discontinued and the next more basal levels of the feathers that formed after the ovarian hormone level dropped were black; *i.e.*, of the male type. This process can be repeated throughout development of the feathers, resulting in formation of feathers that exhibit alternate bands of male and female structural features and coloration.

In certain other birds other hormones are responsible for the sexual dimorphism of plumage. For example, African weaver finches develop a sexual dimorphism of their plumage whether or not males and females have their gonads removed. Assumption of the male type of plumage in these birds depends upon secretion of a luteinizing hormone produced by the anterior pituitary gland. If this hormone is injected into males and females out of the breeding season, or into castrated males or females, it causes them to assume the gaudy yellow-and-black garb of the male.

Thus it is evident that the feather germ is a useful object for the study of hormone-dependent processes. It has been used extensively as an object of study by endocrinologists who are concerned with the production and action of hormones, the products of the endocrine glands. Feathers record permanently the changes in hormone levels that occurred during their formation (*see* also HORMONES, VERTEBRATE).

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(R. L. WA.)

FEATLEY (originally FAIRCLOUGH), **DANIEL** (1582–1645), Anglican priest and controversialist, was born at Charlton, Oxfordshire, on March 15, 1582, and became rector of Lambeth (1619) and subsequently also of Acton, Middlesex (1627). The Anglican account of his famous debate (June 27, 1623) with two Jesuits, John Fisher and John Sweet, was published as *The Fisher Catched in his Owne net* (1623); a Catholic account was issued in 1626. An epidemic of plague caused Featley to publish *Ancilla pietatis* (1626), a book of private devotions. His *Clavis mystica* (1636) was a collection of sermons. An account of Featley's other famous disputation (Oct. 17, 1642), this time against four Baptists, was published in *The Dipper Dipt* (1645). At the 1643 Westminster assembly of divines Featley opposed the Solemn League and Covenant with the Scots; his arguments, in *The League Illegal*, were published (1660) by his nephew. Featley was imprisoned (1643) as "a spy and an intelligencer"; his health declined and he was moved to Chelsea college where he died on April 17, 1645.

FEBRONIANISM, the German counterpart of Gallicanism, was an 18th-century movement within the Roman Catholic Church against the claims of the popes, particularly in temporal matters. *See* GALLICANISM.

FEBRUARY (Lat. *Februarius*) is the second month of the modern calendar, with 28 days (29 in bissextile or leap years). In the early Roman calendar it was the 12th month, primarily devoted, in anticipation of the new year, to ceremonies of purification and the cult of the dead: hence its name, derived from the root of *februare*, "to purify."

The designation of leap-year day as February 29 is relatively modern and only gradually prevailed. In the Julian calendar, as still in some liturgical calendars, the extra day was inserted before the 24th. This accounts for the term bissextile, since the Romans (counting back, inclusively, from March 1) called both days the sixth.

(F. R. WN.)

FÉCAMP, a seaport and bathing resort of northern France, in the *département* of Seine-Maritime, lies at the mouth of the Valmont river 42 km. (26 mi.) N.W. of Le Havre by road. Pop. (1962) 19,308. The town occupies the bottom and sides of a narrow valley opening out between high cliffs.

Fécamp grew up round the nunnery founded in 658 to guard the relic of the True Blood which, according to legend, was found in the trunk of a fig tree that had drifted from Palestine to this spot, and which still remains the most precious treasure of the church. The original convent was destroyed by the Northmen, but was re-established by Duke William Longsword as a house of canons regular, later converted into a Benedictine monastery. King Richard I greatly enlarged this and rebuilt the church. The dukes of Normandy improved the harbour, but later the town was overshadowed by the rising port of Le Havre. In World War II Fécamp was in German hands from June 1940 to Sept. 1944.

The church of La Trinité, built between 1175 and 1220, has a fine central tower and chapel screens; the remains of the Benedictine abbey buildings (18th century) adjoining it are now used as the *hôtel-de-ville* and the *lycée*. In the modern Benedictine distillery and museum can be seen how the liqueur was made by the monks from 1510 to the Revolution, when the business was taken over by a secular company. The initials D.O.M. (*Deo Optimo Maximo*) on the liqueur bottles preserve the memory of the original makers. A new art centre containing a museum, theatre and library is in the public gardens. A municipal casino was built by the sea in 1955. The harbour is tidal with docks capable of receiving ships drawing 26 ft. at spring tide, 19 ft. at neap tide. Fishing for herring and mackerel is carried on and Fécamp sends a large fleet to the codbanks of Newfoundland and Iceland. The chief exports are oil cake, flint, grain, cod and Benedictine liqueur. Imports include coal, timber, tar, hemp and peanuts. Steam sawing, founding, fish salting, shipbuilding and repairing, and the manufacture of ship's biscuits and fishing nets are among the industries.

FECHNER, GUSTAV THEODOR (1801–1887), German scientist and philosopher, who pioneered in psychophysics, was

born on April 19, 1801, at Gross-Särchen, Lower Lusatia, where his father was pastor. Fechner took his degree in biological science in 1822 at the university in Leipzig, where he spent the rest of his life. He became interested in mathematics and physics and was appointed professor of physics in 1834, but, after a long illness and partial blindness, turned in 1843 to the study of philosophy, experimental aesthetics and psychophysics. He died at Leipzig on Nov. 18, 1887.

Fechner's philosophy conceives the world as highly animistic, even plants and the stars being animated; God, the soul of the universe, has an existence analogous to man, and natural laws are the modes of the unfolding of God's perfection. Fechner was a remote disciple of Friedrich von Schelling and learned much from Johann Herbart.

Though he received attention as a philosopher, Fechner's fame stems chiefly from his experimental work described in *Elemente der Psychophysik* (1860), which he intended merely as verification for his philosophy. The basic postulate of Fechner's psychophysics was that mind and body appear to be separate entities but are actually only different sides of one reality. What appears from a subjective viewpoint as the mind appears from an external or objective viewpoint as the body; Fechner uses the illustration that a circle appears concave or convex depending on whether or not the observer stands inside or outside the circle. The apparent dualism is due to the impossibility of taking both viewpoints simultaneously.

Fechner's originality lies in his development of psychophysical methods by which experienced sensation could be measured in relation to the physical magnitude of the stimulus.

Through his psychophysical experiments he derived an equation between stimulus and sensation, and thus, he believed, between body and mind, and he felt that this demonstrated the validity of the identity hypothesis. The equation, Fechner's law, which states that the intensity of a sensation is proportional to the logarithm of the stimulus, can be written

$$\text{sensation intensity} = C \log \text{stimulus intensity},$$

where C is a constant that must be experimentally determined for each sense modality. Ernst Heinrich Weber had originally postulated this constancy in 1834, and the formula is therefore sometimes called the Weber-Fechner law. The law has been criticized on logical grounds, and experimental evidence indicates that it does not have the universal applicability Fechner claimed. Nevertheless, it has proved useful, particularly to researchers in vision and hearing.

Through his influence on Wilhelm Wundt (*q.v.*), Fechner's psychophysical methods and formulations became one of the cornerstones of early psychology. *Elemente der Psychophysik*, though its philosophy did not stand the test of time, gave psychology methods for the measurement of sensation and thereby results that could be expressed in the language of mathematics.

Fechner's chief works, in addition to *Elemente der Psychophysik*, are: *Massbestimmungen über die galvanische Kette* (1831); *Das Büchlein vom Leben nach dem Tode* (1836; Eng. trans., 1882); *Nanna, oder über das Seelenleben der Pflanzen* (1848); *Zendavesta, oder über die Dinge des Himmels und des Jenseits* (1851); *Vorschule der Ästhetik* (1876); *Die Tagensansicht gegenüber der Nachtansicht* (1879). In addition to scientific and philosophical papers, he wrote poems and satires under the pseudonym of Dr. Mises. *See* also PSYCHOPHYSICAL METHODS.

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(T. E.)

FECHNER'S LAW: *see* FECHNER, GUSTAV THEODOR; PSYCHOPHYSICAL METHODS.

FECKENHAM, JOHN DE (JOHN HOWMAN) (*c.* 1515–1584), English priest and the last abbot of Westminster, was born at Feckenham, Worcestershire. He was a monk at Evesham until that monastery was dissolved in 1540. Thereafter he returned for a time to Oxford, where he had formerly been educated, becoming in 1543 chaplain to Bishop Bonner of London. He shared Bonner's disgrace in 1549 and spent most of Edward VI's reign imprisoned in the Tower. Released on the accession of Mary, he was made a chaplain to the queen and in 1554 dean of St. Paul's. Two years later Feckenham was put in charge of restoring the Benedictine monastery at Westminster and was consecrated abbot. He was a leading opponent of the religious changes introduced by Elizabeth I, and when he and his monks refused the oath of supremacy they were ejected and the monastery closed (July 12, 1559). Feckenham was sent to the Tower in 1560 and except for the years 1574–77 passed the remainder of his life in some kind of imprisonment. He died at Wisbech castle in 1584.

Feckenham was an eloquent preacher, and his sermons as dean of St. Paul's attained great popularity. A generous man, both materially and spiritually, he exercised a moderating influence during the Marian persecution (interceding on occasion for Lady Jane Grey and for Elizabeth) and was one of the most prominent of the Marian churchmen who survived into Elizabeth I's reign and refused to conform to the new religious settlement.

See E. L. Taunton, *The English Black Monks of St. Benedict*, vol. i (1898).

FECUNDITAS, the Roman personification of fertility with particular reference to the empress. The senate in A.D. 63 voted a temple to Fecunditas to commemorate the birth of Nero's daughter by Poppaea (Tacitus, *Annals*, xv, 23). It was probably never built, as the child soon died. Fecunditas appears on coins, as a mother with children, to celebrate similar events during the empire, especially during the 3rd century A.D. (R. B. LD.)

FEDCHENKO GLACIER (LEDNIK FEDCHENKO), of the Tadzhik Soviet Socialist Republic, is the longest valley glacier of the U.S.S.R. and one of the longest in the world, being 44 mi. in length and covering about 350 sq.mi. It flows north from the ice field of Revolution peak (Pik Revolyutsii; 22,880 ft.), in the Pamirs, receiving ice also from Communism peak (Pik Kommunizm; 24,590 ft.). Its meltwater forms a headstream of the Surkhob and so of the Amu Darya. (R. A. F.)

FEDERAL BUREAU OF INVESTIGATION. The investigative arm of the United States department of justice, the Federal Bureau of Investigation (FBI) is a fact-gathering and fact-reporting agency with headquarters in Washington, D.C. It does not evaluate the results of its investigations or recommend prosecutive action. In general, the FBI is responsible for the enforcement of all federal criminal statutes with the exception of those specifically delegated to other federal agencies. The jurisdiction of the FBI covers more than 160 federal investigative matters encompassing two major categories: general investigations and domestic intelligence. In the latter field, the FBI has responsibilities in matters of espionage, sabotage and subversive activities.

In addition to investigating violations of laws of the United States, the FBI is charged with collecting evidence in cases in which the United States is or may be a party in interest, and with other duties imposed by law. It reports the results of its investigations to the attorney general, chief legal officer of the United States, his assistants and to the various U.S. attorneys in federal districts throughout the United States for decisions as to prosecutive action. The FBI is also a service agency which assists law-enforcement agencies in identification, technical and training matters.

History.—Established July 26, 1908, by Atty. Gen. Charles J. Bonaparte, the investigative agency originally was known as the Bureau of Investigation. The name Federal Bureau of Investigation was adopted on July 1, 1935.

Reorganization of the agency followed Atty. Gen. Harlan Fiske Stone's appointment in 1924 of J. Edgar Hoover as director. The policies which constitute the foundation of the present organization were inaugurated immediately. Political considerations were divorced from personnel appointments, and promotions were placed on a merit basis. Continuity of direction has been afforded by the fact that each succeeding attorney general has reappointed J. Edgar Hoover as head of the FBI.

Within less than a decade after its reorganization, the FBI was confronted by rapidly increasing responsibilities. A wave of lawlessness in the early 1930s aroused public concern. Local police

officers, often inadequately trained and hampered by the restrictions imposed by state boundaries, were unable to cope effectively with the modern weapons and transportation available to organized criminal gangs. To meet this situation, congress passed a number of laws which extended the jurisdiction of the FBI. The federal kidnaping statute was enacted in 1932. This made the interstate transportation of a kidnaped person a violation of federal law. All kidnaping cases referred to the FBI in the course of the following year were solved. The federal Bank Robbery act was passed in 1934. In the same year, special agents of the FBI were authorized by congress to carry firearms and to make arrests. With the passage of these and other crime bills, the FBI was given authority to act against the criminal gangs. In 1934 alone, three notorious fugitives—John Dillinger, Charles Arthur ("Pretty Boy") Floyd and Lester Gillis, alias "Baby Face" Nelson—met death while resisting arrest. In 1935 Russell Gibson and Kate and Fred Barker refused to surrender and fell in a gun battle with special agents. The arrest of Alvin Karpis in 1936 marked the end of the Barker-Karpis gang. The latter part of the 1930s saw the apprehension of numerous other kidnapers, bank robbers and lesser criminals by agents of the FBI.

While the war on crime was not halted, it was overshadowed as international developments leading to World War II placed additional responsibilities on the FBI. During this period, federal statutes relating to subversive activities were the basis for counteraction by the FBI against intelligence operations of foreign powers. Several espionage agents were arrested before the outbreak of hostilities in Europe. On Sept. 6, 1939, a presidential directive was issued providing that the FBI should take charge of investigative work in matters relating to espionage, sabotage, subversive activities and related matters. The president also called upon all enforcement officers, both federal and state, to report all information in these fields promptly to the FBI, which was charged with the responsibility of correlating this material and referring matters under the jurisdiction of any other federal agency with responsibilities in this field to the appropriate agency. The FBI's responsibility in these matters was reiterated by presidential directives of Jan. 8, 1943, and July 24, 1950. By agreement, the armed forces handle investigations concerning their uniformed personnel. This action by the president obviated the confusion experienced in World War I when more than 20 agencies investigated security in the United States.

In June 1941 the FBI climaxed its investigation of a Nazi espionage ring in New York city with the arrest of 33 persons. All pleaded guilty or were convicted in federal court.

An effective Pan-American intelligence force was created under FBI leadership to oppose the activities of Axis spy and sabotage rings in the western hemisphere. From July 1, 1940, through June 30, 1946, more than 15,000 Axis operators and sympathizers in South America were expelled, interned or rendered harmless. More than 460 spies, saboteurs and propaganda agents were apprehended and 30 secret radio transmitters were eliminated.

In 1939 the FBI undertook a program of surveying industrial plants engaged in the manufacture of strategic war matériel. Before it had concluded its responsibility in this program, more than 2,300 plants had been surveyed and recommendations made for their protection. In the period preceding the attack on Pearl Harbor, new field offices were opened in the continental United States and its territorial possessions. Additional personnel was trained by the FBI to investigate the flood of complaints regarding suspicious activities which citizens reported, and its rolls of clerical and investigative employees reached an allotted peak of 14,300.

A mass of intelligence information had been accumulated by Dec. 7, 1941, when Japan attacked at Pearl Harbor. By the following day, 1,771 potentially dangerous enemy aliens had been arrested and detained. As formal declarations of war were made, German and Italian aliens, known or suspected to be dangerous, were arrested. In all, more than 16,000 such apprehensions were made by the FBI with the assistance of local law-enforcement authorities in an orderly manner and in marked contrast with the disorganized activities of the vigilance committees of World War I. Precautions against espionage and sabotage were increased.

In 1942 eight saboteurs, landed by submarine from Germany, were quickly taken into custody. Two additional saboteurs were dispatched by Germany in 1944 and were quickly apprehended. The normal channels for enemy agents to enter the country were closed, and spies were then sent to the United States as refugees. Spies intercepted by the FBI often became double agents, identifying other espionage agents and transmitting misleading information to their principals.

After the war the nation found itself confronted with a crime wave of serious proportions. The war-born scarcity of consumers' goods created a lucrative market for stolen merchandise and contributed to the reactivation of old criminal gangs and to the task of the FBI.

The postwar period saw increased public concern in matters relating to communism and the infiltration of government and essential industry by persons whose loyalty was subject to question. Congress passed a number of laws charging the FBI with the responsibility for ascertaining the character, loyalty and associations of persons to be employed in the federal government and persons having access to restricted atomic energy data, and for furnishing the results of their investigations to the interested agencies for adjudication and the granting or denying of security clearances. Among the laws passed was the Atomic Energy act of 1946, later rewritten and called the Atomic Energy act of 1954, as amended. In addition, the president on March 21, 1947, by executive order 9835, gave the FBI the responsibility of conducting investigations concerning the loyalty of employees and applicants for positions in the executive branch of the federal government and of furnishing the results to the interested agencies for a decision. This program was continued with the issuance of executive order 10450, dated April 27, 1953. The result was to increase greatly the investigative work of the FBI.

On April 5, 1952, congress transferred responsibility for the bulk of applicant-type investigations to the United States civil service commission and provided that the FBI should handle those cases in which information indicated questionable loyalty or where the position involved was sensitive and important.

From 1948 to 1956 the government, based upon evidence developed by the FBI, indicted 137 leaders of the U.S. Communist party for conspiracy to teach and advocate the overthrow of the United States government by force and violence in violation of the Smith act of 1940. An additional eight leaders were indicted on charges of membership in the party, having knowledge of its illegal objectives, also in violation of the Smith act. All of the arrests were made by FBI agents. At the 19 trials held in 15 cities and in the then territory of Hawaii, resulting in convictions of 109 of the defendants, the key government witnesses were FBI informants who, while masquerading as party members, had actually been reporting on Communist activities to the FBI. A supreme court decision in June 1957, and subsequent appellate court decisions, resulted in many of the defendants being acquitted or being granted new trials.

Other investigations by the FBI in the security field developed evidence of plots to transmit government secrets and information relating to atomic energy and other secret projects to foreign nations. It scrutinized even more closely organizations which advocated policies not in keeping with the U.S. constitutional form of government.

Special Agents.—Applicants accepted for training as special agents of the FBI must be physically qualified male citizens of the United States, between the ages of 23 and 41. They must be graduates of an accredited law school with at least two years of undergraduate work or must have graduated from an accredited four-year college with a major in accounting and have had three years' practical experience in that field. Those accepted for training are put through a 13-week course at FBI headquarters in Washington, D.C., and the FBI academy on the U.S. marine base, Quantico, Va., before being assigned to an FBI field office.

Co-operative Services.—*The FBI Laboratory.*—On Nov. 24, 1932, the FBI laboratory was established to provide scientific crime-detection facilities to authorized law-enforcement agencies. Services of the FBI laboratory are available cost-free to state and

municipal law-enforcement agencies, as well as to other government agencies. Its technical equipment ranges from simple laboratory instruments to complicated spectrographs. Its technicians, who represent many fields of chemistry, physics and engineering, include experts in firearms identification, serology, spectrography, metallurgy, explosives, hair and fibre analyses and handwriting identification. Examinations in the laboratory clear the innocent as well as convict the guilty. Laboratory experts are available to testify without charge in state courts concerning the results of their examinations.

The Identification Division.—A national fingerprint file was established on July 1, 1924, when the FBI was given custody of 810,188 fingerprint cards previously maintained by the U.S. penitentiary at Leavenworth, Kan., and by the International Association of Chiefs of Police. An average of nearly 20,000 fingerprint cards are received each working day for processing at the Identification division. By 1963 the Identification division's files contained more than 165,854,000 fingerprint cards. In addition to fingerprints submitted on criminal charges, these included fingerprints of military personnel, government employees, aliens, prisoners of war and private citizens who voluntarily submitted their fingerprints for protection against loss of identity in the event of amnesia or disfiguring fatal accidents. (*See* also FINGERPRINT.)

Police Instruction.—In 1935 the FBI National academy was established to train selected members of law-enforcement agencies as police executives and instructors for their local departments. The 12-week training course is conducted at Washington, D.C., and at the FBI academy, Quantico, by members of the FBI training staff and recognized outside experts. No tuition or fees are charged. Two sessions are held annually. By 1963 the number of graduates was over 4,000. Among these graduates were police officers and officials from every state in the union, Puerto Rico and the Canal Zone, as well as from several foreign countries. The benefits of the training afforded these men have been transmitted to thousands of their fellow officers.

At the request of local authorities, the FBI co-operates in police training schools, affording training in such matters as firearms, fingerprint classification, traffic control, defensive tactics and other courses of value to law enforcement. In its annual conferences with state and local law-enforcement agencies, the FBI provides a medium for the discussion of common problems related to law enforcement in the various local areas. Such publications as the FBI *Law Enforcement Bulletin* and the *Uniform Crime Reports* further aid in keeping law-enforcement officers abreast of developments in crime detection and trends in crime. Published monthly, the FBI *Law Enforcement Bulletin* provides a medium for exchange of ideas among law-enforcement agencies. The *Uniform Crime Reports* is a statistical analysis of local crime on an annual basis. Tabulations on offenses committed are submitted to the FBI monthly and annually by more than 7,800 law-enforcement agencies throughout the United States.

Administrative Organization.—Headquarters of the FBI are maintained in Washington, D.C., where all administrative and investigative functions are co-ordinated. In Jan. 1963 there were 55 field offices of the FBI in key cities in the United States and in Puerto Rico. Each field office is headed by a special agent in charge, responsible to the director for the supervision of the agency's activities in his field territory.

See also INVESTIGATION, CRIMINAL.

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For annual developments and statistics *see* the article "Federal Bureau of Investigation" in the *Britannica Book of the Year,* American edition.

(J. E. H.)

FEDERAL GOVERNMENT is the government of a federal community. Such a community is characterized by a territorially diversified pattern that calls for two levels of government, one to deal with the common, the other with the territorially diverse. Since such patterns are rarely stable over any considerable period of time, federal government is highly dynamic and the equilibrium of power is continually shifting. Federal government, which is often called federalism, is, therefore, a process rather than a static design. This point needs emphasizing in order to bring out the contrast with older conventional views which laid stress on the problem of sovereignty (*q.v.*) and the resultant distinction between a federal state (*Bundesstaat*) and a federation (or confederation) of states (*Staatenbund*). While not without importance, especially for international law, this dichotomy obscures rather than illumines the vital aspects of federalism and federal government.

While federal systems have had primary importance in providing the opportunity for separate communities to organize themselves in larger unities, as illustrated by the history of Switzerland, the United States, Canada, Australia, Germany and a host of more recent examples, a federalizing process may also be important in solving problems of overconcentration of governmental power, as is demonstrated by the Commonwealth of Nations and the French union.

Federal governments often evolved out of leagues or confederations. It was so in the United States, Switzerland and the Netherlands. Hence, federal government typically exhibits some of the organizational features of confederations. In the early city leagues, no less than in the Swiss and Dutch unions, the American confederation and finally the League of Nations and the United Nations, there is always found a charter or agreement, embodying three features: (1) an assembly of representatives of the constituent members; (2) an executive organ of some sort; and (3) an arbitral or judicial body; arbitration is ordinarily supposed to eliminate the recourse to arms between members. The common objectives of these confederations were different, but there was always the objective of defense against dangers to which all the members were alike exposed.

Distribution of Legislative Functions.—Because of the variety of possible origins, every federal government is likely to be different from every other. The composition of federal representative assemblies as well as the distribution of their legislative functions shows this clearly. Many federal constitutions contain long catalogues of what the federal legislature may do; the United States constitution is relatively simple as compared with the German basic law. It goes without saying that such divisions of the "competencies"—that is, the sphere within which each may operate—must and will vary according to time and place. Economic and social life, military and geographical factors, all play their role in determining the particular arrangement. Jurists have made a great deal of the difference between a central government with powers specifically delegated to it, such as that of the United States, Switzerland and Germany, and one in which the powers are specifically delegated to the provinces, as is the case in Canada. What really matters is that there be some balance between the two, and that whatever distribution of functions might be delegated, it is the constitution that determines the governmental structure as a whole.

A comparison of the several federal constitutions shows that certain matters, such as foreign affairs, customs, money and currency, posts and national defense, are invariably attributed to the federal authorities. On the other hand, certain matters, such as education and cultural affairs, the police and local government, are usually left to the component units. But the focal point of modern life, namely, the economy in all its ramifications of technology, welfare and taxation, is handled with the widest variation, created by judicial interpretation of the constitution as well as by amendments broadening the scope of federal jurisdiction.

Amending Process.—Every federal system of government provides for participation of local units in the process of amending and altering the constitution. How do the local units—states, cantons, *Länder,* provinces, dominions or whatever—actually participate? Through their representatives in the federal representative assembly, or directly, or both? In the United States, as in Switzerland, the provisions for constitutional amendments developed organically. In both countries the component states' representatives in the federal representative assembly as well as the

component states themselves have to assent by qualified majorities. In the United States the state legislatures or special conventions ratify amendments proposed by congress; in Switzerland amendments proposed by the federal legislature (or by a popular initiative) are ratified by a majority of the cantons as well as by a majority of the Swiss people.

In Germany under the Weimar republic, no direct participation of the provinces (*Länder*) was required. This omission shows how weak was German federalism of the period between World Wars I and II. A feeble substitute for *Länder* participation was provided, but it was never actually invoked. Following this tradition, the amending power in the post-World War II Bonn constitution (*Grundgesetz*, or basic law) was lacking in federalistic character also, though the requirement of a two-thirds majority in the states' council (*Bundesrat*) proved of some consequence.

In some of the later federal systems, notably the proposed European Political Community, real participation of the component units was provided, coupled with provisions that distinguished between more and less important articles of the constitution.

Federal Executives.—The second feature of a confederation appertains to the executive sphere. The component units have a part either in selecting the federal executive, or in conducting the executive work for the whole, or in both. The federal structures in the United States, Switzerland, Germany and the dominions of the British Commonwealth all exhibit such arrangements. To be sure, the local units have only a small share in selecting the federal executive. Thus, in the United States, voting by the states in the electoral college is a partial recognition of the states; the president is not elected by a majority of the whole people but by a combination of state majorities.

Another form of state participation as such in the executive sphere is the constitutional right of the U.S. senate to advise on and consent to presidential appointments. "Senatorial courtesy" reinforces this power. Another recognition of the states' position is the civil service rule according to which each state is given a certain quota of appointments. In Switzerland, the president and the executive council are elected by the two houses of the legislature; hence the cantons have an important voice. The strength of local autonomy is further recognized in certain customs: Bern and Zürich are always represented on the council, and council seats are evenly distributed among the other cantons. This means primarily that the French- and Italian-speaking cantons get at least one or two members.

Constitutional Judiciary.—A judicial body for the settlement of disputes between central and local authorities is found in all federal systems. In the United States the supreme court is charged with this duty. Though on the whole favouring the federal government, it has not followed a one-sided course as between the central and local governments. The court was, indeed, nationally minded under Chief Justice John Marshall (1801–35), and several of his most famous decisions, such as *McCulloch* v. *Maryland* and *Gibbons* v. *Ogden*, asserted positions that favoured the central government. Later on, the court, in the course of the slavery controversy, shifted toward a states' rights position, which culminated in the ill-starred Dred Scott decision (1857). After the Civil War, the court returned to its earlier outlook. There was prevalent a feeling that the war had settled all questions in favour of the central government.

At mid-20th century the court seemed to be federally minded in matters of civil rights, but inclined toward a states' rights point of view in certain other respects. Whatever the merits of detailed issues under dispute, however, the notion of judicial settlement of such disputes between local and central authorities remained as a clear indication of the federal nature of the U.S. governmental structure.

This is likewise the case in Switzerland, and it is noteworthy that provisions about the administration of federal legislation by the cantons have not resulted in complications similar to those that arose in Germany under the Weimar republic. This may be explained by several facts: no single canton is large in relation to the federation as a whole; the cantons have been less sharply divided by partisan issues (neither Communism nor Fascism assuming serious proportions); and the central government has practised marked moderation in employing force, relying rather upon persuasion and other kinds of pressure. Under the 1949 basic law, the Germans, it appeared, would follow similar methods.

Commonwealth and Dominions.—Interesting special problems in federalism are presented by the Commonwealth of Nations and the dominions composing it. The commonwealth represents a very loose federal system, which in terms of the antiquated approach must be described as a kind of league. Yet common citizenship, the bonds of a common cultural tradition and language, as well as informal institutional arrangements of various sorts, including the commonwealth conferences, provide a working federal bond among the several members. For example, it is often overlooked in discussions of this matter that Canada still formally depends upon the British parliament for amendments of its constitution. Nor can the weight of what remains of the British Colonial empire, administered by the United Kingdom, be gainsaid.

Australia and Canada provide two outstanding examples of working federalism. Their institutional setup is interesting in terms of the relation of federalism to parliamentarism, for they effectively combine the cabinet system of parliamentary government, on both the federal and the local level, with a functioning federal system. Canadian federalism is reinforced by the powerful sense of local differentiation and autonomy in the French-speaking part of Canada; in both Canada and Australia the continental dimensions of their territory make a territorial distribution of power natural. Elsewhere in the commonwealth, the Federation of Nigeria and the short-lived (1958–62) West Indies federation presented other examples of experimentation with various federal forms of government.

After 1947 India evolved a diversified federal system of its own that provided the basis for solving the problem of how to organize an effective democratic government for its richly differentiated people. It is the most complex federal system ever devised. Some would deny it true federal character because of the broad powers granted to the central government. But the weight of local traditions—linguistic, religious, cultural—is so great that the provinces tend to gain rather than lose in strength. The system is still evolving and the end is not in sight, but it is possible to argue that without the techniques of federalism, Indian constitutional government could not have been achieved.

European Unification.—The same may be emphatically asserted regarding the unification of Europe. Actually, the federalizing of Europe is taking the form of functional integration. Instead of setting up a federal union by concerted constitutional action, European states negotiated a series of separate treaties in particular functional areas. They also created a very loose framework, the Council of Europe, centred at Strasbourg, France, in which, after 1949, the 16 member states consulted with each other about common problems. A representative assembly, composed of delegates of the several parliaments, urged common action, though it possessed purely consultative functions. Its major achievements, besides creating a certain camaraderie and habits of working together, were in the cultural sphere; it was specifically excluded from the consideration of military problems. In the general field of economic co-operation, the Organization for European Economic Cooperation (O.E.E.C.), inaugurated as the co-ordinating body of the European Recovery program, was operative; its most effective work was in overcoming currency problems through its subsidiary, the European Payments union (E.P.U.). Finally, in the military field, the Western European union (W.E.U.) sought to implement policies of the North Atlantic Treaty organization, but its activities were not of great consequence; it took the place of the unrealized European Defense Community (E.D.C.).

Besides these rather loose efforts toward federalizing all of Europe, much bolder efforts were undertaken by "Little Europe," the six states that were ready to form a much closer union than the rest, namely, France, Federal Republic of Germany, Italy and Benelux (Belgium, the Netherlands and Luxembourg). They formed in 1951 the European Coal and Steel Community (E.C.S.C.), which began operation in 1953 as an effective supranational

administration of two basic industries through the territory of the "Six." After the failure of the E.D.C. and its associated proposal for a European Political Community (E.P.C.), the Six formed a European Economic Community (E.E.C.) (1957) and a European Atomic Energy Community (Euratom). The first was to establish a common market, by elimination of all tariffs within the next 12 to 15 years and conjointly to develop common economic policies and a free movement of persons and capital. The second was to pool the resources of the Six for the development of nuclear energy. Europe's energy resources at mid-century were insufficient and growing more so; hence the development of nuclear energy appeared to many to be the means of economic survival. These two communities shared, as planned in early 1958, a representative assembly (not fully legislative, however) with the E.C.S.C.; it was also planned that they would have a common court. (*See* also PAN-EUROPEAN MOVEMENT.)

Association: A New Dimension of Federalism.—The European developments sketched above raise an issue that has also cropped up elsewhere. How can states that do not feel ready to share fully in a federal union participate on a more limited scale? The answer given in Europe is: association. In the European Economic Community treaty, for example, it was provided that other states or union states might become associated with the community. The specific proposal was that of establishing a "free trade area" of adjoining states.

The United States, confronted with the problem of how to give maximum autonomy to Puerto Rico, which desired to preserve its cultural identity while yet remaining part of the United States, granted to the people of Puerto Rico the status of an associated state; the Free and Associated Commonwealth of Puerto Rico represented a novel departure for U.S. federalism. When the Federal Republic of Germany was organized, West Berlin wished to participate but could not become a state because of the four-power control over all of Berlin. Consequently the free part of the city became "associated" with the federal republic; though not voting, its representatives participated fully in federal legislation, and the republic's laws applied to it. As with Puerto Rico, Berlin received substantial aid from the federal union with which it was associated.

Conclusion.—Federalism is intimately related to modern constitutionalism. There is nothing in the distinction between federalism and decentralization that would imply an inherent superiority of one over the other; their advantages and disadvantages can be contrasted only in terms of the peculiar conditions of the time and place under which a particular government is supposed to operate. A federal governmental structure provides a spatial or territorial, as distinguished from a functional, division of powers. Such a division operates as a rather effective restraint upon the abuse of governmental powers by the central authorities. Indeed, in many situations it is more likely to be effective than a functional division, for the latter can be more readily overcome by the extraconstitutional activities of a national party organization. In other words, what federalism does is to mobilize firmly entrenched local powers in support of the constitution and to offer them protection under the constitution as well. Localized groupings are treated in a manner analogous to the treatment of the individual citizen, to whom a sphere of relative independence, of civil liberties is likewise guaranteed.

Besides the constitutional considerations, there is a great advantage in providing an opportunity under a federal system for limited experimentation in one or more of the component units. This, however, may have perilous consequences. These dangers of federalism were illustrated in Germany. It is strange that the legend could grow up later that it was centralization that favoured Hitler, when, as a matter of fact, it was the relative autonomy of Bavaria that provided the seedbed for Hitlerism before and after the beer hall *Putsch* in Munich in 1923. It was likewise the autonomy of the *Länder* in the matter of citizenship that enabled Thuringia, after it had become National Socialist, to confer German citizenship upon Hitler, without which he could not legally have become either a candidate for the presidency or chancellor. By analogy, any markedly federalistic structure may provide a potential foothold and jumping board for an emergent totalitarianism, whether of the right or the left.

Federal structures of government share with all formalized constitutionalism the difficulty of adjusting a relatively rigid scheme to the shifting exigencies of a dynamic industrial society. Under modern conditions, areas of friction are bound to develop where technological change radically alters the conditions under which government has to be conducted. With competencies constitutionally divided between the central government and the local governments, as they are in the United States, governmental functions emerge that can be performed only by one of these units and for which no prior constitutional provision has been made. The rigidities that arise, however, from such a division of powers are inherent in the federal scheme and are the price that must be paid for the advantages of greater variety and local freedom.

See also references under "Federal Government" in the Index volume.

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FEDERALIST, THE. The Federalist papers are a series of essays on the proposed new constitution of the United States and on the nature of representative government written in 1787–88 by Alexander Hamilton, James Madison and John Jay for the purpose of persuading the voters of New York state to support ratification. The 85 papers first appeared serially in New York newspapers over the signature "Publius" and were later published in book form. The authorship of some of the papers is a matter of dispute among historians but it is clear that Hamilton wrote the majority of the papers. Taken together, they presented a masterful exposition of the new federal system and of the major departments in the central government. They also argued that the existing government under the Articles of Confederation (*q.v.*) was defective and that the proposed constitution would remedy its defects without endangering the liberties of the people.

As a general treatise on republican government, *The Federalist* is distinguished for its comprehensive analysis of the means by which the ideals of justice, the general welfare and the rights of individuals could be realized. The authors assumed that the primary political motive of man was self-interest and that men, whether acting individually or collectively, were selfish and only imperfectly rational. The establishment of republican government would not of itself provide protection against such characteristics. The representatives of the people might betray their trust; one part of the people might oppress another; both the representatives and the people themselves might give way to passion or caprice. The possibility of good government lay in man's capacity to devise political institutions which would compensate for deficiencies in both reason and virtue in the ordinary conduct of politics. This was the predominant theme in late 18th-century political thought in America and accounts in part for the elaborate system of checks and balances written into the constitution.

Of particular note is the tenth essay. In it Madison rejected the then common belief that republican government was possible only for small states. He argued that stability, liberty and justice were more likely to be achieved in a large area with a numerous and heterogeneous population. Though frequently interpreted as an attack on majority rule, the essay is in reality a defense of social, economic and cultural pluralism, and of a composite majority formed by compromise and conciliation. Decision by such a majority, rather than by a monistic one, would be more likely to accord with the proper ends of government. This distinction between a proper and an improper majority typifies the fundamental philosophy of *The Federalist:* republican institutions, including the principle of majority rule, were not good in themselves but because they constituted the best means for the pursuit of justice and the preservation of liberty.

See B. F. Wright (ed.), *The Federalist* (1961); J. E. Cooke (ed.), *The Federalist* (1961). (C. M. KE.)

FEDERALIST PARTY. The Federalist party organized the national government of the United States under the constitu-

tion of 1787. It may be regarded as, in various important respects, the lineal predecessor of the U.S. Whig and Republican parties. The name "Federalists" (*see* ANTIFEDERALISTS) was first given to those who championed the adoption of the constitution. Later it applied exclusively to a specific political group, less inclusive than the Federalists of 1787, which developed during the presidency of George Washington.

The palpable weaknesses of the confederation of 1781–89 and the very real threats to the survival of the American nation were the reasons for the rallying together of this group. They sought an "energetic" central government because they feared "the mutability of the laws of the states," as James Madison put it. The confederation had demonstrated its inability to protect property rights, provide a public revenue, uphold the fiscal integrity of government, maintain and expand commerce and come to an understanding with Britain. The economic depression of 1785–86 once more unleashed leveling tendencies—resumption of paper-money issues in the states, assaults on contracts and the Shays's Rebellion. In consequence, the conflict over the constitution—and the appearance of political parties in the United States—was the difference largely between two kinds of property interests and not, as Jefferson put it later, between two philosophical positions. The Federalists were not aristocrats and monarchists, the Antifederalists were not democrats. The Federalists saw political stability and economic growth in terms of sound fiscal policy, establishment and protection of banking and the expansion of commerce. The Antifederalists spoke for the agricultural interests which, frequently weighed down by debt, were cheap-money men and hostile to tax programs of imposts and excises. The mechanics and artisans of Massachusetts, identified with commerce, were Federalists. The large land (and slave) owners of Virginia and the Carolinas were Antifederalists. Most of the Federalists of 1787–88 became members of the later Federalist party.

The political group which became known as the Federalist party may be regarded as definitely organized practically from 1791; it was led, leaving President Washington aside, by Alexander Hamilton and John Adams. Hamilton's domestic and foreign policies gave the party its program and created the bitter hostility to it that made it so short-lived. He started out with the assumption that the constitution gave the central authority broad powers; he believed it necessary to use them to create a government with integrity and honour so that private accumulation could occur with safety, foreign credits and investment would be revived and diversification of economic enterprise take place. These required positive action by government, notably as regards debt management, money and credit, banking and stimulation of trade. In foreign relations, they required a settlement with Britain politically and commercially, and neutrality as war raged in Europe. Over the decade of the 1790s, the Federalists stood for the following: (1) the support and the achievement of the Hamilton program of the funding of the old Revolutionary War debt and the assumption of the state debts, the passage of excise laws, the creation of a central bank, the maintenance of a tariff system and favourable treatment of United States shipping; (2) neutrality in the war between France and Britain, breaking out in 1793; (3) approval of the Jay treaty of 1794, terminating the difficulties with Britain; and (4) the grant of crisis powers to the central government in 1798–99, when French demands almost forced open war. These measures achieved the survival of the republic, linking public and private credit, expanding commerce and foreign investment in the United States and assuring peace.

They provoked deep resentment and were bitterly fought; on these issues the first U.S. political parties were formed. The Republicans (Democratic-Republicans, later, the Democratic party), led by Thomas Jefferson and James Madison, were suspicious of central authority, friendly to the French Revolution and hostile to Britain. While the Federalists controlled the government until 1801, their incapacity or unwillingness to organize politically, their neglect of the arts of consultation, persuasion and discipline, and their failure to devise a program of broad national appeal (including agriculture, small property generally, and the little producers) doomed them. Hamilton in 1799 understood this. Should not, he wrote to one of his correspondents, a wider program be laid out, one that "will extend the influence and promote the popularity of government?" But then it was too late. The Federalists had been made synonymous with "favouritism, influence and monopoly." They never again held national office after Jefferson's victory in 1800. (*See* DEMOCRATIC PARTY [U.S.].)

Nevertheless the accomplishments of the Federalists were great. They organized the new federal government in all its branches, giving it an administrative machinery that in the main endured; they established the doctrine of neutrality toward European conflicts that stood the United States in such good stead while it continued a poor and defenseless country and was preoccupied with its own continental expansion; they laid the basis for the enduring friendship with Britain; and fixed the practice of a liberal construction of the constitution—not only by congress but above all by the United States supreme court, which, under the leadership of John Marshall (who had been appointed chief justice by Pres. John Adams), impressed enduringly on the national system large portions of the Federalist doctrine. These political accomplishments and the economic ones of fiscal integrity, credit worthiness and protection of the investing process and property are their impressive achievements and their claims to memory.

After 1801 the Federalist party never regained power. In attempts to do so, it impaired its morale by internal dissension, by intrigues and by inconsistent factious opposition to Democratic measures on grounds of ultrastrict construction. It took up, too, the Democratic weapon of states' rights, and in New England carried sectionalism dangerously near secession in 1808 and also in 1812–14 during the movement, in opposition to the War of 1812, which culminated in the Hartford convention. By 1817 it was practically dead as a national party. It is sometimes said that Federalism died because the Republicans took over its principles of nationality and accepted its economic ideas. This is true in part. But it fell principally because its great leaders, John Adams and Alexander Hamilton, became bitter enemies; because neither was even distantly comparable to Jefferson as a party organizer and leader; because the party could not hold the support of its original commercial, manufacturing and general business elements; because the party opposed sectionalism to a growing nationalism on the issues that ended in the War of 1812; and because, after 1801, it failed to adjust itself to the growing democratic spirit of the country. In New England, where it persisted longest, it represented a "cordial union between the clergy, the magistracy, the bench and bar and respectable society" (Henry Adams); this inevitably had to fail in a dynamic, expanding United States.

See also references under "Federalist Party" in the Index volume.

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(L. M. H.)

FEDERAL MARITIME BOARD: *see* MARITIME ADMINISTRATION, U.S.

FEDERAL RESERVE SYSTEM. The federal reserve system is the central banking authority of the United States. It acts as a fiscal agent for the U.S. government, is custodian of the reserve accounts of commercial banks, makes loans to commercial banks, and is authorized to issue federal reserve notes which constitute a large fraction of the hand-to-hand currency of the country. Thus it has many of the functions characteristic of the Bank of England and of continental European central banks (*see* CENTRAL BANK).

Origins of the System.—Before the establishment of the federal reserve system and after the liquidation of the second Bank of

the United States in 1836, there was no central banking institution in the United States. The provisions of the National Bank act of 1863, and the banking customs which emerged as a consequence thereof, produced a monetary and banking system which tended to concentrate the reserves of the commercial banks of the country in a small number of banks in a few financial centres, notably New York. The result was that unusual demands for currency or credit would periodically produce great financial stringency in the important financial centres with consequent deflationary results. The National Bank act did not provide a system for changing the quantity of currency so that it would be responsive to the changing needs of the business community or to the continued growth of the nation's economy. (*See* BANKING: *History of Banking: The United States.*)

In 1908, following the financial panic of 1907, congress established a national monetary commission headed by Sen. Nelson W. Aldrich to study the requirements of a sound monetary system and to make legislative recommendations. The proposals of the commission, supplemented by the studies of others, were influential in the discussions which led to the passage of the Federal Reserve act signed by Pres. Woodrow Wilson on Dec. 23, 1913.

The Structure of the System.—The federal reserve system consists of (1) the board of governors of the federal reserve system; (2) the 12 federal reserve banks; (3) the federal open market committee; (4) the federal advisory council; and (5) the member banks. The functions of each of these are discussed in the paragraphs that follow.

Board of Governors.—The board of governors of the federal reserve system (known until 1935 as the federal reserve board) consists of seven members appointed by the president of the United States and confirmed by the senate. They are appointed for 14 years, one seat becoming vacant every 2 years. The chairman of the board is appointed by the president from the membership of the board for a period of 4 years. The members of the board of governors, which has its headquarters in Washington, D.C., devote their full time to the business of the board; they must not be directors, officers, employees or stockholders of any bank and not more than one of them may be appointed from any one federal reserve district. The president, in appointing members of the board of governors, is required "to have due regard to a fair representation of the financial, agricultural, industrial and commercial interests, and geographical divisions of the country."

The board of governors of the federal reserve system is, in most respects, and in all important respects, the body which both supervises and controls the operation of the federal reserve system. The board determines the reserve requirements of the member banks within statutory limits, reviews and determines the discount rates established by the 12 federal reserve banks and reviews the budgets of the federal reserve banks. Its staff of examiners examines the operations of each of the federal reserve banks at least once a year and in a number of other ways exercises substantial control over the operations of the system. The degree to which such control has been centralized in the board of governors was significantly increased in the Banking acts of 1933 and 1935.

Federal Reserve Banks.—The country has been divided into 12 federal reserve districts in each of which there is a federal reserve bank. The districts are not necessarily coterminous with state boundaries. Federal reserve banks are located in (1) Boston, Mass.; (2) New York city; (3) Philadelphia, Pa.; (4) Cleveland, O.; (5) Richmond, Va.; (6) Atlanta, Ga.; (7) Chicago, Ill.; (8) St. Louis, Mo.; (9) Minneapolis, Minn.; (10) Kansas City, Mo.; (11) Dallas, Tex.; and (12) San Francisco, Calif. (The numbers are those of the corresponding federal reserve districts.) Nearly all of these banks have branches in other cities.

A federal reserve bank is a privately owned corporation established pursuant to the Federal Reserve act to serve the public interest. While it is privately owned (by the member banks) the stockholders do not have the powers ordinarily associated with the stockholders of privately controlled corporations. Each member bank is required to subscribe to the stock of the federal reserve bank of its district in an amount equal to 6% of the member bank's capital and surplus. Only half of this amount must be paid but the remainder is subject to call. The maximum dividend which a federal reserve bank may pay to its member-bank stockholders is 6% per annum.

Each federal reserve bank is governed by a board of directors of nine members. Three members known as class A directors and three known as class B directors are elected by the member banks of the district. The class A directors may be bankers; the class B directors must be actively engaged in the district in commerce, agriculture or industry and must not be officers, directors or employees of any bank. The three class C directors are appointed by the board of governors of the federal reserve system. They must not be officers, directors, employees or stockholders of any bank. One of the class C directors is designated as chairman of the board and one as deputy chairman. The chairman of the board is by statute a federal reserve agent. Thus a majority of the directors of a federal reserve bank are not active bankers and three, including the chairman and deputy chairman, are not elected by the stockholders but are appointed by the board of governors.

The board of directors of a federal reserve bank is responsible for the conduct of the bank's affairs subject to the supervision of the board of governors. This supervision does not deal with the details of administrative procedure but with broad policy matters. The board of governors must approve the appointment of the president and first vice-president of a federal reserve bank, and the salaries of all officers and employees of each federal reserve bank are subject to approval by the board of governors.

In addition to the control over the operations of the federal reserve banks by the board of governors there is a statutory limit on dividends payable to stockholders. The federal reserve banks also follow the practice of paying 90% of earnings after dividends to the treasury as an interest charge on outstanding notes. All of these factors result in the operation of the federal reserve banks in the public interest. Profit to the federal reserve banks is not a consideration in the formation of policy.

Federal Open Market Committee.—This 12-member committee consists of the 7 members of the board of governors serving ex officio and 5 members elected by the federal reserve banks. One of the 5 elected members is always chosen by the New York federal reserve district; the remaining 4 are chosen from federal reserve districts grouped for the purpose. The board of governors, if unanimous, always has a majority vote in the open market committee. The committee is responsible for the determination of federal reserve bank policy toward the purchase and sale of securities on the open market. This responsibility provides the system with one of its most powerful instruments of control over the money supply.

Federal Advisory Council.—The council consists of 12 members each of whom is elected by the board of directors of one of the federal reserve districts. It meets no less than four times a year. While its role is purely advisory, the board of governors being free to accept, reject or modify its advice, it may be influential in the formation of policy for the system.

Member Banks.—These consisted in the early 1960s of some 6,750 banks of which approximately 4,850 were national banks; the remainder were banks chartered by the several states. All national banks (*i.e.*, banks operating under charters issued by the federal government) are required to be members of the federal reserve system. Banks operating under state charters may become members of the system if they meet the qualifications for membership and if accepted by the federal reserve system. The member banks represented something less than half of the banks of the U.S.; however, they held about 75% of the total bank deposits and more than 85% of total demand (commercial) deposits. Thus the policies of the federal reserve system have a direct effect on a large segment of total demand deposits and indirectly influence the remainder.

Membership in the federal reserve system provides the member banks with certain advantages. The federal reserve banks are "banker's banks" and they perform a variety of services for the member banks in that capacity. Among the most important of these is the clearing of checks, a service rendered without cost to the member banks. The federal reserve banks also collect notes,

drafts and maturing securities for the member banks, crediting the proceeds to the member banks' reserve account. They make coin and paper money available to the member banks without handling or shipment costs. The federal reserve banks hold the reserve deposits of the member banks and stand ready to make loans to member banks when the latter find it necessary temporarily to augment their reserve accounts.

Membership in the federal reserve system imposes upon the member banks some duties and responsibilities which, it is believed, deter some state-chartered banks from joining the system. Member banks must comply with the reserve requirements established by the board of governors of the federal reserve system. The reserves must be held as deposits (without interest) with the federal reserve bank of the district in which the member bank is domiciled. These reserves in almost all cases are higher than the reserves required by state banking laws. Member banks must submit to regular examinations by the authorities of the federal reserve banks. They must honour all checks drawn upon them at par; *i.e.*, without levying any remittance charges. They must, moreover, hold assets of a quality somewhat higher than those permitted by the banking laws of many of the states.

Monetary and Credit Policies of the Federal Reserve System.—These policies, springing from the exercise of certain powers given to the system by statute, represent in terms of their influence upon the degree of economic stability, upon the level of economic activity and upon the price level, responsibilities which go far beyond the service functions described above. The federal reserve system through its power to alter the size, the availability and the cost of commercial bank reserves may influence greatly the magnitude of commercial bank deposits in the United States. Loans made by the commercial banks ordinarily emerge as increased deposits either in the bank making the loan or in another bank. Since member banks are required to hold a given proportion of their deposits as reserve accounts with the federal reserve banks, changes in the proportion which must be so held, changes in the cost of temporarily augmenting the reserves through loans from the federal reserve banks, or changes in the total size of the commercial bank reserves of the system will have effects upon the volume of new loans and deposits (*see* BANKING: *Principles of Banking*).

The federal reserve system exercises its regulatory powers in several ways, the most important of which may be described as the instruments of indirect control. These instruments have to do with (1) the determination of the legal reserve ratio; *i.e.*, the proportion of its deposits which a member bank must hold in its reserve account; (2) the control of the discount rate, sometimes referred to as the rediscount rate; and (3) the control of open-market operations; *i.e.*, the purchase or sale of securities in the open market by the federal reserve banks. Following a discussion of the bases of monetary and credit policy, the use of each of these will be described below.

The purpose of federal reserve policy is to facilitate the creation of a financial climate conducive to economic stability and to a high level of economic activity. The prevention of rapid rises or falls in the general price level is an essential part of the task. Thus in a period of substantial inflationary pressure, particularly when this occurs in a period of full or nearly full employment, the federal reserve system may use its powers to restrict the growth of the supply of money, or actually reduce it. On the other hand, when signs of a recession appear the system may take steps to increase the supply of money. It must be remembered that the term money as used here refers principally to bank deposits, the most important means of payment (*see* QUANTITY THEORY OF MONEY).

Actions leading to either of these two results may be taken through the exercise of any one or more of the instruments of indirect control mentioned above. Possible actions when inflationary pressures are strong include the following:

(1) The federal reserve system may raise the legal reserve ratio. This action would increase the proportion of deposits which commercial banks are required to hold on deposit with the federal reserve banks and thus reduce the amount of new loans they could make. Since loans give rise to deposits, the potential money supply would be reduced.

(2) Federal reserve bank sales of securities in the open market at the discretion of the federal open market committee tend to reduce the actual size of commercial bank reserves. When the federal reserve sells securities the purchasers of the securities pay for them with checks on their deposits. This reduces deposits and since the amounts of the checks will be charged to the reserve accounts of the banks on which they are drawn, bank reserves are reduced. If, of course, the member banks should themselves purchase the securities, they will pay for them, in effect, by drafts upon their own reserve accounts. In any case, then, open-market sales of securities by the federal reserve banks have the effect of reducing bank reserves. Thus member banks will find themselves increasingly pressed to accommodate their loan customers and the actual or potential volume of deposits will be reduced.

(3) In the circumstances likely to follow upon open-market sales, the member banks might be required to seek loans from the federal reserve banks of their respective districts. If, then, the federal reserve banks increased the interest rate—the discount rate at which such loans are available—member banks would find it increasingly costly to augment their reserves in this way. They would, therefore, tend to be more restrictive and more selective in making loans.

Increasing the reserve ratio, selling securities in the open market and increasing the discount rate—all these steps would restrict the rate of credit expansion and thus reduce the actual or potential money supply. Clearly, opposite policies would be called for in a period of recession or in a period of deep depression. In such circumstances, the federal reserve system might be expected to reduce the legal reserve ratio, to reduce the discount rate and to undertake open-market purchases of securities. These steps taken separately or in combination could be expected to increase excess reserves, reduce the cost of temporary augmentation of reserves and produce an increase in the actual size of member bank reserves. Thus banks would be encouraged to increase their loans to customers, the potential money supply would be larger than otherwise would be the case and, if the demand for loans on the part of the business community was strong, loans and deposits would rise.

The instruments of indirect control described above generally have been conceded to be more effective in preventing inflation in times of high economic activity than they are in bringing about revival from a period of depression.

In connection with attempts to prevent inflation under conditions of full employment, the federal reserve system has, upon occasion, supplemented the indirect controls described above with a series of selective controls. One of these relates to the control of the margin requirements involved in the purchase of securities. The board of governors of the federal reserve system has had, since 1934, the power to limit the amount which lenders may make available on securities. Variable percentage requirements have been in effect since the inception of the program, ranging from 40% for several years prior to World War II to 100% in 1946 and 1947.

By executive order of the president of the United States in 1941, the federal reserve system was authorized to control the terms upon which credit could be extended to consumers for the purchase of important consumer durable goods. The regulation was terminated in 1947, reinstated briefly in 1948, terminated in the summer of 1949 and reinstated again after the outbreak of the Korean War. The authority to impose such regulations was finally repealed in the Defense Production act as amended in 1952. The consumer credit regulations sought to reduce the expansion of credit by controlling the minimum down payment required for the purchase of consumer durable goods and by controlling the maximum length of the amortization period of the loan and thus controlling the size of monthly payments. Similar regulations relating to the financing of real estate purchases were in effect from late 1950 until Sept. 1952.

Relation of the Federal Reserve System to Government.—The federal reserve system is an agency of government theoretically independent of the executive branch. The appointment of the members of the board of governors for terms of 14 years so arranged that one vacancy normally will occur every 2 years is designed, in part, to provide a substantial degree of independence.

The board of governors is, of course, responsible to the congress of the United States.

Many students of banking and financial affairs hold the view that the federal reserve system should occupy such an independent position as an agency of government on the ground that the exercise of power over the banking system and over the supply of money should not be subject to political influence.

In general and with one notable peacetime exception, the independent conduct of the system's affairs has not been modified. During World War I, when the system was in its infancy, and again during World War II the system did, of course, accommodate itself to the full in providing means to facilitate the financing of the huge wartime expenditures. During these periods, large budgetary deficits had to be financed and the federal reserve system followed credit policies designed to ease the process.

In the period immediately subsequent to World War II, the policy of the treasury designed to insure continued low interest rates on the public debt involved the federal reserve system in practices which made the exercise of its normal powers to control the size and rate of expansion of the money supply difficult or impossible. This situation became clarified by the "accord" of March 1951 in which, it was announced, the treasury and the federal reserve system had reached agreement "with respect to debt management and monetary policies to be pursued. . . ." Thereafter, the federal reserve system again undertook with increasing independence of action to influence the flow of money and credit in the interest of controlling inflation and maintaining economic stability. *See* also references under "Federal Reserve System" in the Index volume.

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FEDERAL THEATRE PROJECT. Established on Aug. 27, 1935, at a time when many theatre artists were unemployed, the Federal Theatre project was organized by the U.S. government under the Works Progress administration. Federal Theatre groups were set up wherever the relief rolls showed enough theatre people to operate a company; nine out of ten members had to come from relief rolls, and $9.00 out of $10.00 had to be spent for security wages. The object of Federal Theatre was twofold: to give employment to needy professionals in socially useful projects which would rehabilitate them and develop their skills; and to bring to thousands of people, hitherto unable to afford theatregoing, a theatrical program national in scope, regional and state in operation, and worthy of government support.

Employment of so many people (12,700 in 1936; 7,900 in 1939) required a broad program, including productions of the classics, children's theatre, religious plays, musical comedy, marionettes, circus, vaudeville, dance and radio. Special emphasis was given to regional festivals such as *The Lost Colony*, outdoor drama, Manteo, N.C., and to productions in San Francisco, where Federal Theatre built its own theatre out of admission funds. Federal Theatre also gave impetus to new plays such as *It Can't Happen Here*, by Sinclair Lewis, which opened simultaneously in 21 cities. The most effective new theatre form developed by Federal Theatre was the "Living Newspaper," characterized by vivid exposition of factual material in a flashing, often witty, series of blackouts. Such dramatizations as *Power* and *One Third of a Nation* played to crowded houses throughout the country.

A service bureau acted as a clearinghouse, where plays were written, translated and tested in production and where contracts were signed, royalties paid and research was carried on. The service bureau published *Federal Theatre Magazine*, a graphic story of nationwide theatre, and *Continental Theatre*, at that time the only magazine in the country giving monthly translations of news from European theatres.

Federal Theatre productions were seen by about 25,000,000 people, an estimated 65% of whom had never previously seen a play. Companies also toured various public and private institutions. By Oct. 1938 Federal Theatre was receiving widespread critical acclaim; 2,600 of its members had been returned to private employment; and although over half of Federal Theatre companies were giving free shows, box office admissions had reached the $2,000,000 mark. Support from schools, churches and many business, professional and community organizations was increasingly enthusiastic. Federal Theatre, however, was also sharply criticized, especially for its "Living Newspaper" series. From mid-1938, allegations that the project was communistic were made and the house of representatives subcommittee on appropriations voted to eliminate Federal Theatre. In spite of wide support from spokesmen in New York and Hollywood, all theatre unions and leading critics, Federal Theatre was ended on June 30, 1939.

See Hallie Flanagan, *Arena: An Adventure in the American Theatre* (1941). (H. F. D.)

FEDERAL TRADE COMMISSION, a U.S. government agency created in 1914 to prevent unfair methods of competition in interstate commerce. The law did not define the term "unfair methods of competition," but left the door open for interpretation. Congress gave the Federal Trade commission (FTC) two distinct powers. The first was couched in language similar to that previously given to the bureau of corporations, which had been organized under the department of labour and commerce in 1903. In fact, the bureau was transferred to and became a part of the FTC. Under this power, the commission could investigate corporations and other business concerns and report its findings to congress, the president or the public at large.

The second great power entrusted to the FTC came into play when in the interest of the public welfare the commission deemed it necessary to issue a complaint against any offending business unit that was practising an unfair method of competition. It required the offender to reply, and testimony was taken under oath relative to the issue involved. The statute required the commission either to dismiss the complaint in the event that the testimony was insufficient to establish an unfair method of competition in interstate commerce or, if a case was made out, to issue an order to cease and desist from the offending method. Many of the complaints issued have been based upon charges made by one competitor against another.

The policy of the commission in its earliest days was not to name the offender publicly but to make findings and issue an order to cease and desist. Since this did not seem to halt the practices complained of, the commission later named the offenders publicly when a complaint was issued.

The FTC is composed of five members appointed for seven-year terms by the president of the United States, by and with the advice and consent of the senate. The commission is bipartisan, as not more than three members may belong to the same political party. One commissioner is named by the president to be chairman of the commission and to be responsible for its administration.

Simultaneously with the passage of the Federal Trade Commission act, congress passed the Clayton Antitrust act, approved Oct. 15, 1914. Under it congress entrusted the commission with the prevention of unlawful price discriminations, tying contracts, stock acquisitions in competing corporations and interlocking directorates. The purpose of these provisions was to prevent certain practices which were regarded as lessening competition or tending to monopoly, but which it was feared would not always in themselves be sufficient to bring the person who practised them within the scope of the Sherman Antitrust act of 1890. (*See* MONOPOLY: *Legal Aspects.*)

Trade Practice Conference.—The commission was not long in finding that when one competitor in an industry violated legal rules of practice it was soon followed by many others. This frequently resulted in a deluge of complaints which would have absorbed more time than the legal section could spare. Thus a procedure called the Trade Practice submittal was inaugurated. The name was later changed to that of Trade Practice conference. In these conferences members of the industry concerned were assembled to consider and adopt fair trade practice rules to be submitted to the commission for its approval, the conferences being held under the auspices of the commission. After being subjected to public hearing and full consideration, the approved rules were promulgated by the commission. The early beginnings of the conference method go back as far as 1919. The commission thereafter held many industry

trade conferences and set rules for the different trade or industrial groups. These cover industries whose capital investment and annual volume of sales total several billions of dollars.

An outstanding advantage of this method of regulating business practices is that it effectuates the wholesale abandonment and prevention of unfair methods of competition and trade abuses voluntarily, co-operatively and simultaneously. Correction is thus brought about on a friendly basis and at substantial saving of time and expense to the government and to business, and, at the same time, the public and industry generally are shielded from harmful effects of bad practices.

This procedure affords industry a means of proper self-regulation and co-operative effort with the assistance and supervision of the government. Under the rules, industry and trade receive official guidance and assurance as to the inhibitions of the law. The rules constitute a convenient and authoritative code whereby manufacturers, distributors and buyers may readily be informed as to what the legal requirements are as they apply to the particular industry or trade. Law observance is promoted.

The rules operate as an effective deterrent to violations which result from ignorance, carelessness or even indifference, beside assisting in making compulsory correction more efficient. Consumer rights are carefully protected, and members of the industry who desire to serve the public conscientiously and with increased satisfaction are aided. The trade practice conference procedure thus came to be widely recognized as an official activity productive of great public good.

In order to speed up action with respect to complaints filed and to offer the respondent the privilege of disposing of his case without the cost of a trial, the commission devised a procedure before issuance of a complaint and trial of permitting the respondent to sign a statement of fact and agreement to discontinue the alleged unfair method of competition or practice, the subject matter and form of the stipulation being prepared under supervision of the commission in accordance with the facts as disclosed by its investigation.

Robinson-Patman Act.—Administration of the Clayton act had for some time demonstrated its inadequacy as a restraint upon the growth of monopoly. The result was an amendment by the Robinson-Patman act on June 19, 1936. This act was designed to eliminate certain unfair and discriminatory practices not prohibited by the Clayton act and believed by congress to be injurious to commerce. The purpose of the Robinson-Patman act, broadly speaking, was to promote equality of opportunity in business and check a tendency toward monopoly disclosed as a result of the Federal Trade commission's chain-store investigation, the investigation by a special committee of the house of representatives of the lobbying activities of certain groups, and congressional committee hearings held during consideration of the act itself. The act was not directed at any particular type or size of business organization but was applied to all merchants, large and small alike. It prohibited discriminations in price to purchasers of commodities of like grade and quality where the effect of such discriminations was substantially to lessen competition, in any line of commerce, unless such discriminations were justified by savings attributable to economies of operation effected by the particular method in which commodities were manufactured for, or were sold or delivered to, the purchaser receiving the discrimination. This passing on of savings by sellers to buyers was made permissive, however, not mandatory.

Wheeler-Lea Act.—The Federal Trade Commission act was broadly amended March 21, 1938, by what is known as the Wheeler-Lea act. There were several reasons which induced congress to make these amendments. In a case before the supreme court of the United States in 1931, involving what was considered by the commission to be a dangerously misleading and false advertisement, the court held that the commission had no authority to ban the false advertising because it did not appear that the unfair practices were "methods of competition in commerce."

Congress accordingly amended the act so as to make unfair or deceptive acts or practices in commerce unlawful as well as unfair methods of competition, thus granting the purchasing or consuming public the same protection against unfair practices that a merchant or manufacturer already enjoyed against the unfair methods of a dishonest competitor. Congress also provided definite and substantial civil penalties, through suits to be brought by the attorney general, for violation of the commission's order to cease and desist after they became final. The review by the courts of the commission's orders to cease and desist, through the filing of petitions to review or set aside the same, was amended so as to require thereafter the petition to be filed within 60 days. Otherwise, the commission's order became final, and its violation thereafter subjected the offender to suits for civil penalties.

Prior to the passage of later amendments, there was no penalty for violation of the commission's orders, unless they were violated after they had been affirmed by a circuit court of appeals of the United States. Proof of such violation, after the order had been affirmed by the circuit court of appeals, formed the basis for contempt proceedings. Such proceedings might be brought in cases where, on review sought by the respondent, the courts affirmed the commission's orders, if such orders were thereafter violated. The hearing examiners became an initial trial court on June 1, 1950. Appeals from that court might be made to the commission by respondents and commission attorneys, or the commission might schedule the issue for review on its own motion.

In response to the demand for greater consumer protection in the case of the deceptive advertising of commodities whose use might affect the public health, congress specifically prohibited the dissemination of the false advertisements of food, drugs, cosmetics and therapeutic devices. Where the use of such commodities might be injurious to health, or where they are falsely advertised with fraudulent intent, criminal penalties are imposed. In a further effort to grant adequate protection to the public during the period pending the issuance of and final action upon the commission's complaint, the commission was authorized to bring suit in the several U.S. district courts, or in territorial courts, to enjoin the dissemination of the false advertisements of food, drugs, devices or cosmetics. Such temporary injunction was to remain in effect until the order of the commission to cease and desist became final, unless the complaint was dismissed by the commission or the order to cease and desist was set aside by the court on review.

Advertising over the radio became so extensive that the commission, in 1938, established a Radio and Periodical division. This division took over the duties theretofore handled by the commission's Special Board of Investigation and, at the same time, its supervision was extended to cover mail-order catalogues and foreign-language newspapers. Thousands of pages of magazine and newspaper copy and thousands of radio and television continuities are scanned yearly, and the commission keeps in close touch with broadcasters and their clients. It was found necessary for the commission in the field of medicinal advertisements to add medical experts to its staff as consultants.

In addition to the duties and activities outlined above, the commission carried important responsibilities under the following acts of congress: (1) the Webb-Pomerene Export Trade act of 1918; (2) the Wool Products Labeling act of 1939; (3) Public Law 15 of 1945 relating to the regulation of the business of insurance; (4) the Lanham Trade Mark act of 1946; (5) the Anti-merger act of 1950; (6) the Fur Products Labeling act of 1951; (7) the Flammable Fabrics act of 1953; and (8) the Textile Fiber Products Identification act of 1958. Through its orders to cease and desist and through other means such as formal litigation leading to mandatory orders and voluntary co-operation the FTC protected businessmen from unfair competition and the consuming public from false, deceptive or dangerous trade and advertising practices.

See also INTERSTATE COMMERCE.

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FEDERATION OF BRITISH INDUSTRIES, the largest national voluntary organization representing productive industry in the United Kingdom. It was founded in 1916 and incorporated

by royal charter in 1923. Through it industrial policy is shaped and expressed both nationally and internationally, and industry can develop activities to help itself. It has no connection with any political party. All the leading trade associations representing British industries are members, together with several thousand individual firms.

See TRADE ORGANIZATION: *United Kingdom.*

FEDERER, HEINRICH (1866–1928), Swiss novelist who imparted new vigour to Christian fiction after its long stagnation before 1900, was born at Brienz, Oct. 6 or 7, 1866. He grew up in the Catholic tradition among peasants and mountains round the Lake of Sarnen. These remained, with local variations, predominant themes in his books. His unconventional, warmhearted Catholicism was derived from his greatest teacher, St. Francis of Assisi, whose country he often visited. Federer started to write when asthma, from which he suffered all his life, put an end to his work as a priest in 1899. He then worked as a journalist in Zürich and after 1907 as an independent writer. His wide reading kept his delightful, realistic art free from the narrow outlook of *Heimatkunst* (a group of Swiss local colourists). His writings include *Der heilige Franz von Assisi* (1908), *Lachweiler Geschichten* (1911), *Berge und Menschen* (1911), *Sisto e Sesto* (1913), *Umbrische Reisegeschichtlein* (1921), *Papst und Kaiser im Dorfe* (1925) and *Am Fenster* (autobiographical, 1927). His complete works were published in 12 volumes (1931–38). Federer died at Zürich, April 29, 1928.

See O. Floeck, *H. Federer, Leben und Werk* with bibliography (1938). (A. Bx.)

FEDIN, KONSTANTIN ALEKSANDROVICH (1892–), Soviet novelist who attempted to chronicle the evolution of the Russian intellectual in Soviet conditions, was born in Saratov on Nov. 24, 1892. After publishing some short stories he brought out the novel *Goroda i gody* ("Cities and Years," 1924), based partly on his experiences as an internee in Germany during World War I. In the 1920s Fedin belonged to the literary movement called the Serapion Brothers, consisting of fellow travelers. Thereafter, like several other members of this group, he gradually took up a position more consistent with official Soviet literary policies, and in 1959 he was appointed first secretary of the Union of Soviet Writers. Other novels include *Bratya* ("The Brothers," 1928); *Pokhishcheniye Yevropy* ("The Rape of Europe," 2 vol., 1934–35); *Pervye radosti* (1946; Eng. trans. *First Joys,* 1950); and *Neobyknovennoye leto* (1948; Eng. trans. *An Unusual Summer,* 1950). (R. F. Hl.)

FEDOR I (1557–1598), tsar of Russia from 1584, the third son of Ivan IV ("the Terrible") and his first wife Anastasia Romanovna, was born on May 31, 1557. He nominally succeeded his father on March 19, 1584, but, being of weak intellect, was governed throughout his reign by the boyar Boris Godunov (*q.v.*), whose sister Irene (Irina Fedorovna) he had married in 1580. On his deathbed he is said to have left the throne to his consort, with the patriarch Job (Yov), Boris Godunov and Fedor Romanov (afterward the patriarch Philaret) as her chief counselors. Irene, however, retired into a monastery and Boris himself became tsar. With Fedor's death on Jan. 7, 1598, the Muscovite dynasty of princes of the house of Rurik came to an end. During Fedor's reign there was war with Sweden and in 1595 the territories which Ivan IV had lost to Sweden were regained. In 1589 the metropolitan see of Russia was elevated to a patriarchate. Russian control over western Siberia became more firmly established. New towns were founded on the Volga, in the region of the Ural mountains and on the Terek river north of the Caucasus. Laws were passed to strengthen the control of the landowners over their peasants. (N. An.)

FEDOR II (1589–1605), tsar of Russia in 1605, was the son of the tsar Boris Godunov and of Maria Grigorievna, one of the daughters of G. L. Malyuta-Skuratov, the infamous favourite of Ivan the Terrible. Passionately beloved by his father, he received the best available education and from childhood was initiated into all the minutiae of government, besides sitting regularly in the council and receiving the foreign envoys. On the sudden death of Boris he was proclaimed tsar on April 23 (new style; 13, old style), 1605. His mother attempted to take power into her own hands, which infuriated the boyars. They roused the Moscow mob, by whom, on June 20 (N.S.; 10, O.S.), mother and son were murdered. (N. An.)

FEDOR III (1661–1682), tsar of Russia from 1676, was born on June 9 (new style; May 30, old style), 1661, a son of the tsar Alexis I and his first wife Maria Ilinishna Miloslavskaya. He learned Polish and some Latin from his tutor, Simeon of Polotsk (*see* below). As the eldest surviving son, he succeeded his father as tsar, being crowned on June 28 (N.S.; 18, O.S.), 1676. A sickly boy, he was dominated successively by his uncle, the boyar Ivan B. Miloslavski; by two courtiers, I. M. Yazykov and A. T. Likhachev; and, from 1681, by V. V. Golitsyn (*q.v.*). The most important event of his reign was the final and formal abolition of *mestnichestvo,* or precedence according to birth as opposed to merit (*see* BOYAR), in the official hierarchy.

Simeon of Polotsk, who had been educated at the Orthodox academy in Kiev and also at a Jesuit college in Poland, was probably the author of the memorandum, drafted about 1680, proposing the establishment of a similar school in Moscow. Another admirer of Polish ways in the Kremlin was Fedor's first wife, Agafya Semenovna, née Gruszecka, herself half-Polish, who died in 1680 after one year of marriage. Remarried in 1682 to Marfa Matveevna Apraksina, Fedor died childless on May 7 (N.S.; April 27, O.S.) of the same year.

See E. E. Zamyslovski, *Tsarstvovanie Fedora Alekseevicha* (1871); L. Loewensohn, "1681–1683. Geschriebene Zeitungen aus Russland," *Zeitschrift für osteuropäische Geschichte,* vol. vi (1932). (L. R. Lr.)

FEE, in law, refers to an interest in land, either a fee simple or a fee tail (*see* ENTAIL), which lasts forever, *i.e.,* descends to the owner's heirs or to certain classes of heirs as long as any exist, in contrast to lesser interests such as a life estate or an estate for a term of years. Historically, fee signified an estate in land granted by a superior lord to a tenant on condition that the latter render certain services, such as military or ceremonial service. *See* REAL PROPERTY AND CONVEYANCING, LAWS OF; FEUDALISM: *Feodo-Vasalitic Institutions.* (A. Dm.)

FEEBLE-MINDED: *see* MENTAL DEFICIENCY; RETARDED CHILDREN.

FEEDBACK is the return to a system of some of its output. Originally used to describe the return of output current to improve the performance of such electrical systems as amplifiers (*see* RADIO RECEIVER: *History*), the feedback idea also has found use in such diverse areas as the psychology of learning, propaganda, and control in surgical anesthesia. Basic to cybernetics (*q.v.*), which deals with control and communication processes, feedback permits self-regulation in living beings and machines; for example, keeping missiles on course as instantaneous trajectory data are fed back within the missile.

See AUTOMATION; SERVOMECHANISM: *Automatic Feedback Control.*

FEEDS, ANIMAL. The materials on which animals are fed differ widely in chemical composition and nutritive value. For convenience they are divided into two general classes: concentrates and roughages. Concentrates include a large variety of feeds that have a high value because they are rich in easily digested nutrients, such as starch, fat and protein, and are low in fibre, or woody material, which is not well digested. Roughages have a much lower value because they are relatively high in fibre and contain less of the more digestible nutrients.

Good nutrition is necessary if animals are to be able to maintain health and produce satisfactory amounts of milk, eggs, meat, wool or work. Animals require each day food furnishing sufficient amounts of protein; energy, chiefly supplied by the carbohydrates and fat; essential minerals; and vitamins. Plenty of water and air are also needed.

This article deals with the nutritional value, supply and utilization of (1) proteins; (2) carbohydrates and fat; (3) minerals; (4) vitamins; (5) composition and valuation of animal feeds; (6) important concentrate feeds; and (7) important roughages. In addition to related articles referred to in this article, *see* also for production, marketing and other information on specific feeds

the articles on such individual crops and products, as ALFALFA; CORN; COTTONSEED; SOYBEAN, etc.

Material on storage and processing and on feeders will be found in the articles CROP-PROCESSING MACHINERY; FARM MACHINERY; FARM BUILDINGS. For feeds and feeding practices for specific animals *see* articles such as CATTLE; PIG; SHEEP, etc.

Protein.—A certain minimum amount of protein is needed for the daily repair of muscles, internal organs and other tissues of the body. In addition to this maintenance need, animals that are growing require much larger amounts of protein for the growth of the muscles and other parts of the body. Since milk, eggs and wool contain much protein, additional amounts of protein are needed for their production. Physical work, even hard work, does not perceptibly increase the protein requirement, because carbohydrates and fat can furnish the needed energy.

Proteins are complex substances, made up of a variety of amino acids. In the digestion of food the proteins are largely broken down into these amino acids, which are absorbed into the blood to nourish all parts of the body. For animals with simple stomachs, including humans, monkeys, swine, poultry, dogs, cats, hamsters, rabbits, guinea pigs, mink and rats, the kind or quality of the protein in the ration is more important than the amount. These animals require daily the correct amounts of the following ten essential amino acids: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. In addition to these, poultry need glycine and glutamic acid for growth. High-quality protein contains the correct amounts of the essential amino acids. Such protein is supplied by eggs, milk and milk products, fish meal and meat by-products, and by soybean oil meal. Poor-quality protein, such as found in corn grain (maize), contains too little of one or more essential amino acids to meet the needs of animals. Those feeds having poor-quality proteins are made useful by combining with them other feeds which supply the lacking amino acids.

Fortunately, the quality of the protein in the food is of little importance for ruminants, including cattle, sheep, goats and the other animals that have four stomachs with a large paunch or rumen. This is because the bacteria that are important in the digestion of food in the paunch are able to make complete proteins, containing all the essential amino acids, from simpler nitrogen-containing compounds. They use the simple nitrogen compounds to build proteins in their cells. Then further on in the digestive tract the animals digest the bacteria and thus secure by this indirect means protein of high quality from a food that might originally have had poor protein. By this method cattle and sheep are able to use urea, a nitrogen compound synthesized from the air, in place of protein, which is sometimes scarce and expensive. Only the ruminant animals can use urea instead of protein. Very young ruminants, such as calves, lambs and kids, however, need plenty of good-quality protein until the paunch develops sufficiently for this bacterial process to become well established. (*See* also PROTEINS.)

Carbohydrates and Fat.—Since the body temperature of warm-blooded animals is considerably above the usual temperature of the air, food nutrients must be oxidized, or burned, in the body to supply the necessary heat. In addition, even animals at rest must have a certain amount of energy-producing nutrients to enable them to carry on their normal vital functions. Growing animals need more energy than mature ones that are being merely maintained, because of the storage of energy-rich nutrients (protein and fat) in the growing tissues. For rapid fattening, for milk production and for work, additional amounts of energy must likewise be supplied.

The need for heat and energy can be met by carbohydrates such as starch or sugar, or by fat. If the food of an animal furnishes more protein than is required for the special protein functions, the excess protein can be oxidized in the body to supply heat or energy.

Some of the carbohydrates in feeds, especially starch and sugars, are easily digested by animals and therefore have a high nutritive value. On the other hand, the complex carbohydrates that form the fibre of plants are digested less completely. Also, there is a large loss of energy in the process, this energy being converted into heat in the body. It thus can help keep the body warm, but has no value for productive purposes. Therefore, fibre has a low value in comparison with starch or sugar. Although humans and such animals as swine, poultry, dogs, cats and other animals with simple stomachs can digest but little of the fibre in feeds, cattle, sheep and goats are able to make much better use of it. This is because fibre is digested through the bacterial action that occurs in the paunch, or rumen of these animals. Horses and rabbits are also able to use fibre fairly well, as similar bacterial digestion takes place in the blind gut, or caecum, a greatly enlarged part of the large intestine. These classes of farm animals can, therefore, be fed to a considerable extent, and in some cases entirely, on hay and other roughages which are high in fibre.

Fat in feeds has a high value because it is highly digestible and because it supplies about two and one-quarter times as much energy as does starch or sugar. While fat has this high nutritive value, it can be replaced by an equivalent amount of digestible carbohydrates in the food, except for small amounts of essential fatty acids. It was found in experiments with laboratory animals, and pigs and calves, that very small amounts of certain fatty acids, especially linoleic and linolenic, contained in some fats, are necessary for growth and health. However, usual feeds supply ample amounts of these acids unless they have been removed by processing. (*See* also CARBOHYDRATES; OILS, FATS AND WAXES.)

Minerals.—Certain mineral nutrients are fully as essential for animal life as are protein, carbohydrates and fat. Among these are common salt (sodium chloride), calcium, phosphorus, sulfur, potassium, magnesium, manganese, iron, copper, cobalt, iodine, zinc, molybdenum and selenium. The latter six of these elements are poisonous to animals if excessive amounts are eaten.

All farm animals generally need common salt in addition to that supplied by their feeds, and they should be supplied with it regularly. Of the other essential minerals, phosphorus and calcium are most apt to be lacking, because they are heavily drawn upon to produce bones and also milk. Good phosphorus supplements are steamed bone meal, dicalcium phosphate, or defluorinated phosphates (especially processed to remove most of the mineral element fluorine, which may injure animals). Calcium may readily be supplied by ground limestone, ground shells or marl that is high in calcium.

Small amounts of iodine are needed by the body for the formation of thyroxine, an iodine-containing compound secreted by the thyroid gland. This controls the rate of metabolism or body processes. A serious deficiency of iodine may cause goitre, a disease in which the thyroid gland enlarges greatly in a vain effort to produce thyroxine. In certain regions there have been heavy losses of newborn pigs, lambs, kids, calves and foals from goitre. The young so affected are born dead or weak, and the pigs are usually nearly hairless. Experiments have proved that this trouble can be prevented by supplying small amounts of iodine to the mother animals before the young are born. The simplest method has been to use iodized salt during this period instead of ordinary salt.

In a few districts the soil and forage are deficient in copper and cobalt, which are needed along with iron for the formation of hemoglobin, or red colouring matter of the red blood cells. In these districts farm animals may suffer seriously from anemia, or a lack of red blood cells, unless the deficiency is corrected by means of a suitable mineral supplement. Trace amounts of molybdenum also are needed for certain enzymes in animal tissues. However, excess amounts of molybdenum are found in the soil and legume forages in limited areas of England, the Netherlands, Australia, New Zealand and the U.S. Forages in these areas may cause severe diarrhea and loss of pigmentation in the hair coats of cattle. These symptoms can be prevented or corrected by feeding copper salts. Iron, which is used in hemoglobin formation, is amply supplied in all animal feeds, except milk. The only practical problem with iron deficiency occurs in young suckling pigs before they start to consume other feeds in addition to milk.

Though manganese is essential for animals, sufficient is supplied by the usual rations for all farm animals except poultry. A lack of manganese may cause the nutritional disease of chicks and young turkeys called slipped tendon, or perosis, and also may cause a failure of eggs to hatch. Sufficient manganese is readily furnished in poultry rations by adding one-quarter pound of manganese sulfate to each ton of feed. So far as is known, the other minerals that are essential for farm animals are provided in ample amounts in their ordinary rations.

A number of practical rations for swine have been shown to result in zinc deficiency, especially in the presence of an excess of calcium. Adding 100 parts per million of zinc carbonate will overcome the symptoms otherwise observed, which include retarded growth rate and severe scaliness and cracking of the skin, called parakeratosis. A trace of selenium is necessary for normal health of animals, but the excessive amounts found in forages in some regions prove poisonous to animals and may cause death loss.

To furnish both calcium and phosphorus, livestock may be allowed free access to such a mixture as 60 lb. dicalcium phosphate and 40 lb. common salt. Trace mineralized salt should be used when copper or cobalt may be deficient. It is a good plan also to allow animals access to common salt separately, so that they will not be forced to eat more of the other minerals than they require to get the amount of salt they need. Mineral supplements are relatively inexpensive, and therefore suitable mixtures can be fed when there is any probability of rations being deficient in mineral elements. (*See* FERTILIZERS AND MANURES: *Influence of Fertilizers on Livestock and Human Food.*)

Vitamins.—The numerous scientific discoveries concerning the vitamins had a profound effect upon livestock farming by increasing the efficiency of animal production and preventing serious nutritional diseases. For example, before the functions of vitamins were known, pigs that were born in the fall in colder climates often failed to thrive, and many became paralyzed or died from pneumonia or other diseases. This fall-pig problem was solved through the use of improved rations that provided an ample supply of the essential vitamins.

Vitamin A is the vitamin that is most apt to be lacking in livestock feeds. It is required for growth, reproduction, milk production and even for the maintenance of mature animals. A serious deficiency makes animals especially subject to diseases of the respiratory tract and thus pigs fed rations lacking vitamin A often die of pneumonia.

Feeds of plant origin that have a high vitamin A value really contain little or no actual vitamin A, which is colourless. Instead, they contain yellow-coloured carotene, which animals can readily convert into vitamin A. All green-growing crops are rich in carotene, therefore animals that are on good green pasture have an abundant supply. In curing green crops into hay in the field some of the carotene is destroyed but enough remains so that well-cured, green-coloured hay is nearly always high in vitamin A value. The carotene content of green forage crops is preserved still better by making them into silage. Most seeds and their by-products have little or no vitamin A value. A notable exception is yellow corn, which has considerable, while white corn has little or none.

When cattle, sheep and horses have good pasture during the growing season and receive well-cured hay or hay and silage during the winter, they have an ample supply of vitamin A. For swine that are not on pasture, 5% to 10% of good quality alfalfa hay or other legume hay can be included in the ration as insurance against a lack of this vitamin. Alfalfa meal is also included in most commercial poultry rations to supply this vitamin.

Next to vitamin A, attention is given to vitamin D in livestock feeding. This vitamin is needed to enable animals to assimilate and use the minerals, calcium and phosphorus. A deficiency of the vitamin causes serious bone diseases such as rickets in young growing animals. Fortunately, sunlight that has not passed through window glass has vitamin D value. This is because the ultraviolet rays of sunlight penetrate the skin of animals and produce vitamin D from the provitamin in the tissues. It is strange that green forage crops growing in the bright sunlight contain little or no vitamin D. However, in the field-curing of hay considerable vitamin D is developed through the action of the sunlight on ergosterol in the hay crops. Cod-liver oil and certain other fish oils are very rich in vitamin D.

Livestock that are outdoors in the sunlight much of the time have a plentiful supply of vitamin D. Under winter conditions in cold regions, cattle, sheep and horses ordinarily get ample amounts from the hay they are fed. Including 5% to 10% good-quality field-cured legume hay in swine rations during the winter not only supplies vitamin A, but also usually provides sufficient vitamin D. Because poultry have especially high vitamin D requirements, special vitamin D supplements are included in their rations, particularly under winter conditions, or when they are confined away from the direct sunlight.

The vitamins included in the vitamin B group are not important in the feeding of cattle, sheep and other ruminants. This is because the bacteria that aid in digestion in the paunch, or rumen, synthesize these vitamins and consequently provide such animals with plenty. Very young calves that are being raised on milk substitutes and other special diets may benefit slightly by the addition of yeast, a rich source of these vitamins, to their ration. Poultry, swine and other simple-stomached animals also require the B vitamins in their diets. The B vitamins include thiamine, riboflavin, niacin, pantothenic acid, choline, biotin, folic acid, vitamin B_6 and vitamin B_{12}. There is evidence that there are still other factors in this group (*see* VITAMINS). Of the B vitamins, riboflavin, niacin, pantothenic acid and vitamin B_{12} are the ones most likely to be deficient in ordinary feeds and at times special supplements are needed by pigs, poultry and laboratory animals for best results. Choline may also be deficient in poultry feeds. The other B vitamins are found in adequate amounts in typical feeds so that special sources are usually unnecessary. Some of the B vitamins (biotin and inositol) and also vitamin K are synthesized by bacteria in the intestinal tract of animals and therefore the amount in the feed is of no importance.

Vitamin E is necessary for normal hatchability of eggs, and it plays a role in preventing muscle stiffness and paralysis (dystrophy) in lambs and calves under certain conditions. Except for these instances natural feeds contain ample vitamin E to meet the needs of animals. Vitamin C, which prevents scurvy in humans and guinea pigs can be synthesized in the bodies of other animals and need not be supplied in their food.

Composition and Valuation of Feeds.—In order to combine the various feeds that may be available into rations that will meet the nutritive requirements of animals it is necessary, first of all, to have definite knowledge concerning their chemical composition. In the usual chemical analysis of feeds all the compounds are grouped for simplicity and ease of analysis into the following general classes: dry matter; protein; fat; crude fibre, often called merely fibre; nitrogen-free extract; and mineral matter or ash. The nitrogen-free extract includes the more digestible and valuable carbohydrates, such as starch and sugar. Analyses for the mineral elements, calcium, phosphorus, cobalt, copper, zinc and others, are sometimes made.

The standard reference books on livestock feeding and the publications of the U.S. National Research council contain extensive tables showing the chemical composition of many different feeds. Chemical analyses show merely the total amounts of the various classes of nutrients that a particular feed contains, but they do not give definite information concerning the extent to which animals can digest and use the nutrients. Digestion experiments are, therefore, conducted with animals to determine the amounts of nutrients in various feeds that are actually digestible. From the results of such studies the percentage of digestible protein and the amount of digestible energy is commonly stated. The percentage of "total digestible nutrients" may also be calculated. This is the sum of the digestible protein, the digestible fibre, the digestible nitrogen-free extract and the digestible fat, the last being multiplied by 2.25. This is done because one pound of fat supplies two and one-quarter times as much energy as does one pound of digestible carbohydrates.

Tables stating the percentages of digestible nutrients in various

feeds furnish useful information concerning their values. However, certain losses of energy occur during the absorption and utilization of food which are not deducted in determining the digestible nutrients. The most important of these additional losses is the loss of energy in the work of digestion and metabolism. It is easy to see that energy is required for the movements of the jaws in chewing, for the movements of the digestive tract and for the increased work of the heart and lungs during digestion. Also the secretion of the digestive juices requires energy, and there are losses of energy in the heat produced by fermentations in the digestive tract. The energy used up in these processes takes the form of heat, and it may help to warm the body. However, it cannot be used for other purposes, because the body has no ability to convert heat into other forms of energy.

A further loss occurs through the speeding up of the body processes which always follows the eating of food. While nutrients are being absorbed from the digestive tract following a meal, more heat is produced than at other times. This effect is familiar to all of us, for we know that if we eat a meal when we are chilly, we will soon feel decidedly warmer. Likewise, if we eat too heartily in hot weather, we will suffer even more from the heat.

The losses of energy in the work of digestion are much higher in the case of feeds that are high in fibre than with grain and other concentrates that are low in fibre and therefore readily digested. For example, 30% of the energy in the nutrients from corn grain is used up in this work of digestion, while the loss is 60% in the case of wheat straw.

Many years ago O. Kellner in Germany and H. P. Armsby in the United States conducted long-continued experiments to determine the net nutritive values of typical feeds after all these losses were deducted. Their results and the studies of others on this question furnished valuable information concerning the actual productive value of typical feeds. Kellner expressed his results in terms of starch values, in which one pound of digestible starch is taken as the unit of energy. This system of measuring the net nutritive value of feeds has been widely used in European countries. In the United States the method of Armsby has been generally followed, in which digestible energy, metabolizable energy or net energy values are used.

Composition and Digestible Nutrients in Typical Livestock Feeds

	Dry matter %	Protein %	Calcium %	Phosphorus %	Digestible protein %	Digestible energy kcal./lb.
Roughages						
Alfalfa hay	90.5	15.3	1.47	0.24	10.9	1.02
Timothy hay	89.0	6.6	0.35	0.14	3.0	0.99
Corn silage	27.6	2.3	0.10	0.07	1.2	0.37
Grass silage	25.8	3.2	0.32	0.12	1.9	0.31
Concentrates						
Corn grain	85.0	8.7	0.02	0.27	6.7	1.62
Oats grain	90.2	12.0	0.09	0.33	9.4	1.42
Soybean oil meal	89.3	45.8	0.32	0.67	42.1	1.56
Wheat bran	89.1	16.0	0.14	1.17	13.0	1.33

Source: NRC Publication 464.

In the table is shown the composition of some typical feeds with respect to dry matter, protein, calcium and phosphorus. The digestible protein and digestible energy values are also shown. Such values are useful in deciding which feeds will supply the nutrients needed by animals. Standard books contain tables showing the nutrient requirements of animals of various ages and sizes. Using these tables and others showing the composition of feeds, it is possible to calculate the amounts of various feeds necessary to supply the nutrients needed by animals.

Important Concentrate Feeds.—First in importance among the concentrates are the cereal grains and the high-grade by-products of these grains that are secured in milling them for human food or in processing them for other purposes. All of the cereal grains, such as corn (maize), oats, barley, wheat and the grain sorghums, are rich in starch and high in digestibility, but they are low in protein and also in calcium, one of the important bone-building mineral nutrients. Moreover, their protein is of rather poor quality. The cereal grains are excellent livestock feeds when their deficiencies are made good by other feeds or by special supplements, such as amino acids, vitamins and minerals. They can to a considerable extent be used interchangeably. Certain cereal by-products are rich or fairly rich in protein, while others are low in this nutrient. In the first class are the by-products from milling wheat—wheat bran and wheat middlings; corn gluten feed, the chief by-product from the manufacture of starch from corn; brewers' grains and brewers' yeast from beer manufacture; and distillers' grains from the production of distilled liquors and alcohol. Low-protein cereal by-products include hominy feed, the corn by-product from the manufacture of hominy and brewers' grits, and corn feed meal, the by-product from making corn meal for human food.

Important among the concentrates are also other seeds, especially certain legume seeds, such as soybeans, field peas, horse beans (broad beans) and peanuts. The legume seeds are all high in protein, and soybeans and peanuts are also so high in fat, or oil, that they are important sources of oil for human food and industrial purposes.

From the processing of soybeans, peanuts and other oil-rich seeds for oil production, various oil meals are secured as by-products. In the older methods of processing these seeds, the fat, or oil, was removed by subjecting the crushed seeds to great pressure in hydraulic presses or in continuous screwlike expellers, but the oil meals thus produced still contained 5% or more of fat. In the newer solvent process, oils are extracted from the crushed seeds with a fat solvent, and the oil meals may contain less than 1% fat. While solvent-process meals have very little fat, they are a little higher in protein than the hydraulic- or expeller-process oil meals, and are satisfactory feeds.

In the case of cottonseed and peanuts, which have woody hulls or husks, these are generally removed before the oil is separated in order to secure a more complete recovery of the oil and to produce a by-product with greater feeding value. Where the hulls are not removed, the by-product cannot legally be called oil meals in the United States, but are termed cottonseed feed and peanut feed. In Great Britain these by-products are called undecorticated oil meals.

Cottonseed oil meal, soybean oil meal and peanut oil meal all generally contain at least 41% protein and rank high in digestibility and feeding value. Cottonseed oil meal should not form more than about 9% of the rations for swine, to avoid injury from the effect of gossypol, a compound contained in varying amounts in this feed. However, cattle may safely be fed larger proportions of cottonseed oil meal. Newer processes have been devised for removing the gossypol and such meal can be fed to pigs and poultry in larger amounts. Linseed oil meal, the by-product from flax seed, has somewhat less protein, usually containing 32% to 34%. Because of its palatability and its laxative and conditioning effect, it is one of the most popular livestock feeds. Coconut oil meal, or copra oil meal, has only about 20% protein but ranks high as a feed for dairy cows.

From the beet sugar and the cane sugar factories come beet molasses, beet pulp and cane molasses or blackstrap molasses. These are palatable feeds, low in protein and high in carbohydrates. Important animal by-products are meat scraps and tankage from the meat-packing plants, fish meal from fish-processing plants and poultry waste and feather meal from poultry-dressing plants. These usually have 50% or more of protein, which is of excellent quality and are, therefore, valuable protein supplements for swine and poultry. Excellent protein is also supplied by the dairy by-products—skim milk, buttermilk and whey, all available as dried products.

Important Roughages.—Among the roughages, first place should be given to the pasture plants for they generally furnish, during the growing season, most of the feed for beef cattle and sheep, much of that for dairy cows and even important amounts for swine and poultry. Because pasture usually supplies nutrients more cheaply than do harvested crops, it is important to fertilize and manage pastures so that an abundance of palatable forage is provided over as long a period as possible. For seeding pastures, a combination of grasses and legumes is used that is best adapted

to the particular area. All green, actively growing pasture crops are fair to rich in protein and high in vitamins. When pasture plants become mature and weathered, their feeding value is greatly reduced.

Next in importance among roughages are the various kinds of hay, which is merely a grass or legume forage crop preserved by drying. Legume hay such as alfalfa or clover is much higher in protein, in calcium and usually in vitamin A value than is grass hay. Late cut hay, either legumes or grasses cut in the late bloom or seed stage of maturity, is worth much less than hay cut before the plants are in bloom or in the early bloom stage as it is less palatable, much higher in fibre and lower in protein and vitamins. Early cut and well-cured grass hay may even equal average legume hay in feeding value, except for the lower protein content. The use of special barn-drying procedures whereby air, sometimes heated, is blown through the partially dried hay to complete the drying process makes it possible to produce excellent quality hay even during rainy periods with little or no weather damage. Barn drying of hay often avoids the extensive loss of nutrients from leaching by rain and from prolonged exposure to the sun. (*See* also CROP DRYING AND PROCESSING; GRASSLAND.)

Green forage crops, such as corn, sorghum and the legumes and grasses, are preserved for winter feeding in the form of silage by placing the chopped forage in tower silos or in pits or trenches in the ground (*see* ENSILAGE). Silage is widely used, in addition to hay, as roughage for dairy cows, beef cattle, sheep and mature swine. Root crops, such as mangels or rutabagas (swedes), are raised extensively in some European countries for stock feed.

The straws from the cereal grains and corncobs are very high in fibre and low in digestible nutrients. They can be utilized best for cattle, sheep or horses that are being maintained and not being fed for production or work. Such fibrous feeds require special supplements of protein, minerals and vitamins to give satisfactory results. *See* NUTRITION; AGRICULTURAL EDUCATION AND RESEARCH; *see* also references under "Feeds, Animal" in the Index volume.

See F. B. Morrison, *Feeds and Feeding*, 22nd ed. (1956); L. A. Maynard and J. K. Loosli, *Animal Nutrition*, 4th ed. (1956).

(F. B. MN.; J. K. LL.)

FEELING, PSYCHOLOGY OF. The term "feeling" refers to the perception of events within the body. The term is a verbal noun denoting the action of the verb "to feel," which derives etymologically from the Middle-English verb *felen*, "to perceive by touch, by palpation." It soon came to mean, more generally, to perceive through those senses which are not referred to any special organ. As the known special organs of sense were the ones mediating the perception of the external world, the verb "to feel" came also to mean the perception of events within the body. Psychologists disagree on the use of the term "feeling." The definition above accords with that of R. S. Woodworth, who defines the problem of feeling and emotion as that of the individual's "internal state." Many other psychologists, however, still follow Kant in equating feeling to pleasantness and unpleasantness. In this article this narrow definition is avoided because it does violence to common usage without yielding any corresponding systematic advantages.

Subjectivity of Feeling.—Perception of external objects lends itself to verification by other people. When I perceive a book on my desk I can check on the presence or nature of the object perceived by asking others whether they see the book and how it looks to them. When I perceive a state of inflammation within my body—of my appendix, for example—no such simple checking on the presence and nature of the inflammation is possible. This obvious difference between the perception of external and internal events is expressed by stating that feeling is characteristically subjective.

Problems of Feeling.—A consequence of the subjectivity of feeling is that its study is concerned with two relatively disparate problems. In studying the perception of an external object—of a book, for instance—we know perfectly well what the object is which we are perceiving, and our only problem is to ascertain how we perceive it. In studying the perception of an event within the organism, we often know practically nothing of the nature of this event. In consequence we are faced with two relatively distinct problems, namely, the problem of *how* we perceive the event and the problem of *what* the event is which we perceive.

In many instances of feeling, almost nothing about the nature of the event perceived was known until the 20th century. As a result, motivational systems were developed in which behaviour was related to events defined only in terms of a behavioural consequence, verbal or otherwise. An example is hedonism (*q.v.*), in which behaviour is considered to be determined by pleasure and displeasure. For rough predictions, hedonism is a useful doctrine. The fact, however, that all that is known essentially about pleasures is that they are called pleasures by the subject prevents any detailed systematic development of hedonism. Indeed, it leaves open the possibility that the correlation between pleasure and seeking behaviour is simply due to the fact that the subject labels as pleasures the events which he is in the habit of seeking.

Study of Internal Sensitivity.—After the 1850s great progress was made in knowledge of the internal sensitivity of the organism. (For details of this progress, *see* E. G. Boring's *Sensation and Perception in the History of Experimental Psychology*, ch. 13–14.) An idea of its magnitude is gained by noting that, whereas in 1846 E. H. Weber distinguished only two senses in addition to sight, hearing, taste and smell, C. J. Herrick in 1931 distinguished 23 classes of receptors involved in such additional senses. Much information has been gained on the perception of relatively simple localized stimulation within the body. It is known, for instance, that moderate increases in temperatures of the skin are perceived as warmth, moderate decreases as cold, checkerboard combinations of moderate increases and decreases as heat, intense increases as pain. Comparable information has not been gained, however, on the perception of such presumably widespread and heterogeneous internal states as the emotions.

Perception of Emotions.—A milestone in the psychology of feeling was William James's well-known theory of emotion, first formulated in 1884 and often called the James-Lange theory. The best-known formulation was presented by James in 1890, in his *Principles of Psychology* (vol. ii, p. 449), in which he wrote:

> Our natural way of thinking about the coarser emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My theory, on the contrary, is that *the bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur is the emotion.*

Subsequent evidence indicates that the perception of an emotion is not merely the perception of muscular and glandular responses. Indeed, James admitted this in 1894 by adding that the perception which initiates the emotion is affective in nature. Subsequent evidence also indicates, however, that the James-Lange theory is essentially correct, in that there is an internal sensory basis for feeling.

If emotion is in part a perception initiated by bodily responses, it is obviously desirable to know what these responses are. The best single answer to this question came from the work of the physiologist W. B. Cannon, who in a long series of experiments was able to show that the major emotions involve excitation of the sympathetic division of the autonomic nervous system, and that such excitation, because of the diffuse conduction, gives rise to a widespread set of specific responses of smooth muscles and glands —increase in heart rate, increase in blood pressure, inhibition of peristaltic movements, increased perspiration and many others. Carney Landis and William A. Hunt also showed that a loud sound yields a complex but highly specific skeletal startle response in man, and other investigators discovered a number of specific emotional pattern responses of the skeletal musculature in animals.

Search for "Affective Elements."—With the emphasis of early experimental psychology on analysis of consciousness into elements, the question quite naturally arose: Does feeling consist of special affective elements? Attempts to answer this question led essentially to chaos. Wilhelm Wundt and E. B. Titchener held that there were special affective elements, different from sensations. Theodor Ziehen and Carl Stumpf denied the existence of such special affective elements. The two basic views were in turn

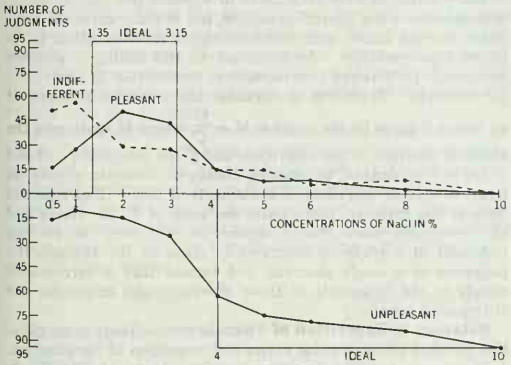
starting points for further divergences. Titchener held that affective elements involved only one qualitative dimension, pleasantness-unpleasantness. Wundt held that they involved three: pleasantness-unpleasantness, strain-relaxation and excitement-depression. Those who agreed to the sensory nature of affective elements were likewise at odds. Ziehen considered pleasantness-unpleasantness to be an attribute of all sensations. Stumpf considered pleasantness-unpleasantness to be an attribute only of certain specific sensations, which he called feeling-sensations.

It is understandable how such disagreement could arise. An affective element, like any other entity in science, is a "construct"; it is not itself a datum, but a concept constructed by the psychologist to systematize his data; thus different psychologists may construct different concepts of affective elements. The fact that the disagreement arose, however, suggests that the type of concept involved does not lend itself to successful systematization.

Something positive, however, came out of this chaotic chapter in the psychology of feeling, namely, the agreement of all these writers that pleasantness-unpleasantness is an important characteristic of feeling. A consequence of this was that the emphasis on psychophysics, so prevalent at the turn of the century, yielded, in the field of feeling, a very extensive psychophysics of affective value, as the dimension pleasantness-unpleasantness is called in English.

PSYCHOPHYSICS OF AFFECTIVE VALUE

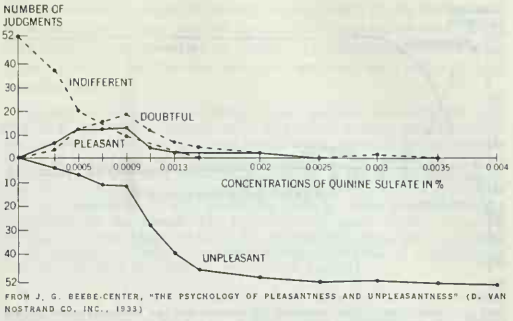
Methods of Measurement.—Affective value is usually measured by one of the three so-called methods of impression. (1) In



FROM J. G. BEEBE-CENTER, "THE PSYCHOLOGY OF PLEASANTNESS AND UNPLEASANTNESS" (D. VAN NOSTRAND CO. INC., 1932)

FIG. 1.—AFFECTIVE VALUE OF SALT SOLUTIONS AS A FUNCTION OF STIMULUS INTENSITY SHOWING IDEAL RANGES FOR PLEASANTNESS AND UNPLEASANTNESS. SEVEN OBSERVERS IN SEVEN SITTINGS (AFTER ENGEL: *see* TEXT)

the method of single stimuli, the observer judges the affective value of a stimulus on a subjective scale, extending from very unpleasant through indifferent to very pleasant, usually involving five or seven steps. These steps are often represented numerically. (2) In the serial method the observer establishes the rank order of a set of stimuli with respect to affective value. This is done sometimes by having the observer select the most pleasant stimulus from the original set, then the most pleasant from the remaining stimuli, and so forth, sometimes by having him arrange the stimuli in a spatial order indicating their rank with respect to pleasantness. (3) In the method of paired comparison the observer judges the relative pleasantness of all possible paired combinations of a set stimuli. Thus, if stimuli *a*, *b* and *c* were involved, he would first be presented with *a* and *b* and judge which is the more pleasant, then with *b* and *c* and judge which of these two is more pleasant, and then with *c* and *a* and judge which of these two is the more pleasant. The frequency with which a stimulus is preferred, when paried successively with all the others, is considered a measure of its affective value.



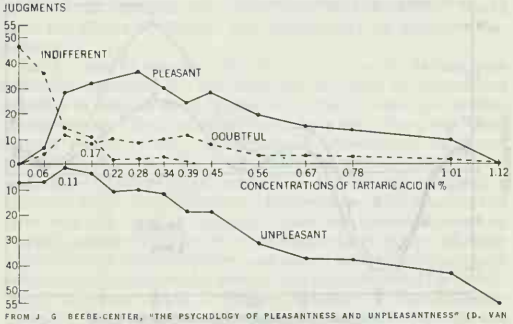
FROM J. G. BEEBE-CENTER, "THE PSYCHOLOGY OF PLEASANTNESS AND UNPLEASANTNESS" (D. VAN NOSTRAND CO. INC., 1933)

FIG. 2.—AFFECTIVE VALUE OF SOLUTIONS OF QUININE SULFATE (BITTER) AS A FUNCTION OF STIMULUS INTENSITY. TEN OBSERVERS IN SIX SITTINGS (AFTER ENGEL)

The method of single stimuli, as described above, makes use of a scale defined in terms of categories. The work of S. S. Stevens in sensory psychophysics indicates that scales defined in terms of categories have a curvilinear relation to scales defined in terms of direct magnitude estimation. The face validity of the latter scales is greater, and Stevens' work shows that they yield remarkably simple and stable relations in sensory psychophysics. It is quite possible that the method of single stimuli with direct magnitude estimation will also prove fruitful in the measurement of affective value.

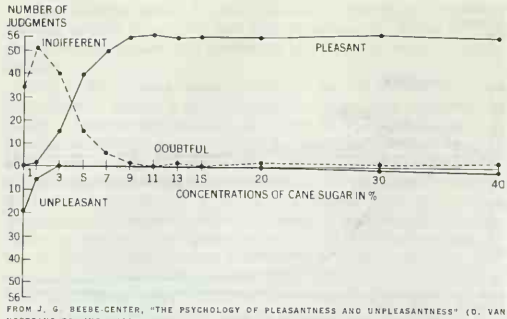
Relation of Affective Value to Intensity of Stimulation.—By and large, weak stimuli are judged to be indifferent, moderate ones pleasant, strong ones unpleasant. This is not, however, invariably the case. The best data on this relationship are those of R. Engel for the field of taste. Engel had observers judge the affective value of various concentrations of sweet, sour, salt and bitter solutions in terms of the four categories: indifferent, pleasant, unpleasant and doubtful. His results are presented in fig. 1 to 4. It will be noted that, although the data for sour, salt and bitter conform to the principle stated above, those for sweet do not. Sweet apparently continues to be judged pleasant no matter how high the concentration.

Relation to Quality of Stimulation.—The relation of affective value to intensity of stimulation, discussed above, implies that to be thoroughgoing, a comparison of the affective value of two or more qualities must involve the complete functions relating affective value to intensity for these qualities. Even for an incomplete comparison the data must refer to corresponding intensities in the case of the various qualities and must be expressed in terms of the same units. Few of the data on the relation of affective value to quality satisfy even the latter two conditions. When further account is taken of affective growth and decay, dis-



FROM J. G. BEEBE-CENTER, "THE PSYCHOLOGY OF PLEASANTNESS AND UNPLEASANTNESS" (D. VAN NOSTRAND CO. INC., 1933)

FIG. 3.—AFFECTIVE VALUE OF SOLUTIONS OF TARTARIC ACID (SOUR) AS A FUNCTION OF STIMULUS INTENSITY. SEVEN OBSERVERS IN SIX SITTINGS (AFTER ENGEL)



FROM J. G. BEEBE-CENTER, "THE PSYCHOLOGY OF PLEASANTNESS AND UNPLEASANTNESS" (D. VAN NOSTRAND CO. INC., 1933)

FIG. 4.—AFFECTIVE VALUE OF SOLUTIONS OF CANE SUGAR AS A FUNCTION OF STIMULUS INTENSITY. TEN OBSERVERS IN SIX SITTINGS (AFTER ENGEL)

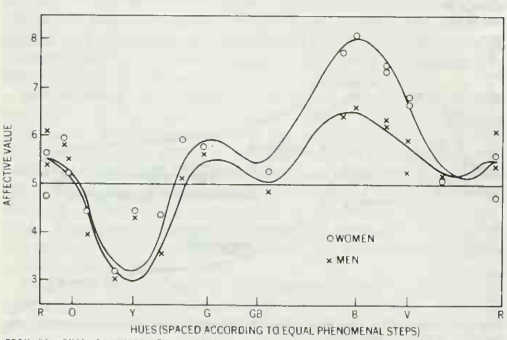
cussed below, it is not surprising that available results on relation of affective value to quality of stimulus are often conflicting.

Engel's data on taste do not satisfy the requirements set forth above. Nevertheless, it seems safe to draw the following conclusions: (1) If intensity is measured in terms of multiple of thresholds, the order of pleasantness is, for the major part of the scale of intensities, sweet, sour, salt, bitter. (2) If, however, intensities are measured in terms of concentrations, the order of the tastes varies with the concentration; at 5%, sugar alone is pleasant; at 1% salt alone; at 0.1% sour alone.

In the case of vision the work of J. P. Guilford yields excellent data on the relation of affective value to hue, with brightness and saturation held constant (fig. 5). As Guilford used not only a set of 18 colours, varying only in hue, but also 22 additional colours introducing variations in brightness and saturation, he was able further to specify, by an ingenious statistical analysis, the relative role of hue, brightness and saturation in determining affective value, and also their joint effectiveness in this respect. His conclusions were as follows:

(1) Hue determined AV [Affective Value] to the extent of about 67 percent for the women and 16 percent for the men. . . . (2) Tint [brightness] determined AV about 20 percent for the women, but only 5 percent for the men. In both cases, the lighter the tint, the more pleasing the color, all other things being equal. (3) Chroma [saturation] determined AV only about 5 percent for the women, but 13 percent for the men, the more saturated colors being preferred to the less saturated. (4) The three attributes combined account for at least 71 percent of the AV of color for women and 26 percent for the men. (J. P. Guilford, "The Affective Value of Color as a Function of Hue, Tint and Chroma," *Journal of Experimental Psychology*, 17:369 [1934].)

With respect to tactile, kinaesthetic and organic sensitivity, knowledge of the relation of feeling to quality of stimulation is



FROM "JOURNAL OF EXPERIMENTAL PSYCHOLOGY," 17:342–370 (AMERICAN PSYCHOLOGICAL ASSOCIATION, 1934)

FIG. 5.—AFFECTIVE VALUE OF COLOURS AS A FUNCTION OF HUE (R-RED, O-ORANGE, Y-YELLOW, G-GREEN, B-BLUE, V-VIOLET) (FROM GUILFORD)

in a curious state. On the one hand, despite the close traditional relation between these senses and feeling, there is little experimental evidence relating affective value directly to quality of stimulation. On the other hand, there is strong evidence relating affective value to specific qualities of experience. The reason for this paradoxical situation is probably the obvious difficulty of ascertaining the nature of internal stimulation.

In 1924 J. P. Nafe published the results of an extensive experiment on the nature of conscious feeling. Observers were given a great variety of affective stimuli and asked to describe carefully and fully the resulting feelings. All observers ultimately agreed in describing pleasantness and unpleasantness as sensory pressures. In terms of quality, pleasantness was reported to be a bright pressure, unpleasantness a dull one. A subsequent experiment by Young suggested strongly that the identification of feeling with pressures was caused by laboratory atmosphere. An experiment by William A. Hunt, however, indicated that the basic correlation between pleasantness and bright pressure and between unpleasantness and dull pressure is correct.

Relation to Form.—Much specific information is available on the relation of affective value to form. This comes in part from the cumulative experience of artists, in part from experimental aesthetics (*see* AESTHETICS). One instance is the codification of knowledge concerning music in the form of rules of melody and harmony. Another is the demonstration of the aesthetic superiority of the golden section; *i.e.*, of the division of a line at such a point that the ratio of the smaller part to the larger part is the same as the ratio of the latter to the whole.

Many attempts have been made to organize this specific information under a few general principles, but in many cases the principles are not stated with sufficient rigour to allow them to be tested experimentally. An exception to this failing is afforded by George D. Birkhoff's mathematical formulation of the classical principle. According to Birkhoff, the aesthetic measure of an object is given by the relation $M = \frac{O}{C}$ where M represents the aesthetic measure, O the orderliness and C the complexity. O and C are in turn defined, for various classes of aesthetic objects, in terms of specific and observable elements of form. Experimental tests of this measure, particularly the work of C. M. Harsh and his co-workers, show that it accords as well with the average judgment of a group of observers as does, on the average, the judgment of a single observer, and further that it corresponds closely to the judgments of those observers who emphasize the criterion of simplicity.

Relation to Repetition of Stimulation.—There is no question but that affective value varies with repetition of the stimulus. In one experiment, for instance, repetition of popular music resulted in a decrease in affective value, repetition of classical music in an increase. In another it was found that when children were made to taste a single substance day after day for several weeks, their liking for such a substance as chocolate and their dislike of such a substance as vinegar both decreased markedly as the experiment progressed.

There is considerable question, however, as to what principle is involved in these variations of feeling. (1) One principle, which may be called the principle of growth and decay, states that with repetition there is an increase of pleasantness or unpleasantness to a maximum, followed by a subsequent decay. (2) Another principle, that of habituation, states that repetition results only in a decrease of pleasantness or unpleasantness. (3) A third principle, that of psychological satiation, states that decrease in pleasantness or unpleasantness does, indeed, usually accompany repetition, but that its effect is due not simply to repetition but to loss of interest. Choice between these alternatives is not possible on the basis of available data. The most promising approach would seem to be through the study of food preferences in the rat, in which past experience and nutritional status can be fully controlled.

FOOD PREFERENCES IN ANIMALS

Study of feeling, as noted above, is complicated by the fact

that the event being perceived is not open to direct inspection by others—by an experimenter, for instance. An approach to the problem of what is being perceived when an object is judged pleasant or unpleasant is the study of food preferences in animals.

P. T. Young, who worked extensively in this field, distinguished three principal methods. (1) In the method of choice, two foods are presented simultaneously for a brief time; the choice, if any, made by the animal is noted, and the foods are then removed. Repetition of this procedure allows a quantitative statement of preference in terms of the frequency of choice of the two foods. (2) In the method of continuous exposure, two foodstuffs are again presented simultaneously, but in this case the presentation is of relatively long duration—Young used periods of 4 to 900 seconds. The criterion of preference here is the time spent by the animal in eating each of the two foods. (3) In the method of self-selection, extensively used by C. P. Richter, a nutritionally adequate set of foods or food components, each presented in a separate container, is continuously available to the animal. The criterion of preference here is the amount of each food or food component consumed by the animal per unit of time, usually per day.

The close relation of food preferences to need is well demonstrated by the work of Richter on self-selection of diets. An early experiment (1936) dealt with rats whose adrenal glands had been removed surgically. Normally such animals die in 10 or 15 days after the operation, apparently because of excessive loss of salt. Richter found that when given free access to salt, adrenalectomized rats took a sufficient amount to keep themselves alive and well. In some animals the salt intake increased 15-fold after adrenalectomy. Much the same picture developed in the case of rats whose parathyroids had been removed. Under ordinary conditions such animals show symptoms of tetany and eventually die. With free access to calcium lactate they lived indefinitely. In one animal voluntary intake of calcium lactate was increased 12-fold after the operation.

These findings suggested that normal animals might be able to select of their own accord the amounts of nutritive components they need. To test this hypothesis, Richter (1938) selected ten substances representing the ten dietary components thought to be necessary in a rat's diet, and gave a group of rats free access to these materials, presented in separate containers. The ten substances, together with the dietary components which they represent, are listed below:

Substance	*Dietary component represented*
1. Casein, autoclaved and purified	Protein
2. Sucrose	Carbohydrate
3. Olive oil	Fat
4. Sodium chloride (3% solution)	Sodium
5. Calcium lactate (2.4% solution)	Calcium
6. Dibasic sodium phosphate (8% solution)	Phosphorus
7. Potassium chloride (1% solution)	Potassium
8. Cod-liver oil	Vitamins A and D
9. Dried baker's yeast	Vitamin B complex
10. Wheat germ oil	Vitamin E

Richter found that the rats fed by this method remained in excellent condition, as judged by such criteria as growth and general activity. It is clear that when given the opportunity, rats select dietary components in accordance with their nutritive needs.

What mechanism is here involved? Richter found that the preference threshold of rats for saline solutions was much lower in adrenalectomized rats than in normals. On the basis of these and other data, he concluded that a specific nutritive deficiency decreases the taste threshold for the substance involved, and that this lowered threshold results in selection and increases intake of that substance. Subsequent work by Carl Pfaffmann and his associates confirmed Richter's finding with respect to the preference threshold, but further showed that the taste threshold, determined electrophysiologically, was not affected by adrenalectomy. It follows that Richter's equation of preference threshold and taste threshold was wrong, and consequently that his theory was to that extent also wrong.

Later attempts to identify the mechanisms underlying food preferences include a series of elegant experiments by E. Stellar and R. A. McCleary, who studied the effect of preloading rats' stomachs with various solutions on the rats' preferences for those solutions. Stellar's conclusions from his own work with salt solutions were as follows:

> Water drinking and the drinking of salt solutions are under the control of at least three factors: taste and other sensory mechanisms in the mouth, gastric distention, and dehydration produced by the osmotic effects of hypertonic solutions on the stomach. The ascending limb of the preference-aversion [function] is partly a matter of response to dehydration, but, more particularly, is an increasing response to increasing taste stimulation. The descending limb is partly due to negative stimulation of the mouth, but is largely the result of the increasing inhibition of drinking produced by increasingly hypertonic solutions in the stomach. (Stellar, Hyman and Samet, *Journal of Comparative and Physiological Psychology*, 47:225–226 [1954]).

The effect of one of these factors, the sensory factor, was studied extensively by P. T. Young, who concluded that results involving this factor may best be interpreted by assuming a so-called "intervening variable" termed "affective process" and defined by the relations found in the study of preferences. Such an intervening variable can be rigidly defined and can serve to systematize findings of studies of preferences. To do so gives a simple answer to the question, "What is the state perceived when we judge an event to be pleasant?" The answer is: an affective process; *i.e.*, a concept systematizing preference behaviour. This answer may well be right. But until more is learned about the nature of concepts, the answer is not very informative.

EFFECTS OF REWARDS AND PUNISHMENTS ON BEHAVIOUR

The study of the effects of rewards and punishments on behaviour constitutes another promising approach to the problem of what is being perceived when an object is judged pleasant or unpleasant. By far the best information on this subject came from the work of B. F. Skinner and his associates. Skinner pointed out that mankind is especially interested in behaviour that has an effect on the environment (operant behaviour), and that this kind of behaviour tends to be influenced by the feedback of its consequences (reinforcement). If now we arrange a situation in which one particular effect on the environment—depression of a bar by a rat—has one particular consequence—the making available of a pellet of food to the rat—we can study the way in which the frequency of the operant *bar-press* is related to the frequency of the reinforcement *food-pellet available*, and also to *deprivation* with respect to food and the occurrence of a signal predicting the reinforcement, the *discriminative stimulus*. Such situations are provided by so-called Skinner boxes, which also provide effective insulation from environmental disturbances, a system for recording the bar-presses or target-pecks and a system for programing the reinforcements. If it is remembered that Skinner's operant is defined in terms of specific effects on the environment, not of specific movements, it is clear that a Skinner box provides an extremely ingenious way of studying what the layman would term the effects of rewards and punishments on purposive behaviour.

In the case of rewards, the relation with which Skinner was especially concerned was that between frequency of operant and schedule of reinforcement, as distinct from, for example, kind of reinforcement. Reinforcement can follow every bar-press (continuous reinforcement) or only some (intermittent reinforcement). In the latter case it can follow the first bar-press after a given time (interval reinforcement) or the nth occurrence of a bar-press (ratio reinforcement). Furthermore, both interval and ratio may be fixed or variable. Also, reinforcement may be stopped completely. The effects on frequency of operant of many instances of all these schedules, and also of many combinations of schedules, were explored by Skinner and his associates (for details, *see* C. B. Ferster and B. F. Skinner, *Schedules of Reinforcement* [1957]). Most of the work was done on pigeons, but enough was done on higher organisms and man to indicate that the principles found have great generality. The result is a vast enrichment of knowledge of how to control behaviour through rewards.

With respect to punishment, the outstanding findings of Skinner and his associates were (1) that moderate punishment does not eliminate permanently the operant behaviour which it follows, but only decreases its frequency temporarily, and (2) that the relative effects of different schedules of punishment are much the same as those of different schedules of rewards.

What is the physiological mechanism by which rewards and punishments influence behaviour? A great step toward answering this question was made by James Olds and Peter Milner in an experiment published in 1954. Olds and Milner ran rats in a Skinner box in which pressing of the bar yielded for the rat not a pellet of food but an electric shock in the brain by means of implanted electrodes. When the electrodes were implanted in the septal region, lying just in front of the thalamus, bar-pressing increased definitely as a function of such electrical "reinforcement."

THEORY OF FEELING

Sense Organs Involved.—In his famous work, *The Integrative Action of the Nervous System* (Yale University Press, 1906) C. S. Sherrington distinguished between three main groups of sense organs on an anatomical and functional basis. These groups and their fundamental characteristics are indicated in the table.

Sherrington went on to point out that a salient character of most of the reactions of the receptor-organs other than distance receptors is affective tone, and that they are particularly closely

Main Groups of Sense Organs and Their Fundamental Characteristics

Loci	Groups		Receptor-organs	Characteristics
Surface	Exteroceptive	Distance	light sound odours	End organs numerous. Connections closer to skeletal musculature than visceral; closely connected to vascular organs
		Other	contact warmth cold pain	
	Interoceptive		taste chemical other?	End organs few; afferent fibres few; connections closer to visceral musculature than skeletal. Closely connected to vascular organs
Underlying	Proprioceptive		in muscles in tendons in joints in blood vessels	Stimuli are events in organism

connected with consummatory reactions. This view of Sherrington's amounts to a definite hypothesis as to the sense organs involved in feeling: all sense organs other than the visual, auditory and olfactory.

Nature of Events Perceived.—What events are perceived in feeling? This question amounts to asking, "What internal events are identified by the organism?" and this in turn amounts to asking, "What internal events are invariant for a given identification by the organism?" In human organisms, identification is judged most readily in terms of specificity of verbal response.

So far as present knowledge is concerned, feeling is largely the perception of muscular contractions. Hunger pangs are in the main perceptions of hunger contractions in the stomach. Fear is in part the perception of complex pattern of muscular contractions. The pain called angina pectoris is the perception of the contractions of the heart musculature deficient in blood supply. Headache is thought to be the perception of tension of the neck muscles.

This is not to say that feeling is solely the perception of bodily movements. Temperature changes, changes in pressure, changes in chemical condition within the body are also perceived. The homeostatic mechanisms of the body, however, tend to minimize such changes. In any case, little information is available concerning the perception of such events.

Feeling a Feedback.—Whether or not the principal events perceived in feeling are muscular contractions, it seems pretty clear that such events are principally reactions of the organism. In the case of muscular contractions, this is naturally obvious. It is true also, however, of chemical and temperature changes so largely controlled by homeostasis. A consequence of this is that feeling is potentially a mechanism by which the internal consequences of reactions of the organism may feed back into the nervous system and affect subsequent reactions. Is this potentiality actually realized? To some extent, yes. Stellar, as noted above, considers that eating behaviour is in part influenced by a taste factor. Again, under certain conditions of intractable pain the patient may be considerably benefited by section of nerves mediating pain sensitivity. G. Razran reported an experiment by E. S. Ayrapetyants showing that a dog can be taught to lift its paws when visceral changes occur. This technique seems very promising for the study of feedback effects of feeling on behaviour.

Categorization of Internal Events.—So far, the theory of feeling has been simple and straightforward. We now come to a feature of feeling which has continued to puzzle psychologists for centuries. Subjects perceiving internal events very often characterize them as pleasant or unpleasant. What is being identified in the case of such a characterization?

Two things should be noted at once in this connection. The first is that characterization with respect to pleasantness or unpleasantness is but one of several characterizations often applied by a subject to events within his organism. Wundt, for instance, considered feeling to have the dimensions of tension-relaxation and excitement-depression besides pleasantness-unpleasantness. The second thing to note is that characterizations with respect to pleasantness or unpleasantness are also applied to objects outside the organism—to colours, for instance.

A widespread view is that the basic feature of perception is categorization. "Perception," according to J. S. Bruner, "involves an act of categorization. Put in terms of the antecedent and subsequent conditions from which we make our inferences, we stimulate an organism with some appropriate input and he responds by referring the input to some class of things or events" ("On Perceptual Readiness," *Psychological Review*, 64:123 [1957]). According to this view the only difference between identifying an internal event by the word "pain" and identifying it by the word "pleasant" would be in the specificity of the identification. In both cases a class of events would be identified, a relatively small one in the case of pain, a large one in the case of pleasant. From this point of view, characterization as pleasant is a verbal response generalized to a large number of stimuli, and the only problem is to determine the way in which this generalization takes place. This is presumably by the selective effects of social approval and disapproval. What, however, guarantees that the responses "pleasant" to candy and warmth and "unpleasant" to vinegar and electric shock shall be useful, and thus maintained by social approval and disapproval? It is not the presence of common affective elements.

Sucrose is a reward which increases the frequency of antecedent behaviour. Almost all subjects judge sucrose to be pleasant. The same correlation is found for a large number of different substances. The suggestion is obvious that reward value and categorization as pleasant are closely related. The older interpretations of this relation started from the categorization, inferred a conscious affective element, and explained the rewarding effect as a consequence of this element. In effect, this interpretation proposed that a substance has reward value because it is consciously perceived as pleasant; *i.e.*, produces a state of consciousness in the person that contains the conscious affective element of pleasure. Psychologists have never been able to agree on the nature of this element. Worse yet, this explanation does not reveal how the substance evokes the element in consciousness or how, once evoked, the element influences behaviour.

One modern alternative to this view replaces the conscious affective element by a so-called intervening variable defined in terms of the stimulus-response relationships involved in both rewarded behaviour and the behaviour of categorizing as pleasant. An example of this view is that of P. T. Young, who termed the resulting intervening variable an affective process (*see* above, *Food Preferences in Animals*).

A second modern alternative eschews both conscious affective elements and affective processes in the form of intervening variables. The starting point here is that certain events are

reinforcing in the sense that the behaviour which they follow increases in frequency, and the categorization is interpreted simply at the naming of this class of events. An example of this view is that of F. S. Keller and W. N. Schoenfeld, who write:

When someone tells us that an object, a color or a design is "pleasant" or "unpleasant," he is reporting upon his own reactions to that object, color, or design. A positive, or a negative, reinforcer has been presented or withdrawn; a change in behavior has taken place, including, perhaps, incipient movements of approach or withdrawal; these movements (or others) provide the SD's (essentially, cues) for his verbal responses—his "affective judgments." (*Principles of Psychology*, Appleton-Century-Crafts, Inc., p. 350 [1950]).

Role of Categorization of Behaviour.—Both these modern alternatives, it might be added, are consistent with Freud's doctrine of motivation and that of John Dollard and N. E. Miller, who combine the Freudian clinical approach with the experimental approach of Clark Hull. Freud held that neurotic behavior was largely determined by repressed affective processes. This is essentially to hold that categorization, in terms of pleasantness and unpleasantness, is a factor in motivation—witness the difference between neurotic and normal—but not a basic one—witness the motivation of the neurotic. Dollard and Miller hold a similar view. "Labeling" emotion facilitates the adjustment of the individual, but emotion is an effective factor in motivation, whether labeled or not.

See also EMOTION; PERSONALITY; PSYCHOLOGY, EXPERIMENTAL; PSYCHOPHYSICAL METHODS; SENTIMENT; and references under "Feeling, Psychology of" in the Index volume.

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FEIJOA, a small tree (*Feijoa sellowiana*) of the myrtle family (Myrtaceae, *q.v.*), related to the guava and often called pineapple guava. It is a native of southern Brazil, Paraguay, Uruguay and parts of Argentina and is cultivated in various mild climates for its highly esteemed fruit. The tree grows about 15 ft. high and has olivelike leaves, dark green above and silvery-gray beneath, and large white flowers that are purplish-crimson within.

The oblong fruit, about 2 in. long and dull green in colour marked with crimson, has a translucent, melting pulp with a somewhat pineapple flavour. When mature the fruits fall, but must be kept in a cool place until sufficiently soft for eating. They are made into jam and jelly and are also crystallized.

The feijoa was introduced into southern Europe in 1890 and about 10 years later was taken to California where it became extensively cultivated. The tree requires a dry climate, such as that of southern France and parts of California; it does not thrive in the moist climate of Florida and Cuba. It is usually propagated by seeds, which come fairly true to type, but cuttings may be rooted under glass and whip grafting effected by using seedlings with stems of the thickness of an ordinary lead pencil. Choice varieties are also perpetuated by the layering of low branches.

FEIJÓO Y MONTENEGRO, BENITO JERÓNIMO (1676–1764), Benedictine monk and scholar, one of the first Spanish essayists, was born at Casdemiro, Orense, Oct. 8, 1676. In his *Teatro crítico universal* (1726–39) and *Cartas eruditas y curiosas* (1742–60) accepted ideas about education, medicine, science, justice, national character, literature and even the miraculous elements in religion were put to the test of rational doubt, personal experiment and the weight of erudite reference. He is the first characteristic figure of Spanish "enlightenment," aware of foreign progress and yet deeply patriotic. He died at Oviedo, Sept. 26, 1764.

See G. Delpy, *L'Espagne et l'esprit européen. L'oeuvre de Feijóo, 1725–1760* (1936). (R. F. B.)

FEININGER, LYONEL (1871–1956), U.S. modernist painter, known for the crystalline clarity and transparent structure of his seashores and cityscapes, was born on July 17, 1871, in New York city. He left the United States for Germany in 1887 to study music, but decided to become an artist instead. Music, however, was the first and principal influence in his life and art. Feininger studied painting in Hamburg, Berlin and Paris between 1887 and 1893 and then worked as a cartoonist for German humour magazines and the *Chicago Tribune*. Under the influence of the Cubists—especially Robert Delaunay—he began to paint important canvases around 1910 and soon established his own style, utilizing prismatic interpenetrating planes of colour. This work, with its intersecting light rays, so impressed the Blue Rider artists (Franz Marc and Wassily Kandinsky) that Feininger was invited to exhibit with them in Berlin in 1913. After World War I, Feininger joined the staff of the famous Bauhaus workshops and soon found himself in the company of Paul Klee as well as Kandinsky.

The structural direction of his own work was closely akin to the aim of the Bauhaus: a synthesis of art, science and technology. In 1936, after the Nazi access to power, Feininger returned to the United States. During the remainder of his life he strove, in both oil and water colour, for the most sensitive refinement of his visionary, yet orderly, crystalline world. He died on Jan. 13, 1956, in New York city.

See A. J. Schardt and Alfred Barr, *Lyonel Feininger* (1944). (P. H. S.)

FEKE, ROBERT (*c.* 1705–*c.* 1750), U.S. portrait painter, whose work maintains the proud stance of a recent colonial aristocracy and achieves a surprising degree of sensuous splendour, was born at Oyster Bay, N.Y., on an unknown date. The place and date of his death are also unknown. Further uncertainties about his being termed a mariner, about his supposed travels and about his artistic training cause differences of opinion among scholars, but the record of his work is reasonably clear. This work was done from time to time in Boston, Mass., and Philadelphia, Pa.; but his home was in Newport, R.I., where he married Elinor Cozzens in 1742 and was visited in 1744 by a Scottish doctor, Alexander Hamilton, who noted the event vividly in his *Itinerarium*. About 15 portraits are signed and dated, and his manner is distinctive enough to warrant his authorship of about 50 more. Five examples in the Walker Art building, Bowdoin college, Brunswick, Me., include the most impressive of all, the "Samuel Waldo." Feke's observation of character was sporadic. The interest of his work is mainly in its technical development of colour and rendering of textures, despite its definite awkwardness.

See H. W. Foote, *Robert Feke, Colonial Portrait Painter* (1930); L. Goodrich, *Robert Feke* (1946). (VL. B.)

FELDSPAR or FELSPAR, a name applied to a group of minerals of great importance. Silicates of aluminum with potassium, sodium and calcium, and, rarely, barium, they constitute practically 60% of igneous rocks and serve as a basis of classification of these rocks, being important constituents, for example, of granite, syenite, diorite, gabbro and peridotite (*qq.v.*). They occur in schists and other metamorphic rocks and through the processes of decomposition are sources of kaolin and other clays and of much of the world's soil. Following discussion of colour and chemical composition, feldspar is discussed in terms of its crystal structure, polymorphism, unmixing at low temperature and other properties.

Feldspar (predominantly potassium-rich) is used industrially in the manufacture of porcelain, and it also forms an important constituent of many ceramic glazes. Some of the coloured varieties are occasionally used as gems (moonstone) and for ornamental purposes. (*See* CHINAWARE; POTTERY AND PORCELAIN: *Modern Manufacturing Techniques.*)

The name feldspar was used by J. G. Wallerius in his *Mineralogy* (1747) in the Swedish form *feltspat*, meaning "fieldspar," but it was subsequently written felspar by Richard Kirwan, who erroneously assumed the derivation of the name from *fels*, "a rock." The term felspar is used only in Great Britain. In German the old name is preserved in *Feldspat*.

A vast number of names exist to designate the different feldspar varieties. They are based on one or more of the following properties: chemical composition; crystallographic symmetry; morphological appearance; state of homogeneity or inhomogeneity; twinning; colour; lustre; and crystal-optical behaviour. They comprise a single mineral species ranging from the alkali potash feldspars (orthoclase or microcline and sanidine), the sodium feldspars (albite and analbite) and the potash-sodium (sanidine-analbite) series through the sodium-calcium feldspars (plagioclases).

The general characters and crystal structure of the feldspars are discussed below. Since certain of the feldspars can crystallize in more than one distinct form, either in the monoclinic or the triclinic systems, they are classified as polymorphous, and this character of polymorphism is discussed in relation to their chemical composition.

Feldspar has been the subject of considerable research relating to the origin of igneous rocks, the processes by which minerals are formed and the behaviour of solid solutions; in addition to the material in this article on unmixing of feldspars in solid solution at low temperatures, *see* GEOCHEMISTRY: *Geochemistry of the Lithosphere;* PETROLOGY: *Petrographical Provinces.*

GENERAL CHARACTERS

The feldspars are fairly hard (about 6 on Mohs' scale) and relatively light for minerals (specific gravity ranges from 2.55 to 2.76).

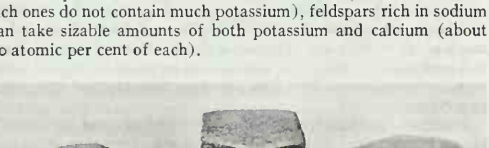
Colour.—Pure feldspars are colourless, but as a result of the presence of minute inclusions or the development of alteration products, most natural feldspars are shades of pink, brown, green or gray. Bright green microclines are called amazonstone. Copper-red varieties (colour caused by iron oxide) are called aventurine. Iridescent varieties are moonstone, peristerite and labradorite.

Chemical Composition.—The chemical composition varies considerably, inasmuch as the feldspars form several series of solid solutions. The chemical formulas of the pure end members can be written as:

1.	$KAlSi_3O_8$	Alkali feldspars
2.	$NaAlSi_3O_8$	Alkali feldspars
3.	$CaAl_2Si_2O_8$	Plagioclases
4.	$BaAl_2Si_2O_8$	Celsian

Members of the series between 1 and 4, that is, with barium replacing part of the potassium, are called hyalophane. Celsian and hyalophane are rare and of minor importance, and they will not be treated here in detail.

The distinction between alkali feldspars and plagioclases is not always clear-cut, because alkali feldspars may contain appreciable amounts of calcium and plagioclases may contain potassium. Feldspars may be considered alkali feldspars if they are monoclinic or if in the triclinic case the atomic ratio potassium/calcium is larger than one. They may be called plagioclases if they are triclinic and this ratio is smaller than one. Whereas the potassium-rich feldspars do not contain much calcium (and the calcium-rich ones do not contain much potassium), feldspars rich in sodium can take sizable amounts of both potassium and calcium (about 10 atomic per cent of each).



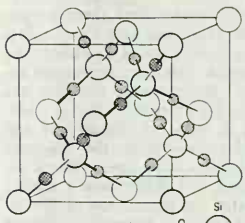
P. M. SHAUB

FIG. 1.—ORTHOCLASE CRYSTALS, A FORM OF ALKALI POTASH FELDSPAR, FOUND IN GOOD SPRINGS, NEV.

CRYSTAL STRUCTURE

Main Features.—As a first step in the process of understanding some of the most important features of the feldspar structure, *see* in fig. 2 the model of the more simple structure of a silica (SiO_2) modification, cristobalite. Note that every silicon atom is surrounded tetrahedrally by four oxygen atoms and that each oxygen atom is surrounded by two silicon atoms. Thus the structure is made up of SiO_4 tetrahedrons in such a way that each oxygen shares two tetrahedrons. The whole arrangement is a relatively loose SiO_2 framework with significant voids.

The framework is electrostatically balanced: one Si^{4+} plus two O^{2-}. This formula, SiO_2, multiplied by four equals Si_4O_8. If some of the Si^{4+} are replaced by Al^{3+}, one obtains $(AlSi_3O_8)^{1-}$ or $(Al_2Si_2O_8)^{2-}$. To neutralize this framework in which Si^{4+} is partially replaced by Al^{3+}, additional positive ions must be inserted within the voids of the structure.



BY COURTESY OF AKADEMISCHE VERLAGS-GESELLSCHAFT

FIG. 2.—UNIT CELL OF THE STRUCTURE OF CRISTOBALITE, A MODIFICATION (CUBIC) OF SiO_2. IN THE ACTUAL STRUCTURE THE OXYGEN AND SILICON IONS ARE CONTIGUOUS, AND THE RADIUS OF AN OXYGEN ION IS ABOUT FOUR TIMES THAT OF A SILICON ION

The feldspar structure contains K^+, Na^+, Ca^{++} ions within the voids of an $(AlSi_3O_8)^{1-}$ to $(Al_2Si_2O_8)^{2-}$ framework to balance the negative charge. The number of the inserted positive ions K, Na, Ca to the total of (Al + Si) ions is always 1:4.

Symmetry.—The main features of the feldspar structure may be discussed through the use of the cubic cristobalite structure. The actual feldspar structure is too complex to be discussed here in detail. The feldspars have a symmetry much lower than cubic; it is monoclinic or triclinic depending on composition, temperature and distribution of the aluminum and silicon ions within the $(Si,Al)_4O_8$ framework.

All feldspars can be referred to a system of co-ordinates that differ only slightly for the different varieties. The extreme values for the crystallographic axes are $a:b:c$ from 0.66:1:0.56 to 0.63:1:0.55; and for the angles between the axes are α from 90° to 95°; β from 116° to 117°; γ from 87½° to 90½°.

In those cases where α and $\gamma = 90°$ the symmetry is monoclinic. If α and/or $\gamma \neq 90°$ the symmetry is triclinic. All plagioclases are triclinic. Virtually continuous changes from monoclinic to triclinic symmetry are known or can be hypothesized as a function of changing composition, temperature or aluminum/silicon distribution.

Unit Cell.—The unit cell based on the conventionally chosen system of co-ordinates has the following approximate lattice constants (in Å = 10^{-8} cm.):

a (K rich) = 8.58; (K poor, Na rich) = 8.12; (K poor, Ca rich) = 8.18

b = 12.8 to 13.0

c = 7.1 to 7.2

Angles α, β, γ are given above.

This cell contains four feldspar molecules $X(Si,Al)_4O_8$ where X = K,Na,Ca. It is side centred. X-ray photographs of the calcium-rich plagioclases (anorthite) indicate that their cell has a doubled c axis and is not side centred (due to an ordered superstructure of the aluminum and silicon atoms and of the calcium positions). Eight anorthite molecules ($CaAl_2Si_2O_8$) are in this doubled cell.

POLYMORPHISM

Potash Feldspar ($KAlSi_3O_8$).—There are at least two polymorphic modifications. The modification stable at low temperature is the triclinic microcline, the one stable at high temperature is the monoclinic sanidine. Both modifications occur in nature. Long heating (months) at approximately 1,000° C. (near the melting point, which is 1,170° C.) changes microcline to sanidine. On

the other hand, attempts to produce microcline either from sanidine or by direct synthesis were not successful. All potash feldspar synthesized in laboratory experiments appears to be sanidine. Geological times seem to be necessary for the formation of microcline. Whereas the crystal structure of sanidine became rather well known through the work of W. H. Taylor and his co-workers, the structure of microcline had not yet been determined by the early 1960s. There was, however, evidence from both X-ray investigations and from several experiments concerned with the physical-chemical behaviour of the alkali feldspars to justify the hypothesis that the difference between sanidine and microcline is the result of a different distribution of the aluminum and silicon ions within the $AlSi_3O_8$ framework.

Fig. 3(A) and 3(B) show schematically in two dimensions how a difference in the aluminum/silicon distribution can produce a difference in symmetry. In both figures the dots represent the positions of aluminum *and* silicon. In fig. 3(A) the dots are not distinguished from one another, indicating that each position may be either aluminum *or* silicon; the aluminum and silicon are randomly distributed. The arrangement is symmetrical with respect to a vertical mirror plane. If, as drawn in fig. 3(B), the aluminum atoms are not distributed at random but take special positions, the mirror plane vanishes. Fig. 3(A) represents the disordered monoclinic case and fig. 3(B) (more or less distorted as in fig. 3[D]) represents the ordered triclinic case. The change from the one to the other might be called a diffusive transformation, as a diffusion of aluminum and silicon is necessary for the process. Obviously a diffusive transformation must be a more or less continuous process and its rate depends on the rate of the aluminum or silicon diffusion. Considering the general structure of feldspars in which the aluminum and silicon atoms are tightly fixed by the relatively strong bonds to the oxygens that surround them one might suspect that the rate of exchange of aluminum and silicon is very low, especially at low temperatures.

The crystallographic differences between microcline and sanidine are:

		Microcline	Sanidine
axes	a	8.58	8.56
	b	12.97	13.03
	c	7.22	7.18
angles	α	90° 39′	90°
	β	115° 56′	116°
	γ	87° 42′	90°

In the light of the above discussion, the following observations may be summarized:

1. Natural sanidines are known only from rocks that have been relatively quickly cooled. The disordered state appears to have been "frozen in."

2. Synthetic potash feldspar is apparently always monoclinic. No synthesis of triclinic microcline has been reported. Laboratory experiments apparently are of insufficient duration to allow the production of the ordered state.

3. There is evidence (interpretation of the twinning exhibited by microcline) that most potash feldspars, now microcline, originally crystallized as a monoclinic (disordered) modification. The transformation to the triclinic (ordered) state took place slowly with the passage of time.

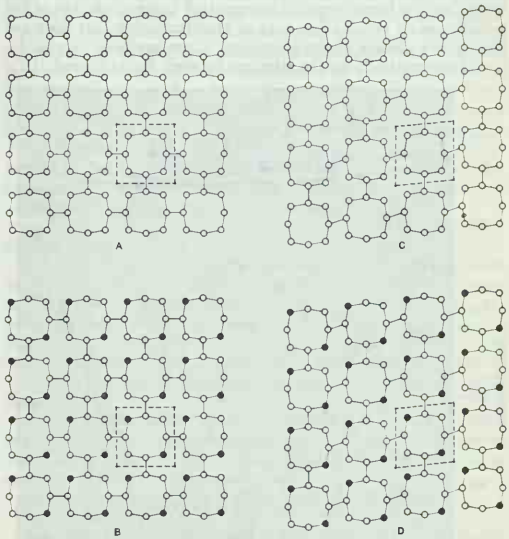
4. Natural potash feldspars exist with angles α and γ between 90° and those values characteristic for microcline, indicating that the diffusive transformation to the state stable at low temperature has not gone to completion.

5. Microcline when held at high temperature (1,000° C.) transforms slowly to sanidine (within months). During this process the values of angles α and γ change continuously toward 90° as a function of time. Similarly the optical properties change continuously from those of microcline to those of sanidine during such heat treatment.

6. Microcline is usually twinned. The width of the twin lamellae may range from millimetre size to submicroscopical bands (occasionally within the same twinned crystal). The over-all optical behaviour of such portions with submicroscopical twinning is more or less monoclinic and the optical properties of such material are very similar to those of common orthoclase.

7. It seems thus that those orthoclase crystals (which also appear monoclinic but are not sanidine), the optical behaviour of which approaches that of very finely twinned microcline, are distinguished from sanidine by a different aluminum/silicon distribution. Therefore, common orthoclase might be considered as somehow intermediate between sanidine and finely twinned microcline. This viewpoint is supported by X-ray evidence (qualitative interpretation of diffuse scattering).

8. Potash feldspar found in low-temperature veins and similar deposits is distinguished by a characteristic morphology (combination of prism, basal pinacoid and orthodome or the forms [110], [001], [101]). It is usually glassy, or at least colourless, and is called adularia. As revealed by optical and X-ray investigations many adularia crystals consist of a virtually monoclinic core (with properties similar to common orthoclase) and a more or



BY COURTESY OF FRITZ LAVES

FIG. 3.—TWO-DIMENSIONAL SCHEMATICS REPRESENTING THE SYMMETRY RELATIONS OF THE ALKALI FELDSPARS. (A) AND (B) DEPICT THE SANIDINE-MICROCLINE RELATION: CHANGES OF SYMMETRY AS A CONSEQUENCE OF DIFFUSIVE TRANSFORMATON. (A) AND (C) SHOW THE SANIDINE-ANALBITE RELATION: CHANGES OF SYMMETRY AS A CONSEQUENCE OF DISPLACIVE TRANSFORMATION. IN (C) AND (D), THE ANALBITE-ALBITE RELATION, NO CHANGE OF SYMMETRY OCCURS, DESPITE DIFFUSIVE TRANSFORMATION. THE ALUMINUM AND SILICON IONS ARE RANDOMLY DISTRIBUTED IN (A) AND (C); IN (B) AND (D) THEY ARE ORDERED (*see* TEXT)

less triclinic rim. The triclinic portions of the rim follow a characteristic sector pattern and are arranged to each other in such a way that a monoclinic symmetry governs the morphology of adularia crystals.

Sodium Feldspar ($NaAlSi_3O_8$).—Two different modifications are known: albite, stable at low temperature; and analbite (or high albite), stable at high temperature. The transformation temperature lies around 700° C. Probably the structural differences between albite and analbite are analogous to those between microcline and sanidine; *i.e.*, the aluminum/silicon distribution is an ordered one in albite and a disordered one in analbite. In accordance with this hypothesis is the fact that it takes a month or more at about 1,000° C. to transform albite into analbite. As in the potash feldspars, no reversal of this process has been noted. Sodium feldspar crystallized in the laboratory has always proved to be analbite, even when synthesized at temperatures as low as 200° C. Apparently laboratory times are too short to produce an ordered aluminum/silicon distribution.

It has been shown in the case of potassium feldspar how the change of the state of order/disorder is connected with a change

of symmetry. Both modifications of sodium feldspar, analbite and albite have, however, the same (triclinic) symmetry. The diffusive transformation from albite to analbite and vice versa is therefore not accompanied by a symmetry change. The possibility of such relations is shown schematically in fig. 3(C) and 3(D).

Sanidine-Analbite Series ($KAlSi_3O_8$–$NaAlSi_3O_8$).—Sanidine and analbite form a virtually continuous series of mixed crystals at high temperature. These mixed crystals can be preserved at low temperature by cooling rapidly enough to prevent the diffusive transformation and the unmixing that starts below about 560° C. (*see* below). Fig. 4 shows the phase diagram of this series that is stable only at high temperature but unstable (undercooled) at low temperature. Mixed crystals that are potassium rich are monoclinic from room temperature up to the melting point, whereas sodium-rich members undergo a so-called displacive transformation, the transformation temperature being a function of the potash/sodium ratio. This kind of transformation that does not involve any change of the aluminum/silicon positions can be depicted schematically by the relations between fig. 3(A) and 3(C).

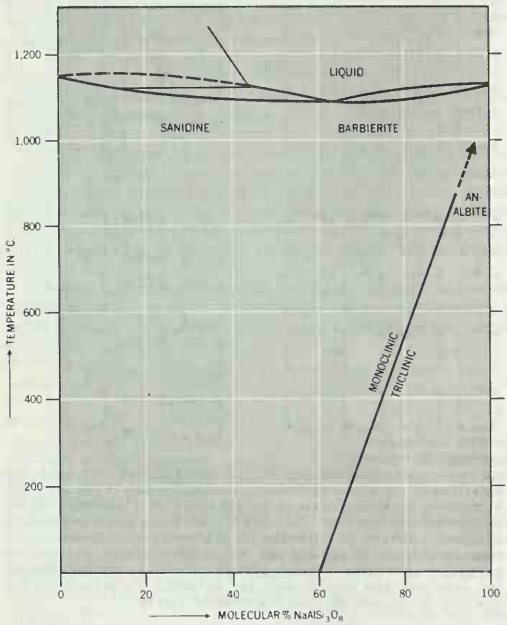


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FIG. 4.—PHASE DIAGRAM (INSTABILITY BEGINS BELOW ABOUT 700° C.) OF THE SERIES SANIDINE-ANALBITE, BARBIERITE (*see* TEXT)

As usual in the case of displacive transformations the modification stable at higher temperature has a symmetry higher than that of the modification stable at low temperature. Because no diffusion is involved in this kind of transformation it can take place very rapidly. It is neither possible to freeze in the monoclinic symmetry by quenching nor to retain the triclinic symmetry by quick heating.

A publication (1952) by W. S. MacKenzie indicates that the line which in fig. 4 divides the monoclinic field from the triclinic one meets the sodium end of the diagram slightly below the melting point of $NaAlSi_3O_8$ (if equilibrium is reached by a prolonged heat treatment), so that at very high temperatures a monoclinic $NaAlSi_3O_8$ modification may exist. Such a modification was earlier proposed (on the basis of optical examination of natural material) and given the name barbierite, but its reality as a mineral has been disputed. In summary, the alkali feldspars can be subdivided in the following way:

Al/Si distribution disordered
- K rich: sanidine (monoclinic, at high temperature)
- Na rich: barbierite (monoclinic, at very high temperature)
- Analbite (triclinic, at high temperature)

Al/Si distribution ordered
- K rich: microcline (triclinic, at low temperature)
- Na rich: albite (triclinic, at low temperature)

Unstable intermediate states are known at the potassium-rich side as common orthoclase and adularia (the latter predominantly as a low-temperature mineral).

The Plagioclases ($NaAlSi_3O_8$–$CaAl_2Si_2O_8$).—The polymorphism of the plagioclases appears to be very complex. Some details have already been given above for the sodium-rich end of the series. A. Köhler showed in 1942 that the optical properties of plagioclases that reach equilibrium at high temperature differ from those that approach equilibrium at low temperature. Some X-ray investigations with calcium-rich plagioclases have shown that there are significant differences between the sodium-rich and the calcium-rich plagioclases as far as polymorphous behaviour is concerned. This difference seems to result largely from the different aluminum-silicon ratio of the end members, which is 1:3 for the sodium end and 2:2 for the calcium end. The aluminum/silicon ratio which equals 2:2 in anorthite ($CaAl_2Si_2O_8$) seems to be responsible for its superstructure, which is not found in the alkali feldspars. The *c* axis of the unit cell of anorthite is approximately twice that of albite. Another difference is that the anorthite unit cell is not side centred, a fact that appears to result from the position of the calcium ions compared with the position of the sodium (potassium) ions in the structure of the alkali feldspars. These conclusions have been drawn from the X-ray behaviour of anorthites after they were subjected to different heat treatments. The X-ray reflections which indicate that the unit cell is not side centred show a varying degree of diffuseness as a function of temperature (F. Laves and J. R. Goldsmith, 1951). After treatment at 1,500° C. these reflections are so diffuse that they almost disappear; after treatment at 1,000° C. all reflections are sharply defined. The reflections that correspond with those observable in photographs of the alkali feldspars remain sharp up to the melting point (1,550° C.). Heat treatment at intermediate temperatures produces intermediate diffuseness in the affected reflections. The time required to reach equilibrium is of the order of ten minutes.

The difference in structural properties of $NaAlSi_3O_8$ and $CaAl_2Si_2O_8$ leads to the conclusion that no complete solid solution series of mixed crystals is possible in the strictest crystallographic sense, not even at high temperatures. On the other hand, there is no reason to doubt the existence of a virtually complete solid solution series as established by N. L. Bowen as early as 1913.

The plagioclases are given different names as a function of their chemical composition: albite (0% to 10% anorthite [An]); oligoclase (10% to 30% An); andesine (30% to 50% An); labradorite (50% to 70% An); bytownite (70% to 90% An); anorthite (90% to 100% An).

UNMIXING AT LOW TEMPERATURE

The feldspars form virtually complete solid solutions at elevated temperatures. At low temperatures they unmix (if this process is not suppressed by relatively quick cooling). The degree of unmixing (as far as coarseness and composition of the unmixed products is concerned) is principally a function of temperature and time. The observation of natural feldspars and the interpretation of experimental work leads to the conclusion that the process of unmixing is much more readily accomplished in alkali feldspars than in plagioclases. This can be understood by the fact that the tightly bonded aluminum and silicon ions are much more reluctant to move by diffusion than the potassium, sodium or calcium ions (Goldsmith, 1952).

Unmixing of Alkali Feldspars.—Because all alkali feldspars have the same aluminum/silicon ratio (1:3) the unmixing process does not involve any aluminum/silicon diffusion. The first step will be the formation of potassium- sodium-rich domains by concentration fluctuations of sodium and potassium within the $AlSi_3O_8$ framework, with differences of concentration that exceed those

always present in a random distribution within a mixed crystal. If more time is available under favourable temperature conditions, these domains will develop into truly unmixed regions, and finally may even be observed macroscopically. In the beginning of the process the $AlSi_3O_8$ framework is still common to both the potassium-rich and the sodium-rich domains. As the unmixing process proceeds stress will be increased because of the difference in lattice constants of the potassium-rich and sodium-rich feldspars. This stress will finally lead to a truly two-phase system composed of potassium feldspar and sodium feldspar, separated by discontinuous phase boundaries. This material is called perthite. Earlier stages—where the phases are distinguishable only under a powerful microscope—are called microperthite. If the unmixing is developed on such a small scale that it can be detected only by X-ray methods or deduced by several other means, the material is called cryptoperthite. If the unmixed areas cannot be seen directly (even with a powerful microscope) but are the cause for a beautiful (white to blue) opalescence or schiller lustre displayed in characteristic crystallographical directions, one speaks of moonstone (*q.v.*). In fig. 5 a phase diagram is proposed with more detailed information on the temperatures at which unmixing should occur (if equilibrium is established) and on the compositions of the different phases in equilibrium.

Unmixed alkali feldspars usually show the potassium-rich material as the host in which the sodium-rich material is precipitated. The opposite is occasionally observed, plagioclase the host and the potassium-rich material precipitated within it. This material is usually called antiperthite.

Besides the degree of unmixing into potassium-rich and sodium-rich areas, the appearance of the products found in nature is further complicated by the different degree of aluminum/silicon order-disorder (discussed above) that may exist. The potassium-sodium feldspars, especially those that are soda rich, exhibit a confusing variety of crystallographic and optical properties. This is a consequence, in addition to order-disorder relations, of composition and of variation in the temperature of the displacive transformation (discussed above). The symmetry change induced by this transformation may also produce twinning that may be submicroscopic. These complications are responsible for the uncertainties and confusion in descriptions found in many textbooks of the "mineral" anorthoclase, which does not exist as a true species.

The term anorthoclase is best defined as a feldspar of the composition between $Or_{70}Ab_{30}$ and $Or_{10}Ab_{90}$. It may or may not be homogeneous; it may be monoclinic or triclinic, or a mixture of both forms.

Unmixing of Plagioclases.—The plagioclases form a virtually complete series of mixed crystals at elevated temperatures from $NaAlSi_3O_8$ to $CaAl_2Si_2O_8$ (analbite-anorthite). Portions of this series are unstable at low temperature. There are (X-ray and optical) indications for two gaps of miscibility: (1) between albite and oligoclase; (2) between oligoclase and bytownite. The X-ray evidence for the first gap is the coexistence of reflections characteristic of two different feldspar structures in single-crystal photographs of plagioclases of compositions near $Ab_{90}An_{10}$. The optical indication for this gap is a characteristic bluish schiller exhibited by many plagioclases of this composition which are called peristerite. The second gap is inferred from ghost reflections on X-ray photographs of plagioclases, the composition of which lies between $Ab_{70}An_{30}$ and $Ab_{30}An_{70}$. These ghost reflections can be explained if one assumes periodically changing composition within the crystals. The optical indication for this gap is the beautiful schiller of all colours exhibited by many plagioclases in this compositional range, a schiller that is known as labradorizing.

Little is known, however, of the phase relations in the plagioclase feldspar system.

No textures within plagioclases are known that resemble those of the perthites in the alkali feldspars. In the alkali feldspars only the rather readily mobile potassium and sodium ions are required to move for a separation into $KAlSi_3O_8$ and $NaAlSi_3O_8$. In the plagioclases sodium and calcium can be segregated into $NaAlSi_3O_8$ and $CaAl_2Si_2O_8$ only if a simultaneous transport of aluminum and silicon ions takes place to maintain electrostatic neutrality.

The great difficulty involved in migrating aluminum and silicon even for short distances, as in the case of changing a disordered distribution to an ordered one (which does not involve large concentration changes), has been discussed.

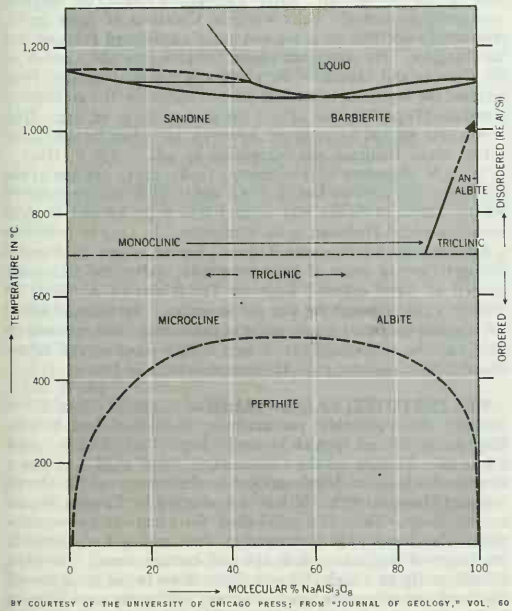

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FIG. 5.—PHASE DIAGRAM OF THE ALKALI FELDSPARS (IN PART HYPOTHETICAL)

OTHER PROPERTIES

Morphology and Twinning.—All feldspars show a similarity of crystal form, generally prismatic but flattened parallel to the side pinacoid face [010], or elongated parallel to the axis *a* with small prism faces. Sodium-rich sanidines (usually high in calcium) that are known from the rhombporphyries commonly have a characteristic habit with a rhomb-shaped cross section. They are elongated parallel to the *c* axis, only the prism and orthodome faces [110] and [201] being developed. The habit of adularia has been discussed. All feldspars cleave readily parallel to the basal pinacoid [001] and side pinacoid [010], producing angles of 90° in the monoclinic varieties and oblique angles in the triclinic ones. Twinned crystals are common and the twinning serves to distinguish various members of the group both in hand specimens and by optical methods under the microscope. In the monoclinic series the most common twin laws are the Carlsbad (twin axis *c*), the Manebach (twin plane [001]) and the Baveno (twin plane [021] or clinodome). In the triclinic series, in addition to these three laws the albite law (twin plane [010]) and the pericline law (twin axis *b*) are very common. They are usually developed as multiple twinning, visible (occasionally only microscopically) as fine striations on the cleavage planes, albite and pericline on [001] and pericline on [010]. Mechanical twinning after the albite and pericline law can be produced easily in analbite but not in albite, another physical consequence of the difference in the aluminum/silicon distribution.

Synthesis, Melting Point and Alterations.—With the exception of hyalophane, which contains barium, feldspars of all compositions have been prepared synthetically, but only as the high-temperature modifications, even at temperatures at which the low-temperature modifications are stable (*see* above). The

alkali feldspars melt in the vicinity of 1,100° C. Addition of calcium raises the melting temperature to 1,550° C. for pure anorthite. Feldspars readily suffer chemical alteration, the most common products being kaolin, sericite, various zeolites and calcite. The anorthite-rich plagioclases, especially under conditions of retrograde metamorphism, break up into albite and a group of calcium aluminum silicates including prehnite, zoisite, epidote and garnet, this assemblage being referred to as saussurite. Albite is the most stable of the feldspars under the action of weathering and is commonly found in detrital sediments and as an authigenic, that is, formed in place and unaltered, mineral. Potassium feldspar is also known as an authigenic mineral in sediments (adularia or microcline).

More detailed information on mineralogical and crystallographical items and conceptions used in this article is given under CRYSTALLOGRAPHY and MINERALOGY. *See* also references under "Feldspar" in the Index volume. (F. H. L.; X.)

BIBLIOGRAPHY.—For more details and a survey of the pertinent literature on which this article is based *see:* F. Laves, "Phase Relations of the Alkali Feldspars," *Jour. Geol.*, vol. 60 (1952); J. R. Goldsmith, "Diffusion in Plagioclase Feldspars," *Jour. Geol.*, vol. 60 (1952); W. S. MacKenzie, "The Effect of Temperature on the Symmetry of High Temperature Soda-Rich Feldspars," *Am. Jour. Sci.*, Bowen volume (1952); H. Sørum, "Studies on the Structures of Plagioclase Feldspars," *Kgl. Norske Videnskab. Selskabs Skrifter*, no. 3 (1951).

Detailed descriptions of the physical properties of the different feldspar varieties are given in textbooks of mineralogy as listed in the article on MINERALOGY, and in the book of A. N. Winchell, *Elements of Optical Mineralogy*, part ii, *Descriptions of Minerals*, 4th ed. (1951).

FELDSPATHOID, one of a group of rock-forming minerals similar to the feldspars (*see* FELDSPAR) in general chemical composition but with a lower ratio of silica to alkalies or containing chloride, sulfide, sulfate or carbonate radicals. They are never associated with primary quartz. Nephelite (nepheline) and leucite (*qq.v.*) are the most important members of the group: sodalite, noselite, haüynite or haüyne (for these three *see* SODALITE) and cancrinite are rarer feldspathoids that occur only as accessory minerals in rocks; kalsilite and kaliophilite are phases of $KAlSiO_4$.

Structurally the feldspathoids are tectosilicates, the SiO_4 and AlO_4 groups being linked as in the feldspars with the metal atoms and the radicals fitting into cavities in this framework. They are all easily decomposed by acids which distinguishes them from feldspars. This property is associated with the high Al:Si ratio; the aluminum is removed in solution, the structure then collapsing, often with the formation of gelatinous silica.

Among the more important rocks characterized by the presence of feldspathoids are the intrusive nephelite-syenite and ijolite (*qq.v.*) and the lavas phonolite (*q.v.*), tephrite, basanite and nephelite-basalt. Nephelite is abundant in the nephelite-syenites of Arkansas, in the United States, Canada, Greenland, India, Norway and the U.S.S.R.; cancrinite and sodalite are frequently associated with nephelite as at Bancroft, Ont., and Miass, South Urals. (W. F. FG.; C. E. T.)

FELICITAS, the Roman goddess "Good Luck," encountered from the mid-2nd century B.C. The dictator Lucius Cornelius Sulla, who from 81 B.C. styled himself *Felix*, revitalized her worship. Pompey, Caesar (whose watchword at the battle of Thapsus in 46 B.C. was "Felicitas") and the triumvir Marcus Aemilius Lepidus followed his lead.

The emperors made her prominent as symbolizing the blessings of the imperial regime. (D. E. W. W.)

FELIX, SAINT (d. *c.* 647), the first bishop of the East Angles, born and ordained in Burgundy, was sent by Honorius of Canterbury to King Sigebert, a convert to Christianity while exiled in Gaul. From his seat at "Domnoc" (Dunwich?) he worked successfully for 17 years at the conversion of the heathen in East Anglia. His relations with the Irish missionaries, especially Aidan and Fursey, were friendly, and he founded a school. He died on March 8 (his feast day), probably in 647; his relics were translated first to Soham, near Ely, then to Ramsey.

See S. E. Rigold in *Journal of the British Archaeological Association*, 24:55–59 (1961); Bede, *Historia Ecclesiastica.* (PL. GN.)

FELIX, SAINT, OF VALOIS (1127–1212), one of the founders of the order of Trinitarians (Order of the Most Holy Trinity), was born in the district of Valois, France, on April 19, 1127. He became a hermit in the forest of Galeresse, where he remained until 1187 when his disciple John of Matha (1160–1213) suggested to him the idea of establishing an order of monks who should devote their lives to the redemption of Christian captives from the Saracens. Obtaining the sanction of the pope about 1198, they founded the mother house at Cerfroid in Picardy. Felix died at Cerfroid on Nov. 4, 1212, and is commemorated on Nov. 20.

The Trinitarians (also known as Mathurins) had about 800 houses during the 15th century when their influence was at its greatest. In the 20th century the only surviving body was the Barefooted Trinitarian order, centred at S. Crisogono in Trastevere, Rome. An order of Barefooted Trinitarian Sisters was established early in the 17th century. *See* also TRINITARIANS.

FELIX, the name of three popes and two antipopes.

ST. FELIX I (d. 274), pope from 269 to 274, was elected on Jan. 5, 269, to succeed Dionysius. Felix was author of an important dogmatic letter on the unity of Christ's person (*see* P. Jaffé and W. Wattenbach, *Regesta*, n. 140). He was the focus of the emperor Aurelian's decision settling the dispute between Paul of Samosata (*q.v.*), deposed bishop of Antioch, and Domnus, his successor, in favour of him with whom "the bishops in Italy and Rome should communicate" (Eusebius, *Hist. Eccl.*, vii, 30). He died on Dec. 30, 274, and his feast day is May 30.

FELIX II (d. 365), antipope, was irregularly installed in 355 following the emperor Constantius' banishment of Pope Liberius. He was forced by popular pressure to retire upon Liberius' return in 358.

ST. FELIX III (d. 492), properly Felix II, pope from 483 to 492, succeeded Simplicius on March 13, 483. His excommunication of the patriarch Acacius for Monophysitic sympathies in 484 was followed at Constantinople by a 35-year schism. Felix' synod of March 487 fixed conditions for readmission to the church of Africans who had been rebaptized by the Arian Vandals. He died on March 1, 492, and his feast is kept in Rome on the anniversary. (H. G. J. B.)

FELIX IV (d. 530), properly Felix III, pope from 526 to 530, owed his election (on July 12, 526) to the influence of Theodoric, king of the Ostrogoths. After Theodoric's death, the election was freely confirmed. Felix wrote to Caesarius of Arles on St. Augustine's doctrine on grace and again condemned Pelagius and his disciples. He converted pagan temples into the Church of SS. Cosmas and Damian. To avoid a disputed succession Felix adopted the expedient of naming his own successor, the archdeacon Boniface (Pope Boniface II). Felix died on Sept. 22, 530. Dioscorus was elected as antipope, however, but when he died after a few weeks Boniface was recognized by all. (J. V. HN.)

FELIX V (Amadeus VIII of Savoy) (1383–1451), the last of the antipopes, was born on Dec. 4, 1383, and in 1391 became count of Savoy. In 1416 Savoy was erected into a duchy and in 1418 Amadeus added Piedmont to his dominions. In 1434 he retired to a hermitage at Ripaille near Thonon, France, where he founded and governed an order of knights-hermits. After the schismatic council of Basel deposed Eugenius IV, it elected Amadeus on Nov. 5, 1439, although he was not in orders. Amadeus accepted the election on Jan. 5, 1440, and was consecrated and crowned on July 24. As antipope, Felix V won scanty support, and he renounced his claims in 1449. He died at Geneva on Jan. 7, 1451. (E. A. R.)

FELIXSTOWE, an urban district and seaside resort in the Sudbury and Woodbridge parliamentary division of East Suffolk, Eng., 11 mi. S.E. of Ipswich by road. Pop. (1961) 17,254. Area 6.2 sq.mi. Though on the east coast, it faces south and has a frontage both to the North sea and to the estuary of the Orwell opposite Harwich, with which it is connected by Eastern Region railway ferry. There is a small dock for yachts and river shipping. The church of St. Peter and St. Paul, mainly Early English, has traces of Norman work in the 12th-century nave. The town is built partly on a high cliff and slopes down to sea level toward the southwest where the beach is shingly with some sand; the sea wall and promenade, 2 mi. long, are laid out with public gardens and pavilions, and there is a promenade pier. Felixstowe has good

golf links, and the open tournament of the East of England lawn tennis championship is held there in August. There are several yacht clubs in the vicinity of Felixstowe and yachting takes place in Harwich harbour and the rivers Deben, Orwell and Stour. There are connections by steamer with Ipswich, up the Orwell. Near the dock is an R.A.F. seaplane station. The chief industry is catering for visitors, but there is some flour milling, glove making and manufacture of electrical components. The vicinity has yielded numerous Roman remains, and a 4th-century Roman fort off Reed pond (now destroyed by the sea) formed part of the coast defense of the Litus Saxonicum (the Saxon shore).

FELL, JOHN (1625–1686), dean of Christ Church (Oxford), bishop of Oxford and benefactor to Oxford university and its press, was born at Longworth, Berkshire, on June 23, 1625, the son of Samuel Fell, himself canon and later dean of Christ Church. John Fell became a student (*i.e.*, fellow) of Christ Church at the age of 11, and took his degree in 1643. During the Civil War he fought on the royalist side, being deprived of his studentship in 1648. He continued to live in Oxford, and with a few friends carried on Church of England services throughout the Commonwealth (he had been ordained in 1647). At the Restoration in 1660 he was made canon and then dean of Christ Church. He was vice-chancellor, 1666–69. In 1676 he became bishop of Oxford while remaining dean. He died in Oxford on July 10, 1686.

Fell restored in the university the good order instituted by William Laud that had been lost during the Commonwealth, compelling attendance at lectures and keeping examiners up to their duties. In his own college of Christ Church he restored the main quadrangle (Tom quad) and built the tower over the gate, where he hung the bell (Great Tom) that still tolls nightly at 9 P.M. He instigated the building of the Sheldonian theatre, in which he installed the university press. He presented it with learned fonts acquired abroad, set up a type foundry and encouraged the foundation of a paper mill at Wolvercote, near Oxford. The "Fell" type that he introduced was discontinued in the 18th century, but rediscovered in 1874 and brought back into use. The university press printed Fell's own books, including editions of Theocritus, Aratus, the New Testament, Athenagoras, Theophilus of Antioch, Clement of Alexandria and Cyprian.

The verse

> I do not love thee, Dr. Fell,
> The reason why I cannot tell;
> But this I know, and know full well,
> I do not love thee Dr. Fell

is reputed to be the extempore translation of Martial's epigram

> Non amo te, Sabidi, nec possum dicere quare;
> Hoc tantum possum dicere, non amo te

made at Fell's request by the satirist Thomas Brown in order to avoid being expelled from the college for some undergraduate offense.

See C. E. Mallet, *A History of the University of Oxford,* vol. 2 (1924); *A Specimen of the Several Sorts of Letter Given to the University by Dr. John Fell, Oxford, 1693* (facsimile, 1928). (G. Hu.)

FELLAH (pl. Fellahin), Arabic for "plowman" or "tiller," a term used in Arabic-speaking countries, especially Egypt, to designate the peasantry as opposed to the Arabs of the desert and the townsfolk. *See* Egypt: *Administration and Social Conditions: Living Conditions.*

FELLENBERG, PHILIPP EMANUEL VON (1771–1844), Swiss educator, was born on June 27, 1771, at Bern. He purchased in 1799 the estate of Hofwyl, near Bern, intending to make schools combining manual training and agricultural and academic instruction the basis of a new educational system to raise the living conditions of the poor, and to weld them and the upper classes together in a closer union than had hitherto been deemed attainable. For some time he carried on his labours in conjunction with Pestalozzi, but incompatibility of disposition soon induced them to separate. Fellenberg's scheme at first excited a large amount of ridicule, but gradually pupils came to him from every country in Europe, both for the purpose of studying agriculture and to profit by the high moral training which he associated with his educational system. Fellenberg died on Nov. 21, 1844.

FELLING, an urban district in the Gateshead East parliamentary division of Durham, Eng., forming a southeastern suburb of Gateshead. The urban district stretches north to the Tyne and includes eight parishes. Pop. (1961) 35,602. The large industrial population is employed in the neighbouring collieries and manufactures, such as engineering, paint making at Felling Shore and Pelaw, and radar equipment at Bill Quay.

FELLOW, by origin a partner or associate, hence a companion, comrade or mate. The Old English *féolage* meant "a partner in a business." The word was, therefore, the natural equivalent for *socius,* a member of the foundation of an incorporated college, as Eton, or a college at a university. In the earlier history of universities, both the junior and senior members of a college were known as "scholars," but later, as now, "scholar" was restricted to those members of the foundation still *in statu pupillari,* and "fellow" to those senior graduate members who had been elected to the foundation by the corporate body, sharing in the government and receiving a fixed emolument out of the revenues of the college, as at Oxford and Cambridge. The academic usage of the term which dates back to the medieval university is generally applied to the members of the governing body or to holders of certain stipendiary positions called fellowships established for a fixed number of years and devoted to special study or research. The word is also used to designate privileged members of various learned societies and institutions.

In the United States the word first appeared in the 1650 charter of Harvard university which provided for five fellows among the officials of the governing body. However, in common usage the term "fellow" is applied in U.S. colleges and universities to selected students who have been awarded stipends for a year or more for graduate or postgraduate study. The selection of fellows is based mainly on intellectual and personal attributes, but financial need also may be considered. (J. M. Bk.)

FELLOWS, SIR CHARLES (1799–1860), British archaeologist known especially for his discoveries in Lycia (*q.v.*), was born in Aug. 1799 at Nottingham, where his family had an estate. In 1827 he discovered the modern ascent of Mont Blanc. He traveled in Italy, Greece and the near east, and many of his sketches were used to illustrate Lord Byron's *Childe Harold.* In 1838 he went to Asia Minor (making Smyrna his headquarters), entered Lycia and explored the Xanthus river from its mouth at Patara upward. Nine miles from Patara he discovered the ruins of Xanthus, the ancient capital of Lycia. He published his results in *A Journal Written During an Excursion in Asia Minor* (1839). Late in 1839 he again set out for Lycia, under the auspices of the British museum, taking with him the draftsman George Scharf. This visit resulted in the identification of 13 ancient cities, and in 1841 appeared *An Account of Discoveries in Lycia, Being a Journal Kept During a Second Excursion in Asia Minor.* Early in 1842 Fellows obtained a firman, or licence, by personal application at Constantinople and accompanied a British naval expedition which shipped a number of works of art to England. In 1844, his fourth and most famous expedition, he succeeded in dispatching 27 cases of sculptures to the British museum. The most famous of these are the important tomb-sculptures from Xanthus, dating from the 6th and 5th centuries B.C.; Lycian in form but purely Greek in execution, these formed a significant addition to early Greek sculpture known at that time. In 1845 Fellows was knighted. He died in London on Nov. 8, 1860.

In addition to the works mentioned above, Fellows published *The Xanthian Marbles, Their Acquisition and Transmission to England* (1843), a refutation of false statements that had been published; an edition containing his two combined journals, entitled *Travels and Researches in Asia Minor* (1852); and *Coins of Ancient Lycia* (1855).

See C. Brown, *Lives of Nottinghamshire Worthies,* pp. 352–353 (1882); *Journ. of Roy. Geog. Soc.* (1861); F. N. Pryce, *Cat. of Sculptures in the Brit. Mus.,* I, 1, pp. 118 ff. (1928). (J. H. Yo.)

FELLTHAM, OWEN (1604?–1668), English author best known for his essays entitled *Resolves, Divine, Morall, and Politicall,* was born about 1604. He became the earl of Thomond's

steward sometime before 1640, and spent most of his life at Great Billing, Northamptonshire, or at the earl's house in London, where he died on Feb. 23, 1668.

The first edition of the *Resolves* (1623) contained 100 essays written "when the author was but 18." The 2nd edition, *Resolves, a Second Centurie* (1628), contains a further 100 essays, and in the later editions the order of the two centuries is reversed. In the 8th edition (1661) the original 100 short, pithy essays are replaced by 85 more diffuse ones. Felltham's striking images, some of which were borrowed by the poet Henry Vaughan, are more original than his ideas. The 1661 edition included *A brief Character of the Low-Countries under the States*, printed separately in 1652 but written after a visit to Holland (*c.* 1628), some letters, and *Lusoria, or Occasional Pieces*, 41 poems including "An Answer to Ben Jonson's New Inn Ode" (he also contributed an elegy to *Jonsonus Virbius*, 1638), and the song "When, dearest, I but think on thee," erroneously attributed to Sir John Suckling. No further additions were made until *A Form of Prayer compos'd for the Family of the Right Honourable the Countess of Thomond* was added to the 12th edition (1709). The *Resolves* were reprinted from the 2nd edition in Temple Classics (1904).

See the articles by F. S. Tupper, *Modern Language Notes*, liv (1939); J. Robertson, *Modern Language Notes*, lvii (1943) and *Modern Language Review*, xxxix (1944). (J. Rs.)

FELO-DE-SE, a self-murderer; *i.e.*, a suicide. Not until the Suicide act, 1961, were criminal penalties for suicide and attempted suicide abolished in England. The Homicide act, 1957, provided that the survivor of a suicide pact is guilty of manslaughter rather than murder. Formerly, the property of a suicide was forfeited to the crown and his corpse subjected to degradation. Until 1823 a suicide was buried on the highway with a stake driven through the body. Virtually all such penalties were abolished before the end of the 19th century. There is great diversity in the U.S. law relating to suicide. In some jurisdictions suicide is declared a crime, and in many states an attempted suicide is punishable. Some states have held one who assists another to kill himself guilty of murder. There is substantial authority for the proposition that one who accidentally kills another while attempting suicide is guilty at least of manslaughter. (F. A. A.)

FELONY. In the English common law of crimes, offenses are classified as treasons, felonies or misdemeanours. In the modern law of England the procedures distinguishing trials of treason and felony cases were virtually eliminated by the Treason act, 1945. The law of the United States generally classifies crimes as either felonies or misdemeanours. The word felony appears first to have been applied to conduct disruptive of the feudal bond between vassal and lord, which had as its consequence the forfeiture of the fief or the lordship, as the case might be. Very early in the history of English law, however, the term was given to heinous offenses of other kinds. The most distinctive consequence of a felony conviction was the forfeiture of the felon's goods or lands to the crown. Forfeitures were abolished in England by the Forfeiture act of 1870 and have only rarely been authorized by U.S. criminal law. (*See* Confiscation and Expropriation.) At the common law all felonies except mayhem (*q.v.*) were punishable by death. Whipping was substituted for the death penalty in cases of petty larceny by a 13th-century statute. In reality, however, recognition of "benefit of clergy" in the English law relieved the felon from capital punishment in many cases (*see* Clergy, Benefit of). The procedures of felony trials differed from those for other offenses. In the early law one charged with felony could not call witnesses in his behalf. Not until 1837 was the defendant's right to be represented by counsel at the trial given statutory recognition.

The consequences of commission or conviction of a felony are numerous and important in the modern law. In the Anglo-American countries one who has been convicted of a felony may be rendered ineligible to hold offices of public trust. In the United States the convicted felon suffers the loss of civil rights, such as the right to vote, not all of which are restored upon completion of the sentence. In many jurisdictions deadly force may be employed to prevent the escape of a felon from a valid arrest. Such force may also be employed to prevent the commission of a felony or, in some jurisdictions, a violent felony. In some states of the U.S. the court is obliged to provide counsel to indigent defendants in felony trials but not in those for misdemeanours.

Among the felonies recognized at common law were murder, manslaughter (*see* Homicide), arson, rape, robbery, burglary and larceny (*qq.v.*). The number of felonies has been significantly enlarged by legislation, particularly in the modern period. The law of England has employed no consistent principle to determine the classification of an offense as a felony. In some instances crimes classified as misdemeanours involve greater social peril than many statutory felonies, and penalties for a misdemeanour may exceed those authorized for some felonies. In the United States the distinction between felony and misdemeanour is usually governed by the penalties attached to the offense. Thus a felony is often defined as an offense punishable by imprisonment in the state penitentiary, while a misdemeanour is punished by fine or a term in a local jail. Tested by any rational standard the classification of offenses in both the U.S. and English law is capricious and unsatisfactory. The need for legislative reconsideration of this important matter is common to most of the Anglo-American countries.

See Criminal Law; Misdemeanour; *see* also references under "Felony" in the Index volume. (F. A. A.)

FELSINA, a city founded by Etruscans on the site of modern Bologna (*q.v.*) in the Reno valley *c.* 510 B.C. Etruscan Felsina is known almost entirely from graveyards situated outside the city (notably at the Certosa, a monastery about 1 mi. W. of it) and from the remains of the large buildings inside the city.

Before Etruscan times, however, the Bologna area was an important centre of Villanovan Iron Age cultures of the central European Urn Field type which dominated north and west central Italy from the Po river to northern Campania, and which in Tuscany and Latium provided the ethnic substratum of Etruscan culture (*see* Villanovans; Etruscans). Villanova, the type site, is 5 mi. N.W. of Bologna, and the cemeteries west of Bologna form the basis on which all Villanovan material culture is divided into phases: Benacci I (*c.* 1050–900 B.C.); Benacci II (*c.* 900–700 B.C.); and Arnoaldi (*c.* 700–450 B.C.), the latter overlapping but culturally distinct from the Etruscan period, to which belong Certosa period graves.

Cremations of Benacci I are characterized by rough biconical cinerary urns with impressed geometrical ornament. Bronze metalwork includes lunate razors, fibulae, elaborate horse bits and belt plaques of beaten raised work. In Benacci II pottery was elaborate, often exotic, and vessels of hammered bronze (buckets, cups and trays) showing Hallstatt (*q.v.*) connections become characteristic. Arnoaldi was a phase of commercial prosperity and innovation in which close links were formed with Atestine culture (*see* Este). Pottery bore stamped designs of birds and humans; iron was prodigally used for weapons, chariots, etc; hammered bronze work, after first showing the influence of Vetulonia (*q.v.*) metalwork, produced (*c.* 500 B.C.) a series of attractive ceremonial buckets (situlae) with raised designs depicting scenes from Villanovan life. Gold jewelry and glass were known.

The Arnoaldi graves are culturally sharply separated from the Etruscan graves of the Certosa. These and the tombs of the Giardini Margherita were rich in Etruscan 5th–6th century metalwork (situlae, cistae and candelabra). Numerous fine Attic redfigure vases attest trade relations with Greece by way of Spina and the Adriatic. The earliest Etruscan tombs were marked with horseshoe-shaped stelae, carved in local Villanovan style.

By 350 B.C. Felsina had fallen to invading Gauls (Boii), who called it Bononia. It was captured by Romans in 196 B.C. and colonized in 189 B.C., and was linked in Roman times by the Via Aemilia with Rimini and by the Via Flaminia with Rome.

See A. Grenier, *Bologne villanovienne et étrusque* (1912). (Wm. C.)

FELSITE, in petrology, a field name originally applied to older (pre-Tertiary) volcanic rhyolites and trachytes in which devitrification or other alteration has rendered the matrix dense and usually compact (*see* Rhyolite; Trachyte).

Under the microscope the groundmass may often be resolved into exceedingly fine-grained quartz and feldspar. Well-

formed crystals (phenocrysts) of quartz, orthoclase and plagioclase feldspar and biotite are usually present and sometimes abundant.

The German equivalents (felsophyre, felsite-porphyry) were originally separated from rhyolite proper solely on the basis of the difference in the megascopic appearance of the groundmass. In Britain, and to nearly as great an extent in America, however, the field name felsite came to be applied to any clearly nonbasaltic but otherwise unidentifiable fine-grained volcanic or hypabyssal rock. Hence, the adjective "felsitic," meaning fine-grained. The broadness of its denotation made it an extremely useful field term but condemned it for any other purpose. (F. Cs.)

FELSPAR: *see* FELDSPAR.

FELSTED, a village in Essex, Eng., lies 10 mi. N. of Chelmsford. Pop. (1951) 1,896. Its church has a Norman tower and south arcade, while the 17th-century Riche side chapel contains a monument by Epiphanius Evesham to Richard, 1st Baron Riche of Leez (1496–1567), lord chancellor, who in 1564 had founded Felsted school, one of the best-known English public schools. There, under the patronage of the founder's heirs, boys from far and wide were taught by Martin Holbeach (1627–49) and Christopher Glascock (1650–90). Pupils included the mathematicians John Wallis and Isaac Barrow, Oliver Cromwell's four sons and William Byrd of Westover, Va. Felsted school is now governed by act of parliament. Outside the village is a beet-sugar factory of the British sugar corporation. (M. R. Cr.)

FELT, a class of fabrics or fibrous structures obtained through the interlocking of wool, fur or some hair fibres under conditions of heat, moisture and friction. Other fibres will not felt alone but can be mixed with wool, which acts as a carrier. Three separate industries manufacture goods through the use of these properties. The goods produced are wool felt in rolls and sheets, hats, both fur and wool, and woven felts, ranging from thin billiard tablecloths to heavy industrial fabrics used for dewatering in the manufacture of paper.

Felts of the nonwoven class are considered to be the first textile goods produced and many references may be found to it and its uses in the histories of ancient civilizations. The nomadic tribes of north central Asia still produce felts for clothing and shelter, utilizing the primitive methods handed down from antiquity.

Wool felts of the "true" or nonthread structure class are produced as both rolls and sheets. Roll felts are made in thicknesses from $\frac{1}{32}$ to $1\frac{1}{2}$ in., and up to 80 in. wide and 60 yd. long. Sheet felts are produced up to 4 in. thick usually as 36 in. squares but other rectangular sizes as well as ovals and circles are made. Wool felts of the better grades are made of all wool but the felting power of wool is such that as little as 10% wool in a blend with nonfelting fibres is sufficient to produce a felt.

The wool fibres selected for felting are usually less than $1\frac{1}{2}$ in. in length and must be of good felting quality and strength. The fibres are scoured, treated to remove tar, paint and vegetable matter such as burrs, and then opened and blended to form a batch. The prepared blend is fed to a carding machine, which further opens, blends and combs the fibres into a web of single fibre thickness that is laid down on an endless apron to form a batt. In most roll felt manufacture two or more cards are set at right angles to each other so that the web from at least one is laid down at right angles to the others to produce "cross" in the batt and dimensional stability in the finished felt.

The carded batts are produced to predetermined weights, after which one or more batts, but usually several to a felt, are laid up on the hardening machine and sprayed with water. Hardening consists of drawing the moistened laid-up batts between aprons across a steam chamber. Steam is forced into the batts to activate the fibres, after which the steamed section is drawn beneath a heavy heated platen. The platen is lowered onto the moist, hot batt and is agitated in a horizontal plane.

The heat, moisture and friction is sufficient to felt and interlock the fibres from the individual batts into a unified mass. After a requisite time the platen is raised, the hardened section drawn forward, and the next area, which has been steamed meanwhile, is subjected to the action of the platen. This operation is plate hardening; a similar operation done on a continuous basis between rollers is called roller hardening.

After the hardening operation, the lightly felted piece is rolled and allowed to cool and drain. Only the thickness of the batts is affected by hardening, whereas area shrinkage or felting up to as much as 50% is accomplished in the next operation known as fulling. The hardened batt is passed through a fulling aid, usually a solution of soap or acid, although occasionally warm water will suffice, and is rolled up and placed in the fulling mill. One type of fulling mill consists of a binlike receptacle with a concave front, straight sides and a back that consists of one or more movable hammers that pound, turn and shrink the goods to the desired dimensions.

The scouring, dyeing, treating and finishing operations that follow are done much as for the production of woolen cloths. Sheet felts follow much the same process except that after carding the batts are cut up and plied to specified sizes and weights and then hardened, fulled and washed as individual sheets. Maximum dimensional stability, density and strength are obtained in the sheet felt process.

Hair felts, widely used in polishing operations, are made much as described above for sheet felts and are an important specialty item to the wool felt industry.

The uses of felt are myriad. Some of the more important include wicking, absorption, vibration isolation, insulation, padding and packaging, polishing, sealing and gasketing, as well as apparel and decorative fields.

Most felts are made to close specification requirements, particularly for mechanical and industrial applications where high standards of quality, reproduction and tolerances are constantly met.

Hat felts are made of both wool and fur. Wool hats are made much as already described for wool felts except that a narrow web is taken from the card and is collected on an egg-shaped mandrel. Two cone-shaped pieces are obtained from this starting shape by further felting operations from which the finished hat bodies are shaped and formed. Beaver, hare and rabbit furs are among the fibres used in fur felt hats and all of these must first be treated with strong chemicals in an operation known as carroting in order to provide the fibres with optimum felting power.

In the manufacture of fur felt hats a blend of furs is air laid on a rotating perforated cone surface with a wet cloth and with a vacuum pulling from within. The fur collects and is removed as a fragile cone shape. After many wet finishing operations, including dyeing, the felted cone is molded to a rough hat shape. Many more dry finishing operations are required to reduce the rough hat to the finished article.

The manufacture of woven felts follows to a large degree the conventional woolen cloth practice. Wools of selected fineness, length and felting property are scoured, blended, combed and spun into yarns. The yarns are woven into the rough cloth structure required depending upon the type of end goods planned. The rough cloth is soaped and fulled or milled in the fulling mill where felting or shrinkage is carefully controlled to preset dimensions after which scouring, dyeing in the case of some of the lighter cloths, and other textile finishing operations follow.

Some special felts for the papermaking trade are made as endless belts 200 in. or more in width. Highly skilled operators hand weave or join the ends to produce the endless belt so that no joint or seam is discernible. Special machines are used to make this class of woven felts since the goods must be run as belts and therefore have to be loaded and unloaded from the side of the machines rather than from the front or back as is conventional.

(T. J. G.)

FELTHAM, an urban district of Middlesex, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Brentford and Chiswick, and Heston and Isleworth to form the new London borough of Hounslow (*see* LONDON). Feltham is 15 mi. W.S.W. of Charing Cross. Pop. (1961) 51,041. Area 7.7 sq.mi. It is a residential and industrial district containing part of London airport, British Railways' Southern region marshalling yard (opened 1921), the central ordnance depot of the Royal Army Ordnance corps, a Borstal institution and the

ship hydrodynamics laboratory of the National Physical laboratories. Hanworth was a royal hunting seat much favoured by Henry VIII; the moat of the castle (burned in 1797) remains. The records of the 19th-century church of St. George date back to 1300 and Oriel school is so named because Adam de Brome, rector in 1315, founded Oriel college, Oxford. In Bedfont many Roman relics have been found. The parish church of St. Mary (with early English mural paintings), by the village green, dates from the 12th century.

FELTON, CORNELIUS CONWAY (1807–1862), U.S. classical scholar, was born on Nov. 6, 1807, in West Newbury, Mass. His annotations on Wolf's text of the *Iliad* (1833) and his *Greece, Ancient and Modern* (2 vol., 1867) were outstanding works. He graduated from Harvard college in 1827, taught at various academies, and joined the Harvard faculty in 1829. In 1860 he became president of Harvard, a position he held until his death, at Chester, Pa., on Feb. 26, 1862.

Felton was a man of unusual intellectual breadth, and vigorously opposed the growing neglect of the humanities in U.S. universities. He edited many classical texts and made several translations.

FELTON, WILLIAM (1715–1769), English clergyman and composer of organ and harpsichord music, was born at Drayton, Shropshire, and educated at Manchester Free school and St. John's college, Cambridge. He was ordained in 1742 and in 1743 was made a vicar choral at Hereford cathedral. In 1769 he was appointed chaplain to Princess Augusta, mother of George III. A gifted performer on organ and harpsichord, he published two books of harpsichord "lessons" and five sets of organ concertos, amounting to 32 concertos in all. His most famous melody is "Felton's Gavotte," which appeared originally in his Concerto, Opus 1, no. 3 and which achieved celebrity during the Jacobite rebellion. Under the name "Farewell Manchester" it is believed to have been played by the troops of the Young Pretender when they left Manchester in 1745. Felton died at Hereford on Dec. 6, 1769.

See C. L. Cudworth, "The English Organ Concerto," in *The Score* (Sept. 1953). (Cs. Ch.)

FELUCCA: *see* Boat.

FENCE. A fence is a man-made barrier erected to confine animals within bounds or keep them out of fields, to exclude unwelcome trespassers, and to enhance the beauty of buildings, gardens and fields.

Materials and methods of constructing fencing on farms reflect changes in technical development. Before the discovery of manufacturing methods for steel fencing, farmers built from materials readily available. Settlers of stony land cleared their fields of stone and erected fences by the expedient of piling stones about the field boundaries. Where stones were not abundant, timber, sod and living or quickset hedges formed fences. When properly trimmed, hedges make a permanent fence as attested by the English privet fence, the Osage orange and the multiflora rose of the United States. Hawthorn (*q.v.*) has been used in England since Roman times. Various species of cactus have long been used for living fences, especially in southern Mexico and Latin America and in Africa. Mud, adobe, brush and wattled fences have been widely employed in sparsely timbered areas; homesteaders in Kansas sometimes made fence posts from native limestone. Farmers with ample timberland chose to construct fences of wood.

In the United States in colonial days, five types of common wood fences were: split rail laid in a zigzag pattern, sometimes called worm; mortised and tenon; stake and bunk; jack pole or jack and pitch pole; and picket. In the mortise and tenon fence, rectangular holes were cut through the posts to support the straight rails, hewed to fit into the holes. The stake and bunk was constructed by placing rails in a straight line into a ladderlike structure of two posts with wooden spacers between them and mounted on a bunk or block. Jack pole and pitch pole fences were both built on X-shaped post structures. Poles to form the fence ran horizontally on the common jack pole fence, but were placed diagonally with one end resting on the ground in the pitch pole fence.

Farmers on the plains of Russia and the United States built earth fences of sod or turf since this material was readily available and low rainfall allowed them to stand over a period of years.

Wire for fencing was first used in the 1800s. Barbed wire and woven wire were developed between 1860 and 1883 when the first woven wire was produced for sale. The industry grew rapidly. In 1923 there were 552 styles of woven wire being produced and sold in 2,072 sizes of packages in the United States. The national bureau of standards of the United States worked to reduce this great variety. Five standard styles of barbed wire were developed, all of them packed in standard 80-rod rolls. Woven wire with rectangular mesh and hinged joints serves for most farm field use. Eight principal sizes are identified by number such as 939-6-11. This means that the wire has 9 horizontal line wires, is 39 in. tall, has vertical stay wires 6 in. apart, and the wires are 11-gauge, except the top and bottom line wires. All wire is galvanized for corrosion resistance. Hinged joint woven wire is packed with 20 rods in each roll.

Other forms of steel fencing include lightweight poultry netting from 12 to 72 in. tall, with 1- or 2-in. mesh; and heavyweight link fence as used by industry.

Post durability is an important factor in determining the life of a steel fence. Reinforced concrete, steel and wood are popular post materials. Although the heartwoods of some species such as black locust, catalpa, cedar, cypress, juniper, mulberry and Osage orange have fairly good decay-resistant properties, scarcity of these species created demands for preservative-treated posts. Wood preservatives are classified as either oils such as coal-tar creosote and petroleum solutions of pentachlorophenol, or water-borne salts such as copper sulfate and sodium arsenate. These materials have been effective in prolonging post life when properly applied.

Traditionally, posts were placed 1 rod (16½ ft.) on centre in the farm fence line, but later standards recommend a 14 ft. on centre spacing. Special bracing must be constructed at the corners and at 20-rod intervals along straight lines of woven wire. Tests conducted at Iowa State college showed that an effective brace system is composed of three well-set posts 8 ft. 6 in. on centre. Two horizontal compression braces are supported on dowels set 8 to 12 in. below the top of these posts. The two braced panels are tied with diagonal tension members made of four strands of smooth galvanized 9-gauge wire twisted tightly to prestress the assembly.

Electric fences are for temporary use where close confinement is not essential. Since they are not a physical barrier, but a symbol of electrical shock in the mind of livestock, they are seldom satisfactory as a permanent fence. When using impulsive electrical charge on fence wire, safety precautions such as outlined in the regulations of British Standard 1222, "Battery-operated electric fences," should be followed. Insulators on the wire should resist passage of current to the ground when submitted to a 1,000-v. potential. *See* also Wire.

Bibliography.—Edward G. Molander, "Farm Fences," U.S. Department of Agriculture *Farmers' Bulletin 1832* (1954); *Building Farm Fences*, Coordinator's Office, Agricultural Engineering Department, University of Georgia (1954); Henry Giese, *Farm Fence Handbook*, (1938); "Electric Fencing," Ministry of Agriculture and Fisheries *Bulletin 147* (1953). (N. C. T.)

FENCING. Modern fencing (Fr., *escrime;* Ital., *scherma*) is a world-wide sport derived from the ancient art of offense and defense with a sword. It is practised with three different weapons: the foil, épée (or dueling sword) and sabre. Each weapon has its own history, characteristics and rules; but the objective of all modern fencing is to score by touching the opponent's target and to avoid being touched.

In earlier days fencing was also practised with wooden weapons, such as the quarterstaff, singlestick and cane. Other obsolete forms include the Japanese game *kendo*, similar to quarterstaff but highly conventionalized as to ceremony and method of scoring; the German students' duels (*schläger-mensur*) designed as a test of courage rather than skill; and bayonet fencing, found in certain military establishments.

Modern fencing, from the point of view of the number of competitors and nations represented, has been a major Olympic sport since the games were revived in 1896. Its ruling body, the Fédération Internationale d'Escrime (F.I.E.), founded in 1913, comprises about 60 countries and conducts annual world champion-

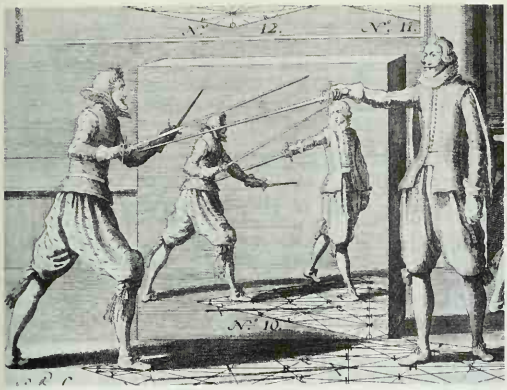

FIG. 1.—LONG WEAPONS AND GEOMETRICAL DESIGNS OF SPANISH FENCING MASTERS OF THE 16TH CENTURY. A CIRCLE WAS INSCRIBED IN A SQUARE INTERSECTED BY CHORDS, AND PUPILS WERE INSTRUCTED BY THIS DIAGRAM

ships except in Olympic years. The Amateur Fencers League of America is affiliated with the F.I.E. Fencing is predominantly a participant (rather than a spectator) sport that can be enjoyed competitively by a varied age group and by both men and women.

This article deals with the historical background and development of fencing as a sport, fencing weapons and equipment, rules and customs of fencing and fencing technique including footwork and fundamentals of foil, épée and sabre fencing.

Historical Background.—In the history of fencing, two great overlapping eras may be discerned. The first spans the period from ancient times to the 19th century, during which the art of swordsmanship was studied primarily for its practical utility (*see* SWORD). The second is the period of fencing as pure sport; in terms of the modern game, it dates roughly from the 18th century to the present day.

Although the sword was the chief weapon of battle until the introduction of gunpowder, relatively little is known about the technique of swordsmanship prior to 1400. The legendary skill of the heroes of Greek, Roman, Germanic and medieval epics seems to have been based mostly on strength and agility. During the golden age of chivalry the two-handed sword used by both knights and footmen was intended to crack heavy armour by powerful strokes with the edge. When, in the 15th century, the invention of firearms destroyed the effectiveness of heavy armour, the trend toward lighter, better-balanced weapons led to greater reliance on skill in the handling of the sword. Quick-firing weapons gradually rendered the sword obsolete in warfare, but the prevalence of dueling and brigandage required continued attention to the art of swordsmanship as a matter of personal safety. Guilds of professional fencing masters were organized and at times enjoyed great social prestige.

For a time fencing masters jealously guarded their knowledge, giving lessons behind closed doors, restricting practice to pupil and teacher, and forbidding disclosure of their "secret thrusts," or coups, which often cost fortunes to learn. Beginning in the 16th century, however, the publication of illustrated fencing treatises opened the way for testing the various theories and methods of swordsmanship. It seems clear that the secret thrusts of old were basic actions improved to a high degree of efficiency through long practice and concentration, with particular attention to the factors of surprise, timing and distance, which are still the keys to success in the sport of fencing.

From a technical viewpoint, the edge of the weapon seems to have been used exclusively until about 1500; thereafter preference was given to the one-handed rapier, and the faster and deadlier point thrust gained ascendancy. The rapier was used chiefly for offensive purposes; the defense was entrusted to the left hand, which carried a buckler or cloak and, eventually, a dagger for use at close quarters. Footwork at first was based on the elaborate geometric designs of Spanish masters, but was improved by the discovery of the effectiveness of the lunge during the second half of the 16th century. The next major advance was the use of a single weapon for both offense and defense, which led to the modern fencing position with the body in profile to offer the smallest target and to increase the reach of the lunge. With the development of the riposte or counteroffensive after the parry, the fundamental structure of modern swordplay with the thrusting weapon was completed, largely by Italian masters, by the beginning of the 17th century. Further refinements resulted from the introduction of the smallsword after 1650, the invention of the French foil about the same time, the evolution of the dueling sword with a rigid triangular blade and the development of a rough mask for practice in the 18th century.

Although the cutting weapon never disappeared, its technical development was much slower. The single-edged broadsword, or backsword, remained the "Englishman's traditional weapon" until the reign of Elizabeth I; it was used for offensive purposes, with a buckler for defense. A basket-hilt sabre was used in Germany for students' duels. The heavy cavalry sabre, which remained a weapon of war until modern times, featured wide circular movements from the wrist and parries made by countercuts. However, by modern standards, the handling of these weapons required only rudimentary skill. Technical advances were made chiefly by Italian masters in the 19th century, and resulted from the prevalence of sabre duels in Italy and eastern Europe under rules similar to those prevailing for combat with the thrusting weapon.

Even a brief history of fencing must refer to the symbolic importance of the sword in ceremony and social status over the centuries and to the ancient notion that the duel (*q.v.*) was an acceptable method of settling disputes. Faith in divine judgment on the outcome characterizes the individual combats between Paris and Menelaus and between Ajax and Hector in the *Iliad*, the Germanic judicial institution of trial by battle and the chivalric tradition of the middle ages. Later, the duel was justified as a remedy for the deficiencies of the law in matters of personal honour. The duel had great impact upon the development of fencing as a sport, not only with respect to the technique of handling the weapons but also in the traditions of courtesy embodied in the punctilious dueling codes.

Development of Fencing as a Sport.—*Foil Fencing.*—The pivotal fencing bout (not a duel) in *Hamlet* indicates that friendly tests of skill in swordsmanship were well established by the year 1600. But fencing did not develop into a distinct game with its own rules for at least another century. The credit for this achievement is usually given to D. Angelo and G. Danet, who wrote treatises on fencing in the middle of the 18th century. The equipment for the new sport included the foil, originally designed as a

FIG. 2.—TWO-HANDED SWORD AGAINST RAPIER IN A MATCH. THE RAPIER, A STRAIGHT TWO-EDGED SWORD USED FOR THRUSTING, TOOK THE PLACE OF THE ESPADON WHEN THE USE OF ARMOUR WAS DISCONTINUED AND THE HEAVIER WEAPON WAS NO LONGER REQUIRED

practice weapon for the smallsword, and the metal practice mask with a horizontal eye slit. The rules were based on certain conventions of play originally adopted for safety reasons prior to the introduction of the mask. These conventions limited the target to the trunk of the body, and provided an orderly alternation of play between the contestants by specifying that the attack had the "right of way" until it was parried; then the defender's riposte had the right of way until it was parried, and so on. Following the invention of the wire-mesh mask around the year 1800, the new game made rapid strides. The rivalry of the French and Italian schools of foil fencing gave rise to the first great international tournaments. Emphasizing precision of movement, split-second timing, deception and counterdeception, fencing has been likened to a game of chess in the variety and intricacy of its actions; and its containment within the framework of the *phrase d'armes* or sequence of play turns the bout into a courteous but spirited argument. Until the end of the 19th century, all the outstanding fencers were foil players. An electrical scoring apparatus was adopted for international foil competitions in 1956.

Sabre Fencing dates from the middle of the 19th century, when the Italian masters introduced a light practice weapon and adapted the conventions of foil play to it. The limited target excluded the legs, and the orderly alternation of play was required. However, scoring could be done with both the point and the cutting edges, thus adding a new dimension to the diversity and complexity of the actions. Early in the 20th century, a number of masters in Hungary, notably I. Santelli and L. Borsody, revolutionized the technique of sabre fencing by favouring a weapon no heavier than the foil and by emphasizing speed, co-ordination and other athletic aspects of the game. By the middle of the century, the popularity of the cut-and-thrust weapon rivaled, and in many countries surpassed, that of the classical foil.

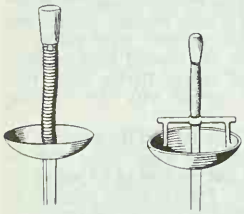

FIG. 3.—FRENCH (LEFT) AND ITALIAN (RIGHT) FOIL HANDLES

Épée Fencing began late in the 19th century as a reaction against the conventions of foil play and a tendency to score on "form" rather than effectiveness. A number of amateurs became interested in fencing outdoors for a single touch anywhere on the body with blunted dueling swords under rules that reproduced the prevailing conditions of the duel. The French term for the dueling sword, *épée de terrain*, indicates the original purpose of the new game exactly, but this realistic fencing soon followed the foil and sabre into the realm of pure sport. The special character of épée fencing was preserved through the elimination of conventions, although the number of touches per bout was increased to three in 1932 and to five in 1955. The decisive change came with the adoption of the electrical scoring apparatus in 1935, which led to an open game, with ample room for highly individualistic styles, that made épée fencing the most popular form of the sport in international competition. Épée fencing is one of the sports in the modern pentathlon, the others being running, swimming, riding and shooting.

Fencing Weapons and Equipment.—Because of the modern emphasis on speed, fencing weapons are usually lighter than the maximum weight permitted by the rules: 500 g. (17.637 oz.) for foil and sabre, 770 g. (27.16 oz.) for épée. The maximum overall length of foils and épées is 1,100 mm. (43.307 in.); of sabres, 1,050 mm. (41.338 in.). Blades are made of finely tempered steel, with a maximum length of 900 mm. (35.433 in.) for foil and épée, and 880 mm. (34.646 in.) for sabre.

The foil is the only weapon used by both men and women. Its two principal forms are the French and Italian (fig. 3). The French favour a plain handle about eight inches long, slightly curved to fit the palm of the hand along the base of the thumb, with a pommel used chiefly for balance. The Italian handle is shorter and straight, with a crossbar about two inches from the guard; balance is obtained by a strap that binds the weapon to the wrist. In both types the weapon is held firmly with thumb and forefinger, while the other fingers control the movement of the point. With the Italian handle, the top joint of the middle finger hooks over the crossbar; this and the strap provide a somewhat stronger grip than the French handle (fig. 4). The latter, however, gives greater freedom of action to the fingers and wrist, particularly at close quarters. Other types of handles have been designed to combine the best features of the French and Italian styles, but have never attained the popularity of the older handles. Under the rules, disarmaments have no effect on the score, since touches after disarmament are not counted. The foil guard is normally circular, with a maximum diameter of 120 mm. (4.724 in.). The blade is rectangular in section, very flexible, tapering to a blunted tip; however, the electrical foil button is rounded and burred to insure registration of hits that land squarely on or off the target.

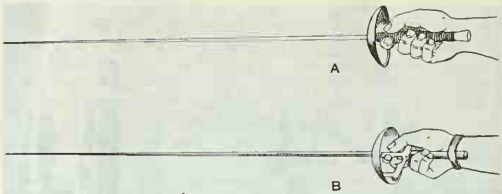

FIG. 4.—FRENCH (A) AND ITALIAN (B) FOIL GRIPS

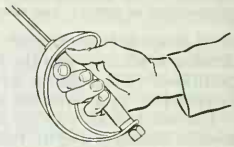

FIG. 5.—SABRE GRIP

The construction of the épée is similar to that of the foil, but the Italian style of handle is not widely used. The guard is larger, 135 mm. (5.415 in.) in diameter, and sometimes mounted off-centre. The blade is triangular in section and fairly rigid; a special tip with three small prongs is used with nonelectric weapons to facilitate judging. In the electrical weapon, the tip is rounded and burred, and is fitted with a spring capable of resisting a pressure of 750 g. (26.455 oz.) before the apparatus registers a touch.

The sabre handle is plain and slightly curved. It is grasped so that it lies clear of the palm at the fleshy base of the fingers (fig. 5). The blade is V-shaped and narrow; it is rigid on the theoretical cutting edges, but quite flexible on the flat plane. The guard sweeps around the back of the hand to the pommel, so that it protects the knuckles against cuts; in size the guard must pass through a gauge 150 mm. (5.905 in.) by 140 mm. (5.512 in.), the flat of the blade being parallel to the 150-mm. sides.

All fencers wear a strong wire-mesh mask, a white suit made of closely woven canvas or gabardine, a glove with a cuff that overlaps the sleeve of the jacket and flat-soled shoes. Women must wear chest protectors. With the electrical épée and foil, the equipment includes a body cord that hooks up to the central apparatus; in foil fencing a metallic vest is also required. An elbow guard is optional in sabre fencing.

Rules and Customs of Fencing.—Since 1914, when the international rules were codified, the sole criterion for judging formal competitions has been the number of touches scored. Bouts are judged by five officials. The president of the jury starts and stops the play and awards the touches. Two judges watch each contest and announce, by raising a hand, when a hit has landed on or off the target. However, when the electrical apparatus is used for épée or foil, there is only one official. In informal bouts each fencer acknowledges the touches he receives.

In international events, bouts are held indoors on linoleum or cork strips about 2 m. (6 ft. 6¾ in.) wide and 18 m. (59 ft.) long. If a fencer retreats more than 4 m. (13 ft. 1½ in.) in foil and 10 m. (32 ft. 9¾ in.) in épée and sabre, he is penalized one touch; if he steps off the side of the strip, he loses 1 m. (3 ft. 3⅜ in.) in distance.

At the beginning of the bout, the contestants face each other

in the centre of the strip and salute by raising their weapons (guard level with the chin) and bringing them smartly down. At the command "On Guard," the fencers put on their masks and take a guard position. The president then asks "Ready?" and, if neither fencer says "No," orders them to "Fence!" The contestants are free to fence as they please, each trying to touch his opponent and to avoid being touched, until "Halt!" is called.

In épée the entire body is valid target; in foil and sabre the target is limited (fig. 6) and hits on the invalid parts of the body stop the action. Since Jan. 1, 1960, the target for women (who participate in foil fencing only) has been the same as that for men and the target has been the same for the electrical and nonelectrical apparatus. If both contestants are hit, but with a sufficient time difference, only the first touch counts. If the hits are simultaneous, a touch is scored against both fencers in épée; but in foil and sabre the hit that has the conventional right of way prevails. After each score, the fencers go back to the centre and play is started again as before; if no touch is awarded, play is resumed at the point where it was halted.

Infighting is allowed, but as soon as there is a clinch (*corps-à-corps*), so that the fencers cannot use their weapons freely, the bout must be stopped. In épée a fencer is permitted to force the clinch without penalty, but in foil and sabre this is considered a violation of the conventions of play; the fencer is warned and then is penalized one touch for each offense. In all weapons dangerous play and unnecessary roughness are strictly forbidden.

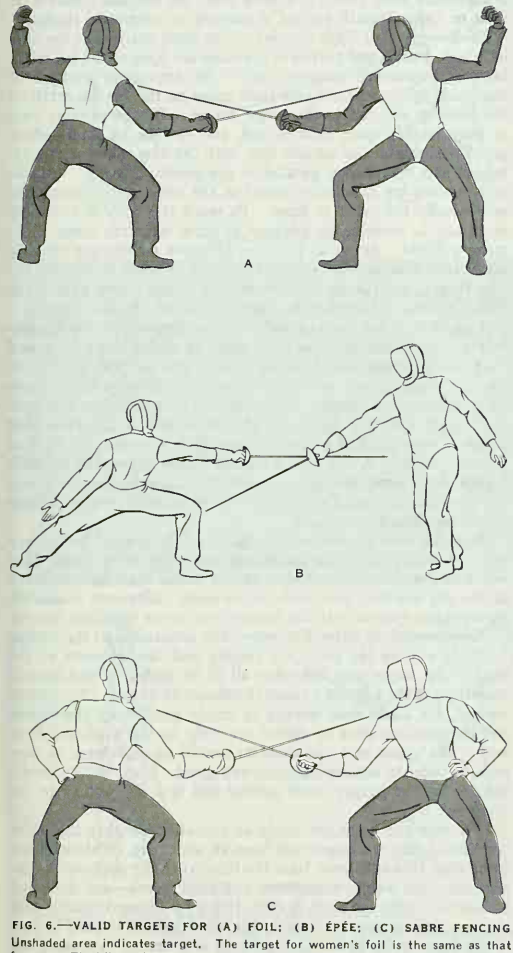

FIG. 6.—VALID TARGETS FOR (A) FOIL; (B) ÉPÉE; (C) SABRE FENCING
Unshaded area indicates target. The target for women's foil is the same as that for men. The bib, no longer valid target in foil, must not extend below the collarbone. The lower limit of the sabre target is a horizontal line passing through the angle formed by the thighs and trunk of the fencer when in the guard position

FIG. 7.—THE LUNGE IN FOIL AND ÉPÉE FENCING

Under F.I.E. rules bouts for men in all three weapons are fenced for five touches; women's foil bouts are for four touches. When one contestant has received the specified number of touches, each fencer salutes his opponent and the jury, and then shakes hands with and thanks his adversary.

Major individual competitions are held by the round-robin pool system. The entries are grouped into pools of six to ten contestants who fence one another, with the top one-third to one-half qualifying for the next round. The elimination process is repeated until only eight or nine fencers remain for a final round robin. Places are determined by the number of victories scored in the final round; ties for first are fenced off, but for other places ties are resolved in favour of the competitor who has received the fewest touches, and if a tie still exists the one who has scored the most touches gets the highest ranking. A number of national championships are conducted on this basis only up to the point where 16 or 32 contestants remain; then the competition proceeds on the basis of direct elimination, each match being fenced for the best two out of three bouts.

The pool system is also favoured for team events in the world and Olympic championships, with a final round of four teams. Each team consists of four fencers and two alternates, and each match is for 16 bouts. If the match ends at 8-all, the winner is the team that has received the fewer touches.

Technique.—*Body Balance and Footwork.*—Although there are many excellent books on fencing, the best way to learn the sport is to take lessons from a qualified teacher. Successful fencing in all weapons demands perfect co-ordination of hand technique and footwork, and high achievement normally requires constant training with a competent fencing master, even after the competitor has reached championship calibre. There are differences among the exponents of various schools of fencing, but all the leading masters agree in their emphasis upon the importance of body balance and footwork.

To take the basic guard position the fencer stands with heels together and feet at right angles so that the front foot points at the opponent; then he moves the front foot about $1\frac{1}{2}$ lengths forward, bends both knees distributing the weight evenly on the legs, and keeps the trunk erect. The sword arm is usually in one of the guard positions; the back arm in foil and épée is raised, palm up, shoulder high and then is bent at the elbow and wrist for balance, but in sabre the back hand rests on the hip. From this position, the fencer must be able to advance (front foot first), retreat (rear foot first), jump forward or backward, lunge and recover smoothly.

In the lunge, the body is propelled forward by straightening the back leg and advancing the front foot as far as consistent with balance and control; usually this means that the knee should be directly over the instep at the end of the lunge. Simultaneously the sword arm is fully extended and, in foil and épée, the back arm is also extended (fig. 7). The recovery from the lunge is to

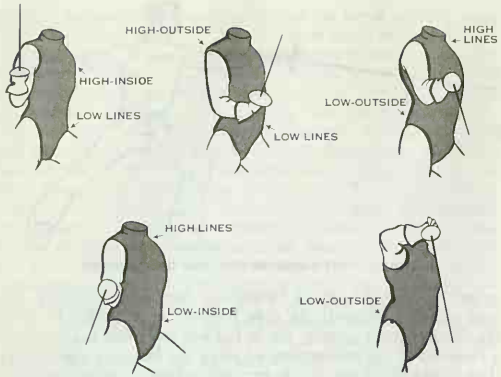

FIG. 8.—FOIL LINES OF ATTACK AS DETERMINED BY THE POSITION OF THE DEFENSIVE HAND

the guard position by flexing the rear leg and bringing the front foot back, or by advancing the rear foot to its normal distance from the front foot. Occasionally the *flèche* or running attack is used instead of, or as a continuation of, the lunge. This action is executed by bringing the back foot forward ahead of the front foot as in running. The *flèche* increases the reach of the fencer, and is particularly useful in épée and sabre, but it sacrifices balance and control of recovery and must be used judiciously.

Footwork is the key to the mastery of distance and timing; an otherwise perfectly executed attack will fail if the weapon cannot reach the target, or if the opponent can see the action coming in ample time to parry or retreat.

Fundamentals of Foil Fencing.—Facing his opponent, a fencer can see the "open lines of attack" according to the position of the defensive hand. The four possibilities are high-outside, high-inside, low-outside, low-inside (fig. 8). There are two guards for each line: 3rd and 6th for high-outside, 1st and 4th for high-inside, 2nd and 8th for low-outside and 5th and 7th for low-inside. In the first-named guard for each line, the weapon is held with the fingernails down (pronation); most foilsmen, however, hold the weapon with the nails up (supination), and the preferred guards are 6th and 4th (fig. 10). When a fencer is in 6th, the elbow should be turned in so that it is six to nine inches in front of the flank, and the weapon should be held so that it forms a straight line from elbow to tip. The tip should be level with and slightly to the right of the opponent's mask.

The simplest attack is a straight thrust into an open line. If the blades are in contact (engaged) on a closed line, the attacker may pass his point into an open line by a small movement of the tip, or he may force an opening by a beat or by exerting pressure upon and gliding along the opponent's blade. When the weapon is held in supination, the point on reaching the target should cause the blade to form an upper arc.

The defender may avoid the attack by retreating or sidestepping, but the parry is preferred because it gains the right to riposte. Parries may be straight or circular (counterparries). The straight parry is made by a blocking movement or a sharp beat—usually executed without displacing the elbow—that meets the opponent's blade in the line of the attack. The counterparry consists of a small circle with the point that picks up the opponent's blade and carries it back to the guard position from which the parry was begun. Parries are numbered according to the guard positions where they block the opposing blade. The preferred foil parries in the high lines are 4th and 6th, and the corresponding counterparries; in the low lines, 7th and 8th. In the Italian school, the 7th parry is called the semicircle (*mezzocerchio*). Occasionally 2nd and 5th are used, but 1st and 3rd are practically obsolete.

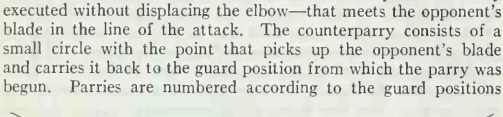

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FIG. 9.—STOP THRUST TO THE WRIST FROM THE STRAIGHT ARM OR INTERMEDIATE GUARD POSITION IN ÉPÉE FENCING

To avoid the parry, the attacker may resort to timing, force or guile. He may attack so fast from close distance that the defender cannot react quickly enough to parry. He may control the opponent's blade by a bind or envelopment, catching the weak part of the defensive blade (the third nearest the point) with the strong part of his own (the third nearest the guard) in a semicircular or circular motion. He may make a feint and then deceive the defender's effort to parry; or he may make a false attack, intending that it be parried, in order to parry the defender's riposte and score on the counterriposte.

The defender after a successful parry has a similar choice of tactics on the riposte. In addition, if the attack is delayed or made in two or more movements, the defender may counterattack by a stop thrust, but if both contestants are hit, the stop to be valid must land before the final movement of the attack has begun. The same principle applies when the attacker makes a remise or counterattack against a delayed or composite riposte.

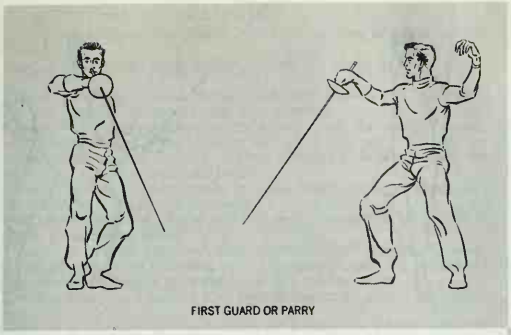
Fundamentals of Épée Fencing.—The basic analysis of the lines of attack, guards and parries is the same for épée as for foil, since both are thrusting weapons only. An impressive number of champion épéeists have based their game on the fundamentals of foil fencing, adapted to the larger target. The contestants tend to keep farther apart than in foil, and to take an intermediate guard position on the outside line, with the arm more or less extended and the weapon parallel to the ground (fig. 9). Attacks and ripostes are frequently aimed at the wrist and forearm, and occasionally the mask or knee. To reach the body it is usually necessary to combine an advance or jump with the lunge, or to make a *flèche*. As far as possible, offensive actions are made in opposition, blocking the adversary's blade in order to prevent the stop thrust; and parries must be made with the strong part of the blade, raising or lowering the hand to achieve the same result.

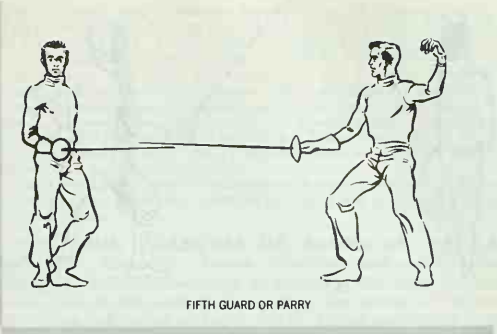
A number of outstanding épée fencers, however, avoid engagements of the blade and base their game on angled shots under and over the opposing arm both on attack and defense, relying on shifting distance, and accuracy of point in the stop thrust more than on parry and riposte. Tall men with long arms find this style particularly effective, especially with the electrical apparatus that registers only the first of two touches if it is one-twenty-fifth of a second ahead. A few strong fencers follow almost the opposite tactics, developing their game around the straight-arm guard, with the arm fully extended so that it and the weapon form a straight line from shoulder to point.

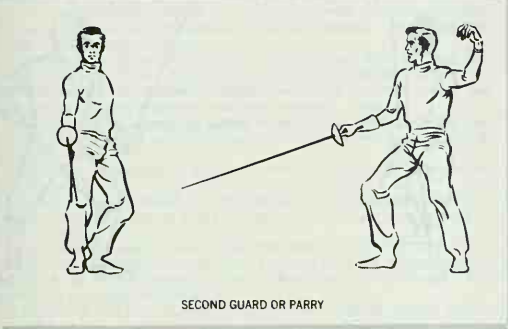
With the épée the fencer can attain a fair level of proficiency by capitalizing upon his individual resources more easily than with other weapons, and the less skilful fencer has a better chance to win any one bout than with foil or sabre. However, consistent victories are open only to the stronger and more complete fencers.

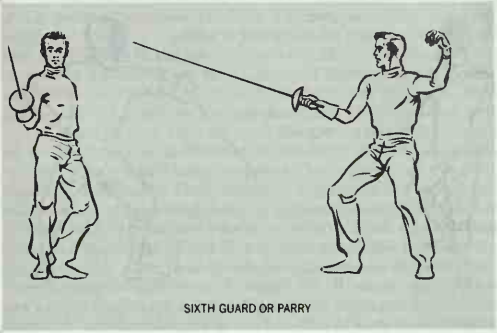
Fundamentals of Sabre Fencing.—The availability of the cutting edges as well as the point for scoring and the inclusion of the head in the target give the sabre all of the technical and tactical variations of the foil and a special brilliance of its own. For proper control, the sabre must always be firmly grasped by the fingers and its direction must be guided precisely by the wrist and forearm. The upper arm and shoulder should be as relaxed as possible, in order to achieve lightness and speed. Hard hitting results from a lack of proper blade control and is a discourtesy to the opponent.

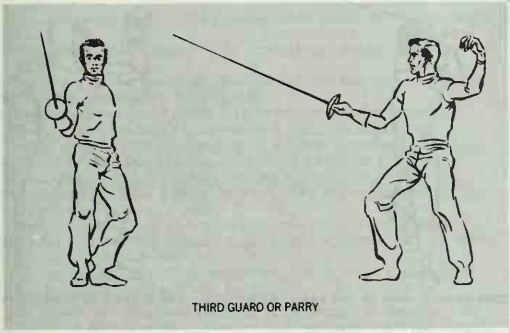
Hits with the point are made in pronation, so that the blade bending against the target will form an upper arc. Cuts with the front edge (the side away from the thumb) to the opponent's outside line—the sword arm, flank and right cheek—are delivered horizontally with the hand in pronation by a forward motion ending in a light tap on the target; the same motion is used in cuts to the head or the inside of the sword arm except that these are made vertically with the thumb uppermost. Cuts to the left cheek and chest are usually made on the way back from a full extension

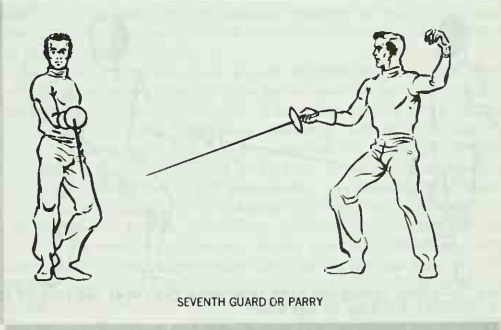


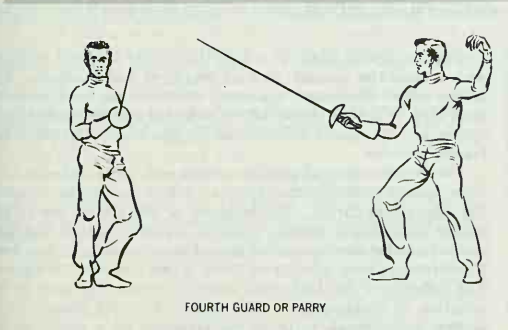












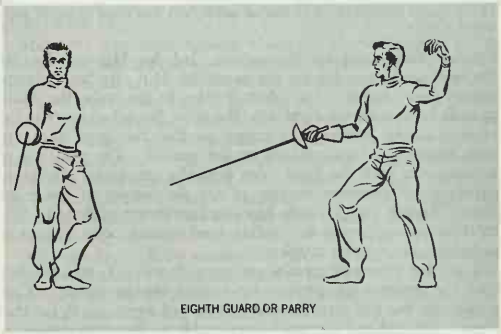


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FIG. 10.—FOIL AND ÉPÉE GUARDS AND PARRIES, SHOWING THE FRONT AND PROFILE VIEW OF POSITIONS OF THE HAND AND WEAPON

of the arm, by a slicing motion with the hand in three-quarter supination; full supination is used only in horizontal cuts to the low inside areas of the target.

The basic guards and parries in sabre are five in number: 1st is

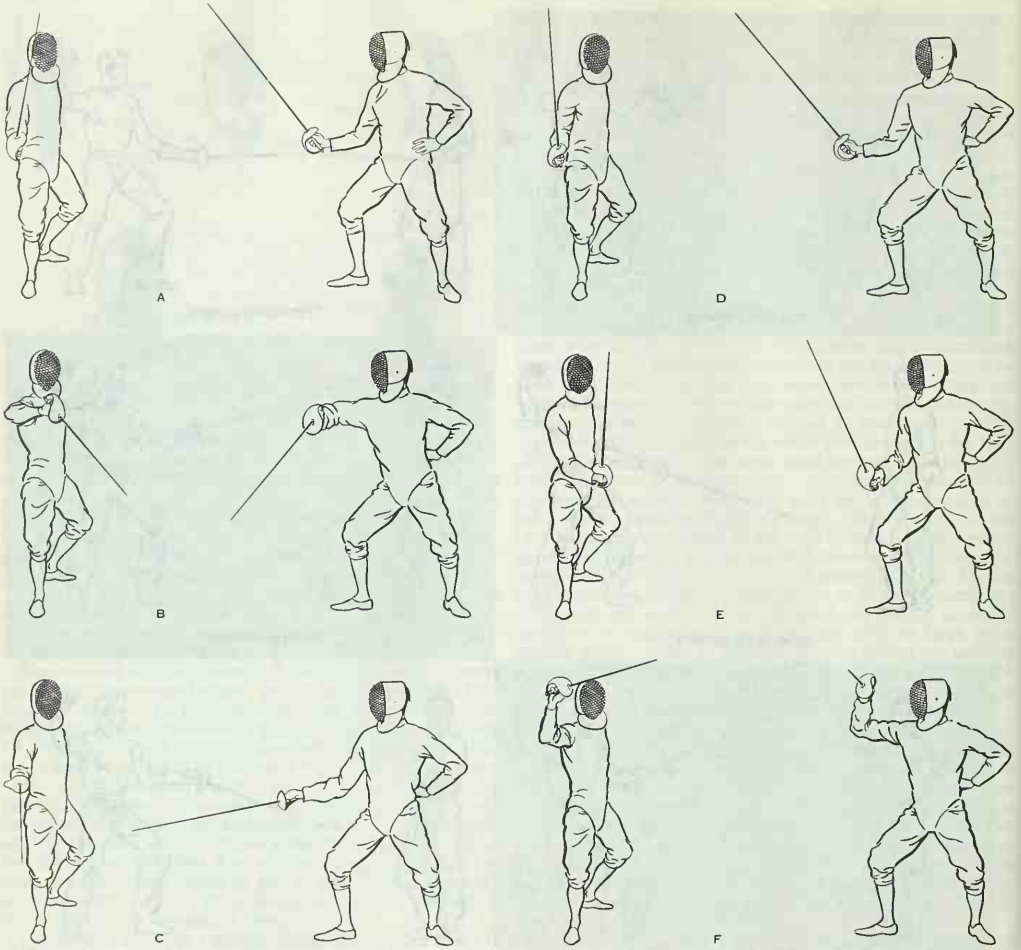

FIG. 11.—SABRE GUARDS AND PARRIES SHOWING THE FRONT AND PROFILE VIEWS OF POSITIONS OF THE HAND AND WEAPON. THE GLOVE HAS BEEN OMITTED TO FACILITATE A VIEW OF THE GRIP

(A) On guard position of the Hungarian school; (B) first guard or parry; (C) second guard or parry; (D) third guard or parry; (E) fourth guard or parry; (F) fifth guard or parry

for low-inside, 2nd for low-outside, 3rd for high-outside, 4th for high-inside, and 5th for the head (fig. 11). By far the commonest guard is 3rd. The elbow is close to the body, the sword hand is level with the right hip, the wrist is cocked so that the sabre is almost vertical and turned so that the front edge will meet squarely a horizontal cut to the outside. The principle of meeting cuts with the front edge near the guard also applies to parries in all positions because of the slenderness of the sabre blade. Against cuts, straight blocking parries are preferred. Circular or counterparries are mainly used against point thrusts or to break up composite attacks.

The most important parries are 3rd, 4th and 5th, because they offer the greatest opportunity for scoring on the riposte. Cuts to the low line will often be met by low 3rd and low 4th for that reason; but 2nd and 1st may be preferable in certain sequences of play. Thus, if the defender is in 2nd, he can more easily parry a chest cut with 1st than with 4th, and if he is in 5th he can more easily parry a flank cut with 2nd than with 3rd. The fastest riposte from 2nd is a horizontal cut to the upper arm or right cheek; the commonest riposte from 1st is a vertical cut to the head executed with a clockwise quarter turn of the wrist and forearm. The Italian school developed a 6th parry to protect the head, with the hand close to the left cheek, but the awkward position makes blade control and the riposte difficult, and for that reason this parry has become obsolete.

The complex range of possible actions with point and edge militates against static defense in sabre and enhances the value of the stop cut or thrust. The inclusion of the arm in the target, on the other hand, requires constant vigilance against the stop and favours the development of second intention attacks that draw the defender's stop in order to parry it and score on the riposte. The influence of the Hungarian school, however, has been in the direction of simplification. The fencers keep far enough apart so that it is difficult to reach the opponent by a simple lunge. Balance and mobility, timing and an exact sense of distance, decisive simple attacks on the *flèche,* direct or preceded by a sharp beat, and lightning ripostes are typical of modern sabre play.

For a list of Olympic champions, *see* OLYMPIC GAMES.

GLOSSARY

Attack.—A series of movements by which one tries to touch the opponent.

Beat.—A sharp tap made on the opponent's blade in order to deflect it.

Bind.—A pushing movement by which one contacts the opponent's blade and brings it from one line into another.

Closing in, or *corps à corps.*—This occurs when the weapon guards or the fencers' bodies come together in such a way as to prevent the free use of the weapon by either fencer. Closing in is penalized in the conventional weapons (foil and sabre).

Composite attack.—An attack in more than one movement, *e.g.,* feint of straight thrust and disengage.

Composite parry.—A combination of defensive actions employed in meeting a composite attack.

Counter or *circular parry.*—A defensive movement executed by making a small circle with the point of the weapon around the opponent's blade, thereby deflecting it in the same line off the target.

Counter-riposte.—A riposte that follows the parry of the opponent's riposte.

Cutover or *coupé.*—An attack made by passing one's blade over the point of the adversary's blade by raising the point with a movement of fingers and hand and bending the arm very slightly, then extending to touch in the opposite line.

Disengage.—An attack made by passing the point into an open line with a small semicircular movement around the opponent's guard.

Envelopment.—A continuous binding movement executed so that the point of the weapon makes at least one complete circle.

False attack.—An attacking action meant to be parried so that the attacker may score on a redoublement, counter-riposte or stop thrust against the riposte.

Feint.—The semblance of an attack made to impel the defender to move his guard.

Flèche, or *running attack.*—A walking or running forward action.

Glide.—A sliding thrust along the opponent's blade usually with a slight pressure.

Jump.—An advance in which both feet move forward at same time.

Lunge.—A forward movement in which the back leg is straightened and the front foot advanced as far as consistent with balance. The sword arm is usually extended.

March.—An advance in which the forward foot is moved before the rear foot.

On guard, or *en garde.*—The position taken before the fencers begin combat.

Parry.—A defensive action with a direct or circular movement of the blade.

Redoublement.—A second attack after the first has been parried, but not followed immediately by a riposte.

Remise.—A stop thrust or cut on a riposte or counter-riposte.

Riposte.—The defender's counterattack following a parry.

Simple parry.—A direct blocking or beating movement of the defensive blade to deflect the attacking blade off the target.

Stop thrust.—A counterattack against the opponent's attack or riposte, intended to land with a sufficient time advantage over the opponent's action to score a touch.

Straight thrust or *cut.*—A simple attack made without contact of the blades or along the opposite blade if the opponent contacts one's blade without exerting pressure.

Time thrust or *cut.*—A counterattack that is both a parry and a riposte, by closing the line where the attack is to be completed.

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FÉNELON, FRANÇOIS DE SALIGNAC DE LA MOTHE (1651–1715), French churchman and writer, archbishop of Cambrai, pre-eminent as a mystical theologian and important also for his teaching on education, was born at the château of Fénelon in Périgord on Aug. 6, 1651. Almost nothing is known of his parents, of their 13 other children, or of his early upbringing. Similarly, nothing is known of his sojourn between the ages of 11 and 14 in the Jesuit school at Cahors. At the age of 15 he went to Paris to study philosophy and theology at the Collège du Plessis. In 1672 (or 1673) he entered the seminary of St. Sulpice where Louis Tronson introduced him to the spiritual writings of Jean Jacques Olier (*q.v.*). He spent three years preaching and teaching the catechism at St. Sulpice. Then the archbishop of Paris, François de Harlay, appointed him superior of the sisterhood of the Nouvelles Catholiques, an institution in which devout ladies undertook the instruction of converts from Protestantism. In Dec. 1685 Fénelon was chosen to direct a mission to the Protestants of Saintonge. There is very little more information about his missionary work than about his activities as superior; both have been the subject of much conjecture. It would seem that he was neither intolerant nor insidious in his approach as has been supposed, but that he tried to use his gifts of easy persuasiveness and his skill in awaiting the favourable moment in order to mitigate the effect of the usual violent methods of conversion, of which he privately disapproved.

About 1679 Fénelon wrote a work on preaching, the *Dialogues sur l'éloquence en général et celle de la chaire en particulier* (published posthumously in 1718). The style of this work is undistinguished but its ideas were strikingly topical. The author pleads for simplicity and for more use of the Bible and of the Fathers, rather than brilliant and facile ideas which dazzle but do not persuade. The *Traité du ministère des pasteurs* (published in 1688 at the same time as Bossuet's *Histoire des variations*), in which Fénelon reveals himself as passionately attached to the church, is a work of apologetics rather than of spiritual teaching and as such is less praiseworthy than his *Lettres sur l'autorité de l'Église* written 20 years later (published 1718). Even so it is a model of controversial style; a restrained lyricism enlivens an argument not always convincing and relieves the dryness of the author's learning.

About the same time Bossuet, whose friend and disciple Fénelon had become, asked Fénelon to compose a systematic refutation of Nicolas Malebranche's *Traité de la nature et de la grâce* (1680). Bossuet did not understand Malebranche, and it must be confessed that Fénelon himself only half understood him. To please Bossuet, however, he wrote *La Réfutation du système de Malebranche,* a facile work against a philosopher of genius which, moreover, Fénelon was then ill-equipped to undertake. Bossuet annotated the manuscript, but it was not published until 1820. Fénelon also wrote *Le Traité de l'existence de Dieu* (first complete edition 1718).

With the *Traité de l'éducation des filles,* written about 1684 and published in 1687, Fénelon first showed his own inimitable characteristics. The duchesse de Beauvillier (Henriette Louise Colbert) had asked him not for a formal treatise but for a written note of the remarks he made to her in the course of conversations at her house on the education of girls. This task gave full scope to his genius in psychology and in teaching. The mystic had not yet been born in him but the humanist had reached perfect maturity. Education, he maintains, should make the lady of the house both Chris-

tian and accomplished, neither ignorant nor *précieuse*. Practical and prudent, his recommendations are quite realistic; the charge of excessive idealism once brought against them is altogether unjustifiable.

When in Oct. 1688 he met Jeanne Marie Bouvier de la Motte Guyon (*q.v.*) Fénelon was, from the worldly point of view in a happy situation but he was suffering from profound spiritual unrest. Lost in wonder at the greatness of God, whose existence he had proved and whose attributes he had strictly analyzed, he yet could not "feel" God and despaired of ever being able to reach lasting peace in him. Haunted by desire for the experience of God, he found the way to it opened for him by Mme Guyon. This lady, however, had the reputation of an adventuress and her strange and extravagant behaviour had already made her suspect to the ecclesiastical authorities: in Jan. 1688 the archbishop of Paris had had her imprisoned in a convent in the Faubourg St. Antoine. Yet despite her psychological troubles and a certain childishness by which he was not deceived, Fénelon considered her mystical experience to be essentially authentic. He perceived in her that wisdom the secret of which he, although so wise, had not been able to discover: the wisdom that is founded on complete surrender to God, on renunciation of the self, on a childlike spirit and on "the union of pure grace." He seldom saw her but he corresponded regularly with her and it is to his credit that he never repudiated her.

Two indiscretions of Fénelon's were the origin of the controversy over Quietism (*q.v.*): first, he encouraged Mme Guyon's visits to Mme de Maintenon's girls' school at St. Cyr, where she soon incurred the suspicions of Mme de Maintenon; second, he advised Mme Guyon to submit her doctrine to Bossuet's judgment. Bossuet, ignorant of the church's mystical tradition and considering it his duty to silence her, launched himself into an unjust attack. The controversy was at first calmly theological. The 34 articles of the formulary drawn up by an ecclesiastical commission at Issy perfectly satisfied Fénelon and would, in the ordinary course of things, have ended the argument; purely doctrinal, they made no mention of Mme Guyon. Then Bossuet ill-advisedly brought her personally into the disputes. Fénelon refused to be associated with this attack and hastily wrote the *Explication des Maximes des saints sur la vie intérieure* in reply. The book appeared on Jan. 25, 1697, a few weeks before Bossuet's *Instruction sur les états d'oraison* which condemned Mme Guyon's *Moyen court*. Anger caused Bossuet to cast aside all prudence and even all dignity. In his *Relation sur le quiétisme* (June 1698), a pamphlet containing little theology, he exposed to the general reader mystical tracts of Mme Guyon's and private letters of Fénelon's. The affair had already been referred to Rome (April 1697) and at last, on March 12, 1699, Pope Innocent XII, on the insistence of Louis XIV, condemned 23 propositions in Fénelon's *Maximes des Saints*. Fénelon submitted immediately, having long since recognized the imprudence of these propositions. In a long series of subsequent works he set forth his own doctrine. These, which provide a complete account of mystical theology on a scale never before undertaken, have never been condemned, or even suspected, by the Catholic Church.

In Aug. 1689 Fénelon had been appointed preceptor to Louis XIV's eldest grandson, Louis, duc de Bourgogne; and on Feb. 4, 1695, he had been made archbishop of Cambrai. For more than two years thereafter he held the two posts simultaneously but on Aug. 1, 1697, the king ordered him to cease to appear at court. Meanwhile, for the education of the prince, Fénelon had composed a large number of fables, stories, dialogues, *e.g., Les Dialogues des morts,* 1690, and "portraits." Above all, he had written *Télémaque* (published in 1699) in which the adventures of Telemachus in search of his father, Ulysses, are told in the form of a political novel with passages of poetical imagination. Less practical than his various *mémoires* and *plans de gouvernement* (otherwise known as the *Tables de Chaulnes*), *Télémaque* contains the fundamental political ideas of Fénelon. These were prophetic in their time and were regarded as such during the 18th century. Characterized by horror of despotism (insofar as it is one of the most terrifying expressions of that ownership mentality which Fénelon considered as sin itself) and by an orientation of thought toward a future brotherhood of peoples in accordance with the spirit of the Gospel, Fénelon's doctrine may well be criticized by modern sociologists for a certain confusion in the transitions he constantly makes between the mystical and the political plain. Such critics, however, would be less prompt than their 19th-century predecessors to denounce his ideas as utopian and visionary.

Fénelon should not be held responsible for the timidity and scruples which to some extent paralyzed the activities of the duc de Bourgogne in later life; on this matter Bossuet's mockery has misled posterity. What remains of Fénelon's correspondence with his pupil is enough to show that he strove to make him courageous and competent, as a prospective king should be.

From the condemnation of his *Maximes* till his death on Jan. 7, 1715, Fénelon remained at Cambrai, a churchman working for the church. His last writings were devoted to the campaign against Jansenism. Even so, he found time to include among his numerous and varied writings a *Lettre à l'Académie* (1714) in which, while judging the literary movement of his time, he put forward advanced ideas on poetry and the theatre.

Fénelon was, above all, a master of the spiritual life and a mystical theologian. To formulate his doctrine of pure love he drew upon traditional streams of thought within the church. He simplified the ambitions that mystics of all preceding ages had entertained. The 19th-century view of him as a romantic in religion, as an apostle of "sensibility," is mistaken. The keystone of his system is the identity of simplicity, or singleness of heart, with the purity or disinterestedness of love. Simplicity and purity are impossible unless God is allowed to substitute his own activity for ours. This divine sanctifying operation is a supernatural gift which, destroying the proprietary attachment all creatures naturally have for themselves, places them in a "passive state." This "passive state" and selfless love are one and the same thing.

Few characters have been more thoroughly misrepresented than Fénelon's has in the centuries since his death. Fascinating as he may be—and Saint-Simon rightly stresses his fascination—Fénelon remains first and foremost the man who wrote "Everything about us is vain, except the death of self, which is brought about by Grace."

The best complete edition of Fénelon's works was brought out by the *abbé* Gosselin, 10 volumes (1848–52). In volume x of this edition is *L'Histoire de Fénelon* by L. F. de Bausset (an English translation of the *Histoire* was published in 1810). Selections include *Les Plus Belles pages de Fénelon*, edited by H. Brémond (1930), and *Fénelon: Oeuvres spirituelles*, edited by F. Varillon (1954).

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FENESTELLA (52 B.C.–A.D. 19 or 35 B.C.–A.D. 36), a learned and capable Latin annalist whose lost work, the *Annales*, seems to have contained antiquarian matter as well as historical narrative. It was in at least 22 books and certainly included the year 57 B.C., though the exact period it covered is unknown. The few surviving fragments which are ascribed to Fenestella refer to such varied subjects as the origin of the appeal to the people (*provocatio*), the use of elephants in the games, the wearing of gold rings, the material for making the toga and details of the lives of Terence and Cicero. It has been suggested that the work of Fenestella which the elder Pliny uses was not the *Annales* but a lost treatise on the growth of luxury. The grammarian Diomedes (4th century A.D.) quotes from an epitome of the *Annales*. Of Fenestella's poems mentioned by St. Jerome not a word survives. The work entitled *De magistratibus et sacerdotiis Romanorum*, sometimes attributed to "Lucius Fenestella," was written by Andrea Fiocchi (Floccus), secretary to Pope Eugenius IV (1431–47).

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FENESTRATION, an architectural term applied to the arrangement and proportions of windows on the outside walls of a

building. The structural nature of load-bearing masonry walls usually limits the size, number, and placement of exterior windows. When curtain walls (nonload-bearing) are used, the windows may be sized and placed in accordance with the needs of the plan or exterior appearance. When a building is sheathed completely in glass (*e.g.*, Lever house, New York city) the term applies to the size and proportions of the panes and supporting members as well as to the proportional relations between the various panes. *See* also WINDOW. (H. MN.)

FENG-HUANG, one of the four symbolical creatures (*ssu ling*) which in Chinese mythology guarded the Celestial empire. It was begotten by fire, born in the Hill of the Sun's Halo and its body is inscribed with the five cardinal virtues.

According to the dictionary *Shuo-wen,* it has the breast of a goose, the hindquarters of a stag, a snake's neck, a fish's tail, a fowl's forehead, a duck's down, the marks of a dragon, the back of a tortoise, the face of a swallow, the beak of a cock, is about six cubits high and perches only on the wu-t'ung tree. Its appearance heralds an age of universal virtue. The two words *feng* and *huang,* meaning "male phoenix" and "female phoenix," constitute the generic term for this creature.

FENG-T'IEN: *see* LIAONING.

FENG YÜ-HSIANG (1882–1948), Chinese warlord who dominated parts of north China during the period 1918 to 1930, was born on Sept. 26, 1882, at Hsing-chi-chen, Chihli (Hopei). Feng was an opportunistic but nonetheless outspoken exponent of Christianity and came to be known as the "Christian general." He demonstrated some enthusiasm for social reform and became identified with the liberal side of Chinese politics.

Feng gained prominence in 1921 when his well-trained troops played a major role in the Chihli military clique's successful campaign against the Manchurian warlord Chang Tso-lin (*q.v.*). In 1924 Feng deserted the Chihli faction and after reorganizing his soldiers into the Kuominchün (Peoples' army) attacked Chang Tso-lin in the name of Chinese nationalism. Although he was defeated he received enough aid from the Soviet Union to revitalize his army and came to the assistance of the Kuomintang when Chiang Kai-shek led its forces northward in 1927. Nevertheless, Feng disappointed the Russians by supporting Chiang against his Communist and liberal opponents within the Kuomintang. In 1928 Chang Tso-lin withdrew from Peking, which fell into the hands of Feng and Yen Hsi-shan, the warlord of Shansi. Feng and Yen defied Chiang Kai-shek's efforts to extend his authority into north China but were beaten in 1930 and driven into exile.

In 1933 Feng Yü-hsiang made an unsuccessful attempt to gain popular support by leading an army of volunteers against the invading Japanese. Thereafter, he continued to criticize the Chinese government and was instrumental in forming an opposition group called the Revolutionary Committee of the Kuomintang. In 1947 he went to the United States, where he openly denounced what he termed the "reactionary" policies of Chiang Kai-shek. On his way back to China in Sept. 1948 he died in a fire aboard a Russian ship. (D. G. G.)

FENIANS, AMERICAN, an Irish-American revolutionary secret society active in the United States during the 1860s. The name was derived from *fiann, féinne,* the legendary band of warriors in Ireland led by Finn Mac Cumhaill. The society was founded in the United States in 1858 by John O'Mahony (1816–77), who had been concerned in an uprising in Ireland in 1848. The Irish wing of the society was sometimes called the Irish Republican (or Revolutionary) Brotherhood, a name which continued to be used after Fenianism proper had virtually died out. Members bound themselves by an oath of "allegiance to the Irish Republic, now virtually established." The organization had ramifications in every part of the world, the Fenians being found in Australia, South America, Canada and, above all, the United States as well as in centres of population in Great Britain such as London, Manchester and Glasgow (*see* IRELAND: *History: The Union, 1800–1921*).

The movement became more active in the United States after a convention held at Chicago under O'Mahony's presidency in Nov. 1863. The close of the American Civil War in 1865 brought its greatest opportunity. Irishmen who had borne arms flocked to Ireland, and plans were made for a rising. The British government now took action. The Habeas Corpus act was suspended in 1866, a considerable number of persons were arrested and some small disturbances were put down by the police.

Late in 1865 the brotherhood in the U.S. split, one wing under O'Mahony (and later John Savage) advocating action in Ireland, the other under William Randall Roberts (1830–97) desiring to attack Canada. The Roberts wing attempted to invade Canada at the end of May 1866. John O'Neill (1834–78) crossed the Niagara with perhaps 600 men. He defeated a detached column of Canadian volunteers at Ridgeway (June 2) and escaped from Canada that night before other troops could close in on him. The returning Fenians were arrested by U.S. patrols but soon released.

The Roberts Fenians continued their threats and repeatedly obliged the Canadian government to make defensive preparations. O'Neill succeeded Roberts in Jan. 1868. In May 1870 another raid, on the Vermont border, was defeated by Canadian forces and O'Neill again was arrested by U.S. authorities. His final enterprise, against Manitoba in 1871, was frustrated by U.S. troops. Canada sought, but did not obtain, compensation from the United States for damage done by these expeditions organized on U.S. soil. With O'Mahony's death in 1877 the movement came to an end.

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FENNEC (*Fennecus zerda*), a desert-dwelling fox, characterized by small size and large ears. The fennec is whitish or buff-coloured to sandy and has a short, black-tipped tail. It is mainly nocturnal, spending the heat of the day underground. The species is found in north Africa, the Sinai peninsula and Arabia. The name "fennec" is sometimes erroneously applied to the caama, or chama fox (*Vulpes chama*), of south Africa, and to Rüppell's fox (*Vulpes rüppelli*), of north Africa and southwest Asia. *See* Fox. (Jo. E. H.)

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FENNEC (FENNECUS ZERDA)

FENNEL (*Foeniculum vulgare*), a perennial plant of the family Umbelliferae (*q.v.*), used as a flavouring agent. When cultivated it is from two to three or four feet tall and has stalks with finely divided leaves composed of numerous linear or awl-shaped segments. The grayish compound umbels bear small yellow flowers. The fruit is laterally compressed, five-ridged, and has a large single resin canal or vitta under each furrow.

The plant appears to be of south European origin but is naturalized in the eastern U.S. and is met in various parts of Britain and temperate Eurasia. All parts of the plant have an aromatic taste and odour. The blanched shoots are eaten. The seeds (and extracted oil) are used for flavouring foods, candies, liqueurs and medicine, and for scenting soaps and perfumes.

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FENNEL (FOENICULUM VULGARE)

Giant fennel is *Ferula communis,* a member of the same

family, native to the Mediterranean region, where the stems, which grow from 8 to 12 ft. high, are used for tinder. Hog's-fennel, or sulfurweed (*Peucedanum officinale*), is another umbellifer. The fennel-flower (*Nigella sativa*) is of an entirely different family (*see* RANUNCULACEAE).

See also FOOD PREPARATION: *Herbs and Spices.*

FENRIR (sometimes FENRISÚLFR) was the monstrous wolf of Norse mythology. He was the son of the demoniac god Loki and of a giantess. Fearing Fenrir's strength and knowing that only evil could be expected of him, the gods bound him with a magical chain made of the sound of a cat's footsteps, the beard of woman, the breath of fish and other strange materials. When the chain was placed upon him, Fenrir bit off the hand of the god Týr. He was gagged with a sword and will lie bound to a rock until the Ragnarök (Doomsday), when he will break his bonds and fall upon the gods. According to one version of the myth Fenrir will devour the sun, and in the Ragnarök he will fight against Odin and swallow him. Odin's son Vidar will avenge his father, stabbing the wolf to the heart according to one account and tearing his jaws asunder according to another. Fenrir figures prominently in Norwegian and Icelandic poetry of the 10th and 11th centuries, and the poets speak apprehensively of the day when he will break loose. Ideas closely comparable to those surrounding Fenrir have been found in the mythologies of Asian peoples. (G. T.-P.)

FENS, a district in the east of England possessing peculiar characteristics and a distinctive history. It lies largely south and west of the Wash, in Lincolnshire, Huntingdonshire, Cambridgeshire and Norfolk. Its extreme length from Lincoln to Cambridge is about 73 mi.; its exreme breadth from Peterborough to Brandon is about 36 mi. Across its surface, the rivers Witham, Welland, Nene and Ouse flow into the Wash, but the original drainage of the area has been largely replaced by artificial channels.

Words such as swamp, marsh, fen and bog are used somewhat loosely in ordinary speech. More strictly, however, *swamp* denotes an area in which the water level is above ground at all seasons; it is usually characterized by reeds, rushes and sedges. *Marsh* implies waterlogged soil in which the summer water level approximates to the surface of the ground or lies just above it. *Morass* is also used in this sense. *Fen* implies a rather similar condition, but one in which the soil is organic (peat) in character and alkaline rather than acid. The term *carr* is applied to a stretch of fen bearing trees such as the alder and the willow and a variety of shrubs. *Bog,* on the other hand, indicates a tract of acid peat derived from vegetation associated with an acid soil. Such tracts are commonly known in northern England and southern Scotland as *mosses* or mosslands. The word *moor* is used to describe tracts of open country (usually at relatively high altitudes) which may be dry with heather and associated vegetation, or wet with an acid peat vegetation. (*See* also SWAMP; MARSH; BOG.)

In origin the English Fenland is essentially a flooded Jurassic clay plain which had for its limits the harder rocks around—chalk to the north and south and resistant Jurassic rocks to the west. The surface of this Jurassic plain was uneven, and its higher portions projected above the general level of the surface to become the "islands" of the historical period, Ely, March and so on. The whole region emerged from the complicated events of the various phases of the Ice Age with its islands capped with boulder clay but with its basin character unchanged. All subsequent time has witnessed the filling up of this basin by various agencies leaving the Wash of the present day as the remnant of a much larger indentation of the sea.

The postglacial deposits are of two kinds. To the north, on the seaward side around the Wash, are marine silts and clays, while south of this belt of silt, an expanse of black peat covers the whole area except where the islands protrude above the surface. The thickness of the peat now varies from a few inches to 10 ft. and more, but before the drainage took place the peat was very much thicker (*see* below). It was this peat area that the cartographers of the 17th century described as *regiones inundatae,* and in that area lay the main effort of draining from the 17th century onward. Except for some outlying peat areas and for the seaward margins, the silt zone was not in need of such extensive draining. The main emphasis of any history of the draining of the Fenland must, therefore, be upon the southern peat area.

Early Attempts at Draining.—The condition of the Fens during Roman times has aroused considerable speculation, but aerial photography has shown that not only the islands but also the siltlands were extensively cultivated. All this stood in great contrast with conditions in Anglo-Saxon times. To explain the transition is one of the major problems that awaits solution. The alternative answers are: (1) that the Romans, with their highly developed political organization and engineering skill, practised artificial drainage with conspicuous success and that their works fell into disrepair after the occupation was over; (2) that the deterioration was the result of natural agencies, silting up of watercourses, or a basic land subsidence in post-Roman times. Both answers may be correct.

Whatever the cause of the transformation, by Anglo-Saxon times the region had become a thinly settled, marshy country which for a time formed a frontier area between the Anglo-Saxon states of East Anglia and Mercia. On the islands scattered among the marshes many religious houses were founded during the 7th and 8th centuries, at Crowland, Thorney, Ely and elsewhere, and these continued despite the raids of the Danes from the 9th to the 11th century.

The Domesday survey of 1086 shows that villages were limited to the silt area in the north and to the islands; settlement was impossible on the peat area because there the soil provided no stable foundations on which to build. Normal arable agriculture seems to have been restricted to the islands and to the silt belt. Fishing and the gathering of reeds and rushes were important occupations, especially in the peat area.

The whole of fen life during the middle ages was dominated by the necessity of maintaining the banks and channels to prevent flooding, and it is clear that a number of practices established "time out of memory" had grown up to regulate the management of the Fenland streams. From the middle of the 13th century there began a series of commissions of sewers appointed by the crown to enforce repair and to settle disputes about the maintenance of banks. There was no sign of any large-scale project of reclamation, but there was a continuous piecemeal encroachment upon the edges of many fens, and this seems to have been very general. The process of improvement was particularly active on the silt areas, and a comparison of 14th-century statistics with those of the Domesday Book indicates that the siltlands of Lincolnshire and Norfolk had been improved so much that they were many times as wealthy as the surrounding uplands. The peatlands remained a poor country, still sparsely populated.

The economic life of the area was, however, disturbed four times by local campaigns: in 1070–71 when Hereward the Wake defied the Normans; in 1139 and 1142 during the anarchy of Stephen's reign; in 1216 when some barons held out against King John; and in 1265 during the reign of Henry III. On each occasion, a group of people seized the Isle of Ely and fortified it. A period of amphibious guerrilla warfare followed until the forces of the king were able to gain an entrance across the marsh. But long after the last defense of the island was over, the tradition of Ely as a camp of refuge continued.

Shortly before the end of the 15th century a hint of changes to come was provided by the work of Archbishop John Morton, who seems to have been the first person to carry out a large design for draining. He made a straight cut, about 12 mi. long, from Stanground near Peterborough to Guyhirn, in order to convey the waters of the Nene in a direct line to Wisbech; it is still known as Moreton's Leam. Coming at the close of the middle ages, it pointed the way forward to a new regime.

During the 16th century complaints about the maintenance of banks and channels continued. The upkeep of any channel involved many interlocking interests, and the dissolution of the monasteries in 1536–39 served only to increase the confusion of divided responsibilities. The commissioners of sewers were finding it increasingly difficult to maintain the "ancient custom" of the Fens. But, as Samuel Hartlib wrote, "in Queen Elizabeth's dayes, In-

genuities, Curiosities, and Good Husbandry, began to take place." During the later years of the 16th century various plans and experiments prepared the way until in 1600 came "An Act for the recovering of many hundred thousand Acres of marshes." Of the many stretches of marsh in the kingdom, that of the great Fenland itself provided the most spectacular opportunities for draining.

17th-Century Draining.—The passing of the act in 1600 did not mean, however, that difficulties were over. Common pasture rights were a most important feature of predrainage economy, and the fenmen, known as slodgers, living largely on the perquisites of the commons, fowling and fishing, resented any suggestion of interference with their traditional livelihood. There was, moreover, much debate about ways and means, and nothing effective was done for another generation. At length, some fenmen approached Francis Russell, 4th earl of Bedford, the owner of 20,000 ac. near Thorney and Whittlesey, who contracted to drain within six years all the expanse of peat in the southern Fenland later known as the Bedford Level. An agreement was drawn up in 1630. In the following year, 13 co-adventurers (so called because they "adventured" their capital) associated themselves with the earl, and in 1634 they were granted a charter of incorporation. Their hope was to turn this expanse of "great waters and a few reeds" into "pleasant pastures of cattle and kyne"; and they secured the services of the Dutch engineer Cornelius Vermuyden (1590–1677), who had been at work upon the reclamation of the Isle of Axholme marshes. Under his direction, drains and sluices were made. Chief among these was the Old Bedford river extending from Earith to Salter's Lode, 70 ft. wide and 21 mi. in length. In 1637 the Level was judged to have been drained according to the agreement of 1630.

Complaints and petitions showered upon the privy council, and royal feeling turned against the corporation. The inner history of this change in royal favour is obscure; at any rate, in the following year the judgment was set aside, and the king himself undertook to complete the draining; the services of Vermuyden were retained. Soon, however, the fen difficulties were overshadowed by greater troubles, for the Civil War broke out in England.

During the Civil War (1642–49) the draining was in abeyance, but the project had not been forgotten. After much negotiation, an "Act for the draining of the Great Level of the Fens" was passed in May 1649; and the 5th earl of Bedford and his associates were "declared to be the undertakers of the said work." Despite the continued hostility of the fenmen, activity was restarted in the Fens. The earlier works were restored; banks were made, sluices built and channels scoured. In particular, the New Bedford or Hundred Foot river was cut, running parallel to the Old Bedford, about half a mile to the east. Between the two rivers a strip of land was left open, partly to provide a reservoir for surplus water in time of flood and partly to enable a heavy flood discharge to be carried with a small surface gradient, or, as Vermuyden put it, "so that the water in time of Extremity may goe in a large roome to keepe it from rising too high." This strip, called the Hundred Foot Washes, has continued to serve these purposes. Various other cuts and sluices were also made, and in March 1652 the Level was formally adjudged to be drained. It was divided into three portions—North, Middle and South. In the decade that followed, the organization for preserving the works of the drainers was completed until, in 1663, the General Drainage act was passed.

In the northern Fenland there was nothing to compare with this great work. It is true that various arrangements were made for draining individual stretches of fen, but, taken as a whole, the northern effort was sporadic in character and small in achievement. Generally speaking, the fen commoners of Lincolnshire remained in possession of their ancient privileges.

At first, great success followed upon the work of the drainers in the Bedford Level. Cultivation was introduced on lands which, as far as record went, had never before known a plow. The crops grown on the newly reclaimed land were numerous and varied: wheat, oats, barley, turnips, beans, peas, coleseed, chicory, mustard, hemp and woad. As Thomas Fuller said in 1655, "the best argument to prove that a thing may be done, is actually to do it." But despite many praises, it was soon evident that all was not well in the Bedford Level. Some of the complaints were only to be expected, disputes about the allotment of the reclaimed land and about the management of the new drains. These were problems of routine administration and could be settled by negotiation and compromise. But there were other difficulties of a much more fundamental character; they nearly brought the drainage work to disaster, and have remained important considerations ever since. They are connected with the lowering of the peat surface and the condition of the tidal rivers that flow through the Fens.

Lowering of the Peat Surface.—Neither Vermuyden nor any of his associates apparently foresaw, when they planned and executed their plans, that as soon as they began to drain the Fens the surface of the peat would become rapidly lower in level. This lowering was attributable in part to the shrinkage of the peat and in part to the wasting away of the peat surface as a result of bacterial action and cultivation. As a result, the surface of the peat soon became lower than the level of the drainage rivers. This difference in height can be seen along many of the fen channels. There soon came a time when the water of the small drains right in the heart of the peat area could no longer flow into the main channels. The amount of lowering has varied from place to place, but even a very small rate of lowering becomes critically important over a period of years. The surface of the undrained peat must have stood at about 10 or 12 ft. or so above ordnance datum (mean sea level as defined for the Ordnance Survey department). By the 1960s the surface of much of the drained peat stood at about ordnance datum, or just below. A basic subsidence of land relative to the sea also has been postulated, and this may have been upward of 3 ft. since the 17th century.

The Windmill.—What had seemed a promising enterprise in 1652 had become a calamity by 1700. There was but one way to save the situation, the substitution of artificial drainage for the natural drainage by gravity. Water was pumped from small dike to drain and from drain to river. It was this introduction of windmills for pumping purposes that saved most of the drained fens from being reinundated. Windmill drainage became more and more frequent, and the windmills imparted a distinctive character to the landscape.

But the windmill was far from being a perfect engine. It was at the mercy of gale, frost and calm. It was never very powerful, and it soon ceased to provide a satisfactory solution to the problem of clearing water from the drains. The paradox was that the more the problems of lowering were combated by more effective draining, the more rapidly the peat surface continued to sink. Thus the works of one generation became inadequate for the needs of the next. Inundations grew frequent. By the end of the 18th century, according to Arthur Young, there were many fens "all waste and water," where 20 years previously there had been "buildings, farmers and cultivation." Moreover, not only were there large stretches of the Bedford Level relapsing into "waste and water," but there were still some tracts that had never been drained at all; in the west, in Huntingdonshire, were the large reed-bordered lakes of Whittlesey mere and Ramsey mere. Fishing and fowling continued to be characteristic Fenland occupations. The large copper butterfly (*Lycaena dispar*), too, was not yet extinct in the area, nor was the ague or fen-fever against which the fenmen indulged in brandy drinking.

Outside the Bedford Level, in the northern Fens, the work of draining was taken up again in the 18th century. There, effort was more divided than in the Bedford Level, for the arrangement of upland and coast disposed the area into a number of separate tracts. Conditions varied from place to place; several districts were brought into cultivation, but, as in the southern Fens, complaints about inundation were frequent. In many of these northern districts, too, stretches of original fen lingered on, nursing the old economy based on fishing, fowling, reed cutting and the like. In wintertime, the East Fen, the West Fen and Wildmore Fen (lying north of Boston, Lincolnshire) consisted of a mass of lakes connected by "narrow reedy straits"; even in dry summers the East Fen "deeps" were covered on an average by about 2 ft. of water.

The Steam Engine.—By the 1820s a great change for the better had come over the whole area. There were still floods bringing with them a reminder of former conditions, but improvement was mak-

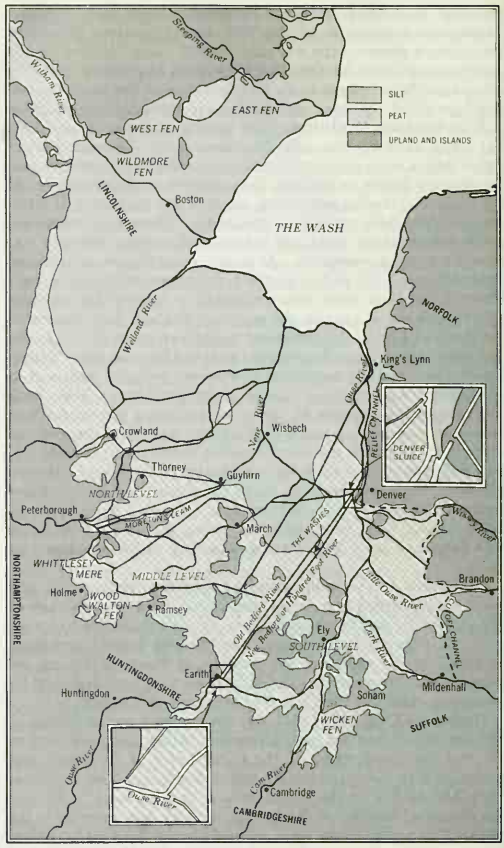
ing itself felt "almost annually." The main factor responsible for this transformation was the introduction of the steam engine for pumping. At first there was delay and hesitation, and not until 1819–20 was the first steam-driven pump set up. Many others soon followed and the Fenland was greatly relieved from the threat that previously had hovered over it. So effective were the new engines that one of the most characteristic elements of the landscape of the fen for more than 100 years was doomed to disappear. Windmills fell into disuse and were replaced by pumping stations, though some windmills still lingered on into the 20th century. There were other changes also, for the great scoop wheels that had been in use since the 17th century were replaced after 1850 by the more effective centrifugal pumps. It was an Appold centrifugal pump that, in 1851, was used to drain Whittlesey mere, the last remaining large stretch of water in the Fenland. From then on, the area benefited by the increasing technical improvements of the age. To overcome the continued lowering of the peat surface, increasingly powerful pumping units were installed.

The Diesel Engine.—After about 1913 diesel engines were used to supplement steam engines, which by mid-century had been almost entirely superseded. Diesel engines have the great advantage that they can be started up quickly at short notice, and they are much more suitable for intermittent running than steam engines.

The Care of Banks.—The advent of improved pumping facilities did not solve all the problems produced by the lowering of the peat surface. The miles of banks brought into being in the 17th century, and increased in later times, still need constant care. Many of these banks were originally constructed or repaired with poor materials and in great haste. The continued lowering of the adjoining surface increases their weakness, and they strain unevenly toward the fen to reveal unsuspected flaws in time of flood. The danger is not only that of overflow but also of seepage. No matter how good the repair of the upper portion of a bank, it must frequently rest upon foundations that may be weak in many places. There is risk, therefore, of the upper portion of a bank slipping over the lower portion when subject to a great head of water. A number of crises have emphasized this danger. In the spring floods of 1937 and 1939, for example, breaches in one of the smaller banks caused flooding near Soham, and in 1937 it was feared that the western barrier bank of the Old and New Bedford rivers might give way at one point, thus allowing the great mass of water in the Washes to pour over the surrounding countryside. Alarms such as these culminated dramatically in the great floods of March 1947, when several banks were breached, and large stretches of cultivated land were inundated. The breaches were repaired and the summer was spent in rehabilitation aided by government grants.

The Tidal Rivers.—As a result of the lowering of the peat surface, two water-level systems came into being: one, the low-level system of the internal drains of the Fens themselves; the other, the high-level system of the large rivers that flow through the Fens from the uplands down to the sea. The problem of disposing of the water of the low-level drains was solved by pumping, but that of protecting the drained lands from the high-riding rivers, especially in times of flood, remained. The real difficulty is that of securing a quick discharge of floodwater.

After the early days of the draining much attention was concentrated on the condition of the outfalls of the fen rivers into the Wash. In a normal river the current of water is strong enough to force its way out to sea and so keep both channel and estuary clear. But the Fenland rivers are far from normal. The downward force of the fresh waters in the gently graded streams is no match, especially in summer, for the strong tidal flow each day. The incoming tide, moreover, brings large quantities of silt from the Wash. With swift flood tides and weak ebb tides deposition is inevitable, and the fresh-water discharge is able to maintain a channel of only limited capacity. The result is that in very wet weather, with large quantities of water pouring down from the uplands, high water levels are inevitable in the great Fenland rivers. The great Fen controversies of the 18th and 19th centuries were largely outfall controversies concerned with topics such as the mechanics of silting, the formation of sandbanks and the disposition of sluices. There was much conflict of opinion and interest



H. C. DAREY

MAP OF THE FENS SHOWING THE LOWER DRAINAGE BASINS OF THE OUSE, NENE, WELLAND AND WITHAM RIVERS WITH ARTIFICIAL CHANNELS

about all these matters, but the increasing technical equipment of the 19th and 20th centuries enabled some improvements to be made in the outfalls of the Ouse, the Nene, the Welland and the Witham. New and straight channels were made to cut off bends in their estuaries; training walls were built out to sea; and various measures were taken to improve the conditions of the channels generally. But despite much effort the results in many cases were not as great as were hoped for.

An important feature of the tidal rivers are the sluices necessary to prevent the tidal waters from passing up some of the rivers and cuts. On the Witham are the Grand sluice and the Black sluice; on the Nene, the North Level sluice; on the Ouse, the St. Germans sluice and Denver sluice. Upon Denver sluice depends the safety of the southern part of the Bedford Level, and it has become the most famous of the Fenland sluices. Immediately below the sluice the waters of the Hundred Foot river fall directly into the Ouse. Consequently, when there is a great volume of upland water passing down the Hundred Foot, the level of water on the seaward side of the sluices never falls sufficiently low for the sluice gates to be opened long enough to provide an adequate runoff for the waters of the South Level. These waters can only accumulate within the straining banks of their rivers and drains. A crisis is, therefore, always liable to be produced by a combination of heavy land floods, a high spring tide and adverse wind conditions. A new feature in fen investigation was the experimental model set

up at Cambridge in 1935 by the Great Ouse Catchment board, with the object of providing data for the study of tidal and silting conditions both in the Wash and in the river itself.

But no amount of work in the outfalls can much alter the high- and low-tide levels of the sea; nor can it appreciably alter the surface gradient of the river water upstream. Yet it is upon this surface gradient, as much as anything, that the discharge of a river depends. Alterations at the river outfalls, while producing local and temporary results, have had insufficient effect in lowering water levels higher up the rivers. Moreover, with the lowering of the peat areas, the high flood gradients of these rivers were greatly increased because the flood discharge is unable to spread far beyond the normal river channels because of the high banks needed to protect the low-lying country around. Opinion in the South Level has, therefore, shifted the emphasis from attempts at outfall improvements to other measures for lowering the surface gradients of the high-level rivers during floods.

In the years following the severe crisis of 1937, new proposals for lowering the flood levels in the Ouse were discussed and debated. The widespread floods of 1947, and the great tidal surge of 1953, served to emphasize the problems that were involved. The plan that has emerged comprises three parts, or three groups of works, together with their associated sluices: (1) the construction of a relief channel northward from Denver for about 11 mi.; this was to run roughly parallel to the main channel of the Ouse (on its eastward side) and enter it at a point above King's Lynn; (2) the deepening and widening of the channel of the Ouse above Denver for about 19 mi. to its junction with the Cam; (3) the construction of a cutoff channel, around the eastern edge of the Fens, to intercept the waters of the Lark, the Little Ouse and the Wissey, and convey them into the new relief channel near Denver. Work upon the first part of this project was completed during 1954–59.

Drainage Administration.—Looming above all technical questions connected with the lowering of the peat surface and the condition of the tidal rivers, there was the problem of administration. The outstanding difficulty lay in the lack of any single authority along the course of a river and in the absence of adequate co-operation among existing authorities. The responsibilities of the Bedford Level corporation did not extend beyond the maintenance of the major rivers. In order, therefore, to meet the new situation produced by the lowering of the peat, groups of landowners were forced to supplement the larger drainage scheme by local district enterprise. The first drainage district was formed by act of parliament at Haddenham near Ely in 1727, and it created a principle that was followed at frequent intervals. The whole of the Fens came to consist almost entirely of small districts, each dependent for its internal drainage upon small cuts leading to a main drain which in turn discharged its water by pumping into one of the major rivers. Each of the statutory districts had its own authority with full control over the internal drainage of its area, with wide powers of local taxation and with powers of negotiation with adjacent bodies over matters of common concern.

The necessity for co-operation was repeatedly urged, and many advocated the establishment of authorities responsible for the whole length of each main river. Bills were introduced into parliament in 1877, 1878, 1879 and 1881 with the idea of setting up conservancy boards, but difficulties of rating were among the main reasons that prevented their success. The tangle of authorities, working with antiquated powers and inadequate resources, remained for another 50 years. At last, in 1927, a royal commission was set up to examine the working of the 361 drainage authorities in England and Wales. The remedy it suggested was the same as that advocated in 1877, the establishment of conservancy boards, each with exclusive control over a main river and "clothed with supervisory powers (in order to secure co-ordination of effort) over the internal drainage authorities." It suggested, too, that the ancient formula of benefit should be abolished and that the new authorities should be empowered to levy rates over the whole of their respective catchment areas, recognizing a distinction between uplands and lowlands. This report formed the basis for the Land Drainage act of 1930. Thus there came into existence the catchment boards of the Great Ouse, the Nene, the Welland and the Witham (and Steeping). By another act of 1948, these catchment boards were replaced by river boards with somewhat enlarged powers.

Modern Fenland Agriculture.—The improvements in draining that marked the 19th century were paralleled by agricultural changes. Indeed, only a fertile soil could have supported the heavy drainage rates that the improvements involved. One great innovation about 1830 was the introduction of the practice of "claying the land"; *i.e.*, digging up clay from below the peat and spreading it over the surface. Everywhere there were signs of prosperity, and a survey of 1848 spoke of the rich pastures and luxuriant crops of the district. Despite this prosperity the Fenland shared in the general ebb that marked English agriculture from the 1870s onward, and conditions were bad locally. But in many ways the Fenland did not suffer as much as the upland around. The introduction of new crops helped to save the situation. Potatoes proved the "mainstay of the fen farmer" according to one report; vegetables and fruit, too, became important. The first orchard had been planted in the Wisbech area as early as the 1850s. Many farmers, subsequently, were forced to adopt a fresh form of husbandry, and turned to market gardening and fruit farming. Flowers, too, spread, and Lincolnshire bulbs grown around Spalding became famous. Thus, from the agricultural depression of the 19th century, the 20th century inherited the foundations of prosperity, and the Fenland became one of the richest arable areas in England, supporting traditional crops such as wheat, but characterized by potatoes, flowers, small fruits and market garden crops; a newcomer on the southern peats was the sugar beet. But when World War II broke out there were still some patches of ill-drained derelict lands. In the national endeavour to increase food production their black peat soil was made to yield its richness as elsewhere in the Fenland. Wild fowl are still to be found, especially in winter on the flooded Washes.

A few isolated stretches of peat fen have survived, particularly around the margins of the Fenland, and these are of special interest from a botanical and entomological point of view. Two, in particular, must be mentioned because they are nature reserves under the supervision of the Nature conservancy, and are well-known for their rare moths and other insects. Along the western edge of the Fens is Wood Walton fen (514 ac.) to the north of Huntingdon. Along the eastern edge is Wicken fen (730 ac.), which has been the scene of much investigation. Its waterlogged surface stands several feet higher than that of the adjoining peatlands, which have been drained and cultivated. It is not strictly "natural," because the water levels are manipulated, the channels are kept open and the fen is periodically cut over. Left to itself, most of its surface would become covered with bushes, and the fen species of plants, birds and insects would be reduced or exterminated. Carefully controlled, Wicken fen gives an idea of what the "vast and deep fen" was like before Vermuyden's day.

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FENTON, ELIJAH (1683–1730), English poet who with Pope and William Broome translated the *Odyssey*, was born at Shelton, Staffordshire, May 20, 1683, and educated at Jesus college, Cambridge. His unwillingness to swear allegiance to William III prevented his taking orders. In 1710 he resigned the headship of Sevenoaks grammar school upon promises from Henry St. John (later Viscount Bolingbroke). These were unfulfilled, and

he spent the rest of his pleasantly indolent life as tutor for noble families. He died at Easthampstead, Berkshire, July 16, 1730. Pope wrote his epitaph, and Johnson his life.

Fenton's poems (1707, 1710, 1711, 1717) drew praise from Pope who asked him to translate books 1, 4, 19 and 20 of the *Odyssey,* which he did with considerable skill. He wrote a life of Milton for an edition of *Paradise Lost* (1725), edited Edmund Waller's poems, with *Observations* (1729) and wrote *Mariamne* (1723), a successful tragedy.

See E. Harlan, *Elijah Fenton 1683–1730* (1937); M. J. Valency, *The Tragedies of "Herod" and "Mariamne"* (1940).

FENTON, SIR GEOFFREY (*c.* 1539–1608), English writer and statesman, was the son of Henry Fenton of Nottinghamshire and the brother of the navigator Edward Fenton. Geoffrey is said to have visited Spain and Italy in his youth; possibly he went to Paris in Sir Thomas Hoby's train in 1566, for he was living there in 1567, when he wrote *Certaine tragicall discourses written oute of Frenche and Latin,* a free translation of François de Belleforest's French rendering of Matteo Bandello's *Novelle.* Fenton's other works are: *Monophylo* (1572), *Golden Epistles gathered out of Guevarae's workes as other authors . . .* (1575), *The Historie of Guicciardin . . . reduced into English, by G. F.* (1579) and a number of Protestant tracts, among them *A forme of Christian pollicie* (1574) which anticipates all the later Puritan arguments against the stage. Through Lord Burghley he obtained, in 1580, the post of secretary to the new lord deputy of Ireland, Lord Grey de Wilton. He held the secretaryship until the end of his life by the favour of Queen Elizabeth I. whom he kept informed of the activities of her other servants in Ireland. Under James I he had to share the post with Sir Richard Coke. Fenton died in Dublin on Oct. 19, 1608, and was buried in St. Patrick's cathedral.

FENTON, LAVINIA, afterward DUCHESS OF BOLTON (1708–1760), English actress, the original Polly Peachum of John Gay's *Beggar's Opera,* was probably the daughter of a naval lieutenant named Beswick, but she bore the name of her mother's husband. Her first appearance was as Monimia in Thomas Otway's *Orphans* in 1726 at the Haymarket theatre, London. She then joined the company of players at the theatre in Lincoln's Inn Fields. Miss Fenton made her greatest success in 1728 as Polly Peachum, and a famous painting by William Hogarth shows her in one of the *Beggar's Opera* scenes. She ran away with Charles Paulet, 3rd duke of Bolton, a man much older than herself, who married her after the death of his wife in 1751. She died at Greenwich on Jan. 24, 1760.

See C. E. Pearce, *Polly Peachum* (1913).

FENUGREEK (*Trigonella foenum-graecum*) is a slender, annual plant of the legume family, native to the Mediterranean region. The plants are erect, loosely branched, 20 to 30 in. tall with trifoliate leaves and yellowish-white flowers. The slender pods are 3 to 6 in. long, curved, and distinctly beaked. It is cultivated in parts of central and southeastern Europe, western Asia, the India subcontinent and North Africa. The seeds are used externally in poultices for boils, abscesses, carbuncles, etc., and internally as an emollient for inflammation of the digestive tract. They have long been used as the principal ingredient of "condition powders" for cattle and horses. Fenugreek seeds are also used in various ways for human food—mixed with flour for bread, eaten raw or boiled, as a constituent in curry powders and as flavouring. In India the young plants are used as a pot herb and in North Africa the crop is utilized for hay. A small acreage is grown in California, largely as a green-manure crop. (Q. J.)

FEODOSIYA, a town and resort in the Crimean *oblast* of the Ukrainian Soviet Socialist Republic, U.S.S.R., is located on the south coast of the Crimea, 116 km. (72 mi.) E. from Simferopol, in a sheltered position at the western end of the broad sweep of Feodosiya bay. Pop. (1959) 46,327. Its harbour is protected on the south by the rocky headland which marks the eastern end of the Crimean mountains. The town was founded as Theodosia by Greeks from Miletus in the 7th–6th centuries B.C. and it became one of the most flourishing of the Greek colonies on the Black sea, noted for its export of grain. In the 4th century B.C. Feodosiya became part of the Greco-Cimmerian kingdom of the Bosporus (*see* BOSPORUS, KINGDOM OF THE) and later part of the Byzantine empire. During the 2nd century A.D. the town was destroyed in the barbarian invasions and it remained an insignificant village until the Genoese established a trading factory there in the 13th century, under the name of Kaffa. Strong fortifications were built and Kaffa became the main Genoese centre on the Black sea, with trading links with Asia Minor, the Caspian and Trans-Caspian regions, Russia, Lithuania and the Balkans. Many Armenians settled there in this period. In 1475 it fell to an alliance of the Crimean Tatars and the Turks. It was largely destroyed and once more underwent a long period of unimportance, until Catherine the Great annexed the Crimea in 1783, when the fortifications were rebuilt. In 1802 it regained its ancient name of Feodosiya. During World War II it was occupied by the Germans (1941–44).

Modern Feodosiya is one of the main health and holiday resorts of the Crimea, famous for the excellent sand beaches on the bay and enjoying a climate of Mediterranean type. In and around the town are a number of sanatoriums and rest homes. Feodosiya retains importance as a port for coastwise traffic and as a base for a fishing fleet. A branch line connects with the main railway from Kerch to the mainland, and there are motor roads to Kerch, Simferopol and along the picturesque coast to Yalta. Feodosiya was the birthplace of the Russian seascape painter I. K. Ayvazovski (1817–1900). It exports grain and produces tobacco, flour and canned fish. (R. A. F.)

FEOFFMENT, in English law, was the usual way of granting or conveying the fee simple in freehold land in the feudal period. The feoffor, in the presence of witnesses, enfeoffed the feoffee by making "livery of seisin" (delivery of possession) to him. This was done on the land by the feoffor's uttering appropriate words of transfer and symbolically handing to the feoffee some turf or twig or the like; this was "livery in deed." In "livery in law" the transaction was carried out in sight of the land but was not effective until perfected by entry by the feoffee during the feoffor's lifetime. Feoffments were usually evidenced by writing; the Statute of Frauds, 1677, made writing essential, and the Real Property act, 1845, required a deed. The latter act also authorized conveyances by deed without feoffment, and the Law of Property act, 1925, in effect abolished feoffments. (*See* REAL PROPERTY AND CONVEYANCING, LAWS OF.) (R. E. MY.)

FER-DE-LANCE (*Bothrops atrox*), a lance-headed venomous snake of the pit viper (*q.v.*) family (*Crotalidae*) found from southern Mexico to Brazil and in several of the Windward Islands. *Bothrops,* very closely related to the old world *Trimeresurus,* is sometimes included in the latter genus. The fer-de-lance is known as *barba amarilla* ("yellow chin") in Central America; *caiçaca* or *jararaca* in Brazil. Although usually shorter, it may attain a length of eight feet. Broods often exceed 50 in number. It feeds on small mammals and may become a menace while seeking rats in refuse piles around native villages. (L. M. KR.)

BY COURTESY OF SAN DIEGO ZOO

FER-DE-LANCE (BOTHROPS ATROX)

FERDINAND I (1793–1875), emperor of Austria from 1835 to 1848, was born in Vienna on April 19, 1793, the eldest son of the Holy Roman emperor Francis II (later Francis I of Austria) by his second wife, Maria Theresa of Naples-Sicily. As a child he showed signs of both feeble-mindedness and epilepsy, while the eldest of his brothers, the archduke Francis Charles, showed great talents; but his father, to protect the principles of succession to the monarchy, insisted on Ferdinand's being heir. In 1830 Ferdinand was crowned king of Hungary. When an attempt was made on his life (Aug. 9, 1832), he remained uninjured, but his epileptic fits thereafter became more frequent. After his succession to the throne (March 2, 1835) a body of councilors, the "state

conference," was in charge of government affairs; it consisted of the archdukes Louis, the least capable of Ferdinand's uncles, and Francis Charles, and the statesmen Franz Anton Kolowrat and Metternich, the last-named exercising the decisive influence. There followed in 1836 Ferdinand's coronation as king of Bohemia in Prague—the last Habsburg to be so crowned—and in 1838 his coronation in Milan as king of Lombardy and Venetia. The revolution of 1848 was directed less against him than against the body of councilors, which rigidly refused all innovations. Ferdinand abdicated in favour of his nephew Francis Joseph in Olmütz on Dec. 2, 1848, and thereafter lived in Prague where he died on June 29, 1875. His marriage in 1831 with Maria Anna (d. 1884), daughter of Victor Emmanuel I of Sardinia, remained childless.

(K. O. v. A.)

FERDINAND I (1503–1564), Holy Roman emperor from 1558, was born at Alcalá de Henares, in Spain, on March 10, 1503, the second son of the archduke Philip the Handsome (son of the emperor Maximilian I and Mary of Burgundy) and of Joan the Mad of Castile and Aragon. His eldest brother, the emperor Charles V, in 1521 granted to Ferdinand the duchies of Upper and Lower Austria, Carinthia, Styria and Carniola and in 1522 Tirol with the regency both of the Habsburg territories in southwestern Germany and of the duchy of Württemberg. Ferdinand was also to be president of the *Reichsregiment*, the imperial government of Germany during the emperor's frequent absences.

In May 1521 Ferdinand married Anna, daughter of the king of Bohemia and Hungary, Vladislav (Ulászlo) II. They had 4 sons and 11 daughters. After the death of Anna's childless brother Louis II at Mohács in 1526, Ferdinand claimed both Bohemia and Hungary by virtue of his wife's right and the succession treaty of 1516 between her father and Ferdinand's grandfather Maximilian I. He took possession of Bohemia after his election as king in Oct. 1526. In Hungary, the rival claimant, John (*q.v.*) Zápolya, received support from national opposition to the Habsburgs and from the encroaching empire of the Ottoman sultan. Though Ferdinand was elected king in Dec. 1526 and crowned in Nov. 1527, Hungary remained divided between the sultan, Zápolya and Ferdinand; and war, interrupted by short truces, continued throughout his reign. The Turks unsuccessfully besieged Vienna in 1529 and threatened the Austrian lands in 1532 and 1541. Ferdinand secured the right to succeed Zápolya by the treaty of Grosswardein (Nagyvárad) in 1538; but when Zápolya died (1540) the Hungarians and the Turks took up the cause of his infant son, John Sigismund. After the peace treaty of 1547 Ferdinand paid tribute to the sultan for his small part of Hungary; these terms were confirmed in 1562.

Because Ferdinand required imperial aid against the Turks, he advised Charles V to conciliate the European powers and, later, the German Protestant princes. Yet he had at first been more hostile than Charles toward the Reformers and bears some responsibility for the secession of the "Protestants" at the diet of Speyer in 1529. In Jan. 1531 he was elected king of the Romans and thereby became heir to the imperial throne. In 1534 Württemberg was seized by the landgrave Philip of Hesse and other Protestant princes on behalf of the dispossessed duke Ulrich, whose restoration Ferdinand now had to recognize (though the duchy remained under Austrian suzerainty). Ferdinand helped Charles against the Protestant league of Schmalkalden in 1546–47, but after 1548 he adopted an independent position. He was aggrieved that Charles gave inadequate assistance against the Turks and would not reinstate him in Württemberg, which had been reconquered. Furthermore, Charles now intended his son Philip (the future Philip II of Spain) to succeed as emperor after Ferdinand or possibly, as was rumoured, in place of Ferdinand. Ferdinand agreed in 1551 that Philip should succeed him, but was not reconciled until Charles consented in 1553 that Ferdinand should be succeeded by his son Maximilian. Ferdinand stood apart from the emperor's war with Maurice (*q.v.*) of Saxony and, in 1552, negotiated with Maurice the treaty of Passau, which declared a truce in the religious disputes. The peace of Augsburg (*q.v.*) of 1555 was Ferdinand's personal achievement; it established the right of German princes to determine the religion of their states. Charles transferred his imperial authority to Ferdinand in 1555 but did not abdicate completely until 1558. Ferdinand was crowned emperor at Frankfurt on March 24, 1558.

Ferdinand sought to revive Roman Catholicism in his lands, though unsuccessfully in Bohemia and Hungary. Yet he realized the political necessity of compromise with the Protestant princes of the empire. Despite the strict terms of the "ecclesiastical reservation" in the peace of Augsburg, he permitted Protestant administrators in former Catholic bishoprics. In Bohemia he secured a papal privilege of communion in both kinds for the laity. But he compelled his son Maximilian to renounce Protestant inclinations before his election as king of the Romans in 1562.

Ferdinand died in Vienna on July 25, 1564. He divided the Austrian lands between three sons, but had converted the elective crowns of Bohemia and Hungary into hereditary Habsburg possessions. He reorganized Maximilian I's imperial councils, established the *Reichshofrat* or aulic council (*q.v.*) of the empire and centralized the Austrian and Bohemian administrations. Hard-working, intelligent and even-tempered, Ferdinand was less unbending than Charles V and more popular with the people and with Protestant princes; his policy of conciliating Protestants was more appropriate to the divided religious loyalties of the empire. There is an edition of his *Familienkorrespondenz* by W. Bauer and R. Lacroix, two volumes (1912–38). *See* also references under "Ferdinand I" in the Index volume.

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FERDINAND II (1578–1637), Holy Roman emperor from 1619, was born in Graz, Aus., on July 9, 1578, the eldest son of the archduke Charles, ruler of Inner Austria (Styria, Carinthia, Carniola, Gorizia), and Maria of Bavaria. At the Jesuit university of Ingolstadt, which he attended from 1590 to 1595 together with his cousin the future elector Maximilian I of Bavaria, Ferdinand imbibed the tenets which he upheld throughout his life and which made him the pattern of the ideal prince according to the political theories of the Jesuits: loyal to the Roman Catholic Church, obedient to the directions of his confessors, imbued with the absolutist doctrine of "one church, one king," frugal in his personal tastes but ceremonious in his public appearances, applying himself assiduously to his duties as a regent while paying due attention to his councilors, a discriminating patron of the arts.

When he received the homage of the estates of Inner Austria (Dec. 2, 1596; his father had died in 1590), Ferdinand refused to confirm the "religious pacification" that Charles had granted in 1578 and soon set about suppressing Protestantism and the estates. As the great majority of the Austrian nobles, citizens and peasants were Protestants, Ferdinand thus broke simultaneously the forces resisting religious uniformity and political absolutism. (*See* AUSTRIA, EMPIRE OF.)

From 1606 Ferdinand took part in the conspiracies of the archdukes against his cousins the emperors Rudolf II and Matthias (*qq.v.*) without forfeiting the good will of either. In 1617 the childless younger brothers of Matthias renounced their right of succession in favour of Ferdinand, and Ferdinand was crowned king of Bohemia (June 29, 1617) and of Hungary (July 1, 1618). He failed however to obtain election as king of the Romans, *i.e.*, successor-designate to the emperor, because of the opposition of the Protestant electors and of the cardinal Melchior Klesl, Matthias' principal minister. Thereupon Ferdinand imprisoned Klesl (1618–22) and confiscated his property.

Though after Matthias' death Ferdinand was unanimously elected emperor (Aug. 28, 1619), his situation was desperate. The Bohemians, in open revolt since the defenestration of Prague (May 1618), in Aug. 1619 concluded a confederation with the Austrian estates and elected Frederick V of the Palatinate as their king; and Hungary maintained an ambiguous neutrality while Gabriel Bethlen of Transylvania marched on Vienna after taking Bratislava (Sept. 15). From this plight Ferdinand extricated himself only with foreign support. Spanish troops occupied the Palatinate; the

Lutheran elector of Saxony, John George I, was turned against the Calvinist elector Palatine by the cession of Lusatia; Maximilian of Bavaria and the Catholic league reduced Upper Austria (which Maximilian kept in pawn until 1628) and Bohemia; and Bethlen was forced back by Ferdinand's brother-in-law, King Sigismund III of Poland. In Bohemia royal absolutism and Catholic supremacy triumphed. Protestantism, the power of the nobility and the independence of the towns were all crushed. (*See* further BOHEMIA: *History;* also, for these and the succeeding events of the reign, THIRTY YEARS' WAR.)

Ferdinand's unscrupulous exploitation of the inflation that ravaged Germany from 1619 to 1623 benefited his exchequer at the expense of his creditors. The main source of his weakness was remedied when Albrecht von Wallenstein (*q.v.*), who had already served him well in a war with Venice (1617), raised an imperial army, which lessened Ferdinand's dependence on the Catholic league. The victorious outcome of the Danish war (1625–29) permitted Ferdinand to issue the Edict of Restitution (March 6, 1629), which ordered the return to the Roman Catholic Church of all property alienated since 1552. This upheaval would have established the imperial ascendancy all over Germany; however, it could not be carried out because it united the Protestant and the Catholic opponents of imperial centralism. They prudently chose as their target the imperial generalissimo, Wallenstein, whose enforced dismissal (Aug. 13, 1630) deprived Ferdinand of the mainstay of his power.

The victorious advance of the Swedish king Gustavus Adolphus and the utter defeat of the Catholic league at Breitenfeld made Ferdinand recall Wallenstein (April 13, 1632), but the fear of Wallenstein's potentially dangerous schemes, fanned by Spain and Bavaria, eventually caused Ferdinand to agree to Wallenstein's second dismissal and assassination (1634). By this time, Ferdinand, prematurely aged, had already resigned a large part of his work to the capable hands of his son Ferdinand III (*q.v.*), who was chiefly responsible for the peace of Prague (May 30, 1635). This plan sealed the failure of Ferdinand II's endeavour to impose his will on the non-Habsburg territories of the empire. Having achieved his son's election as king of the Romans (Dec. 22, 1636), Ferdinand II died in Vienna on Feb. 15, 1637. He had been married first, in 1600, to Maria Anna (d. 1616), sister of Maximilian I of Bavaria; second, in 1622, to Eleonora Gonzaga (1598–1655), sister of Vincenzo II of Mantua.

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(S. H. S.)

FERDINAND III (1608–1657), Holy Roman emperor from 1637, was born in Graz, Aus., on July 13, 1608, the eldest son of the future emperor Ferdinand II (*q.v.*) and Maria Anna, sister of Maximilian I of Bavaria. His father had him crowned king of Hungary (Dec. 8, 1626) and of Bohemia (Nov. 21, 1627) and, recognizing his son's energy and ability, soon granted him an increasing share in political and military affairs. Ferdinand III was instrumental in the overthrow of Albrecht von Wallenstein (*q.v.*), whom he succeeded as the nominal commander of the imperial armies (*see also* THIRTY YEARS' WAR). Acting on the advice of Matthias Gallas (*q.v.*), he conquered Regensburg (July 28, 1634) and defeated the Swedes in the first of the battles of Nördlingen (*q.v.*). As the leader of the peace party in Vienna, he worked for the conclusion of the peace of Prague (May 30, 1635), which restored the equilibrium between the emperor and the German princes and meant the tacit abandonment of his father's centralistic and absolutistic plans. Elected king of the Romans (successor-designate to the emperor) on Dec. 22, 1636, despite the opposition of Bavaria and of the Roman *curia,* he was unanimously elected emperor in 1637, after his father's death. Though he was as firm as his father in his adherence to the Roman Catholic Church and strictly maintained religious conformity in his hereditary territories, Ferdinand III was willing to compromise in religious matters in order to attain political ends. Thus he worked hard for the pacification of the empire, which he achieved in the peace of Westphalia (*see* WESTPHALIA, PEACE OF) in Oct. 1648 and in the Nürnberg agreement of July 1650; and he conceded a large measure of toleration to the Protestants of Hungary. In return, he secured the election of his eldest son, Ferdinand IV (1633–54), as king of Hungary (1647) and as king of the Romans (1653) and, after the latter's premature death, the election of his second son, Leopold I (*q.v.*), as king of Hungary (1655) and of Bohemia (1656), though French intrigues prevented Leopold's election as king of the Romans. The creation of a standing Austrian army (1649) and the proclamation of a revised regulation for the imperial aulic council (1654) testify to Ferdinand's administrative ability. He died in Vienna on April 2, 1657. He had been three times married: in 1631 to the infanta Mariana (d. 1646), daughter of Philip II of Spain; in 1648 to Maria Leopoldina of Tirol; and in 1651 to Eleonora Gonzaga (1628–87; of the Nevers branch of the Gonzaga dynasty).

See M. Koch, *Geschichte des Deutschen Reiches unter Ferdinand III.,* 2 vol. (1865–66).
(S. H. S.)

FERDINAND I (1379–1416), king of Aragon from 1412 to 1416 and co-regent of Castile from 1406 during the minority of his nephew John II, was the second son of John I of Castile and Eleanor, daughter of Peter IV of Aragon. As regent he conducted himself honourably, refusing a suggestion that he should oust his nephew from the throne, and gained a famous victory by capturing (1410) the supposedly impregnable Granadine fortress of Antequera. However, he left the Castilian crown much weakened by excessive grants to his own children. When the childless Martin of Aragon died (1410), Ferdinand presented himself as one of the candidates for the vacant throne, and secured it by the compromise of Caspe (1412) against the strong opposition of the Catalans. Ferdinand's success was achieved through the support of the Aragonese antipope Benedict XIII and the efforts of St. Vincent Ferrer, as well as by a judicious use of threats, bribery and political skill employed by Ferdinand himself. Once elected, he withdrew Aragonese allegiance to Benedict and so helped to end the Great Schism. Ferdinand was evidently an intelligent man, a prudent politician and an able general, but it is difficult to discern toward exactly what end these gifts were directed. His accession marked the end of the long Catalan political domination of the Aragonese state and so brought measurably nearer the latter's union with Castile. Ferdinand died at Igualada in Catalonia on April 2, 1416.
(P. E. R.)

FERDINAND II (1452–1516) of Aragon (Ferdinand V of Castile), known as THE CATHOLIC, unified Spain by his marriage to Isabella of Castile (*see* ISABELLA, la Católica) and made Spain the foremost power in Europe. He was born at Sos, in Aragon, on March 10, 1452, the son of John II of Aragon and his second wife, Juana, daughter of Fadrique Enríquez, grand admiral of Castile. His father preferred him to Charles, prince of Viana, the son of his first marriage, whom he fought for years and who conveniently died in 1461. In 1469 John II succeeded in arranging Ferdinand's marriage to Isabella of Castile, helped by the Castilian opposition to Isabella's brother, Henry IV of Castile, and by some of the rich Jewish families of Castile and Aragon. (This help did not prevent Ferdinand from decreeing the expulsion of the Jews from Spain in 1492.) On the death of Henry IV (1474) Ferdinand claimed the crown of Castile in his own right; but Isabella, firmly backed by the Castilians, insisted on hers. Always a political realist, Ferdinand gave way and, from then on, ruled jointly with Isabella. He succeeded his father in Aragon in 1479 and associated Isabella with himself in the government of that kingdom in 1481.

Together, the *Reyes Católicos* ("Catholic kings"), as Ferdinand and Isabella were now known, re-established the power of the monarchy in Castile and conquered Granada (1492). Ferdinand, however, did not in his own kingdom of Aragon follow Isabella's policy of expelling the Moors.

Ferdinand's foreign policy was dominated by the interests of Aragon and its traditional rivalry with France in Italy and along the Pyrenees. Hence he gave only halfhearted support to Cardinal Jiménez de Cisneros' attempts to conquer north Africa for Castile and Christianity (1505–10). Ferdinand's Italian policy led to the resounding success of the conquest of Naples (1503) by

his general Gonzalo de Córdoba (*q.v.*). The military victory had been carefully prepared by years of astute and unscrupulous diplomacy. Ferdinand was the first non-Italian ruler to build up a regular diplomatic service, but, characteristically, he distrusted his own diplomats. Machiavelli's view of Ferdinand, as a prince who gained his ends by lying while successfully protesting his honesty, was shared by many of Ferdinand's contemporaries. Modern historians have generally agreed with this verdict.

Ferdinand had carefully arranged the marriages of his children to strengthen his diplomatic position against France. The unexpected deaths of the two eldest and of their children left the succession of Castile, after Isabella's death (1504), to the third, Joan the Mad (*see* JOAN THE MAD), and her husband Philip the Handsome (Philip I of Castile). Philip was supported by a large section of the Castilian nobility, and Ferdinand had reluctantly to recognize his claims. Ferdinand himself married Germaine de Foix, niece of Louis XII of France. Germaine's son was to succeed in Aragon. It is very likely, as R. B. Merriman has argued, that Ferdinand planned to place the prince on the throne of Castile as well. In the event, both Philip the Handsome and Germaine's son died (1506 and 1509). Ferdinand was left in control of Castile until his death at Madrigalejo, in Extremadura, on Jan. 23, 1516. In 1512 he had conquered the part of the kingdom of Navarre that lay south of the Pyrenees and in 1515 it was formally annexed to Castile.

His contemporaries did not find Ferdinand an attractive personality, but they were impressed by him and by his achievements. With the possible exception of Henry VII of England, he was undoubtedly the most intelligent and successful ruler of his day. Philip II is reported to have stood one day before Ferdinand's portrait and to have said: "To him we owe it all." (*See* SPAIN: *History: The "Catholic Kings."*) For Ferdinand's relations with Columbus, *see* COLUMBUS, CHRISTOPHER.

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FERDINAND I (1861–1948), king of Bulgaria from 1908 to 1918, was born in Vienna on Feb. 26, 1861, the fifth and youngest son of Prince Augustus of Saxe-Coburg and Gotha. In 1879 he traveled with his brother Augustus to Brazil, and the results of their botanical observations were published in Vienna under the title of *Itinera Principum S. Coburgi* (1883–88). Ferdinand was a lieutenant in an Austrian hussar regiment when he was elected prince of Bulgaria on July 7, 1887, in succession to Prince Alexander (*q.v.*) of Battenberg, who had abdicated in 1886. He assumed the government on Aug. 14, 1887, but Russia for a long time refused to acknowledge the election, and he consequently had to guard against military conspiracies at which the Russian government connived. The firmness and skill with which he foiled all attempts at revolution were at length rewarded and his election was confirmed in March 1896 by Turkey and the great powers. On April 20, 1893, he married Maria Luisa (1870–99), eldest daughter of Robert of Parma. The prince adhered to his Roman Catholic faith, but his son and heir, Boris, was received into the Greek Orthodox Church on Feb. 14, 1896, with the Russian emperor Nicholas II as godfather. This marked a real *rapprochement* with Russia. In 1908 Ferdinand married Eleanor (1860–1917), a princess of Reuss. In October of the same year, in connection with the Austro-Hungarian annexation of Bosnia-Hercegovina, he proclaimed the independence of Bulgaria and took the title of king or tsar.

Ferdinand in 1911 was the instigator of the Balkan league between Bulgaria, Serbia, Greece and Montenegro, which was formed in 1912 and enabled these four states to declare war against Turkey that same year. This pact provided for the future division of the Balkan peninsula, reserving any doubtful claims to the arbitration of the emperor of Russia. The war started in Oct. 1912, before the conclusion of the treaty of Ouchy, which put an end to the Italo-Turkish War. The Bulgarian army dealt rapid and decisive blows at the Turks; having conquered most of Macedonia and Thrace, it started on the open road to Istanbul. Europe was alarmed; the great powers brought about the armistice of Dec. 3, 1912, and the London conference which started on Dec. 16.

These discussions, however, broke down, and military operations were resumed on Feb. 3, 1913. The Bulgarian armies entered Adrianople on March 26, 1913. However, the preliminaries of peace signed in London (May 30, 1913) did not sanction these victories. The result was a war between the Balkan states, which began on June 28, 1913, with a Bulgarian attack on the Serbs and Greeks in Macedonia. The former allies became bitter rivals, Rumania and Turkey joining Montenegro, Greece and Serbia against Bulgaria, which was forced after a few weeks of resistance to submit unconditionally to the victors' terms. The treaty of Bucharest, signed on Aug. 10, 1913, annihilated in one stroke the results obtained by the Bulgarian armies in 1912–13. It deprived the Bulgars of all their conquests including part of Dobruja. This treaty was the principal cause of Bulgaria's participation in World War I on the side of Germany. It explains the resentment of Ferdinand and his government against the other Balkan states. (*See* BALKAN WARS.)

During May 1915 the Bulgarian government approached the Allies with regard to the fulfillment of Bulgaria's legitimate claims in Macedonia. As no concrete promises were obtained, Ferdinand turned to Germany, where his request was received with great cordiality. Berlin made lavish promises at once. The desire for revenge against Serbia, Greece and Rumania inspired Ferdinand to bind Bulgaria to the Central powers. On Sept. 21, 1915, he gave the order for general mobilization. In reaction to this, Russia sent an ultimatum to Bulgaria on Oct. 4, 1915, which was succeeded by formal declarations of war against Bulgaria on the part of Serbia, France, Great Britain and Italy. Under Gen. Nikolai Zhekov, the Bulgarian armies were victorious on most of the battlefields of Macedonia, Thrace and Rumania, in 1915, 1916 and 1917, against the Serbs and against the Rumanians. However, in Sept. 1918, the Bulgarian army, demoralized by long privations, was defeated in Macedonia by the Allied troops. This was the sign for a general retreat. An armistice was signed at Salonika on Sept. 30. After this catastrophe Ferdinand abdicated in favour of his son Boris on Oct. 4, 1918, and left Sofia the same evening for Coburg, Ger. He died there on Sept. 10, 1948.

See H. R. Madol, *Ferdinand of Bulgaria* (1933).

(A. St.; N. I. M.)

FERDINAND, the name of five kings of Castile and León.

FERDINAND I (1016 or 1018–1065), "the Great," king of Castile and León, was a son of Sancho III "the Great" of Navarre. He became king of a truncated Castile on his father's death (1035). He had married Sancha, sister and heiress of Bermudo III of León, and when Bermudo was killed at Tamarón (1037) fighting against the Castilians, Ferdinand, despite opposition, seized the Leonese throne and was crowned emperor at León (1039). He reorganized the administration of León, particularly by reducing the hereditary powers of the magnates. In 1054 he proceeded to recover the Castilian territory given by his father to Ferdinand's brother García IV, king of Pamplona. García himself was killed by Ferdinand's troops at Atapuerca (1054) and Navarre then accepted the emperor's suzerainty. Ferdinand next moved against the Moors, first recovering the region of Beira Alta in Portugal, and Gormaz and Berlanga in the east. In 1062 he attacked the kingdom of Toledo and made its king, Yahia I, his vassal, while the kings of Saragossa and Seville also acknowledged his suzerainty. In this way a large part of Spain—Christian and Moorish—became subject to Ferdinand's will. He, however, following his father's unwise example, partly destroyed what he had so successfully built up by dividing his empire, on his death (at León, Dec. 27, 1065), between his three sons, Sancho, Alfonso and García.

FERDINAND II (1137–1188), king of León from 1157 to 1188, was Alfonso VII's second son. Despite several internal revolts against his rule, his reign was notable for the repopulation of Leonese Extremadura and for the victories he secured farther

south against the Almohads in the last 20 years of his reign. These included the capture of Alcántara (1166) and Badajoz (1169). He also gave important support to the new military order of Santiago, founded with his approval in 1170. Ferdinand, who called himself *rex hispanorum*, established a temporary tutelage over Castile during the minority of his nephew Alfonso VIII and occupied Segovia and Toledo (1162–66). Later Alfonso reacted violently against Ferdinand, who was also frequently engaged in hostilities with the nascent Portuguese kingdom, but came successfully to the rescue of the Portuguese when the Almohads invested the key city of Santarém (1184). Ferdinand died at Benavente in Jan. 1188.

FERDINAND III (1201?–1252), "the Saint," king of Castile from 1217 to 1252 and of León from 1230 to 1252, was the son of Alfonso IX of León and Berenguela, daughter of Alfonso VIII of Castile. To make good his claim to the Castilian throne Ferdinand had to make war on his father, who was supported by some of the Castilian nobles. In 1230, after his father's death, he found himself debarred by the latter's testament from inheriting León. By the pact of Benavente (1230), however, this provision was set aside and León and Castile were permanently united under Ferdinand. Ferdinand was a religious zealot and, perhaps urged on by his first wife, Beatrice of Swabia, he set about destroying Moorish rule in Andalusia with a vigour and a crusading zeal that were new in Spanish Christian relations with the Moors. From 1224, taking advantage of the political disintegration of the Almohads in the south, he began a series of campaigns that led to the permanent conquest of most of the cities of Andalusia, including Córdoba (1236), Jaén (1246) and the Andalusian capital, Seville, which fell, after a year's siege, in 1248. He also occupied the kingdom of Murcia while James I of Aragon was busy conquering Valencia, and so secured a Castilian outlet to the Mediterranean. Only the Muslim kingdom of Granada survived the Christian occupation of Andalusia, but as a vassal state of Castile. A new feature of Ferdinand's great conquests was that the defeated Moorish inhabitants were expelled from their former homes by the Christian conquerors with disastrous and permanent results to the economy of Andalusia and to that of Castile, as well. For his remarkable achievement, which virtually completed the long-delayed reconquest of Spain, Ferdinand was canonized in 1671. In 1237 Ferdinand married again; his second wife was Joan of Ponthieu. Their daughter Eleanor married (1254) the future Edward I of England.

FERDINAND IV (1289–1312), king of Castile from 1295 to 1312, succeeded his father, Sancho IV, at the age of six. His minority was marked, as was usual, by continuous rebellions and conspiracies mounted by the Castilian nobles against the crown. His reign is chiefly remarkable for the skill and courage shown by his mother, María de Molina, in defending her son's position. He died at Jaén in Sept. 1312.

FERDINAND V (1452–1516), "the Catholic": *see* FERDINAND II, king of Aragon. (P. E. R.)

FERDINAND I (1423–1494), in Italy also known as DON FERRANTE, king of Naples from 1458, was born at Valencia in Spain in 1423, the natural son of Alfonso V of Aragon. His father having in 1443 finally established himself as king of Naples (as Alfonso I), Ferdinand, whom he had legitimized, was recognized as heir to the kingdom. Shortly after Ferdinand's accession to the throne (1458) rebellion broke out against him, led by the greater barons and supported by René (*q.v.*) of Anjou, the pretender to the throne. Ferdinand finally overcame the rebellion in 1464.

Ferdinand was faced not only by Angevin pretensions, which were later taken over by the king of France, but also by the Turkish peril, by the designs of the other great states in Italy and by the agitation of his own barons. He therefore pursued an opportunist policy. The Turks in July 1480 suddenly seized Otranto, and the task of expelling them, achieved in 1481, necessitated financial aid from Florence, for which he had to renounce acquisitions that he had hoped to make in Tuscany. He then made a lasting alliance with Florence, and in the War of Ferrara (1482–84) Naples and Florence were at one against Venice.

Ferdinand's attempts to break the power of his barons, in which he appears as a pioneer of royal absolutism, provoked another rebellion (1485–87). The barons' object was to depose Ferdinand and replace him by René II of Lorraine or by Frederick of Aragon, Ferdinand's second son. Pope Innocent VIII also declared war but had to agree to a separate peace (Aug. 11, 1486) when René failed to arrive and when Alfonso of Calabria (the future Alfonso II, Ferdinand's elder son) advanced on Rome. The series of arrests, confiscations, trials, sentences of imprisonment and executions whereby Ferdinand suppressed the rebels damaged his reputation as a statesman. He died on Jan. 25, 1494.

See C. Porzio, *La Congiura dei baroni del regno di Napoli contra il re Ferdinando I* (1565; ed. by E. Pontieri, 1958); E. Pontieri, *Per la storia del regno di Ferrante I d'Aragona, re de Napoli* (1946) and *La Giovinezza di Ferrante d'Aragona* (1959). (E. Po.)

FERDINAND II (1467–1496), called FERRANDINO by his contemporaries, king of Naples from 1495, was born in Naples on June 26, 1467, the son of the future Alfonso II of Naples and Ippolita Maria Sforza. When his father became king (1494), Ferdinand took command of the army collected to resist the French king Charles VIII (*q.v.*) in northern Italy. Failing to check the French, he returned to Naples, where Alfonso abdicated in his favour on Jan. 23, 1495. Unable to prevent Charles from entering Naples on Feb. 22, Ferdinand withdrew to Messina. After a few months, however, he recovered Apulia with Venetian help (for which he had to cede the most valuable Adriatic ports there to Venice) and Calabria. The reconquest of Campania began with his landing at Naples on July 7, 1495, and by the end of summer in 1496 almost the whole kingdom was his again. He died at Naples on Oct. 7, 1496, shortly after his marriage to his cousin Joan, a niece of Ferdinand II of Aragon.

See B. Croce, "Re Ferrandino," *Storie e leggende napoletane*, 2nd ed. (1923); N. Minervini, *Re Ferrandino* (1923). (E. Po.)

FERDINAND (1345–1383), king of Portugal from 1367 to 1383, the son of Pedro I of Portugal and Constanza, daughter of Don Juan Manuel (*q.v.*), was born in Lisbon on Oct. 31, 1345. He succeeded his father in 1367 and became a contender for the Castilian throne after the assassination (1369) of Pedro I of Castile. This led to the first (1369–71) of three unsuccessful wars with Castile. After negotiations conducted by João Fernandes Andeiro, Ferdinand allied himself in 1372 with John of Gaunt, duke of Lancaster, against Castile and Aragon. This resulted in a second war with Castile (1372–73), in which Castilian troops invaded Portugal, surrounded Lisbon (1373) and obliged Ferdinand to repudiate the English alliance and to accept the conditions of Henry II of Castile.

The period of peace which followed was taken up with successive, and sometimes contradictory, diplomatic negotiations—with England, Castile, Aragon and France—but the Anglo-Portuguese treaty of June 16, 1373, continued to form a basis of alliance between the two countries. The confirmation of the English treaties in 1380 gave rise to a third war with Castile (1381–82), which, like the earlier conflicts, was characterized by the the lack of success of Portugal's military operations, in spite of forces sent from England under Edmund of Langley. Compelled once more to sign a peace treaty (Aug. 1382) and to abandon his allies, Ferdinand obtained from the king of Castile the ships for repatriation of the English troops.

Notwithstanding his preoccupation with war, Ferdinand promulgated laws which encouraged the development of agriculture, external trade, the merchant marine and the army. In his lifetime Ferdinand's marriage (1372) with Leonor Teles, a lady of somewhat doubtful morals, provoked discontent; the marriage (April 30, 1383) of his only legitimate child, Beatriz, with John I of Castile precipitated, on Ferdinand's death (Oct. 22, 1383), one of the most serious dynastic and national crises in Portuguese history (*see* PORTUGAL: *History*). (V. R. R.)

FERDINAND I (1865–1927), king of Rumania from 1914, was born on Aug. 24, 1865, at Sigmaringen, Ger., the second son of Prince Leopold of Hohenzollern-Sigmaringen and Antonia, infanta of Portugal. As his uncle King Carol I of Rumania had no heir, Ferdinand was adopted as crown prince and heir presumptive in 1889. On Jan. 15, 1893, Prince Ferdinand married Princess

Marie of Edinburgh, granddaughter of Queen Victoria and of the emperor Alexander II of Russia. Six children were born of the marriage. Shy and retiring, Ferdinand was kept in the background during his time as crown prince. He found an outlet in military affairs, was active in reorganizing the army and acted as commander in chief during the Bulgarian campaign of 1913.

Ferdinand succeeded to the throne on Oct. 11, 1914, shortly after the outbreak of World War I. As a Hohenzollern and a believer in German military strength, he naturally sympathized with the Central Powers. After two years of neutrality, however, Ferdinand, influenced partly by his English queen but chiefly by his appreciation of the importance to his country of securing Transylvania, agreed to Rumania's entering the war on the side of the Allies in Aug. 1916.

When Bucharest was occupied by the Germans at the end of 1916, Ferdinand withdrew with the government and the rest of the army to Moldavia, making Iaşi (Jassy) the capital. There, with his people he endured a period of acute anxiety, sickness and want. Despite the crumbling of the Russian front the Rumanian troops led by Gen. Alexandru Averescu repulsed the German attack at Marasesti in July 1917, thus saving the rest of the country from invasion. With the defeat of the Central Powers Rumania was able to secure Transylvania, Bukovina, part of the Banat and Bessarabia, which, detached from Russia by the Revolution, finally voted for incorporation in Rumania. Thus in 1918 Greater Rumania was proclaimed, and on Oct. 15, 1922, Ferdinand was solemnly crowned at Alba Iulia as king of all Rumanians.

Two important measures, the agrarian reform and universal suffrage, were enacted in Ferdinand's reign. He is said to have played a large part personally in the land redistribution, and was in fact the first landlord to hand over his estates to his peasant soldiers. It was also in part due to the king's initiative that full civil and military rights were granted to Rumanian-born Jews. Ferdinand's later years were clouded by anxiety over his heir, the future king Carol II (*q.v.*), who after a morganatic marriage renounced his rights to the throne in Dec. 1925. Ferdinand died on July 20, 1927.

See Princesse M. L. Bibescu, *Une victime royale: Ferdinand de Roumanie* (1927); E. Wolbe, *Ferdinand I, der Begründer der Grossrumäniens* (1938). (B. Br.)

FERDINAND I (1751–1825), king of the Two Sicilies from 1816, having previously been Ferdinand IV of Naples and III of Sicily, was born at Naples on Jan. 12, 1751, the third son of King Charles of Naples (afterward Charles III of Spain) and Maria Amalia of Saxony. When his father ascended the Spanish throne in 1759, Ferdinand, in accordance with the treaties forbidding the union of the Spanish and Neapolitan crowns, took his place on the throne of Naples. Until he came of age he was under a regency council controlled by Bernardo Tanucci and by Domenico Cattaneo, principe di San Nicandro. At the age of 16, however, Ferdinand's minority ended and the regency council was dissolved, but Tanucci continued to hold the reins of power. In 1768 the king married Maria Carolina of Austria, daughter of the empress Maria Theresa. She exercised great influence on him and was able to free him from control by Tanucci, who was the tool of Spanish policy at Naples. When the queen gave Ferdinand an heir, thus acquiring the right to enter the council of state, the struggle with Tanucci became more bitter, and in 1777 the powerful minister was displaced. From that moment the Neapolitan dynasty adopted an Austro-British policy, which was more in keeping with the true interests of the country than that of the Bourbon "family compact." The medium through which the queen conducted her personal policy was an Englishman, Sir John Acton (*q.v.*).

At first some moderate reforms, with such acts as the expulsion of the Jesuits (1767) and the abolition of the kingdom's tribute to the pope (1788), made Ferdinand's reign appear as the realization of the ideals of the Enlightenment. The model colony, on communal lines, and the silk factory at San Leucio, close to the royal palace at Caserta, were expressions of the philanthropic spirit. Then, from 1789, the French Revolution provoked an upheaval. The Neapolitan Jacobins organized themselves into lodges on the masonic principle (*see* CARBONARI) and a gulf opened between the monarchy and the more progressive section of the people.

The king, who had wanted to join the first coalition against France in 1793 (*see* FRENCH REVOLUTIONARY WARS), took the initiative in 1798, encouraged by the battle of the Nile and the arrival of Nelson's fleet. He then sent his army to attack the French-sponsored Roman republic and to restore the old regime. The enterprise proved disastrous and provoked a French invasion of Naples. On Dec. 21 Ferdinand left for Palermo in Nelson's flagship, despite the outcry of the "Lazzaroni" in Naples, who declared themselves ready to defend him. A republic was proclaimed in Naples. This, however, was overthrown in June 1799 when the reaction of the peasant masses and the "Sanfedisti," led by the cardinal Fabrizio Ruffo, enabled the Bourbons to re-enter Naples. The patriots who had proclaimed the republic were put to death, in violation of the terms of surrender.

In 1806, when the French again conquered Naples, Ferdinand had to take refuge again in Sicily, where he remained until 1815, protected by the British forces. During these years he clashed with the Sicilian parliament which, backed by the British, was trying to mitigate the absolutism of his regime. In 1812 he was forced by Lord William Bentinck to appoint as *vicario* or regent his son Francis, who granted a constitution to the Sicilians, and to send his wife away from Palermo. The fall of Napoleon and the end of Joachim Murat (*q.v.*) allowed Ferdinand to return to Naples. He now assumed the title "king of the Two Sicilies" (Dec. 1816), intending to centralize the administration of Naples-Sicily.

The discontent of liberals against Ferdinand's renewed absolutism began to spread over the kingdom. Prepared by the underground activity of the Carbonari, a constitutionalist rising broke out at Nola in July 1820 and the king was compelled to grant a constitution. This took the form of the famous Spanish constitution of 1812, with suitable modifications. At the same time he handed over the government to his son Francis as *vicario*, as if wanting to divide his own responsibilities. The success of the rising, however, alarmed the powers of the Holy Alliance (*q.v.*) and Ferdinand, despite his oath to uphold the constitution, made repeated appeals for help to Austria and to England unbeknown to the constitutional government. Invited by the powers to the congress of Laibach (*q.v.*), he obtained his parliament's consent to his attending it after promising publicly to act as a peacemaker there and to uphold the principles of the constitutional regime. Once there, he plotted with Metternich to re-establish absolute rule in Naples and returned to his kingdom only after the Austrian forces had overthrown the constitutional government (March 1821).

A widower in 1814, Ferdinand had morganatically married Lucia Migliaccio, principessa di Partanna. He died at Naples on Jan. 4, 1825.

See H. Acton, *The Bourbons of Naples*, vol. 1 (1956). (E. Po.)

FERDINAND II (1810–1859), king of the Two Sicilies from 1830, was born at Palermo on Jan. 12, 1810, the son of the future Francis I and the Spanish infanta Maria Isabel. While still a child he was the object of political scheming: in 1812, during their quarrels with his grandfather (*see* FERDINAND I), the British considered making him king of Sicily, and in 1820 the Carbonari offered him the crown of Lombardy. His proclamation on his accession to the throne of the Two Sicilies (Nov. 8, 1830) raised the hopes of the liberal Neapolitan middle class, as also did his marriage in 1832 to the pious and gentle Maria Cristina (fl. 1836), youngest daughter of Victor Emmanuel I of Sardinia-Piedmont. A generous amnesty was offered to political prisoners; officers who had served under Joachim Murat were reinstated in the army; and a policy of friendship with the French July monarchy was initiated. These good beginnings, however, were not followed up. Married in 1837 to the Austrian archduchess Theresia, Ferdinand adopted a new policy of authoritarianism. Risings in Sicily and in Calabria, stimulated by Mazzinian propaganda, were severely suppressed, and the king incurred fresh hatred when Attilio and Emilio Bandiera (*q.v.*) were executed in 1844. In 1847 Luigi Settembrini published anonymously his impassioned if unjust indictment of the Bourbons, the *Protesta del popolo delle Due*

Sicilie, which had wide repercussions even outside Italy.

Dismayed by the revolution that broke out at Palermo on Jan. 12, 1848, Ferdinand, on Jan. 29, was the first Italian prince to grant a constitution in that year, modeled on the French one of 1830. On May 15, however, the day of the opening of the new chamber of deputies, serious disturbances broke out in Naples. Ferdinand forcibly dissolved the assembled parliament, dismissed Carlo Troya's ministry and recalled the troops that had been sent to fight for the Piedmontese against the Austrians in northern Italy. He withdrew the constitution on March 13, 1849, and launched a ferocious repression in Sicily which earned him the nickname of "King Bomba." Among the prosecutions resulting from the events of 1848, the most famous was that of the Unità Italiana group to which Settembrini belonged. W. E. Gladstone, who visited Naples in 1850, denounced the regime as "the negation of God erected into a system of Government" (letter to Lord Aberdeen, April 7, 1851), but discussions in the London house of commons did not deter Ferdinand.

Conspiracies in Sicily, Carlo Pisacane's attempt at revolt (June 1857) and, above all, Agesilao Milano's attempt to assassinate him (Dec. 18, 1856) all aggravated the king's morosity. He died at Caserta on May 22, 1859.

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FERDINAND VI (1713–1759), king of Spain from 1746 to 1759, was the fourth but only surviving son of Philip V of Spain by his first marriage with María Luisa of Savoy. He was born in Madrid on Sept. 23, 1713, and became heir to the throne in 1724, following the death of his brother Louis I of Spain. Ferdinand married in 1729 Barbara of Braganza, daughter of John V of Portugal, and thenceforward all his actions were governed by her. He played no part in political life during the reign of his father, whom he succeeded in July 1746, because of the dislike felt toward him by his stepmother, Isabella Farnese, who regarded him as an obstacle to the fortunes of her own children.

Ferdinand VI's reign was characterized by the maintenance of peace; it represented, in fact, the longest period without war enjoyed by Spain since the reign of Philip II. Once he had secured in 1748 the recognition of his half brothers as the rulers of Naples and Parma, Ferdinand had little further interest in foreign policy, and limited himself to resisting the efforts of his ministers to ally Spain with France or England (*see* Spain: *History*). Domestic policy interested him no more than foreign affairs, but, fortunate in having inherited from his father an able prime minister, the marqués de la Ensenada (*q.v.*), his reign was notable for some valuable reforms in the internal administration of the kingdom. During the last part of his life, particularly after the death of Barbara in 1758, Ferdinand exhibited the same sort of insanity as that shown by his father. He died at Villariciosa de Odón on Aug. 10, 1759. (B. J. R.)

FERDINAND VII (1784–1833), king of Spain from March to May 1808 and from 1814 to 1833, was the ninth child and eldest surviving son of Charles IV and María Luisa of Parma. He was born at El Escorial on Oct. 14, 1784, and took the oath as prince of Asturias in 1789 after the accession of his father. A group, known as *Ferdinandistas*, in opposition to the policies of Charles's favourite Manuel de Godoy, formed around the prince during the first years of the 19th century. Godoy attempted to expose and rout the faction early in 1808, after Ferdinand in 1807 had been in secret correspondence with Napoleon, but almost immediately there occurred the Aranjuez rising of March 17, 1808, which led to Godoy's dismissal and Charles's abdication in favour of Ferdinand (March 19). Shortly afterward Ferdinand was summoned by Napoleon to a meeting at Bayonne and there was obliged to restore the crown to his father (May 5) who granted it to Napoleon. Ferdinand renounced his rights as heir on May 10 and then was detained at Valençay, where he remained until 1814. Spanish reaction to these events found expression in the rising of May 2 against the French.

Ferdinand returned to Spain in March 1814. He repudiated in May the constitution of 1812 which had been promulgated by the *Cortes* of Cádiz, and went on to re-establish the Inquisition and persecute the supporters of the constitution. There followed a series of insignificant ministries which gave rise to Liberal conspiracies in 1814, 1815 and 1817. When Gen. Rafael del Riego proclaimed the 1812 constitution at Cabezas de San Juan in Jan. 1820, Ferdinand was forced to accept a Liberal ministry and he promised to observe the constitution. This was mere dissimulation; royalist risings brought about a state of civil war and Ferdinand appealed for help to the Holy Alliance. In response to this appeal, French troops under the duc d'Angoulême entered Spain in April 1823 and had freed the king by October. Ferdinand then resumed absolute control and launched a systematic and harsh persecution of the Liberals, which continued until the moderating influence of the king's fourth wife María Cristina (*q.v.*) made itself felt.

Before María Cristina, Ferdinand had married in 1802 María Antonia of the Two Sicilies (d. 1806); in 1816 María Isabel of Portugal (d. 1818); and in 1819 María Josefa Amalia of the Two Sicilies (d. 1829). No children survived from these marriages. But in March 1830, when María Cristina was pregnant, Ferdinand proceeded to his most important political action: the confirmation of Charles IV's revocation of the Salic law introduced by Philip V. Although this meant that the daughter born on Oct. 10, 1830, was able to succeed Ferdinand on the throne as Isabella II, it also provoked long-lived civil strife (*see* Carlism). Ferdinand died in Madrid on Sept. 29, 1833. (R. S. Ll.)

FERDINAND III (1769–1824), grand duke of Tuscany from 1790, was born in Florence on May 6, 1769, the second son of the Austrian archduke Leopold, grand duke from 1765. When his father became Holy Roman emperor as Leopold II, Ferdinand succeeded him in Tuscany. He was one of the first sovereigns to enter into diplomatic relations with the French republic (1793); and though, a few months later, England and Russia compelled him to join the coalition against France, he made peace with the republic in 1795. By observing a strict neutrality he saved his dominions from invasion by the French, except for a temporary occupation of Livorno, till 1799, when he was compelled to vacate his throne, and a provisional republican government was established at Florence. Shortly afterward the French suffered severe reverses in Italy, and Ferdinand was restored to his territories; but in 1801, by the peace of Lunéville, Tuscany was converted into the kingdom of Etruria, and he retired to Vienna. He was given the secularized territories of the archbishopric of Salzburg, with the title of elector, in 1803, but exchanged them for those of Würzburg in 1805. As grand duke of Würzburg he was admitted to the confederation of the Rhine in 1806. He was restored to the throne of Tuscany after Napoleon's abdication in 1814. When Joachim Murat, as king of Naples, proclaimed war against Austria in 1815, Ferdinand had to leave his capital for a short time. After Waterloo he remained secure in his grand duchy. The restoration in Tuscany did not lead to reactionary excesses as it did elsewhere, and much of the French legislation was retained. Ferdinand's rule was mild; he was interested in his subjects' welfare, gave enlightened patronage to art and science, encouraged commerce and was generally tolerant. He was an exception among the Italian princes of his time. He died in Florence on June 18, 1824, and was succeeded by his son Leopold II (*q.v.*).

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FERDINAND, Duke of Brunswick (1721–1792), field marshal of Prussia and victor at the battle of Minden (*q.v.*), was born at Wolfenbüttel on Jan. 12, 1721, the fourth son of Ferdinand Albert II, duke of Brunswick-Bevern-Wolfenbüttel (d. 1735).

In 1740 Ferdinand entered Prussian service as commander of the newly formed Brunswick regiment and was present at the Prussian victories of Mollwitz (1741) and Chotusitz (1742) in the first Silesian War. In 1744 he succeeded to the command of Frederick II of Prussia's *Leibgarde* battalion and distinguished himself at the victory of Sohr (1745) during the second Silesian War. In the years that followed he became an intimate friend of

Frederick, who was also his brother-in-law. He made a close study of the king's military methods, to which he owed much of his later success.

In the Seven Years' War Ferdinand first commanded the right wing of the Prussian infantry in the victory of Lobositz (1756), in the campaign which led to the capitulation of the Saxon army at Pirna (1756). In 1757 he greatly distinguished himself at the siege of Prague and served in the campaign of Rossbach. Shortly afterward he was made commander in chief of the allied forces in western Germany where the French had overrun Hanover and dictated the capitulation of Kloster-Zeven. Ferdinand restored the shattered forces. In July 1758 he defeated the French at Krefeld; this, however, left him strategically exposed and he withdrew to Lippe. Later that year he became field marshal. The first half of 1759 saw heavy fighting; on Aug. 1 he won the famous victory of Minden; other victories followed. This western drive helped the king, hard pressed in the east, to gain his great successes there. Yet Ferdinand had the harder task, because the king controlled both policy and resources.

When peace returned Ferdinand devoted his time and resources to alleviating the sufferings caused by the war. In June 1766 he became estranged from the king and retired from Prussian service. However, he declined all offers of a command from other governments; indeed, the old friendship with Frederick was soon revived on a personal basis (Ferdinand visited the king several times between 1772 and 1782).

On retiring, Ferdinand went to live at the castle of Vechelde in Brunswick. Thereafter he concentrated on cultural pursuits and charitable work and continued a zealous freemason, becoming grand master in 1782. He died at Vechelde on July 3, 1792.

See F. O. W. F. von Westphalen (ed.), *Geschichte der Feldzüge des Herzogs Ferdinands von Braunschweig-Lüneburg*, 6 vol. (1859–72).

(C. N. B.)

FERENTINO (anc. FERENTINUM), a small town and episcopal see of Italy, in the province of Frosinone in Lazio (Latium), lies 74 km. (46 mi.) E.S.E. by rail from Rome. Pop. (1957 est.) 16,682 (commune). Prominently situated on a commanding spur, 1,290 ft. above sea level, overlooking the valley of the Sacco river and controlling all traffic down the Via Casilina (anc. Via Latina), it still possesses considerable remains of its ancient fortifications, Roman or earlier. There are two well-preserved gates in the outer circuit, the Porta Sanguinaria (with polygonal jambs and tufa voussoirs) and the Porta Sta. Maria, a double gate of squared tufa. Within this circuit the town is dominated by the ancient cathedral (rebuilt 1099–1118) and the bishop's palace, standing on the level top of the acropolis. The retaining walls at this point provide one of the outstanding surviving examples of republican Roman architecture. Despite the varied character of its masonry, the towering, bastionlike projection that flanks the gate was all built on a single occasion. It incorporates a number of barrel-vaulted passages and chambers which were ingeniously lit by a series of small windows just below the vault and which served as foundations for a monumental building (a temple?) on the platform above, in the form of a rectangular hall, more than 30 ft. wide, with internal colonnadés against the two long sides. An inscription, twice repeated, records the building of the platform by two local officials, one of them, Aulus Hirtius, usually identified as the father of the consul of 43 B.C., although a date as early as *c.* 180 B.C. has also been proposed. The other surviving Roman monument of the acropolis is the covered market hall, dating from *c.* 100 B.C. The cathedral contains a fine 13th-century cosmatesque Easter candlestick and altar canopy, the latter a gift from John, archdeacon of Norwich, a native of Ferentino. The principal medieval monument of the lower town is the fine Cistercian-type church of Sta. Maria Maggiore (13th–14th century). The irregular street plan is medieval, but certainly reflects that of Roman times.

The chief city of the Hernici, Ferentinum passed to Rome in 361 B.C. With the southward extension of Roman rule and the construction of the Appian way, it lost much of its strategic importance and its later history is uneventful. A favoured papal residence, in 1223 it was the scene of a meeting between Pope Honorius III and the emperor Frederick II. Considerably damaged in World War II, the lower town is expanding rapidly outside the walls, on either side of the Via Casilina.

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FERGANA is the name of an *oblast* (formed 1938) and town in the Uzbek Soviet Socialist Republic, U.S.S.R. The *oblast* occupies the southwestern part of the Fergana valley (*q.v.*) and had a population of 1,138,770 in 1959, of whom 806,069 were rural. The climate is continental with a hot summer and a mild winter. The southern part is irrigated by streams descending from the Alai range and fanning out into complex networks in the valley.

The main features of the economy are cotton cultivation and sericulture with their attendant textile and cottonseed oil industries. These are mainly at Fergana, Margelan and Kokand. There are cement works at Kuvasai; oil fields at Chimion with a cracking plant at Vannovski; and important chemical works at Shor-Su. Vines and other fruit trees are widely cultivated and stockbreeding is carried on. The Fergana Valley railway passes through the *oblast*. The main line from Ursatyevskaya (in Tashkent *oblast*) to Kokand has two branches: the southern (Kokand–Gorchakovo –Andizhan), and the northern (Kokand–Namangan–Andizhan). From Gorchakovo there is a branch line to Kyzyl-Kiya in Kirgiz S.S.R. In the early 1960s there were more than 500 primary, middle and seven-year schools, and various technical and other training establishments.

The town of Fergana (pop. [1959] 80,000) is the capital of the *oblast*. Until 1907 it was known as Novy Margelan and from 1907 to 1924 as Skobelev. It was founded in 1876 as capital of the province of Fergana formed out of the former khanate of Kokand. It has silk and cotton textile plants and other light industries.

(G. E. WR.)

FERGANA VALLEY (FERGANSKAYA DOLINA) lies mainly in the Uzbek Soviet Socialist Republic, U.S.S.R., and partly in the Tadzhik and Kirgiz Soviet Socialist Republics. The fertile valley is in the form of an ellipse, 186 mi. long and 93 mi. wide. Its area is 8,494 sq.mi. The valley is almost entirely enclosed by mountain ranges: to the south by the Alai and Turkistan ranges, to the northwest by the Chatkal and Kurama, and to the northeast by the Fergana range. Only on the west is there the narrow Leninabad pass, through which the Syr-Darya river emerges to the edge of the Golodnaya steppe. The altitudes of the surrounding ranges reach nearly 19,500 ft. The surface of the valley is fairly level, its height varying from 1,000–1,300 ft. in the west to 3,000–3,300 ft. in the east. In the central and western parts there are sands and alkaline marshes. The climate is dry and warm with an average temperature of 20° C. (68° F.) in March rising rapidly to 35° C. (95° F.) in June, July and August. Snow and frost occur in December and January, when the temperature may fall to −15° C. (4° F.). No rain falls during the five months following April and the valley owes its fertility to irrigation from the Naryn and Kara-Darya rivers, which unite near Namangan to form the Syr-Darya (*q.v.*). The vast snow fields and numerous glaciers which lie in the mountains (especially in the Alai range) provide the sources for most of the rivers which irrigate the valley: Sokh, Isfara and others. Irrigation has been developed through a branched network of small and large canals, the principal of these being the Great Fergana canal (170 mi. long), and the South Fergana canal. The main soil structure of the valley is black earth formed on loess; it has changed as the result of the introduction of fertilization. In the irrigated land cultivated vegetation predominates.

Animal life in the valley is comparatively scarce. In the reeds along the Syr-Darya can be found wild boar, in the foothills foxes, occasional wolves and, on the borders of the oases, badgers and porcupines. The birds include eagles, vultures, starlings, nightingales and sparrows. There are various species of duck in the lakes and marshes near the Syr-Darya.

The Fergana valley constitutes an important economic district of the Uzbek, Tadzhik and Kirgiz Soviet Socialist Republics. On the slopes of the mountains there are coal deposits (Kizyl-Kiya

and Shurab), oil at Chimion, and sulfur and other deposits at Shor-Su. There has been considerable industrial development, and the combination of coal and iron deposits has contributed to the development of heavy industry throughout Soviet central Asia. On the southern edge there are mercury and antimony mines at Khaidarken, Frunze (formerly Kadamdzhai) and Chauvai. There are cotton and silk mills at Fergana, Margelan, Leninabad and Kokand, cement works at Kuvasai and an oil cracking plant at Vannovski. A circular railroad links Kokand, Andizhan and Namangan, with spurs serving the mining settlements along the periphery of the valley. A large part of the area is occupied by fields of cotton, vineyards, fruit gardens (apricots, peaches and plums), and mulberry tree plantations. Near the mountains, food grains are cultivated without irrigation. The main towns are Leninabad, Kokand, Fergana, Andizhan, Dzhalal-abad and Osh.

The Fergana valley has had an eventful history; its fertility has always proved attractive and the Khodzhent or Leninabad pass made it vulnerable to invaders. It was overrun by Arabs in A.D. 719. In the 9th and 10th centuries it was ruled by the Persian Samanid dynasty, while in the 12th century it became subject to the Kara-Kitai, the forerunners of Genghis (Jenghiz) Khan, who later conquered it. Timur (Tamerlane) conquered it in the 14th century. In 1513 the Uzbeks expelled Babur, the last descendant of Timur, and until about 1770 the separate cities and clans each had its own *bek*, or ruler. From that time until its conquest by Russia, it was ruled by the khans of Kokand. In 1876 it became part of a much larger unit called Fergana, which was created as a province of Russian Turkistan, with Novy Margelan (now Fergana) as its administrative centre. After the fall of the tsarist regime, the valley was for a time an independent Soviet province. Politically it is now divided into Osh, Frunze, Fergana, Leninabad and Andizhan *oblasts*. (G. E. WR.)

FERGUSON, ADAM (1723–1816), Scottish man of letters respected as a philosopher, as a historian and as a patriot, was born the son of a Presbyterian minister at Logierait in Perthshire on June 20, 1723, and educated at St. Andrews university. Appointed deputy chaplain to the Black Watch regiment in 1745, he charged sword in hand with it at Fontenoy. Abandoning the clerical profession, he succeeded his friend David Hume as advocates' librarian at Edinburgh (1757) and eventually became professor at Edinburgh, first of natural philosophy (1759), then of mental and moral philosophy (1764). He interrupted his professorial work in 1774, when he went to Europe to supervise the young earl of Chesterfield, and in 1778, when he went to Philadelphia with a commission sent to negotiate with the Americans. Resigning his chair in 1785, he spent a few months in Germany and Italy in 1793, but thereafter lived in retirement till his death, at St. Andrews, on Feb. 22, 1816. Walter Scott composed his epitaph.

Ferguson's works include *The Morality of Stage Plays Seriously Considered* (1757), an anonymous pamphlet in defense of his friend John Home's *Douglas; The History of the Proceedings in the Case of Margaret, Commonly Called Peg, Only Lawful Sister of John Bull, Esq.* (1761), remonstrating for the establishment of a Scottish militia; *Essay on the History of Civil Society* (1767; 7th ed. 1814), largely inspired by Montesquieu; *Institutes of Moral Philosophy* (1769); *Remarks* (1776) on Richard Price's *Observations on . . . Civil Liberty*, in which Ferguson proposed peace terms for the Americans; *History of the Progress and Termination of the Roman Republic*, 3 vol. (1783; new ed., 5 vol., 1813); and *Principles of Moral and Political Science*, 2 vol. (1792).

FERGUSON, HARRY GEORGE (1884–1960), British industrialist and designer of agricultural equipment, was born in Dromore, County Down, Ire., on Nov. 4, 1884. In 1900 he began selling and repairing automobiles and motorcycles, and in 1909 designed and built his own airplane in which he made the first recorded flight over Ireland. In World War I he supervised the operation of farm machinery in Ireland. The poor quality of the equipment available impressed upon him the need for a dependable low-cost tractor that could be used as a unit with a plow or other farm implement. By the latter 1930s he had perfected the Ferguson system of tractor-implement integration that utilized a hitch whose linkages and controls made the tractor and implement work as a single unit operated almost entirely from the driving seat. In 1938 Henry Ford agreed to manufacture the Ferguson tractor in the U.S. Following termination of the agreement with Ford after World War II, Ferguson manufactured his own equipment in Great Britain and the U.S. A patent infringement suit against the Ford company was settled for over $9,000,000.

He died at Stow-on-the-Wold, Gloucestershire, on Oct. 25, 1960. (H. J. Sc.; X.)

FERGUSON, ROBERT (*c.* 1637–1714), British conspirator and pamphleteer known as "the Plotter," who gave indiscriminate support to the opponents of Charles II and James II and to the Jacobites against William III, was born in Aberdeenshire and educated for the Presbyterian ministry. Going to England in the 1650s, he received the living of Godmersham, Kent, only to be ejected in 1662. As a Protestant dissenter of known literary ability he was later taken up by Anthony Ashley Cooper, 1st earl of Shaftesbury, and published in 1680 two notorious pamphlets purporting to demonstrate the legitimacy of James, duke of Monmouth, Charles II's illegitimate son. In the next two years he published at least six more exclusionist pamphlets and claimed the authorship of many more. He fled to the Netherlands with Shaftesbury in 1682, and he was outlawed after the discovery of the Rye house plot (1683). He was one of Monmouth's right-hand men in the rising of 1685, but he enjoyed a less prominent position in William III's expedition in 1688. Whether out of resentment or simply a chronic itch for conspiracy, he now became an active Jacobite, and in his last notable work, *The History of the Revolution* (1706), he argued that this event was a Roman Catholic plot. Both sides, however, regarded him with understandable suspicion, and he died in great poverty in London in 1714. (J. P. K.)

FERGUSSON, ROBERT (1750–1774), Scottish poet, one of the leading figures of the 18th-century revival of Scots vernacular writing, and the chief forerunner of Robert Burns, was born in Edinburgh on Sept. 5, 1750. He was educated at Dundee grammar school and at St. Andrews university, and became a copying clerk in a lawyer's office in Edinburgh. In 1771 he began to contribute poems to Ruddiman's *Weekly Magazine*. He was a member of the Cape club, which met at a tavern in Craig's Close, and was noted for the vivacity of temperament that is reflected in his verse. From 1773, however, his good spirits were encroached upon by fits of depression and religious guilt, and after being severely injured in the head by a fall he became insane, and died in the Edinburgh asylum on Oct. 17, 1774.

Fergusson's poems were popular from their first appearance, and a collected volume came out in 1773. He wrote in both Scots and English, but the English verse has little value. His Scots poems, racy, realistic, wittily descriptive and humorous, had a stimulating effect on Burns, whose "Holy Fair" and "Cotter's Saturday Night" stem from Fergusson's "Leith Races" and "The Farmer's Ingle"; but vigorous poems like "The Daft-Days," "To the Tron-Kirk Bell" and the famous "Auld Reikie" prove how well Fergusson can stand as a poet in his own right.

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FERISHTAH (FIRISHTA), **MOHAMMED KASIM** (*c.* 1560–*c.* 1620), Indo-Persian historiographer, was the author of the famous *Tarikh-i-Firishta* ("Ferishtah's History"), an account of the Muslims in India from the 10th century. When captain of the guard to Murtaza Nizam Shah, ruler of Ahmadnagar (1565–88), Ferishtah conceived the idea of writing a history of Indo-Muslim rulers and saints. He fulfilled his intention when he compiled the *Tarikh-i-Firishta* under the patronage of Ibrahim 'Adil Shah, ruler of Bijapur, whose service he entered in 1589. With the passage of time the *Tarikh-i-Firishta* has gradually lost its status as an authority for Indo-Muslim history before Ferishtah's own day, especially since independent copies of the Indo-Persian histories, on which it was based, have become available and historical criticism has developed. It is, however, a valuable

source for the history of the Muslim Deccan where he served and a remarkable example of the Indo-Muslim genius for historical writing. (P. H.)

FERMANAGH, a county of Northern Ireland, is bounded on the northeast by County Tyrone and west, south and east by the frontier of the Republic of Ireland. Area, including water, 714.65 sq.mi.; excluding water, 653 sq.mi. Pop. (1961) 51,613. The county lies chiefly in the basin of the Erne river which divides it into two nearly equal sections. The surface is hilly and, especially round Lough Erne, picturesque. Upper and Lower Lough Erne stretch from southeast to northwest. These lakes are expansions of the Erne river, which enters the county from Cavan, flows through Upper Lough Erne, past Enniskillen and through Lower Lough Erne on its way to the Atlantic. At Belleek, where it leaves the county, the river is dammed by a large hydroelectric power station half a mile downstream from the village. There is good trout fishing in the Lower Lough and part of the river. Pike and perch are found in both loughs. The southwest boundary of the county takes in a small portion of Lough Melvin and of Lough Macnean Upper and most of Lough Macnean Lower. An area of high ground lies between Lower Lough Erne and Lough Macnean Upper, including Belmore mountain (1,316 ft.). On the southern frontier of Fermanagh there are hills of greater height, including Cuilcagh (2,188 ft.) and Tiltinbane (1,881 ft.).

The county includes in the north an area of gneiss extending from Donegal and an area of metamorphic rock extending from Tyrone. A fault divides the latter from the Old Red Sandstone which spreads south. Limestone forms fine scarps on the southern side of Lower Lough Erne. The scenery about Lough Macnean Upper and Lower rises in similarly scarped hills to the summit of Cuilcagh. The Marble Arch cave near Belcoo, with its emerging river, is a characteristic subterranean waterway in the limestone. Higher Carboniferous strata form highlands on both sides of Lower Lough Erne. There are other caves including those at Boho near Enniskillen and at Knockmore near Derrygonnelly. Because Fermanagh is predominantly of limestone formation it is hard to obtain water supplies in some areas in spite of the chain of lakes.

Evidence of prehistoric occupation includes horned cairns at Aghanaglack (Giant's Grave) and Ballyreagh, as well as other cairns and megalithic remains. Fermanagh became in historic times the country of the Maguires. There are many monuments of early Celtic Christianity, particularly on islands in the loughs. Devenish Island in Lower Lough Erne is the site of an ancient abbey; substantial ruins there date from the 6th century, with a round tower 81 ft. high and a standing cross. On White Island and Inishmacsaint are other ecclesiastical antiquities. There are ancient carvings in Killadeas graveyard, north of Enniskillen.

The county was included in the scheme for the plantation of Ulster in the reign of James I. At Newtownbutler, in 1689, the Protestant Enniskillen men severely defeated a superior Roman Catholic army of James II and began the victorious tradition of the "Inniskillings," now represented in the British army by the Royal Inniskilling Fusiliers and the 5th Royal Inniskilling Dragoon Guards. Enniskillen, a municipal borough strategically situated between Upper and Lower Lough Erne, has long been the county town. It was once the site of a Maguire stronghold.

Fermanagh is chiefly a pastoral and agricultural county, but there are industries in a number of towns. Nylon stockings and clothing are manufactured at Enniskillen. Pottery is made at Belleek, cotton thread at Lisnaskea, while tweeds and blankets have been made at Lisbellaw since the mid-19th century.

As a result of agreement between the governments of the Irish republic and Northern Ireland the hydroelectric capacities of the Erne were developed in the mid-1950s. The republic uses the power; Northern Ireland benefits from flood control.

Fermanagh sends three members to the Northern Ireland parliament and unites with South Tyrone to send one member to the United Kingdom parliament.

See W. C. Trimble, *History of Enniskillen,* 3 vol. (1919–21). (J. J. Mag.; Hu. S.)

FERMAT, PIERRE DE (1601?–1665), French mathematician, was the greatest number theorist between Diophantus and Leonhard Euler. He is reported to have been born at Beaumont-de-Lomagne on Aug. 17, 1601, and he died at Castres on Jan 12, 1665; but his age at death is given on his tombstone as 57.

For Fermat, a punctilious counselor of the parliament of Toulouse and a lover of classical learning, mathematics was but an avocation. About the year 1629 he made, but did not publish, the remarkable discovery that an equation $f(x,y) = 0$ represents a curve in the xy-plane—the fundamental principle of analytic geometry, which first appeared in print in 1637 in the *Géométrie* of Descartes. At this time he also showed that relative maxima and minima of $f(x)$ are found from $\frac{f(x+h)-f(x)}{h} = 0$ by allowing h to vanish. This is equivalent to the modern equation $f'(x) = 0$, and Fermat has been acclaimed as the inventor of the differential calculus. (*See* Calculus, Differential and Integral: *History.*) By 1636 he had used this device to find tangents as limits of secants, a procedure that led Newton to the method of fluxions. Fermat also noted that the area under the curve $y = x^n$ from $x = 0$ to $x = a$ is $\frac{a^{n+1}}{n+1}$, but he failed to remark the fundamental inversion theorem relating areas and tangencies.

From correspondence, in 1654, between Fermat and B. Pascal the theory of probability largely arose (though developed earlier by G. Cardano, *q.v.*); and Fermat was one of several mathematicians who independently disclosed (1659) the rectification of an algebraic curve, $ay^2 = x^3$. But it was in the theory of numbers that the genius of Fermat was most apparent, and here two theorems bear his name: (1) the "lesser Fermat theorem," that if p is prime, then $a^p - a$ is divisible by p; and (2) "Fermat's last theorem," that no positive integers x,y,z satisfy $x^n + y^n = z^n$, where n is an integer greater than two. The "lesser theorem," first given in a letter of 1640, was proved by Leibniz before 1683 and a proof was published by Euler in 1738; the "last theorem" remains a celebrated unsolved problem (*see* Fermat's Last Theorem). For some of his theorems Fermat gave demonstrations by his method of "infinite descent"; but one conjecture—that $2^{2^n} + 1$ is prime if n is a positive integer—was shown to be false when Euler found $2^{2^5} + 1$ to be composite.

Fermat was the greatest mathematician of his day, but his influence was circumscribed by a reluctance to publish. The two volumes of his *Opera mathematica*, edited by his son, appeared belatedly in 1670–79. The definitive edition of his work is the *Oeuvres* (four volumes and supplement, 1891–1922) edited by Paul Tannery and Charles Henry. *See* also references under "Fermat, Pierre de" in the Index volume.

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FERMAT'S LAST THEOREM, famous in mathematical history, still awaits proof or disproof. It states that there is no solution for

$$x^n + y^n = z^n \qquad (1)$$

in nonzero integers x, y and z if n is an integer greater than 2. Pierre de Fermat wrote (*c.* 1637) on the margin of his copy of the works of Diophantus, "I have discovered a truly remarkable proof [of the theorem] which this margin is too small to contain." Although he proved it for $n = 4$, the general proof he claimed remains undiscovered. L. Euler's proof (1770) for $n = 3$ was incomplete, but the missing steps were supplied by later writers.

To prove the theorem in general, it is sufficient to demonstrate the impossibility of

$$x^l + y^l + z^l = 0 \qquad (2)$$

in nonzero integers x, y and z for any odd prime $l > 3$. If x, y and z are prime each to each and to l in (2), this is case I of Fermat's last theorem; if x, y and z are prime each to each and one of them is divisible by l, case II of the theorem is defined.

In an effort to prove the theorem for case I, A. M. Legendre

published (1823) the following (due to Sophie Germain): If there exists an odd prime p where the congruence

$$u^l + v^l + w^l \equiv 0 \pmod{p} \tag{3}$$

has no set of integral solutions, u, v and w, each not divisible by p, and where l is not the residue of the lth power of any integer modulo p, then (2) is impossible in case I for all primes $l < 100$.

The proof by Legendre (1823) that (2) is impossible when $l = 5$, by G. Lamé (1839) for $l = 7$ and V. A. Lebesgue's simpler proof (1840) for $l = 7$ excited great interest among mathematicians, and many efforts, some erroneous, were made to extend proofs to other values of l. In considering these mistakes, E. E. Kummer formulated the notion of ideal numbers, a most powerful and fruitful concept (*see* NUMBERS, THEORY OF: *Algebraic Numbers*), which enabled him to prove (1850) that (2) is impossible in nonzero integers x, y and z for all primes l for which none of the numerators $a = 1, 2, \ldots, (l-3)/2$ of the Bernoulli numbers (*q.v.*) B_a is divisible by l, where $B_1 = \frac{1}{6}$, $B_2 = \frac{1}{30}$, etc. Primes l of this character are called regular, and there are three primes less than 100 which are not regular. In 1857 Kummer reported that (2) is impossible for irregular primes of a certain type, and concluded that (2) was impossible for all primes $l < 100$. Kummer also proved that certain congruences must hold for (2) to be satisfied in case I. D. Mirimanoff (1905) showed that these congruences could be reduced to the form $B_n f_i(t) \equiv 0 \pmod{l}$, where $n = (l-i)/2$; the B's are the Bernoulli numbers as before; $i = 3, 5, \ldots, l-2$; $-t = x/y, y/x, x/z, z/x, y/z, z/y$; and

$$f_i(t) = \sum_{k=1}^{l-1} k^{i-1} t^k \tag{4}$$

Mirimanoff also added the criterion

$$f_{l-1}(t) \equiv 0 \pmod{l} \tag{4a}$$

for the solution of (2) in case I. The criteria (4) and (4a) are generally referred to as the Kummer criteria.

In 1912 P. Furtwängler proved that if (2) is satisfied where x, y and z are integers prime each to each, then $r^{l-1} \equiv 1 \pmod{l^2}$ where r is any factor of x if x is prime to l, and similarly for y and z. Also, the congruence holds if r is a factor of $x^2 - y^2$, provided this number is prime to l.

In 1934 M. Krasner proved that for l exceeding a certain limit, the existence of three integers x, y and z satisfying (2) in case I implies that l is a divisor of $[\sqrt[3]{\log l}]$ consecutive Bernoulli numbers, the last of which is $B_{(l-3)/2}$. Here the symbol $[k]$ means the greatest integer in k.

By using transformations of the Kummer criteria, A. Wieferich (1909) showed that if (2) is satisfied in case I, then $2^{l-1} \equiv 1 \pmod{l^2}$. This prompted a series of investigations by Mirimanoff, H. S. Vandiver, G. Frobenius, F. Pollaczek and T. Morishima, which led to B. Rosser's proof (1939 and 1941) that $m^{l-1} \equiv 1 \pmod{l^2}$ for each prime $m < 44$ if (2) is satisfied. Applying this, Rosser's powerful analytical method showed that (2) does not hold in case I for any $l < 41{,}000{,}000$. Extending the method of Rosser, D. H. and Emma Lehmer (1941) carried this result to $l < 253{,}747{,}889$.

Vandiver (1934) set $k_i = \zeta^{r^i/2} - \zeta^{-r^i/2}$ and $\sigma_i = k_{i+1}/k_i$ with r a primitive root of l, and

$$E_n(\zeta) = E_n = \prod_{i=0}^{(l-3)/2} \sigma_i^{r^n - 2in}$$

where ζ is a primitive lth root of unity. He considered the Bernoulli numbers in their lowest terms, and let $B_{a_1}, B_{a_2}, \ldots, B_{a_s}$ be the only Bernoulli numbers with indices less than $(l-1)/2$ whose numerators are divisible by l. He then proved that if (2) is satisfied in case I, then at least one of the quantities $E_{a_1}, E_{a_2}, \ldots, E_{a_s}$ is the lth power of an expression of the form $c_0 + c_1\zeta + \ldots + c_{l-2}\zeta^{l-2}$, with the c's integers. Using extensions and modifications of the methods used by Kummer (1857), Vandiver (1929) had obtained four different sets of criteria for the solution of (2), each of which yielded proofs that (2) is impossible for certain exponents in case II. In 1954 the Lehmers and Vandiver took one of these sets of criteria and put it in a form which is convenient for use with a digital computing machine. They then developed the theorem that when $B_{a_1}, B_{a_2}, \ldots, B_{a_s}$ are considered as the only Bernoulli numbers, in their lowest terms, with indices less than $(l-1)/2$ and whose numerators are divisible by l, then if $Q_{a_i}^k \not\equiv 1 \pmod{p}$ holds for $i = 1, 2, \ldots, s$, Fermat's last theorem holds for the exponent l.

In the above, t is any integer greater than zero, such that $t^k \not\equiv 1 \pmod{p}$, and p is a prime of the form $p = kl + 1$ and less than $l^2 - l$. Also,

$$Q_a = t^{-kd/2} \prod_{b=1}^{\mu} (t^{kb} - 1)^b l^{1-1-2a}$$

where $\mu = (l-1)/2$ and

$$d = 1^{1-2a} + 2^{1-2a} + \ldots + \mu^{1-2a}$$

The criteria of the Lehmers and Vandiver, just mentioned, were tested with a digital computer, and in 1954 and 1955 it was shown by these means that Fermat's last theorem is true for all exponents less than 4,002 in (1). C. A. Nicol and J. L. Selfridge aided in this work.

The Fermat theorem has been attacked by many mathematicians, and seems to have acquired a unique reputation because of the great difficulties it presents. So far, all criteria obtained for the solution of (2) have involved the idea of divisibility of rational integers in some form, and some offer such formidable problems that nothing has been done with them. One of these problems is the question of whether there is a finite or infinite number of distinct values p such that $(p-1)! + 1 \equiv 0 \pmod{p^2}$. Possibly the solution of the Fermat problem requires the solution of a divisibility problem as difficult as this. In case I, many of the criteria found suggest that the theorem is true. This is not so in case II, however, and a number of mathematicians think that Fermat's statement is incorrect. It may be that the theorem will never be proved or disproved.

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FERMENTATION, the chemical transformation of organic substances into simpler compounds by the action of enzymes, complex organic catalysts produced by microorganisms (fungi, yeasts or bacteria). Originally, it referred to the enzymatic breakdown of carbohydrates in the absence of air (a definition that has been considerably modified—see *The Modern Position,* below). The production of leavened bread, cheese, butter, beer and wine, vinegar, antibiotics and vitamins and certain industrial compounds depends on fermentation. In industrial practice the word fermentation refers to any process by which raw materials (usually agricultural products such as grain, or industrial by-products such as molasses) are transformed by the controlled action of carefully selected strains of microorganisms into definite products. Fermentation, in this connection, denotes the key operation in manufacturing processes that, by virtue of their increasing importance and specialized techniques, can fairly claim consideration as a separate branch of applied science (see *Industrial Fermentation Processes,* below). Louis Pasteur (*q.v.*) used the term in a narrower sense to describe changes brought about by microorganisms growing in the absence of air. In the modern biochemical laboratory, general terms such as "fermentation" tend to be replaced by a scientific terminology describing the individual enzymes, or associated groups of them (*see* ENZYMES).

The great advances in understanding living organisms achieved by the sciences of bacteriology and biochemistry have created the newer fermentation industries. Side by side with these exist the old, established industries of brewing (*q.v.*), wine making, tobacco

curing and so on, from which science increasingly eliminates the factor of chance, if not that of art.

Early History of Fermentation.—Fermentations involving (as is now known) one of the many strains of yeast—*e.g.*, brewing of beer, wine making, raising of dough in breadmaking—were practised long before the beginning of recorded history. The word fermentation itself, derived from the Latin meaning "to boil," is a reminder of a time when chemical knowledge was so meagre that the bubbling and foaming of fermenting liquors could only be compared with boiling. That this appearance was due to the evolution of a gas (carbon dioxide) could not, of course, be understood until the existence of gases was recognized in the 17th century. Alcohol, which had been prepared long before, was the first pure organic compound known, and the process of distillation by which it was obtained from wine played an important role in the development of chemistry. Acetic acid (vinegar; *qq.v.*), originally made by the souring of wine (a fermentation process dependent on the action of the bacterium *Acetobacter*), was the first acid to be made.

When yeast (*q.v.*) grows in sugary solutions in the virtual absence of air, most of the sugar is converted into alcohol and carbon dioxide. Only a fraction is used by the yeast to build up new cell material. It was therefore possible, without great error, to disregard the part played by the yeast and to study the over-all change by purely chemical methods. This was done notably by Antoine Lavoisier, who, after establishing that organic compounds contain carbon, hydrogen and oxygen, applied his new technique of analysis to the products of alcoholic fermentation. His figures showed that the alcohol and carbon dioxide formed equaled, in total weight and in amount of carbon, oxygen and hydrogen, the sugar consumed. Fermentation therefore obeyed the law of the conservation of matter as did more conventional chemical reactions. The sugar, he considered, split into two parts, one of which oxidized the other to carbon dioxide and was itself reduced to alcohol. Ironically, Lavoisier's analytical figures (*e.g.*, for the composition of sugar) were grossly in error, though his conclusions were nearly correct, as shown by J. L. Gay-Lussac (1810), who summarized the process of fermentation by the equation

$$\underset{\text{sugar}}{C_6H_{12}O_6} \longrightarrow \underset{\text{carbon dioxide}}{2CO_2} + \underset{\text{alcohol}}{2C_2H_6O}$$

Fermentation was thus to be considered as a chemical reaction. Yeast, which was not even classified as a definite substance (let alone an organism with remarkable powers of chemical synthesis and degradation), was thought to play a physical rather than a chemical part, an idea dating back to the time of Georg Stahl (1697). The molecular vibrations of decomposing complex organic matter, it was held, could initiate the chemical reaction of fermentation in much the same way as a spark could cause the combination of hydrogen and oxygen. This attitude gained powerful reinforcement as new examples came to light of catalysis (*q.v.*), the name given to the action of certain substances of diverse character—*e.g.*, finely divided metals, acids and bases—which were found to accelerate the rate of a chemical reaction without themselves being materially altered. In 1817 it was found possible to oxidize a mixture of alcohol vapour and air to acetic acid by catalysis, using platinum as the catalyst. This apparently duplicated the action of the acetic acid ferment upon wine.

Moreover, about this time complex organic catalysts (then called ferments, now enzymes) began to be prepared from plants and from animal tissues and secretions: the starting material admittedly living, the enzyme preparations themselves equally obviously not. Among these were some which played a role in alcoholic fermentation. Yeast will not ferment starch, the molecule of which is made up of a large number of units of the simple sugar glucose linked together. Malt (sprouted barley) contains enzymes that split starch to the sugar maltose, made up of only two glucose units, which is fermentable. The conversion occurs during the mashing process of brewing. The agent responsible for this process, diastase (now known to be a mixture of enzymes), was prepared in 1833 by A. Payen and J. F. Persoz. Later, in 1860, P. E. M. Berthelot was to prepare from yeast itself the enzyme invertase, which splits sucrose (ordinary domestic sugar) into the simple sugars glucose and fructose.

Could not yeast, then, be simply considered as a catalyst? This is so close to the modern position as to make one wonder, at first, at the bitterness and fury with which the controversy over the mechanism of fermentation was conducted in the last half of the 19th century. It is now considered that the complex chemical changes of life are brought about by enzymes, each highly specialized in its catalytic action and responsible for one small step in such apparently simple reactions as the transformation of sugar to alcohol. However, enzymes themselves are produced only by living organisms, and if these marvelously active and specialized catalysts are to be used in a controlled way, it is the organism that must first be controlled. It was in insisting upon the importance, the primacy, of the living organism that Pasteur was right and his opponents wrong.

Pasteur: Fermentation as *La vie sans air* ("Life Without Air").—Establishing fermentation as a vital activity was not an exercise in experimental skill and logic; it was a triumph of the human spirit. And the 50-year-long fight to prove that it was the activity of a living organism was to lead to the germ theory of disease with its immeasurable consequences. Patient experimentation and intuition, rational argument and rhetoric, personal, national and professional pride, sheer chance, all played their part. Evidence of the living nature of yeast existed before Pasteur commenced work on the problem (1855). In 1837–38 three publications appeared, by C. Cagniard de la Tour, T. Schwann and F. Kützing respectively, all of whom as a result of microscopic observations concluded that yeast was a living organism that reproduced by budding. Schwann gave to it the name *Zuckerpilz* ("sugar fungus," whence comes the generic name *Saccharomyces* applied to types of yeast commonly used in baking and brewing) and explained alcoholic fermentation as "the decomposition brought about by this sugar fungus removing from the sugar and a nitrogenous substance the materials necessary for its growth and nourishment."

These views immediately aroused savage resentment and bitter scorn. Scientific innovators, for example Galileo, have often had to meet attacks from entrenched interests outside science; this time, however, the attack came from organized science itself, with J. J. Berzelius, F. Wöhler, J. von Liebig (*qq.v.*) and other chemists in the vanguard. It is worthwhile to consider why this should have been so. For science, the 19th century was a period of transition. Organic chemistry, in particular, had already discarded the idea that substances of natural origin had anything essentially mysterious about them and was becoming established as the chemistry of carbon compounds. To reintroduce any concept which smacked of vitalism must have appeared as a dangerous and retrograde step.

In the succeeding 20 years the recognition of yeast as a living organism became more widespread, but its exact function in alcoholic fermentation remained a matter of controversy. It was still maintained that fermentation was due to catalytic action at the surface of the yeast cell, or to the transmission of molecular vibration from decomposing organic matter arising from the death of the cells. Nevertheless, when Pasteur was asked to investigate the difficulties a manufacturer was having with his fermentation process, he was already predisposed to take up a biological point of view. This was not apparently due to the publications of Cagniard de la Tour and others, but arose from his own researches in a purely chemical field.

In studying the optical activity of organic compounds, which he correctly related to their molecular asymmetry, Pasteur had become convinced that optically active substances could not be synthesized by chemical methods. This is actually not the case, since the optical inactivity of synthetic products is sometimes due to their being mixtures of two forms of equal and opposite rotation. Nevertheless, his assertion that molecular asymmetry was correlated with life is, broadly speaking, correct. In alcoholic fermentation a certain amount of an optically active amyl alcohol was known to be produced, and this appeared to Pasteur to be possible only through some vital process. (*See* also STEREOCHEMISTRY:

Early History of Stereochemistry: The Work of Pasteur.)

In 1857 Pasteur showed that the malfunctioning of the fermentation process he was investigating was due to a new "ferment"—a minute organism which converted sugar into lactic acid. At this time there was no suspicion that lactic acid fermentation, for example of milk, involved anything other than a chemical change. Pasteur went on to study alcoholic fermentation itself and completely disproved the views of Liebig. His crucial experiment was to produce yeast by growing it in a liquid medium containing simple substances of known composition—sugar, ammonium tartrate, inorganic salts. Fermentation paralleled multiplication of the yeast. In this experiment he was to some extent fortunate for, as was shown later, yeast will not grow in such a simple medium from a very small seeding if the materials have been carefully purified, a finding which was to lead to the discovery that yeast and many other microorganisms require traces of vitamins for growth, as do higher forms of life.

In a famous passage in *Études sur la bière* (1876), Pasteur summarized fermentation as *la vie sans air*. An abundant supply of air was found to suppress alcohol formation by yeast. Under such conditions, however, the organism grew more rapidly and was able to incorporate into its cell substance a far greater proportion of the sugar which had been transformed, a discovery which forms the basis of the modern pressed-yeast industry.

Buchner: Cell-Free Fermentation.—Fermentation was now established as a chemical change that occurred inside the cells of microorganisms, which were then called organized ferments, to distinguish them from unorganized ferments, of which diastase of malt had provided an early example. A relation between the two types of ferment was suspected by many, and in 1858 M. Traube had put forward the theory that all fermentations were due to ferments, definite chemical substances he regarded as related to the proteins and produced in the cells of the organism. Confusion between the two sorts of ferment was later to lead W. Kühne to give the name enzymes to the substances then known as "unformed ferments."

Many investigators, including Pasteur, made unsuccessful attempts to liberate the fermentation enzyme from yeast. Success was not to come until 1897, and then almost fortuitously. Four years before, H. and E. Buchner had found that the cells of microorganisms were disrupted when they were ground with sand. After yeast had been treated in this way, a yellow viscous liquid, free from cells, could be squeezed out with a hydraulic press. This was not intended for use in experiments on fermentation, but for pharmaceutical studies. As it kept badly, antiseptics were added; these proved unsuitable as the juice was being used in experiments with animals. Sugar was then tried as a preservative. The changes which occurred were recognized as fermentative—a feat of scientific imagination—by E. Buchner, who named the fermentation enzyme of yeast zymase. Zymase, it was observed, differed in some respects from invertase, an enzyme from yeast known since 1860. It was less stable to heat, and catalyzed a reaction of greater complexity. That Buchner succeeded where so many others had failed seems to have been due partly to his fortunate choice of yeast, only a few types of which are suitable.

The Complexity of Zymase.—The complexity of alcoholic fermentation by living yeast was almost an article of faith with Pasteur, and in consequence it was realized from the outset that the production of alcohol and carbon dioxide from sugar by yeast juice probably occurred in a stepwise fashion, and that zymase was merely a convenient term for a mixture of an unknown number of enzymes. Unraveling the whole story was to take nearly 40 years.

Three general methods were used in the attack on the zymase problem: (1) Suspected intermediates were added to yeast juice to see if they could be fermented. (2) The fermentation system was altered, either by removing some essential factor (such as a coenzyme, *see* below) or by interfering with certain steps by the addition of selective poisons (now called enzyme inhibitors), and the nature of the products of the modified process investigated. The use of inhibitors may be understood by considering a complex of enzymes that first convert a substance A to B then B to C and so on. If the conversion of B to C is interfered with, then B will accumulate instead of the usual end product and this increase in the concentration of B enormously facilitates its isolation and identification. (3) Individual enzymes themselves were separated from zymase and purified, and the intermediate reactions studied in isolation.

Of these methods, the second proved initially the most powerful. The first method often had value merely as confirmation, since it proved difficult, from a knowledge of synthetic organic chemistry, to predict the nature of the chemical intermediates involved in biochemical transformations. The third method, in essence the most decisive, had to wait until the technical problems of enzyme purification were solved. Enzymes, it must be realized, are chemically so complex that even now they are recognized chiefly by their action rather than by chemical analysis. In the early days of enzymology chemists had no means of knowing how pure their preparations were. The unrecognized enormous potency of enzymes often led them to underestimate the degree of impurity of their preparation; in consequence, there was considerable controversy about the chemical nature of enzymes. The problem was further bedeviled by the fact that invertase, with which much early work was done, was in many ways atypical in its chemical properties. Finally, in 1926, J. B. Sumner succeeded in preparing an enzyme (from jack bean) in crystalline form, a cogent argument for its purity, and showed it to be a protein. This enzyme, urease, was extremely active and decomposed its own weight of urea in just over one second. It is now generally accepted that enzymes are proteins, and techniques for their isolation are well established. Many of those concerned in fermentation have been crystallized. Some are even available, in small quantities, commercially. One fermentation enzyme has found application in forensic medicine to estimate alcohol in the blood of motorists suspected of drunkenness.

Zymase itself in a sense constitutes an altered enzyme system. As shown by Sir A. Harden and W. J. Young in 1905, fermentation by yeast juice proceeds rapidly only when salts of phosphoric acid are added. For each molecule of sugar split to alcohol, one is esterified to form a sugar phosphate, fructose diphosphate, called the "Harden-Young ester." (In the living cell, other reactions outside the fermentation system reform free phosphate and prevent the accumulation of sugar phosphates.) Harden and Young made another fundamental advance when they found that the fermentative action of yeast juice depended not only upon enzymes, which have large complex molecules, but also upon a simpler substance, which could be separated by ultrafiltration and which was to be classified as a coenzyme. (Coenzymes are agents necessary for the action of enzymes.)

At first the role of phosphorylation in the initial steps of the fermentation process gave rise to much controversy. Meanwhile a clue as to the nature of one of the later steps was provided by C. Neuberg's discovery (1911) of carboxylase in yeast and yeast juice. This enzyme splits pyruvic acid (*q.v.*) into acetaldehyde and carbon dioxide, and is now known to be responsible for the evolution of gas in alcoholic fermentation. A further important advance was made by G. Embden three years later, when he showed that fructose diphosphate was transformed to lactic acid by enzymes present in muscle preparations. It soon became evident that the characteristic fermentation process of animal tissue, glycolysis, the splitting of sugar into two molecules of lactic acid, showed striking similarities to alcoholic fermentation. From this time on, the nature of the intermediate steps in sugar breakdown was worked out sometimes with one system, sometimes with the other. The differences between the fermentation systems of different types of organism, which Pasteur found so striking, are less impressive than the similarities, when these systems have been analyzed into their component enzyme-catalyzed steps. (*See* also ANTIMETABOLITES.)

The Modern Position.—By 1939, as a result of the work of Embden, O. Meyerhof and others, knowledge of the intermediate steps in alcoholic fermentation and glycolysis was believed complete. During its breakdown, the sugar molecule goes through about a dozen intermediate stages. The same number of enzymes, each highly specialized in the catalysis of a single step, is involved. As

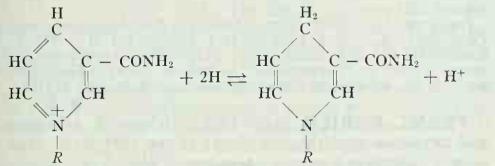
forecast by Lavoisier, Schwann and others, an oxidation-reduction process occurs, hydrogen being taken from one of the intermediates in an early step and transferred to one of the later intermediates. This is not a direct process. Hydrogen is first transferred to a carrier substance (diphosphopyridine nucleotide [DPN] or cozymase), which is a coenzyme (the one discovered by Harden and Young). Another carrier molecule, or coenzyme, is involved in phosphate transfer. These coenzymes may be likened to the conveyer belts linking the machines (enzymes) in a factory assembly line. They are not so specialized as are the enzymes themselves, and they interact with many different enzymes concerned with processes other than fermentation. In so doing, they provide one means by which fermentation is integrated into the life of the cell as a whole.

In the 1930s cozymase was shown to contain nicotinamide, shortly afterward found to be the vitamin whose deficiency in human beings induces pellagra. Another fermentation coenzyme (cocarboxylase, concerned in the splitting of the intermediate pyruvic acid) was found to be related to thiamine, also a B group vitamin. This elucidation of the biochemical function of vitamins exemplifies the repercussions, in all fields of biochemical research, of the work on fermentation.

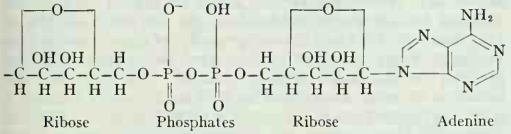
Diphosphopyridine nucleotide, the hydrogen-transferring coenzyme, has a complicated structure. It may be degraded chemically into a number of less complex substances, so that the coenzyme may be represented in terms of these units as

nicotinamide—ribose—phosphate—phosphate—ribose—adenine.

Oxidation and reduction during fermentation affect only the nicotinamide part of the molecule, as shown by the equation:



Here R stands for the remainder of the molecule, namely:



The phosphate-transferring coenzyme, adenosine triphosphate (ATP), has the structure

adenine—ribose—phosphate—phosphate—phosphate

and the biochemical reaction of transfer involves only the terminal phosphate grouping. The function of the complex nonactive part of these molecules is to ensure that the coenzymes combine with the appropriate enzyme, with the active groups of atoms correctly positioned. It is generally found that biologically active molecules contain only a small "active centre," the remainder of the molecule conferring specificity in much the same way as the wards of a key adapt it to open one lock, or at most only a few. Different "keys" are constructed from simple units, such as adenine and other purine bases, sugars such as ribose, or amino acids, and the arrangement as well as the nature of these units determines the specificity of the biologically important molecule.

Yeast will ferment any one of three simple sugars: glucose, fructose and mannose. They differ only slightly in the arrangement of atoms in the molecule and can be converted one to the other by the action of dilute alkalies. The first step in fermentation is the addition to the sugar molecule of a phosphate group (transferred from a coenzyme). The three sugar monophosphates are interconvertible by enzymes which thus reproduce the catalytic action of alkali on the free sugars. From the trio of monophosphates one, fructose monophosphate, is selected for further transformation. A second phosphate group is accepted from the coenzyme to give fructose diphosphate. This molecule is split into halves, each retaining one phosphate group. The two substances so formed also belong to the class of (phosphorylated) sugars known as trioses, since the molecule contains only three carbon atoms; sugars such as glucose are termed hexoses, as their molecules have six carbon atoms. The two triose phosphates differ in the structure of their molecules in the same way as glucose monophosphate differs from fructose monophosphate, and are likewise interconvertible by a specialized enzyme. The action of the splitting enzyme, in reverse, can be imitated in the chemical laboratory; the free triose sugars can be made to combine to give fructose, by the catalytic action of alkalies.

In the next stage, the key to the whole process, one of the triose phosphates is oxidized, hydrogen being transferred to the carrier cozymase. The product remains attached to the enzyme, however, until a molecule of free inorganic phosphate (not phosphate bound to the phosphate-transferring coenzyme) is encountered, when the final step occurs by which phosphate is incorporated to form an intermediate containing two phosphate groups per molecule (diphosphoglyceric acid). This then undergoes several intramolecular rearrangements, each catalyzed by its specific enzyme. The two phosphate groups are split off and bound to the phosphate-transferring coenzyme, and eventually pyruvic acid is formed. The net result is

glucose ⟶ 2 pyruvic acid
2 cozymase ⟶ 2 reduced cozymase
2 phosphoric acid ⟶ bound to coenzyme

This series of enzyme reactions is common to sugar transformation in muscle and yeast, as well as some bacteria and plants. It is only the subsequent fate of the pyruvic acid that is different. In muscle, hydrogen is taken from reduced cozymase (which is thus restored to its original form) to give lactic acid. In yeast, pyruvate is first split to carbon dioxide and acetaldehyde; the latter accepts hydrogen to form alcohol. (Alcohol, however, is not formed when the yeast cell is abundantly supplied with air; in this case another complex system of enzymes converts pyruvic acid to carbon dioxide and water.)

Especially as a result of studies of the bacterium *Pseudomonas fluorescens*, it has been realized that modifications of this scheme of carbohydrate breakdown occur in different organisms. In the one mentioned, glucose is first oxidized to gluconic acid. The similarities are, however, still more striking than the differences.

In the living yeast cell, the enzymes of the zymase system are enclosed within a membrane through which the phosphorylated intermediates cannot diffuse; as, normally, the cells occupy only a small proportion of the total volume, very little of the total sugar fermented is at any time present in the form of these intermediates. For this reason they escaped detection until the Buchners succeeded in liberating the enzyme complex from the cell.

The importance of phosphate, in its various forms, is clear from this summary of the chemical changes of alcoholic fermentation. In seeking further understanding of this point, it is necessary to refer to one of the most fruitful concepts of modern biochemistry, that combined phosphate is the form in which energy released by the degradation of the sugar molecule is preserved and subsequently transferred to all parts of the living cell. This energy is available for chemical synthesis, as in growth. In muscle it is converted to mechanical work, or it may appear in other forms, for example light, as in fireflies and luminescent bacteria, such as those responsible for the phosphorescent glow of rotting fish. The complexity of the fermentation process therefore becomes understandable if it is remembered that its action enables the yeast cell to grow, *i.e.*, to synthesize new cell material. Zymase may be likened to an oil refinery producing both fuel oil (phosphorylated coenzyme) and raw materials for chemical processing (the intermediates of fermentation). The growth process of the yeast cell finds a counterpart in the manufacturer specializing,

for example, in plastics production who requires a particular raw material and also oil to drive his machines. Also, he may require raw materials from other sources, in the same way as the yeast cell requires ammonium salts, for example, before it can construct protein molecules.

When yeast grows in the absence of air, part of the sugar transformed is incorporated as new cell substance, but a far greater part is excreted as alcohol. This apparent waste may be a means of rendering the sugar unavailable to other organisms and therefore valuable to the survival of the species. In air, more phosphorylated coenzyme is formed by enzymes outside the fermentation system and a greater proportion of the sugar can be used in building cell material.

Modern research on the biochemistry of fermentation falls into three broad classes: (1) the enzymes and reactions described are being studied in an increasing variety of organisms; (2) the individual enzymes are being examined in fine detail, in an effort to understand catalysis in terms of the molecular forces involved; (3) enzymes and their action are being investigated *in situ* in the living cell.

Industrial Fermentation Processes.—These start with the selection of a suitable microorganism. Each main type (*e.g.*, yeast or lactic acid bacteria) exists in a bewildering number of strains, and selection of the best one is of key importance. Fermentation conditions such as acidity, air supply and concentration of nutrients must be carefully adjusted in the light of the result aimed at.

Products may be of many types. In some cases, a major part of the raw material (usually sugar in some form) is transformed into the desired product. Examples are: alcohol, glycerol, carbon dioxide (marketed as Dry Ice) from yeast fermentations; butyl alcohol and acetone, lactic acid, acetic acid from fermentation by one or another type of bacterium; citric acid, gluconic acid from mold fermentations. Fermentation alcohol and acetone are being partially displaced by cheaper synthetic products. A notable product of bacterial fermentation is dextran, a gummy material. The bacteria responsible for this are well-known troublemakers in sugar refineries, but the product of their action under controlled conditions finds occasional application as a blood extender, to replace blood plasma transfusions.

A later development is the manufacture by fermentation of amino acids, an advantage over chemical synthesis being that only one of two possible optically active forms is produced. Japanese scientists devised a bacterial fermentation process to make L-glutamic acid, a widely used flavouring agent. L-Lysine, a substance of great importance in human and animal nutrition, is manufactured in the U.S. The fermentation process is ingenious in that it uses a mutant strain of coliform bacteria; *i.e.*, organisms "created" in the laboratory by the action of ultraviolet radiation on the natural strain. This mutant is incapable of making the lysine it needs for its own growth and has to be supplied with this amino acid before it can be cultivated. But in exchange it forms in the course of fermentation a much greater amount of a precursor substance, which is then converted into lysine itself in a second stage of the process.

Other substances are produced in relatively small amounts, so that their extraction and purification are more complicated. Predominant among these are the various antibiotics. These are made by mold fermentation, as are the antianemia factor vitamin B_{12} and the vitamin riboflavin. Antibiotics, and vitamin B_{12}, find increasing use outside medicine as supplements to poultry and animal foodstuffs.

In the manufacture of baker's yeast the organism itself is the desired product. Enzymes extracted from various microorganisms, usually in rather crude form, are also valuable. Invertase, from yeast, is used to prevent the crystalization of sugar in the manufacture of soft-centred chocolates. In the textile industry, bacterial and fungal amylases find application in removing starch sizing from cloth. Among other enzymes, an interesting one is glucose oxidase, used to destroy glucose, which otherwise would cause browning and deterioration of dried eggs. Yeast fermentation has been employed as an adjunct to synthetic methods in pharmaceutical manufacture. Here what is sought is not a product of the fermentation itself, but a change (usually reduction) of some chemical added to the fermentation. Benzaldehyde in this way yields a product which can be further converted, by purely chemical methods, to ephedrine. Phytochemical reduction is also being applied in the synthesis of steroids related to cortisone. These methods have the advantage of producing only one of two possible optically active forms, an interesting echo of Pasteur's insistence on the connection between molecular asymmetry and life. *See* BIOCHEMISTRY: *Glycolysis and Fermentation; see* also references under "Fermentation" in the Index volume.

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(W. E. TS.)

FERMI, ENRICO (1901–1954), Italian-U.S. experimental and theoretical physicist and winner of the 1938 Nobel prize in physics, contributed to many branches of physics and especially to nuclear physics, directing the work leading to the first controlled nuclear chain reaction (Dec. 2, 1942) at The University of Chicago. Fermi was born in Rome on Sept. 29, 1901. He obtained a doctorate in physics from the University of Pisa in 1922 and from 1927 to 1938 was professor of physics at the University of Rome. In 1926 he discovered the statistics valid for particles obeying Pauli's exclusion principle. This theoretical discovery is of great importance in solid-state physics because it applies to the electrons in a metal; it is equally important in atomic and nuclear physics, where it is possible to assimilate the electrons of an atom or the nucleons (protons and neutrons) in a nucleus to a cloud of particles obeying Fermi's statistical laws. In Rome in 1934 he developed the theory of beta decay based on Pauli's idea of the neutrino. This theory clarified a very difficult subject and its developments have dominated a large part of theoretical nuclear physics.

In 1934–37 Fermi turned to experimental work, discovering artificial radioactivity induced by neutrons, and, in association with his former pupils Edoardo Amaldi, Bruno Pontecorvo, Franco Rasetti and Emilio Segrè, slow or thermal neutrons and their properties; the latter are of paramount importance for a controlled chain reaction. It was for this work that he was awarded the Nobel prize in physics for 1938.

To escape the Italian Fascist government, Fermi went to the U.S., where he became professor of physics at Columbia university in 1939. Soon thereafter, when nuclear fission was discovered by Otto Hahn and Fritz Strassmann, he embarked upon the development of a controlled chain reaction. This work was later subsidized by the U.S. government and formed a large part of the Manhattan project. In 1942 the controlled chain reaction was achieved. Fermi then moved to Los Alamos, N.M., working on the development of the atomic bomb. In 1946 he returned to The University of Chicago as professor in the newly created Institute

for Nuclear Studies, later renamed the Enrico Fermi Institute for Nuclear Studies. He worked for a short time on applications of neutrons to problems of solid-state and nuclear physics, introducing many novel ideas that were later developed extensively by others, and then turned to high-energy nuclear physics. His studies were mainly concerned with the interaction between pi mesons or pions, as he called them, and nucleons. In this area he obtained important results both in experiment and in theory, succeeding in demonstrating some of the important features of the interaction. He died on Nov. 28, 1954, while still at the peak of his scientific powers.

Fermi was unique in his generation in combining supreme ability as a theoretical and experimental physicist. His work is characterized by the breadth of its scope, by the simplicity of its approach and by the depth of its original thought. He had great gifts as a teacher—many important physicists in Europe and the United States owed to him instruction, inspiration and ideas—and was the recipient of nearly all the awards and distinctions available to physicists. Fermi's papers were collected and reprinted in 1962 by the Accademia Nazionale dei Lincei in Rome and by The University of Chicago press. He also wrote textbooks on atomic physics, thermodynamics, molecular and solid-state physics, etc. *See* also references under "Fermi, Enrico" in the Index volume.

See Laura Fermi, *Atoms in the Family* (1954); E. Fermi, *Collected Papers* (1962). (Eo. S.)

FERMIUM. The synthetic element fermium has the chemical symbol Fm and the atomic number 100. It occupies a position in the periodic system of the elements as the 11th member of a rare-earthlike transition series, the actinide series, which includes the heaviest known elements and in which an inner electronic shell (the 5f shell) is being filled. The eighth transuranium element to be discovered, it was first identified by A. Ghiorso and coworkers. For a discussion of its discovery, *see* TRANSURANIUM ELEMENTS.

As in the case of a number of the other actinide elements, there is no completely logical assignment of atomic weight because the isotopic composition is variable, depending on the source. If there is a formal requirement for this quantity the use of the mass number of the longest-lived isotope might be considered. Since the longest-lived fermium isotope known in the early 1960s was Fm^{253}, it seemed unlikely that this element could be isolated in weighable amount. Its chemical properties have been studied on a tracer scale, and in aqueous solution only the III oxidation state appears to exist. Most of the chemical studies have been concerned with the determination of its ion exchange properties.

Isotopes of Fermium

Isotope	Half life	Type* and energy of radiation (Mev)	Isotope	Half life	Type* and energy of radiation (Mev)
$Fm^{248, 249}$	short	α	Fm^{253}	4.5 days	EC, α 6.94
Fm^{250}	~0.5 hr.	α 7.43	Fm^{254}	3.24 hr.	α 7.20
Fm^{251}	7 hr.	EC α (1%) 6.89	Fm^{255}	22 hr.	α 7.1
Fm^{252}	23 hr.	α 7.04	Fm^{256}	3 hr.	SF

*EC = electron capture; α = alpha particle; SF = spontaneous fission.

Fermium can be separated from the other tripositive actinide elements by adsorption and elution from columns packed with ion exchange resins. Separation from the rare-earth elements can be effected by the use of eluting agents such as concentrated hydrochloric acid, which forms complex ions with the actinide elements which are much more stable than the corresponding ions formed with the rare-earth elements. Since fermium is the 11th member of the actinide transition series it seemed probable that the chemistry of the tripositive ion would be similar to that of the corresponding ions of other members of the series.

The isotope Fm^{254} and heavier fermium isotopes can be produced by intense neutron bombardment of elements of lower atomic number, such as plutonium, by a process of successive neutron capture reactions interspersed with beta particle decays until atomic number 100 and these mass numbers are attained.

See J. J. Katz and G. T. Seaborg, *The Chemistry of the Actinide Elements* (1957); G. T. Seaborg, *The Transuranium Elements* (1958). (G. T. Sg.)

FERMO (anc. FIRMUM PICENUM), a town and archiepiscopal see of the Marches, Italy, in the province of Ascoli Piceno, stands on a prominent hill 1,046 ft. above sea level, overlooking the Adriatic sea, 6 km. (4 mi.) distant. It is connected by a branch line with Porto San Giorgio (anc. Castellum Firmanum) on the coast. Pop. (1957 est.) 28,267 (commune). The centre of a prosperous agricultural district, the Fermana, it has a celebrated bronze foundry, noted for its bells.

The esplanade on the summit, "Il Girone," marks the site of the Sforza castle destroyed in 1446. At one end stands the cathedral, on the site of an Early Christian church (5th century mosaic pavement) which replaced a pagan temple; of the original Gothic building (1227) the fine west door and campanile remain. A blue silk chasuble embroidered with gold thread in the cathedral is believed to have belonged to St. Thomas à Becket; it is Islamic work, made in 1116 at Almería in Spain. Other surviving ancient remains are the Roman theatre; the settling tanks of the Roman aqueduct (A.D. 41–68); and short stretches of both the pre-Roman and the Roman city walls. The main piazza, with a large statue of Pope Sixtus V, occupies the site of the forum. The medieval town is enclosed by a well-preserved circuit of walls.

Firmum, already a native Picene stronghold in the Early Iron Age, became a Latin colony in 264 B.C. In 42 B.C., after the battle of Philippi, it was made a colony with full rights. Conquered successively by the Goths, the eastern empire (553–570), the Lombards and the Franks, it passed in the 8th century to the Church. As the centre of the duchy, and later the march (*marchia*), of Fermo, it was the capital of a large territory from the 9th century until, in the 12th, the march was merged in that of Ancona. During the later middle ages it underwent many shifts of allegiance, but in 1550 it passed once more under the direct rule of the Church, to which it remained subject until 1860. (J. B. W.-P.)

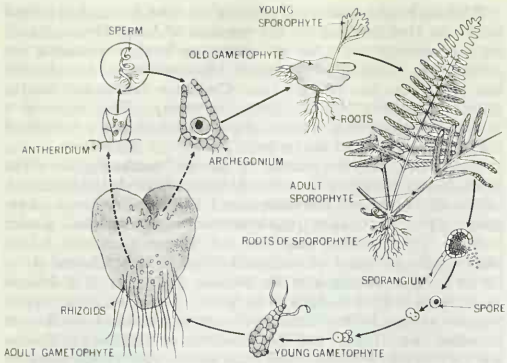
FERN, any plant belonging to the class Filicineae (subclass Filicinidae in some classifications), distinguished by having true roots, stems and leaves but no flowers, fruits or seeds. Ferns were formerly included with the club mosses, horsetails and various fossil relatives in the phylum or division Pteridophyta. Later research, however, has indicated that the ferns are more closely related to the higher seed-bearing vascular plants than to the club mosses and horsetails (see *Classification,* below).

The ferns were prominent in the vegetation of certain former geologic ages. They contributed to the formation of coal beds during the Carboniferous period (also known as the "Age of Ferns"; beginning about 260,000,000 years ago and lasting for about 25,000,000 years). On the present earth they are of worldwide distribution but are most abundant in the humid tropics. They are extensively grown in gardens, greenhouses and homes for their attractive foliage and their ease of handling (*see* also HOUSE PLANTS). The foliage and the underground rhizomes of some ferns are eaten in several parts of the tropics, and an ether extract of the rhizome of the so-called male fern constitutes a drug (aspidium) used chiefly in veterinary medicine to expel parasitic worms.

LIFE CYCLE AND GENERAL FEATURES

Ferns are reproduced by means of the microscopic single cells called spores. It is a matter of technical interest that the spores are haploid, *i.e.,* their nuclei contain single sets of chromosomes. An individual fern plant may produce an enormous number of spores; those of most ferns are capable of remaining alive for long periods. The spores are wind-borne and may be very widely distributed. They are able to germinate, however, only under favourable conditions of moisture, temperature and shade.

Gametophyte.—The germinating spore gives rise to a structure called the gametophyte (prothallus or prothallium), which is actually a minuscule plant totally different in structure from its parent. It may be described as a bright green, ribbon- or heart-shaped structure, a fraction of an inch wide, lying prostrate upon the soil. It contains chlorophyll and manufactures its own food. Toward the margins it is one cell thick, the midrib being thicker. On the lower surface, hairlike cells called rhizoids penetrate the soil to absorb water and minerals. The fern gametophyte is

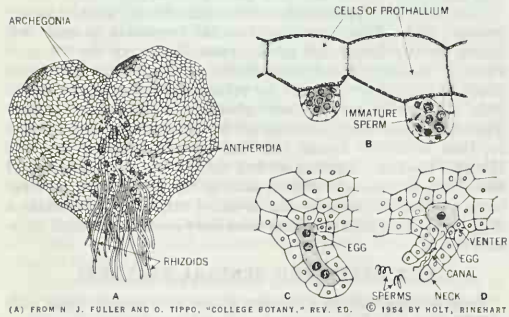


FROM C. A. VILLEE, "BIOLOGY," 1954, REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 1.—LIFE CYCLE OF A FERN, SHOWING THE ALTERNATION OF A SEXUAL (GAMETOPHYTE) AND AN ASEXUAL (SPOROPHYTE) GENERATION. IN THIS ILLUSTRATION THE ADULT SPOROPHYTE, OR FERN PLANT, IS REDUCED IN SIZE; THE OTHER STAGES ARE VARIOUSLY ENLARGED

morphologically comparable to a moss plant, although much simpler in structure; it bears on the lower side the same microscopic reproductive structures, called antheridia (sperm producers) and archegonia (egg producers), as are found in mosses and liverworts.

The antheridium consists of a wall of sterile cells surrounding a body of cells that develop into sperms (spermatozoids). The archegonium consists principally of a cylinder of cells that leads to an egg (ovum) embedded in the tissue of the gametophyte. In the presence of water (the capillary water of moist soil is sufficient) the ripe antheridium discharges its sperms and the neck of the ripe archegonium becomes an open tube. The sperm is a minute, motile elongate cell provided with many threadlike flagella. Sperms swim to the archegonium, being attracted by substances exuded from the latter. Although more sperms than one may enter an archegonium, only one of them unites with the egg. The union of the sperm nucleus (haploid) with the egg nucleus (also haploid)



(A) FROM H. J. FULLER AND O. TIPPO, "COLLEGE BOTANY," REV. ED. © 1954 BY HOLT, RINEHART AND WINSTON, INC.; (B, C, D) FROM G. M. SMITH, E. M. GILBERT AND OTHERS, "A TEXTBOOK OF GENERAL BOTANY"; REPRINTED WITH THE PERMISSION OF THE PUBLISHER. © 1953 BY THE MACMILLAN CO.

FIG. 2.—GAMETOPHYTE, OR SEXUAL GENERATION OF A FERN: (A) LOWER SURFACE OF GAMETOPHYTE OR PROTHALLUS, ABOUT 10X NATURAL SIZE; (B) ANTHERIDIA, GREATLY ENLARGED; (C) NEARLY MATURE ARCHEGONIUM; (D) MATURE ARCHEGONIUM AT TIME OF ENTRANCE OF SPERM, GREATLY ENLARGED

produces a nucleus that is diploid, *i.e.*, provided with two sets of chromosomes.

Sporophyte.—The fertilized egg develops into a diploid body called the sporophyte, which is the familiar fern plant. Morphologically, the fern sporophyte is comparable to the fruits of mosses. An individual gametophyte is usually able to support the growth of only one sporophyte, which presently establishes contact with the soil and becomes an independent plant. In the course of this development the gametophyte shrivels and dies.

The early development of the sporophyte is varied in different ferns. In several of the primitive ferns (family Ophioglossaceae) it takes place as follows: The fertilized egg, embedded in the gametophyte, divides repeatedly to form a globular mass of cells. Part of this mass develops into an absorbing organ, the foot. Two cells in other parts become the growing points, respectively, of a descending and an ascending axis. The descending axis is the primary root of the plant. It breaks downward through the tissue of the gametophyte and into the soil. Its tip is protected by a cap and it bears root hairs. The ascending axis breaks forth upward into the air. It takes the form of a minute green ribbon, which forks once or twice and then ceases to grow. It is, in fact, a first leaf and may be called a cotyledon. Further leaves, successively larger and of more complicated structure, grow forth from the base of the first leaf. The bases linking successive leaves presently take the form of a continuous axis, growing by means of its own apical cell and constituting a stem (often called rootstock or rhizome). Once a stem is established, further leaves and roots originate as appendages upon it.

The stems of most ferns are rhizomes; this means that they

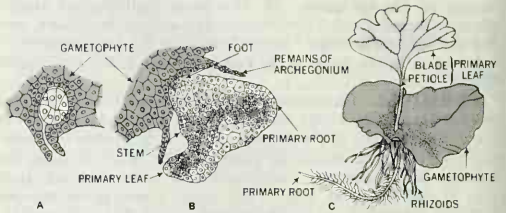


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FIG. 3.—DEVELOPMENT OF SPOROPHYTE, OR ASEXUAL GENERATION: (A) EARLY EMBRYO ENCLOSED IN ARCHEGONIUM, GREATLY ENLARGED; (B) OLDER EMBRYO, STILL PARTLY WITHIN ARCHEGONIUM, AFTER DIFFERENTIATION INTO PRIMARY PLANT PARTS, GREATLY ENLARGED; (C) YOUNG SPOROPHYTE STILL ATTACHED TO, AND DEPENDENT UPON, THE GAMETOPHYTE, ABOUT 7X NATURAL SIZE

are prostrate, either in the soil or, in the case of epiphytes, upon rocks, trees or other supports. The leaves (alternatively called fronds) are usually large and repeatedly compounded. Each new frond appears as a tightly coiled fiddlehead or crosier which unfurls slowly, producing the mature leaf.

Anatomical Features.—Two anatomical features of the sporophyte of ferns require notice as indications of the relationships of the group: (1) the stomates and (2) the vascular tissue.

All aerial parts are covered by a microscopic waterproof layer called the cuticle. On all relatively bulky parts, and particularly on leaves, the cuticle is punctured by numerous slit-shaped openings called stomata or stomates. Each stoma lies between two crescent-shaped cells called guard cells. The guard cells are capable of changes of shape, with the effect that when the plant is well supplied with light and water, the stomates are open and thus carbon dioxide can reach the food-manufacturing cells of the interior. In the presence of a deficit either of light or of water the stomates are closed to protect the plant against drying. Stomates are characteristic of the entire group of vascular plants, being an evolutionary inheritance from certain bryophytes: they occur on the fruits of the liverwort *Anthoceros* and of the mosses.

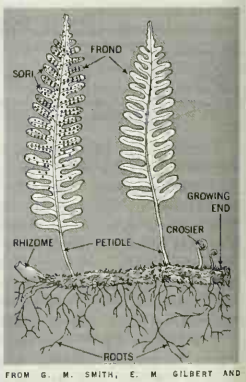

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FIG. 4.—MATURE FERN PLANT OR SPOROPHYTE OF POLYPODIUM VULGARE, WITH FRONDS ABOUT ONE FOOT LONG

Plant and roots of the common polypody (*Polypodium vulgare*), a fern widely distributed in the U.S., Great Britain and Europe

Grape fern (*Botrychium virginianum*), one of the Ophioglossales or succulent ferns, primitive types limited to four living genera

A polypody (*Polypodium virginianum*) showing underside of fronds with fruiting dots

Staghorn fern (*Platycerium bifurcatum*) is found in forests of Africa, Malaya and Australia

Detail of the fiddlehead, or crozier, of the Christmas fern (*Polystichum acrostichoides*)

Tree ferns, about 20 ft. high, growing on the island of Fernando Po, Spanish Guinea. These are true ferns of the family Cyatheaceae

Leaf of a broad beech fern (*Thelypteris hexagonoptera*)

FERNS

PHOTOGRAPHS, (TOP LEFT) J. HORACE MCFARLAND CO., (TOP CENTRE, TOP RIGHT, CENTRE LEFT, CENTRE, BOTTOM RIGHT) JOHN H. GERARD, (BOTTOM LEFT) R. J. HARRISON-CHURCH

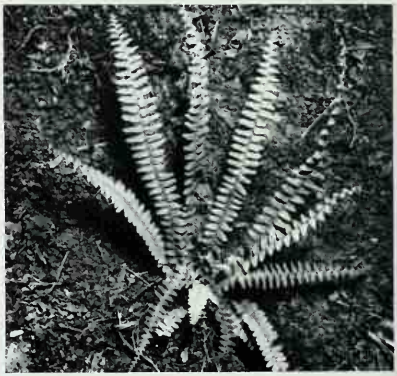
FERN

Bulblet fern (*Cystopteris bulbifera*) usually found on rocky limestone slopes

Bird's-nest fern (*Asplenium nidus*), native to the oriental tropics, is frequently cultivated. This plant was photographed in Polynesia

Croziers of the cinnamon fern (*Osmunda cinnamomea*). Each head unfolds into a leaf

Crested table fern (*Pteris cretica*), a coarse fern of the oriental tropics



Ebony spleenwort (*Asplenium platyneuron*), a tall fern widely distributed in the U.S.

Maidenhair fern (*Adiantum pedatum*), another fern common to much of the U.S. from the Gulf states to Alaska

Walking fern (*Camptosorus rhizophyllus*), so named because the tips of its leaves often take root and sprout new plants. Note irregular pattern of fruit dots on the underside of leaf at centre

FILICALES: TRUE FERNS

PHOTOGRAPHS, (TOP LEFT, CENTRE, CENTRE RIGHT, BOTTOM LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT) E. AUBERT DE LA RUE, (CENTRE LEFT) J. HORACE MCFARLAND CO.

All parts of the sporophyte are traversed by strands of tissues that have the functions of giving strength and of conducting food, water and minerals. Typically these tissues constitute, in an individual root or stem, a single vascular cylinder (stele); in leaves they make up the veins. The most characteristic cells in the fibrovascular tissues are the lifeless water-conducting tracheary cells. The presence of these cells is a distinctive character of all vascular plants.

The stele in the stem of ferns always contains a central core of relatively undifferentiated tissue, the pith. The vascular tissue takes any of three forms: (1) it may form a continuous cylinder about the pith, the stele in this case being called a siphonostele; (2) it may form a cylinder of discrete strands about the pith; or (3) it may occur as strands both in a cylinder around the pith and within the pith. In the last two arrangements the stele is termed a dictyostele. Wherever a leaf is attached, the structure of the stele is differentiated: the departure of conducting strands to the leaf produces a "leaf gap," an area in which the vascular cylinder is interrupted by undifferentiated tissue. This structural feature is believed to establish two points: (1) that the leaf is, in evolutionary origin, a branch of the stem; and (2) that the leaves of ferns are true leaves, like those of seed plants, in contrast to the so-called leaves, or scales, of club mosses and horsetails. (*See* PLANTS AND PLANT SCIENCE: *Anatomy of Plants.*)

Details of Reproduction.—The reproduction of the sporophytes of all vascular plants is by spores, which are produced in cases called sporangia. Like the entire body derived from the fertilized egg, the internal cells of a developing sporangium, namely the spore mother cells, are diploid. The nuclei of the spore mother cells, however, undergo meiosis (or reduction division), by which one diploid nucleus produces four haploid nuclei. Thus each spore mother cell produces four spores, each of which upon germination becomes a gametophyte. (*See* PLANTS AND PLANT SCIENCE: *Morphology of Plants.*)

It is probably sound theory that in all plants having true leaves sporangia are borne exclusively upon the leaves. The sporangium-bearing leaves are called sporophylls. In most ferns all leaves of the mature plant are sporophylls, differing from the vegetative leaves produced by the immature plant only in the presence of sporangia. In a minority of ferns (those said to have dimorphic fronds) the sporophylls are definitely distinguishable, generally by smaller extent.

The sporangia may be partially fused in bodies called synangia. More often they are gathered into brownish or yellowish clusters called sori (sing. sorus). A sorus may be protected during development by a scale or film of tissue called an indusium.

In some ferns and in the seed plants each sporangium develops from a cluster of cells of the layer next within the epidermis and has a sterile wall of several layers of cells. These plants, being in this respect the typical vascular plants, are said to be eusporangiate. The only vascular plants that are not eusporangiate are the majority of existing ferns. In these ferns, said to be leptosporangiate, each sporangium develops from a single epidermal cell and has a wall of a single layer of sterile cells. This wall is marked by a group (file or cycle) of cells, the annulus, having the walls partially thickened. When a ripe sporangium is exposed to air of a certain degree of dryness, the cells of the annulus first contract and then violently spring back to their original size, with the effect that they first tear the sporangium open and then violently discharge the spores.

It has been taken for granted in the foregoing account that the sporophyte produced spores of a single type and that the gametophytes that grow from these spores produce both sperms and eggs. Plants with these characteristics, including the overwhelming majority of ferns, are said to be homosporous. In all homosporous plants the gametophyte has a life span of at least several months and achieves at least moderate growth, becoming visible to the naked eye.

While the gametophyte of typical ferns, as described earlier, is completely self-nourishing, there are certain lower ferns with notably bulky gametophytes whose self-nourishment by photosynthesis is supplemented by absorption through mycorrhizae

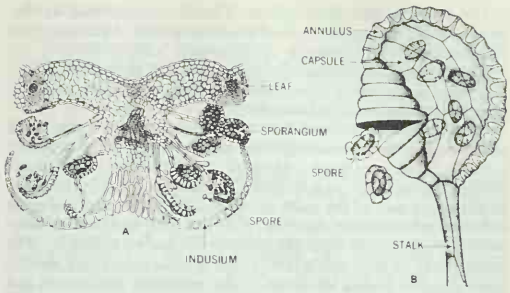


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FIG. 5.—REPRODUCTION OF SPOROPHYTE GENERATION: (A) CROSS SECTION OF FERN LEAF AND SORUS, HIGHLY MAGNIFIED; (B) SPORANGIUM, MORE HIGHLY MAGNIFIED

(sing. mycorrhiza). A mycorrhiza is a fungus, held somehow in symbiotic helotism, extending from the tissues of its host into the surrounding soil; the mycorrhiza absorbs nourishment from decaying matter to the benefit of its host. In some lower ferns the gametophyte is completely subterranean and is completely dependent on its mycorrhizae. Since the mycorrhizal habit occurs in the liverwort *Anthoceros*, it is probable that its occurrence in lower pteridophytes is by inheritance from certain bryophytes.

In contrast to the homosporous plants, a few small genera of ferns and all seed plants are heterosporous. That is, they produce two types of spores from which develop, respectively, sperm-producing male gametophytes and egg-producing female gametophytes. The two kinds of spores are produced in distinct sporangia, which may be borne upon distinct sporophylls. The male structures are generally smaller than the female. Male and female structures are designated, respectively, by terms with the prefixes micro- and mega- or macro-. Thus microsporophylls bear microsporangia, which produce microspores (which will develop into male gametophytes); while megasporophylls bear megasporangia, which produce megaspores (which will develop into female gametophytes). The gametophytes of all heterosporous vascular plants are greatly reduced: they may consist, for example, of a few vegetative cells with one or a few antheridia or archegonia, all enclosed within the original wall of the spore: these kinds of gametophytes depend entirely upon food stored within the spore by the parent sporophyte. In connection with the production of seeds, heterospory has enabled the plants that exhibit it to become the dominant vegetation of the earth today.

The heterosporous ferns are a rather insignificant assemblage of plants. It is evident, therefore, that when heterospory is not associated with the production of seeds, it is not a particularly advantageous character.

CLASSIFICATION

In earlier classifications the ferns were included with the club mosses, horsetails and various other groups, living or fossil, in the phylum or division Pteridophyta. For pteridophytes other than ferns the common name "fern allies" is used. Paleontological and anatomical evidence has established the point that the thorn-, bristle- or scalelike appendages of the fern allies are not true leaves, whereas the leaves of ferns are true leaves, of the same morphological nature as those of the seed plants (the former division or phylum Phanerogamia or Spermatophyta). For this reason the two traditional phyla are merged as a single phylum of vascular plants, Tracheophyta or Cormophyta.

The ferns are most simply treated as the class Filicineae, placed in the phylum of vascular plants, following the fern allies and followed by the seed plants. A subphylum Pteropsida, to include both ferns and seed plants, may be recognized; or Pteropsida may be construed as a class, and the ferns as a subclass, Filicinidae. (*See* PLANTS AND PLANT SCIENCE: *Classification of Plants.*)

The ferns include four orders. The Coenopteridales, an important fossil group, are omitted from the present treatment (*see* PALEOBOTANY). The orders Ophioglossales and Marattiales are small relic groups, uniformly eusporangiate and homosporous; the Filicales, the dominant ferns today, are leptosporangiate and may be either homosporous or heterosporous.

Ophioglossales.—These are small plants each of which has a scaleless stem, usually underground and horizontal, that produces a single frond each year. Most of the fronds are sporophylls bearing the sporangia in a spikelike or branched "fertile segment" on the upper side of the stalk or blade. The prothallium of most species is subterranean, tuberous, provided with mycorrhiza, without chlorophyll. The Ophioglossales are not known as fossils. The living examples are a single family Ophioglossaceae of four genera. *Ophioglossum,* having the frond or its vegetative part simple and usually entire, with netted venation, includes about 50 species in all lands. *Botrychium,* having the frond or its vegetative part pinnate and the venation free, consists of about 50 widely distributed species. *Helminthostachys* is a single oriental species; *Rhizoglossum* is a single rare species in South Africa.

Marattiales.—The plants range from small to very large; the fronds, provided with fleshy stipules, are compound (sometimes reduced to a single leaflet; in some species repeatedly compounded); the sporangia are in sori or synangia on the lower surface; the prothallia are massive, growing on the surface of the earth and green in colour, yet provided with mycorrhiza.

The living Marattiales are a single family Marattiaceae of six essentially tropical genera: *Angiopteris, Macroglossum* and *Marattia,* with massive upright stems and great leaves up to five metres long, pinnate or repeatedly pinnate; and *Archangiopteris, Christensenia* and *Danaea,* which are smaller with prostrate stems.

The Marattiaceae go back as fossils to the Carboniferous period. Of all known plants that do not produce seeds, these come nearest to the extinct group of lowest seed plants, the Cycadofilicales (Pteridospermae), and to the lowest of living seed plants, the cycads. The seed plants are presumably derived from some more primitive group of fossil ferns. At the same time, these ferns are of the same general nature as the typical ferns of the present making up the following order.

Filicales (Filices).—These are the typical ferns; they constitute the only group of vascular plants that are leptosporangiate, *i.e.,* having the sporangia derived from a single epidermal cell and walled by a single layer of cells.

There are approximately 10,000 species. The traditional classification divided the homosporous types into seven small families and one very numerous one, Polypodiaceae. The heterosporous types were placed in a separate order, Hydropterides, of two families. The latter, however, are related to different homosporous groups, and the order is not tenable. The breaking up of the old family Polypodiaceae into many, first notably attempted by F. O. Bower, was continued by R. C. Ching, who distinguished 33 families. In this article an intermediate position is taken: the leptosporangiate ferns are treated as 21 families, including the two of heterosporous ferns.

Osmundaceae.—There are three genera: *Osmunda,* cosmopolitan; *Todea,* a tree fern of southern Africa, Australia and New Zealand; and *Leptopteris,* with six species ranging from New Zealand and Tasmania to New Guinea and Samoa, with leaves finely divided and exceedingly thin. Some of the species are small tree ferns of remarkable beauty.

Schizaeaceae.—The genus *Schizaea* resembles a grass; one species ranges northward to Newfoundland, while all others, numbering about 30, are austral. *Lygodium* is the climbing fern. The scandent structure is not a stem but the midrib of an indefinitely extended frond.

Gleicheniaceae.—These are distinguished by sporangia with a transverse annulus. They are terrestrial ferns, often large and brakelike, the fronds of some species growing indefinitely like those of *Lygodium.* Genera are *Gleichenia; Sticherus,* including the majority of the species; and others.

Loxsomaceae.—A small group of peculiar character. *Loxsoma* includes one species in New Zealand. *Loxsomopsis* includes three species distributed from Bolivia to Costa Rica.

Hymenophyllaceae.—This is the family of filmy ferns. The fronds of most species are only one cell thick; stomata are completely absent. There is wide variation in size; fronds of some species have an area of only a few square millimetres; those of others, always finely divided, reach lengths of 50 cm. Sporangia are clustered at the tips of segments of the fronds, or on bristlelike extensions of these, protected by indusia that are tubular or divided into a pair of scales. The prothallia of many species are filamentous.

There are about 500 species, native predominantly in austral regions such as New Zealand, although almost equally well represented in the Philippines. Two small species extend into the United States from the West Indies; one species, a migrant from Asia, was found in western Canada.

Formerly botanists divided the filmy ferns into just two genera, *Hymenophyllum* and *Trichomanes,* distinguished by the type of indusium; it was found necessary, however, to segregate numerous genera from each of these. The largest known genera are *Mecodium* and *Sphaerocionium. Callipteris* and *Cardiomanes* respond to greenhouse culture.

Pteridaceae.—These are characterized by marginal sori, round or elongated, protected by indusia opening toward the margin or by recurved margins. Spores are tetrahedral. There are 62 highly diversified genera.

Thyrosopteris is a small tree fern of Juan Fernandez Island. *Dicksonia* includes 25 species of tree ferns, mostly austral, one of them in cultivation. *Dennstaedtia* consists of about 70 species with creeping stems and large fronds; one of them is the hay-scented fern of the southeastern United States. *Lindsaea* comprises 200 species, terrestrial, epiphytic or climbing, having simple to finely divided fronds. *Pteridium aquilinum* is the bracken fern, a single world-wide species, unless many scarcely distinguishable forms are to be recognized as such. *Pteris* includes about 280 species of rather coarse ferns, scarcely ornamental. *Acrostichum aureum* is a large coarse fern of brackish waters, also sometimes found in hot springs. *Cheilanthes* includes 180 species of fine small ferns of dry places everywhere from Australia to the United States. *Pellaea* comprises about 80 species of small to moderately large ferns likewise of dry places. *Pityrogramma calomelanos* is perhaps the most commonly cultivated of all ferns; it or its hybrids have spread in cultivation to all lands.

Adiantaceae.—These are the maidenhair ferns represented by a single genus *Adiantum* of more than 200 species, the majority occurring in South America. Many species are cultivated for their beauty.

Parkeriaceae.—Included here are *Ceratopteris siliquosa* and a few other species, growing on mud or submerged; they are edible and cultivated for food.

Hymenophyllopsidaceae and Plagiogyriaceae.—These two small families are of little importance.

Davalliaceae.—There are a dozen genera chiefly of epiphytes of the oriental tropics. A few species of *Davallia* and *Humata* and one of *Araiostegia* are raised as epiphytes in greenhouses. *Oleandra* is shrublike in habit. *Nephrolepis* is shrubby or scandent, popular in warm places and prone to hybridize.

Cyatheaceae.—This family comprises the typical tree ferns. They have trunks of 10 to 80 ft. high, each with a majestic crown of great fronds two or three times compound, usually scaly and with free venation; the sporangium is large with an oblique annulus; the spores are tetrahedral. The bulk of the species—about 800—is assigned to a single genus *Cyathea.* Among the small genera distinguished from this, *Gymnosphaera* includes a few stout climbing species.

Aspidiaceae.—This family comprises 63 genera. They are mostly terrestrial plants with creeping stems; exceptions are scandent, epiphytic or have erect stems. The stem, and to some extent the leaves, are scaly; there are sori on the lower surfaces of the fronds, with or without indusia; spores are bilateral.

Matteucia, Onoclea and *Woodsia* are boreal genera. *Polystichum,* with nearly 200 species, occurs in the north but is more abundant in the Andes and in New Guinea. *Phanerophlebia* con-

sists of about 20 species, several of them in cultivation. *Bolbitis*, with 85 species in all tropical lands, shows notable dimorphism of sterile and fertile segments of the fronds. *Lomagramma* has markedly distinct sterile and fertile fronds. *Elaphoglossum*, with more than 400 species, has simple fronds, more or less dimorphic. *Dryopteris* has been credited with more than 1,000 species; several genera now divide these. The male fern, *Dryopteris filix-mas*, ranges around the northern hemisphere. *Lastrea* has fully 500 species in every land habitable by ferns. Free veins distinguish it from *Cyclosorus*, with 300 species, in which the lowest veinlets are united. (*Cyclosorus* and *Lastrea* may be combined as a single genus.) *Athyrium* has at least 300 species, of which the best known is *A. filix-femina*, the lady fern.

Blechnaceae.—The stems are scaly, creeping or partly erect; veins are branching and anastomosing, forming one or more rows of areolae parallel to the midribs of the segments; spores are bilateral.

Blechnum is widely distributed, the species being most numerous in New Guinea. *Doodia* has several parallel rows of sori on the fronds; the difficulty in distinguishing the species may be a result of hybridization in nature. *Brainea* produces short stout trunks; sori are indefinite; distribution is from south China to Sumatra. *Woodwardia* is a large fern widely distributed in the northern hemisphere; it is cultivated. *Stenochlaena* is a climbing fern. *Stenochlaena areolaris* grows among the crowns of screw pines or pandans, exhibiting a remarkable case of adaptation to a particular environment.

Aspleniaceae.—These are terrestrial or epiphytic, small to large, the fronds simple to repeatedly compound; sori are elongate, along the veins, and usually indusiate.

Asplenium includes the overwhelming majority of the approximately 700 species of the family. Species with large fronds, simple and entire, are called bird's nest ferns; among them, *A. nidus* is common in cultivation. The rock ferns are small plants prone to hybridize. One of these is *Camptosorus*, the walking fern of the eastern United States and Siberia.

Diellia includes nine species endemic in Hawaii. Evolution in this genus has twice independently given rise to the same species.

Matoniaceae.—This family includes *Matonia* in Malacca, Sumatra and Borneo and *Phanerosorus*, one species of which is found in Borneo and one off the northwest coast of New Guinea. Fossils representing this family and even representing the genus *Matonia* go back to the Mesozoic era.

Polypodiaceae.—These are mostly tropical epiphytes with creeping stems; fronds are simple to pinnate; venation usually is reticulate; spores are bilateral. About 50 genera are distinguishable.

Platycerium consists of large epiphytes of bizarre appearance, producing fronds of two types: normal fronds, elongate, repeatedly forking, becoming pendant, bearing the sori on special areas; and stalkless large-scale fronds that protect a mass of stems, roots and decaying debris. *Polypodium* formerly included more than 1,000 species, among which fewer than 100 are retained in it. *Polypodium vulgare* is the common polypody of Europe and North America. *Drynaria*, a large coarse epiphyte, is not uncommon in greenhouses.

Grammitidaceae.—*Grammitis* and other genera of this family are small epiphytes with creeping stems and simple leaves, nearly 500 species, characteristic of the mossy forest.

Vittariaceae.—*Vittaria* and other genera are much like the foregoing, characteristically having the sori elongate along the veins.

Marsileaceae.—These plants are rooted in mud. *Marsilea* (water clover or pepperwort) has the leaf blade of four wedge-shaped segments in the form of a cross, like a four-leafed clover. *Regnellidium*, from a limited area of Brazil, has a leaf blade of two fan-shaped segments. *Pilularia* resembles a very fine low grass. This family, believed to be related to Schizaeaceae, and the next family are the heterosporous leptosporangiate ferns, as a group called water ferns; they produce the microscopic short-lived gametophytes characteristic of heterosporous plants.

Salviniaceae.—*Salvinia* and *Azolla* float on water and resemble mosses. This family is possibly distantly related to Hymenophyllaceae.

See also references under "Fern" in the Index volume.

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FERNALD, MERRITT LYNDON (1873–1950), U.S. botanist noted for his publications in plant systematics and plant geography, was born in Orono, Me., Oct. 5, 1873. Fernald published works extending over a 60-year period beginning with his first published paper in 1890. He was educated and spent his entire professional career at Harvard university, ultimately becoming (1915) Fisher professor of natural history and director of the Gray herbarium (1937). He was the recognized authority on the vegetation of eastern North America and propounded the so-called nunatak hypothesis to explain the persistence of plants through the ice age in areas largely covered by glaciers. Fernald died Sept. 22, 1950.

His principal books are: the 7th edition of *Gray's Manual of Botany* (with Benjamin L. Robinson) (1908); *Persistence of Plants in Unglaciated Areas of Boreal America* (1925); and *Edible Wild Plants of Eastern North America* (with Alfred C. Kinsey) (1943); 8th (centennial) edition of Gray's *Manual of Botany* (1950). (R. C. R.)

FERNANDES, ÁLVARO (fl. 15th cent.), the most successful Portuguese captain of the earlier 15th century, was sent southward by Prince Henry the Navigator to explore the west African coast. Most of the Portuguese made little progress beyond Arguin, and were only concerned with slave raiding. When Prince Henry's expedition of 1445 sailed for Arguin, Fernandes was entrusted by his uncle, Gonçalves Zarco, discoverer of Madeira, with a caravel, under injunctions to devote himself to discovery. After visiting the mouth of the Senegal and rounding Cape Verde he continued to the "Cape of the Masts," 50 leagues beyond Cape Verde. In 1446 he returned to west Africa and coasted on to a bay 110 leagues beyond Cape Verde, little short of Sierra Leone. This was the farthest reached by Portuguese exploration during Prince Henry's lifetime and was not surpassed until 1462. (For another opinion, *see* HENRY the Navigator.) A wound from a poisoned arrow compelled Fernandes to return to Portugal. He made no further effort to explore the African coast, as Prince Henry was content to establish trade in slaves, ivory and gold dust with Guinea (the region of the Senegal and Gambia). (A. Ds.)

FERNANDES, JOÃO (fl. 1446), Portuguese traveler who stayed seven months with the nomads of Río de Oro, played an important part in Portuguese expansion in Africa. In 1445 he went with a Portuguese trading ship to the Río de Oro, at a latitude of about 23° N. An elderly Moorish trader wished to go back in the ship to investigate trade possibilities in Portugal; and Fernandes, then a young squire, volunteered to stay with the Moorish family as hostage, having already learned Arabic when a captive in Morocco before this date. Jews, French and Italians had earlier accompanied trade caravans into the Sahara, and Fernandes was welcomed by the nomads with their customary hospitality. The nomads had horses and lived by herding sheep, having to move every eight days in search of fresh pasture. They lived mainly on milk, mutton and dates, while grain from Morocco was exchanged for slaves and gold dust from the Sudan. They were Muslim but did not speak Arabic. Fernandes was taken south across the desert to visit an old patriarch who from time to time went to the Sudan to trade for slaves and gold dust. He found that

the nomads got their slaves from Negro kings who raided other tribes. Fernandes re-embarked at about 19° N. and was able to give Prince Henry the Navigator detailed information of the western Sahara and the trade with Guinea. Until then the Portuguese had raided the coasts for slaves as far south as the Senegal, but this roused hostility, and the Negroes repelled Portuguese attacks with poisoned arrows. From 1448 Prince Henry stopped slave raiding and made exchange treaties with Moorish and Negro chiefs, a vastly more profitable policy that made further exploration along the coast unnecessary. In 1446 and 1447 Fernandes again visited Río de Oro to arrange trade agreements.

See Gomez Eannes de Azurara, *Chronica . . . de Guiné.* (A. Ds.)

FERNÁNDEZ, GREGORIO: *see* HERNÁNDEZ, GREGORIO.

FERNÁNDEZ, JUAN (1536?–1604?), a navigator in the service of Spain, in 1563 made a celebrated voyage from Callao to Chile which won him the title of *brujo* ("wizard"). By sailing out to the westward he avoided the southerly offshore winds and reached Valparaíso in only 30 days. He discovered the islands San Félix and San Ambrosio in 1574 (according to Sarmiento de Gamboa and Leonardo de Argensola); and at an uncertain date (probably sometime between 1563 and 1574) discovered the group of islands which bear his name, establishing a settlement there. On the failure of this settlement (1580) he resumed his work as a pilot and died in about 1604. The tradition that he had discovered the southern continent in latitude 40° S., to the west of Chile, originated in a memorial by Juan Luis Arias, written after 1614. *See* JUAN FERNÁNDEZ ISLANDS.

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FERNÁNDEZ, LUCAS (1474?–1542), Spanish dramatist and musician, whose plays are notable for their effective dialogue, simple humour and skilful use of interpolated songs and music, was born and educated at Salamanca. He was professor of music there from 1522. His six plays (1514) show clearly the influence of Encina (*q.v.*), his rival as a musician. His most impressive work is the *Auto de la Pasión*, the others being short homely Christmas pieces and comic shepherd plays. His *Diálogo para cantar* (1514) is a shepherd duologue set to a popular tune and is the first example of a rudimentary zarzuela (a Spanish form of musical comedy). (J. Gs.)

FERNÁNDEZ NAVARRETE, JUAN (*c.* 1526–1579), Spanish painter of the Spanish Mannerist school, called EL MUDO (because he was mute), was born in Logroño. He is said by José de Sigüenza (*Historia de la Orden de San Jerónimo*, 1605) to have studied in Italy under Titian and others and to have been summoned back to Spain by Philip II. In 1568 he was appointed painter to the king, who chose him to play a major role in the decoration of the Escorial, near Madrid (1576), though he did not live to fulfill it; of the 32 altarpieces commissioned for the church only 8 were completed at the time of his death in Toledo on March 28, 1579.

El Mudo's eclectic style was based on that of the Italian Mannerists working in the Escorial; and he was strongly influenced by Titian, though there is no evidence that he was his pupil. In the "Burial of St. Lawrence" (Escorial), unfinished at his death, naturalism and chiaroscuro foreshadow later developments of the Spanish school. (E. Hs.; X.)

FERNANDO DE NORONHA, a Brazilian island in the South Atlantic ocean located about 225 mi. N.E. of Cape São Roque. The main island has an area of 10 sq.mi. and is 11 mi. long by 4 mi. wide. A neighbouring island has an area of 3½ sq.mi., and there are several rocky islets. The islands are of volcanic origin and have steep, unprotected shore lines. The highest peak on the main island rises 1,089 ft. above sea level. The temperatures are always mild because of the island's latitude 3° 49′ S. of the equator and its exposure to the full sweep of the southeast trade winds. The temperature ranges from an average of 26° C. (78.8° F.) in March to 24° C. (75.2° F.) in August. The rainy season is from February to June. During the long dry season there is often a serious shortage of water, although the average annual rainfall is 42.6 in. The population, 1,389 in 1960, fluctuates considerably because most of the inhabitants are in the military garrison. In the 18th century it was a penal colony, and some prisoners are still sent to the island.

The island was given to Fernando de Noronha, its discoverer, in 1504. Later it became a dependency of Pernambuco. In the 17th and 18th centuries it was attacked several times by naval powers, but the Portuguese successfully defended it. In 1942 the island was made a federal territory. Of little importance economically, its main products are salt and guano. However, Fernando de Noronha has considerable strategic importance because of its position off the bulge of Brazil. The island lies in the 5,500-mi. rocket-firing corridor between Cape Canaveral, Fla., and Ascension Island. An agreement was concluded on Jan. 21, 1957, between the U.S. and Brazil whereby a guided-missile tracking station was established under a five-year concession. (P. E. J.)

FERNANDO PÓ (FERNANDO PÓO), a Spanish island in the Gulf of Guinea lying about 20 mi. off the Cameroon coast of west Africa. It is 785 sq.mi. in area, volcanic and precipitous, but more fertile than most of west Africa. Pop. (1960) 62,612. With the island of Annobón it constitutes an African province of Spain. *See* SPANISH GUINEA. (R. J. H. C.)

FERNDALE, a city of Oakland county, in southeastern Michigan, U.S., is one of Detroit's northern suburbs, about 2 mi. N. of Highland Park (*q.v.*). The Eight Mile road forms its southern boundary and the Ten Mile road its northern. Ferndale became a village in 1918. The increase in Ford car production along with the war industries of World War I brought many people to the area. The open farm lands in the north Woodward area provided homesites for these workers. It was incorporated as a village in 1919 and during the 1920s the area built up rapidly. In 1927 Ferndale was incorporated as a city. A council-manager form of government has been in effect since 1924. Ferndale is both residential and industrial. For comparative population figures *see* table in MICHIGAN: *Population.* (F. E. Le.)

FERONIA, a goddess whose worship was diffused in antiquity throughout central Italy. Her shrine and sacred grove at the foot of Mt. Soracte near Capena were especially famous. Her cult was established in Rome before 217 B.C. when offerings were made at her temple in the Campus Martius. Feronia may have been originally a deity of fresh-water springs. The name suggests Etruscan provenance, but even in antiquity her functions were obscure. Slaves were given their freedom at her temple near Terracina.

See G. Wissowa, *Religion und Kultus der Römer*, 2nd ed., pp. 285 ff. (1912). (D. E. W. W.)

FEROZEPUR (FEROZEPORE), a town and district of the Jullundur division of Punjab, India. The town lies 5 mi. from the left bank of the Sutlej, which there forms the frontier between India and Pakistan, and about 230 mi. N.W. of Delhi, with which it has rail and road connections; it is likewise linked with Amritsar, Jullundur and Ludhiana. Pop. (1961) 47,060. Ferozepur is a walled town girdled by a circular road. The main streets are wide and metaled. There are two colleges and one teachers' training college affiliated to the Punjab university, also a hospital and school run by the U.S. Presbyterian mission. The cantonment, 2 mi. S., is well laid out with open parks. The offices of the district administration and of the divisional superintendent of Northern railways are situated in the cantonment area which also has an airfield. Ferozepur has a large grain and cotton market, and there are cotton ginning and pressing factories.

The town and some surrounding territory first came under British rule in 1835 and in 1839 Capt. (afterward Sir) Henry Lawrence became political officer there. It became an outpost of British India toward the Sikh power, and played an important part in the first Sikh War.

FEROZEPUR DISTRICT (area 3,882 sq.mi.; pop. [1961] 1,619,116) forms part of a level alluvial plain, with a meagre rainfall, and is dependent on canal irrigation. Agriculture is the main occupation and wheat, cotton, gram, millets and oilseeds are the major crops. Other important towns are Moga (pop. [1961] 47,779), Fazilka (32,015) and Muktsar (30,765). (O. P. B.)

FERRABOSCO, the name of a family of Italian, later English, musicians of the 16th and 17th centuries. Domenico Maria (1513–74), singer and composer; *maestro di capella* of S. Petronio at Bologna. A book of his four-part madrigals was published in Venice in 1542; several other madrigals appear in collections of the time. He also composed a number of motets. Alfonso I (1543–88), composer of madrigals, motets and music for the lute. Born at Bologna, he was the eldest son of Domenico. By 1562 he had settled in England. He traveled abroad on several occasions, acting as a spy for the English government, and was granted a life pension by Elizabeth I, but in 1578 he returned to Italy for the last time and entered the service of the duke of Savoy. Two sets of his madrigals were printed in 1587 and several other madrigals were included in English collections. Two fine pieces for the lute were printed in Robert Dowland's *Varietie of Lute Lessons* (1610). Alfonso II (*c.* 1575–1628), composer, violist and lutenist. Born at Greenwich, he was the illegitimate son of the preceding and was left behind in England when his father returned to Italy. Educated in music at the queen's expense, he remained in royal service until his death. He collaborated with Ben Jonson and Inigo Jones in the extravagant masques produced at the court of James I. His pavans and fantasies for viols are among the finest of their kind. His *Lessons for 1, 2 and 3 Viols* and his *Ayres* for voice and lute were published in 1609. Solo lute music marked "Alfonso" in English manuscript sources may be by either Alfonso I or Alfonso II. Alfonso III (*c.* 1620– before 1660), violist and wind player, son of the preceding, was employed at court during most of his life. Henry (*c.* 1623–*c.* 1658), brother of the preceding, was court musician until 1645. John (1626–82), organist, wind player and composer, another son of Alfonso II, was court musician until 1662 when he was appointed organist at Ely. Elizabeth (1640– ?), singer, was a daughter of Henry. A Mrs. Ferrabosco "who sings most admirably" is mentioned by Samuel Pepys in his diary. (D. Po.)

FERRAR, NICHOLAS (1592–1637), English founder and director of a unique experiment in Christian family living, was born on Feb. 22, 1592, in London. He gained a fellowship at Clare hall, Cambridge, in 1611, and from 1613 to 1618 he was abroad, pursuing medical studies at Padua and elsewhere. On his return to England he joined the council of the Virginia company and became deputy treasurer in 1622. Two years later he entered parliament. At this point, with a great and distinguished career in public life before him, he turned aside to what he knew to be his real vocation. He was ordained deacon in 1626 by William Laud; and then, with his mother, his married brother John and sister Susanna and their respective families, he retired to the remote manor house of Little Gidding in Huntingdonshire, proposing to devote his life wholly to the service of God. The household consisted of about 30 persons. They gave themselves to many charitable works in the locality and set up a school for their own and the neighbouring children. They carried out much fine work in needlework, embroidery and bookbinding. Three times a day—for matins at 6, for the singing of the litany at 10 and for evensong at 4—the family worshiped together in the little church which stood close to the house. They observed, on a voluntary basis, a night watch when psalms were sung or recited. Regular times were set apart for the study of the scriptures. All was under the direction and inspiration of Nicholas, who also planned the compiling of the series of scriptural harmonies which made Little Gidding famous. Many friends and visitors came to share in the family's life of devotion; Charles I visited Little Gidding on three occasions. Nicholas Ferrar died on Dec. 4, 1637, but his family continued to observe the "rule of Little Gidding" for 20 years after his death.

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FERRAR, ROBERT (d. 1555), English Protestant martyr, bishop of St. David's (1548–54), came of a Yorkshire family and was educated at both Cambridge and Oxford before becoming a canon regular of St. Augustine. He was a chaplain to Protector Somerset, who nominated him bishop of St. David's. After Somerset's fall he was tried (1551) on 156 charges brought by enemies in his diocese. He was kept in prison and was condemned under Mary I for denial of Roman Catholic doctrine on the Eucharist. He had been deprived in March 1554 and was burned at the stake at Carmarthen on March 30, 1555.

FERRARA, a city and archiepiscopal see of Emilia, Italy, and the capital of the province of Ferrara in Emilia-Romagna, is 48 km. (30 mi.) N.N.E. of Bologna, and lies 30 ft. above sea level on the Po di Volano, a branch channel of the Po. Pop. (1957 est.) 144,801 (commune). The layout of the town, in which brick is widely used, with terra-cotta details, has an impressive circuit of walls, broad streets and many fine palaces, and is still essentially that established in 1492 by Biagio Rossetti for Duke Ercole I.

In the centre of the town stands the massive castle of the house of Este begun by Bartolino Ploti in 1385 and completed in 1472. The cathedral of S. Giorgio nearby was consecrated in 1135. A verse inscription in mosaic, now destroyed, which recorded it as the work of Guglielmo (Adelardi) and the sculptor Nicolò, is generally regarded as the earliest recorded document of literary Italian. The façade combines elements of the original building with an elaborate gothicizing superstructure dating from the end of the 13th century. The original north flank is intact. The loggia against the south flank was added in 1472 to serve the market which is still held in the adjoining piazza. The campanile is a Renaissance addition. The interior was entirely remodeled in 1712–18. Little else has survived of the medieval city. The Palazzo Comunale and the Palazzo della Ragione are both heavily restored, and the university founded in 1391 is housed in a 17th-century building, in the library of which is a valuable collection of manuscripts, including part of *Orlando Furioso* by Ariosto and letters and poems by Tasso (*qq.v.*). The principal artistic treasure of Ferrara is the magnificent series of palaces of the later 15th and 16th centuries. These include the Palazzo dei Diamanti (begun in 1493), now the municipal picture gallery, the Palazzo di Schifanoia (1391–1471) with its splendid Hall of the Months, frescoed by Francesco Cossa and others; the Casa Romei with its two elegant courtyards; the Palazzo di Ludovico il Moro, now the museum housing the finds from Spina (*q.v.*); and numerous lesser buildings, a complex of unique Renaissance domestic architecture. Of the churches, S. Francesco, S. Benedetto, Sta. Maria in Vado and the Certosa (S. Cristoforo) are all handsome Renaissance buildings. Other buildings of historic interest are the house of Ariosto, where he died in 1572; and that built for himself by the most distinguished of the Ferrarese architects, Biagio Rossetti.

Ferrara lies on the main line from Bologna to Padua and Venice, with branches to Ravenna and Comacchio. It is the centre of a flourishing agricultural area (fruit, particularly apples), much of it reclaimed marshland. The period following World War II saw a great expansion of industrial activity and the creation of an industrial zone 6 sq.mi. in extent between Ferrara and the road and railway bridge at Pontelagoscuro (3 mi. N.). The principal products are plastics, chemical fertilizers, methane, sugar and alcohol.

There is no record of Ferrara earlier than A.D. 753, when it was captured from the exarchate of Ravenna by the Lombards. From them it passed in 774 to the papacy, under which it enjoyed an independent government by the 10th century. Occupied successively by Tedaldo of Canossa, nephew of Otho I (988), by the countess Matilda (1101) and by Frederick I Barbarossa (1158), its internal history in the 12th century is largely that of the struggle between the rival families of the Adelardi and the Salinguerra. After the death of Guglielmo III Adelardi in 1184, his rights passed through his niece and heiress Marchesella to the house of Este, which after many vicissitudes established its undisputed rule over the city in 1240. For the story of Ferrara and of the Estensi until, on the death of Alfonso II, Pope Clement VIII claimed the city as a vacant fief in 1598, *see* Este, House of. After 1598 there followed two centuries of commercial decline and political obscurity. The seat of an Austrian garrison from 1832, Ferrara became part of the kingdom of Italy in 1860.

Ferrara Province (area 1,016 sq.mi.; pop. [1961] 399,805)

comprises a low coastal plain, largely the Po delta. The area is mainly agricultural and there has been considerable land reclamation, especially around Codigoro which has a large pumping works connected with an extensive canal-drainage system.

(J. B. W.-P.)

FERRARA-FLORENCE, COUNCIL OF (1438–*c.* 1445), counted by the Roman Catholic Church as the 17th ecumenical council, was a meeting of the Latin and Greek churches to try by free discussion to reach agreement on their doctrinal differences and so end the schism between them. It ended in an agreed decree of union, but the reunion was short-lived. Ferrara-Florence was not a new council but the continuation of the Council of Basel (*see* COUNCIL), which Pope Eugenius IV transferred, to open in Ferrara on Jan. 8, 1438. The Greeks—including the patriarch Joseph II and 20 bishops (some also as procurators of Alexandria, Antioch and Jerusalem), the emperor John VIII Palaeologus, his brother Demetrius and court—numbered about 700 persons. They arrived in Ferrara on March 4–7. Their voyage, maintenance and return were at the expense of the pope.

The council was solemnly inaugurated on April 9, 1438, the emperor stipulating for a four months' delay to await representatives of the western princes, only two of whom responded. Discussions on purgatory, one of the points at issue, were held between committees of ten, without agreement resulting, from June 4 till mid-July. From Oct. 8 till Dec. 13, 13 public sessions treated of the addition by the Latins of the Filioque clause to the Nicene Creed (*see* CREED), the chief source of disagreement. The Greeks claimed that the Council of Ephesus (431) forbade change in that creed of any word or syllable, both to local churches and to the universal church, for all time. The Latins interpreted the prohibition to mean change only of the Nicene faith, not of its mere expression. No agreement resulted.

Because of plague (which had attacked Ferrara in July), danger from Milanese troops and lack of money to pay the Greeks, the council was transferred to Florence on Jan. 10, 1439. There, after a preliminary session on Feb. 26, in eight sessions and without final agreement, the Greeks upheld the doctrine that the Spirit proceeds from the Father only, the Latins that the Spirit proceeds from both Father and Son though as from one principle. The Greeks refused further public discussions. From March 24 till May 27 other expedients were unsuccessfully tried. In an atmosphere of general despair Eugenius addressed the Greeks (May 27). The Greek unionists renewed their efforts, arguing that all saints, as inspired by the one Spirit, cannot err in faith; so, though Latin and Greek saints express themselves differently, they must believe the same. Therefore, the faiths of the Latin and Greek churches are substantially the same. Finally all but four of the Greek prelates freely accepted the Latin statement on the procession of the Spirit (June 8).

The patriarch died on June 10. In the following weeks the Latins presented statements on the Eucharist and papal primacy (which were explained also in two public sessions), on purgatory and the addition of the Filioque clause to the creed, which, with some modification, were eventually accepted by the Greeks. The decree of union, composed of those statements after an introduction, was signed by the Latins and all but two of the Greek prelates on July 5, and promulgated as an infallible pronouncement in the bull *Laetentur coeli* the next day. The Greeks then departed. Unions with the Armenians (Nov. 22, 1439), with the Copts of Egypt (Feb. 4, 1442), with certain Syrians (Sept. 30, 1444) and with Chaldeans and Maronites of Cyprus (Aug. 7, 1445) followed. No extant document records the closing of the council in Rome, where it had moved in Sept. 1443.

The significance of the Council of Ferrara-Florence lies in its definition of doctrine, in the principle it established for church union—unity of faith with equality of rite—followed in subsequent unions, in its defeat of the Latin conciliar movement—since the definition of the primacy in *Laetentur coeli*, made possible by the union with the Greeks, justified Pope Eugenius against the Council of Basel—and in its leaving the problem of church reform unsolved. The union was repudiated by most of the Greeks on their return to Constantinople. The Armenian union lasted till 1475. For the others exact information is lacking.

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FERRARI, GAUDENZIO (1470/80–1546), Italian artist of the Lombard school and a painter of frescoes and altarpieces, was born at Valduggia in Piedmont. He was stated to be *annorum circa 75* when he died in Milan on Jan. 31, 1546, but he probably was born between 1475 and 1480. His earliest dated work is of 1507. The painter and writer G. P. Lomazzo, who was a pupil of one of Gaudenzio's pupils, says that he studied first under the obscure Stefano Scotto and then under Bernardino Luini; the latter's influence is visible in Gaudenzio's works, as is also that of the Milanese B. Suardi, called Bramantino. On the whole, however, Gaudenzio seems to belong to the older Lombard school, relatively little influenced by Leonardo da Vinci. He is perhaps not ranked as highly as he might be, largely because his major works are in remote churches, but Lomazzo placed him seventh among the painters of Italy.

His earliest works were done at Varallo (near the Swiss border), where he painted the frescoes in the chapel of S. Margherita in S. Maria delle Grazie in 1507, as well as an altarpiece (probably now in Turin, Galleria Sabauda) which was contracted for in 1508, and some frescoes in 1513. His major work, however, was the decoration of some of the chapels on the Sacro Monte at Varallo, a task that occupied many years. In this work he made an ambitious attempt to secure extreme realism by setting coloured terra-cotta figures against a frescoed background, but it is arguable that this waxworks effect defeats its own ends.

In 1510 and 1511 he painted an altarpiece for S. Maria at Arona; in 1514 he worked on the S. Gaudenzio altar at Novara, which established his fame and secured further commissions in the region. From 1529 to 1535 he is documented as living and working at Vercelli, but between 1534 and 1536 he painted the "Angelic Choir" in the dome of S. Maria dei Miracoli at Saronno. In 1539 he moved to Milan, where he spent the rest of his life and where he painted several frescoes in churches. There are other works by him in European galleries and in Sarasota, Fla.

See G. P. Lomazzo, *Trattato dell'Arte* (1584), *Idea del Tempio* (1590); E. Halsey, *Gaudenzio Ferrari* (1904) and the catalogue of the Vercelli exhibition, *Mostra di Gaudenzio Ferrari* (1956) with full bibliography. (P. J. MY.)

FERRARI, GIUSEPPE (1811–1876), Italian historian and political thinker whose philosophy of history was linked with his interpretation of contemporary events in Italy, was born in Milan on March 7, 1811. After studying law at Pavia, and publishing an edition of G. B. Vico's *Opere*, six volumes (1835–37), he went to France in 1838. There his *Vico et l'Italie* (1839) and other early works earned him several academic appointments in the 1840s, but clerical opposition to his views eventually caused him to resign and to live as a writer. His *Essai sur le principe et les limites de la philosophie de l'histoire* (1843) and his *Filosofia della rivoluzione*, two volumes (1851) prepared the way for his *Histoire des révolutions d'Italie, ou Guelfes et Gibelins*, four volumes (1858; Italian edition, *Storia delle rivoluzioni*, three volumes, 1870–72) and for his *Histoire de la raison d'état* (1860; Italian edition, *Corso sugli scrittori politici italiani*, 1862), in which he gave the reasons for his belief in the historical necessity of the Risorgimento. He also published several short commentaries on current affairs. As he both recognized the need for French intervention in Italy and desired an Italian federal republic instead of a unitary kingdom, he was at variance with the leading statesmen and politicians of his time. He returned to Italy in 1859. Elected deputy for Luino, he sat with the left. Subsequently he taught at Milan and other universities and published *La Chine et l'Europe: leur histoire et leurs traditions comparées* (1867), *Teoria dei periodi politici* (1874) and *L'Aritmetica della storia* (1875). Ap-

pointed senator in May, Ferrari died in Rome on July 2, 1876.

See *Le più belle pagine di Giuseppe Ferrari*, ed. by P. Schinetti (1927).

FERRARI, LODOVICO (1522–1565), Italian mathematician, is chiefly known for his solution of the biquadratic equation (an equation which contains the fourth power of the unknown quantity but no higher power). He was born in Bologna, Feb. 2, 1522. As a lad of 15 he came into the service of Girolamo Cardano (*q.v.*) in Milan, and most of the information about him can be found in Cardano's writings. He reputedly had a fiendish temper; when 17 he lost most of the fingers on the left hand in a brawl. Cardano taught him Latin, Greek and mathematics. In 1540 he became Cardano's successor as public mathematics lecturer in Milan after defeating Zuan da Coi, Brescian mathematician. At this time he found the solution of the quartic equation, later published in Cardano's *Ars Magna*. He invented a mechanism for transforming circular into rectilinear motion, and considered geometric constructions with a fixed compass opening. The publication of the *Ars Magna* brought Ferrari into a celebrated scientific controversy with Niccolò Tartaglia in regard to the solution of the cubic equation. After six printed cartels and countercartels Ferrari was declared the winner in a public dispute in Milan on Aug. 10, 1548. Subsequently Ferrari was deluged with offers—from Rome, Venice, from Charles de Brissac, the French commander in chief, and even from the emperor Charles V to be tutor for his son. He accepted an offer from Ercole Cardinal Gonzaga, regent of Mantua, to become supervisor of tax assessments, a position which in a short time made him a wealthy man. Later, ill-health and a quarrel with the cardinal made him take a professorship in mathematics at the University of Bologna. He died shortly afterward, in Oct. 1565; Cardano suspected that Ferrari had been poisoned for the sake of his money by his sister Magdalena and her lover.

See E. Giordani, *I sei cartelli di matematica disfida di Lodovico Ferrari* (1876); O. Ore, *Cardano, the Gambling Scholar* (1953).

(O. Oe.)

FERRÉ, CHARLES THÉOPHILE (1845–1871), French revolutionary socialist, one of the leaders of the Commune of Paris (*q.v.*), was born in Paris and began his career as a business accountant. Becoming a follower of Auguste Blanqui (*q.v.*), he took part in every political demonstration during the last years of the second empire and was imprisoned at Ste. Pélagie in 1869. During the German siege of Paris in 1870–71 he organized the committee of vigilance of the 18th *arrondissement*, by which he was elected to the Commune on March 26, 1871. Elected to the committee of general security, he became assistant public prosecutor and on April 4 was appointed delegate in charge of general security. Between April 14 and May 24, however, he performed the duties of prefect of police and became known for his icy terrorism. He had a passionate admiration for the French Revolution, "the real revolution" of Hébert, Marat and Chaumette. When the troops from Versailles broke into Paris and shot Communard prisoners, Ferré ordered the execution of hostages, including Archbishop Georges Darboy. After the fall of the Commune, he went into hiding in Paris but was discovered and brought before a court-martial at Versailles. He refused to defend himself but vigorously denied the authenticity of part of the evidence produced against him. He was shot at Satory on Nov. 28, 1871.

FERREIRA, ANTÓNIO (1528–1569), Portuguese poet, the principal advocate and theorizer of the classical school of poetry in Portugal, was born in Lisbon in 1528. He studied at the University of Coimbra at a time when humanistic culture was enjoying its brief flowering on Portuguese soil. He later followed a legal career and rose to be a judge of the supreme court in Lisbon where he died in 1569.

Ferreira, a disciple of Sá de Miranda (*q.v.*), who had introduced the Renaissance style of poetry into Portugal, did more than anyone to foster the new school, both by exhortation and example. He deprecated the literary use of Spanish (a common practice) by Portuguese writers, as well as the use of the traditional metres of the Iberian peninsula. His more lyrical compositions are without distinction but he handles the hendecasyllable with greater fluency than Miranda. In his verse epistles, inspired by the moral and aesthetic tenets of humanism, he reveals his integrity as critic of a society in which moral and intellectual standards were waning.

Ferreira also tried his hand at drama in a classical style. Apart from two comedies, *Bristo* and *Cioso*, he left a fine tragedy, *Castro* (written *c.* 1558; published in 1587), which is one of the first in modern European literature. The historical subject of this impressive work concerns the liaison between Prince Pedro (later Pedro I of Portugal) and Ines de Castro, a Spanish lady whose murder is instigated as a matter of political expediency.

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(T. P. W.)

FERRERS, the name of an Anglo-Norman feudal family, derived from Ferrières-St.-Hilaire in Normandy. HENRY DE FERRERS (d. 1089?) took part in the Conquest and by the time of the Domesday survey held 210 lordships, mainly in Derbyshire; his chief seat was at Tutbury castle in Staffordshire, where he founded a Benedictine priory. His eldest son inherited his Norman lands and was ancestor of the Ferrers of Lechlade and Oakham. The honour of Derby passed to ROBERT (d. 1139), Henry's third son, who, for his services at the battle of the Standard, was created earl of Derby by Stephen (1138). ROBERT (d. *c.* 1160), the 2nd earl, founded the abbeys of Merevale in Warwickshire and of Darley in Derbyshire. WILLIAM (d. 1190), the 3rd earl, burned Nottingham, which was held for Henry II in the revolt of 1173–74. He died at the siege of Acre. The marriage of his son, WILLIAM (d. 1247), the 4th earl, to Agnes, sister and coheiress of Earl Ranulf of Chester, afterward brought him the castle and manor of Chartley, Staffordshire, and lands in Lancashire. He helped to secure the succession (1216) of the young Henry III and joined in the battle of Lincoln (1217). The career of his grandson, the violent and intransigent ROBERT (d. 1279), 6th and last earl, brought disaster to the family fortunes. Although married (1249) to Mary of Lusignan, niece of Henry III, he rebelled against the king at Chesterfield (May 1266). He was imprisoned and was deprived of the honour of Derby and most of his lands. These passed (July 1266) to the king's son, Edmund of Lancaster, whose successors used the title of earl of Derby.

Robert's eldest son, JOHN FERRERS (d. 1312), was summoned as baron in 1299, and became the ancestor of the Lords Ferrers of Chartley. ROBERT (d. 1350), 2nd lord, fought at Crécy and the siege of Calais (1346–47); his son, JOHN, was slain at the battle of Nájera in 1367, and EDMUND (d. 1435), 4th lord, was present at the siege of Harfleur and the battle of Agincourt (1415) and on Henry V's later campaigns. On the death (1450) of his son, WILLIAM, the barony passed with his daughter Anne to the Devereux family, later (1572) earls of Essex, who held it until 1646. It then passed by marriage to the Shirleys, Robert Shirley being summoned as Lord Ferrers in 1677 and created Earl Ferrers in 1711. The barony has been in abeyance since 1855. Robert (d. *c.* 1381), a younger son of Robert the 2nd lord of Chartley, married Elizabeth le Botiller (d. 1411), heiress of Wem, in Shropshire, and was summoned as baron in her right; but the line ended with their son, Robert (d. *c.* 1396).

The family of Ferrers of Groby was founded by a younger brother of the last earl of Derby, WILLIAM (d. 1287), who inherited from his mother, Margaret de Quincy, her estate of Groby in Leicestershire. His son, WILLIAM (d. 1325), was summoned to parliament (1299), becoming the first Lord Ferrers of Groby. WILLIAM (d. 1371), 3rd lord, fought at the battle of Poitiers (1356) and in other French campaigns. On the death (1445) of WILLIAM, 5th lord, the barony passed with his granddaughter Elizabeth to the Grey family, and was forfeited with their dukedom of Suffolk in 1554. William's younger son, THOMAS (d. 1459), married the heiress of Tamworth castle, and his line was seated there until 1680, when an heiress carried it to a younger son of the first Earl Ferrers. The Ferrers of Baddesley Clinton, Warwickshire, seated there until the late 19th century, descended from Sir HENRY, a younger son of Thomas Ferrers of Tamworth. Higham Ferrers, Northamptonshire, and Woodham Ferrers, Essex,

take their names from this family.

See H. Norris, *Baddesley Clinton, With Account of the Family of Ferrers* (1897). (C. D. R.)

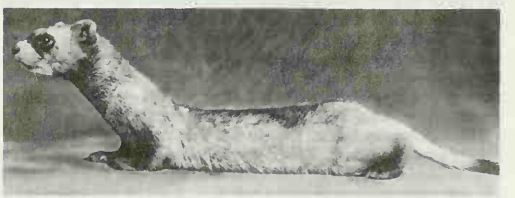
FERRERS, LAURENCE SHIRLEY, 4TH EARL (1720–1760), the last nobleman in England to suffer a felon's death, was born on Aug. 18, 1720, and succeeded to his uncle's earldom in 1745. In 1758 his wife obtained a separation from him for cruelty and the Ferrers estates were vested in trustees, an old family steward, John Johnson, being appointed receiver of rents. Ferrers tried in vain to persuade Johnson to break his trust, and also to give up the lease of a farm granted to him by the trustees. On Jan. 18, 1760, the earl summoned Johnson to his house at Staunton Harold, Leicestershire, and during the interview shot him. Ferrers was tried for murder by his peers in Westminster hall. He pleaded insanity but was found guilty. On May 5, 1760, dressed in his wedding suit of white embroidered with silver, he was driven in his own landau from the Tower of London to Tyburn and there hanged. It has been said that as a concession to his rank, the rope used was of silk.

See Peter Burke, *Celebrated Trials Connected with the Aristocracy in the Relations of Private Life* (1849). (G. H. J.)

FERRET, a domesticated breed (*Mustela furo*) of the wild polecat (*q.v.; M. putorius*), which it resembles in size, form and habits, and with which it interbreeds. It differs in the colour of its fur, which is usually yellowish-white, and of its eyes, which are pinky-red. The "polecat-ferret" is a brown breed, apparently the product of the above-mentioned cross. The common ferret attains a length of about 14 in., exclusive of the tail, which measures 5 in. It is little known in America; but ferreting, the employment of the animal in destroying rats and other vermin and in driving rabbits from their burrows, has been practised for several centuries in Europe, and even earlier in Asia. The Romans were familiar with the sport; Pliny states that the animal was used in his time in rabbit hunting.

The ferret is remarkably prolific; the female, or gill, brings forth two broods annually, each numbering from six to nine naked and sightless kittens. Both the female and the male, or hob, have become so dependent upon man that they cannot survive without his care and if lost often die within a few days.

The animal should be kept in dry, clean, well-ventilated hutches, and fed twice daily on bread, milk, and meat, such as rabbits' and fowls' livers. When used to hunt rabbits the ferret is provided with a muzzle or with a cope, made by looping and knotting twine about the head and snout, in order to prevent it killing its quarry.



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BLACK-FOOTED FERRET (MUSTELA NIGRIPES)

As the ferret enters the hole, the rabbits flee before it and are shot as they break ground. A ferret's hold on its quarry is as obstinate as that of a bulldog, but it can easily be broken by pressure of the thumb just above the eyes. Only full-grown ferrets are "worked to" rats.

The wild black-footed ferret (*M. nigripes*) of the western Great Plains of the U.S. resembles the common ferret in size and general body colouring but has a black mask across the eyes and brownish-black markings on the feet and tail tip. Since the prairie dog (*q.v.*), its main source of food, has almost disappeared, the black-footed ferret likewise faces extinction.

FERRI, CIRO (1634–1689), Roman painter, the chief disciple and successor of the painter and architect Pietro da Cortona, was born in Rome. When he was a little past 30 he completed the painting of the ceilings and other internal decorations begun by his instructor in the Pitti palace, Florence. He also co-operated in or finished several other works by Pietro, both in Florence and in Rome. Of his own independent productions the chief is an extensive series of scriptural frescoes in the church of Sta. Maria Maggiore in Bergamo; also a painting (rated as Ferri's best work) of St. Ambrose healing an invalid, the principal altarpiece in the church of S. Ambrogio in Rome. He executed a large number of etchings and frontispieces for books. Ferri was appointed to direct the Florentine students in Rome, where Antonio Gabbiani was one of his leading pupils. He died in Rome on Sept. 13, 1689.

FERRIER, JAMES FREDERICK (1808–1864), Scottish metaphysician distinguished for his agnoiology or theory of ignorance, was born in Edinburgh on June 16, 1808. Educated at Edinburgh and Oxford, he qualified as a barrister in 1832, but came under the influence of Sir William Hamilton (who may have inspired his visit to Heidelberg in 1834 to study German idealist philosophy) and was appointed professor of civil history at Edinburgh (1842) and then of moral philosophy and political economy at St. Andrews (1845). He died at St. Andrews on June 11, 1864.

Ferrier's publications include a number of articles in *Blackwood's Magazine* (from 1838 onward), mainly on metaphysics though one dealt with "Some Plagiarisms of S. T. Coleridge" (1840); *Institutes of Metaphysic, the Theory of Knowing and Being* (1854), his major work; an edition of the works of John Wilson ("Christopher North"), his uncle and father-in-law, 12 vol. (1855–58); and *Scottish Philosophy, the Old and the New* (1856), in which he defended his *Institutes* and denounced the "philosophy of common-sense" that Hamilton had tried to combine with Kantianism. His *Lectures on Greek Philosophy and Other Philosophical Remains*, 2 vol. (1866), and *Philosophical Works*, 3 vol. (1875), appeared posthumously.

Ferrier's Hegelian epistemology (a word that he introduced into English) and ontology are based on the concept of the unity of the act of knowledge, which combines the knowing subject and the object known. The mind cannot apprehend anything except in conjunction with an apprehension of itself, and the distinction of subject and object is a source of error. Only minds in synthesis with what they know can be said to exist, and it is nonsense to speak of the mind's "ignorance" of what is allegedly unknowable (as the Kantian "thing-in-itself" was said to be), since ignorance must refer to what is still knowable though not actually known.

See E. S. Haldane, *James Frederick Ferrier* (1899).

FERRIER, KATHLEEN (1912–1953), English contralto and the most widely loved British singer of her day, was born at Higher Walton, Lancashire, on April 22, 1912, and educated at Blackburn. After leaving school she became a telephone operator, with no thought of a musical career though she had won a national piano competition at the age of 15. In 1940, dared by a friend, she entered and won a local singing competition, and thereafter studied with J. E. Hutchinson and gave recitals for war workers, often arranging the songs herself. In 1943 she began to study with Roy Henderson in London and quickly emerged as an oratorio singer of first rank. In 1946 she made her operatic debut when Benjamin Britten asked her to sing the name part in his *The Rape of Lucretia* at Glyndebourne. The following year at Glyndebourne she sang Orpheus in Gluck's opera, a part closely identified with her; and at the first Edinburgh festival, 1947, a performance of *Das Lied von der Erde* under Bruno Walter, repeated in the United States the following year, led her to specialize in Mahler's music with international success, and to give lieder recitals with Walter. Her association with Britten continued with the *Spring Symphony* and the canticle *Abraham and Isaac*, both of whose contralto parts were written for her, as was Sir Arthur Bliss's scena *The Enchantress*. It was the purity and spiritual fervour of her singing as much as the velvet quality and emotional power of her voice that everywhere endeared her to her public. Her career was cut short in its prime by cancer and she died in London on Oct. 8, 1953.

See W. Ferrier, *Kathleen Ferrier* with *A Memoir*, ed. by N. Cardus (1959). (WI. S. M.)

FERRIER, SUSAN EDMONSTONE (1782–1854), novelist of Scottish society, was born in Edinburgh Sept. 7, 1782, the

daughter of James Ferrier, principal clerk of sessions and colleague of Sir Walter Scott. From early life she was in touch with Edinburgh intellectual circles. She paid three visits to Scott, who greatly admired her writing and in his *Tales of My Landlord*, called her his sister shadow. She died in Edinburgh on Nov. 5, 1854.

She wrote three novels anonymously. *Marriage* (1818), which had an interpolation and criticism from a Miss Clavering, is a little marred by faulty construction. In *The Inheritance* (1824), probably her best work, Gertrude St. Clair, heiress presumptive to the earl of Rossville's estates, is courted by her two cousins, the profligate Colonel Delmour and the sincere Edward Lindsay. The fascinating Delmour gains favour until Gertrude loses her hopes of wealth, and Edward shows his real worth. She also wrote *Destiny, or the Chief's Daughter* (1831).

Susan Ferrier's work is distinguished by its vigour and sardonic wit. She made an incisive exposé of the pretensions of the Scottish society of her day. Many of her characters are memorable, notably Lady MacLaughlan (*Marriage*) and Uncle Adam and Miss Pratt (*The Inheritance*).

See *Memoir and Correspondence of Susan Ferrier,* ed. by J. A. Doyle (1898). (W. L. G. Ja.)

FERRO (Hierro), the westernmost island of the Spanish archipelago of the Canary Islands. Pop. (1960) 7,957; area 107 sq.mi. The smallest of the main islands of the group, Ferro extends about 18 mi. by 15 mi. and has a cliffed coast of 59 mi. and a summit height of 4,924 ft. Fresh water is scarce but a mineral spring attracts visitors. The once celebrated and almost sacred tree, probably a til tree (*Ocotea foetens*), that dripped abundant water from its leaves was blown down in 1610 and in 1957 a new sapling was planted. Ferro lacks a harbour and landings from the interinsular steamer are made by small boat at a short mole. Valverde, the main town (pop. [1960 municipal] 4,601), lies 6 mi. inland. Formerly some meridian systems were based on Ferro (about 18° W.), long the most westerly land known to Europeans. (R. P. Be.)

FERROCONCRETE: *see* Concrete: *Structural Concrete.*

FERROL, EL (known after 1939 as El Ferrol Del Caudillo, as it was the birthplace of Gen. Francisco Franco, ["El Caudillo"], Dec. 4, 1892), a city of northwestern Spain in La Coruña province, is situated on Ferrol bay (Ría de El Ferrol) 41 mi. N.E. of La Coruña city by rail (about 12 mi. by sea). Pop. (1960 municipal) 74,799. One of the principal Spanish naval stations, El Ferrol is on a north shore headland of the bay and is concealed from the sea by rocky hills. Its natural harbour is the third largest in Spain. There are shipbuilding yards and a large arsenal basin, with workshops and foundries, a naval academy and two dry docks.

The city is divided into four parts: Old Ferrol, containing the naval headquarters; New Ferrol with the district and municipal headquarters and business centre; Esteiro, with the naval hospital; and El Ensanche, with the municipal stadium and elegant modern buildings. Across a broad inlet, west of the headland, lies the Atlantic submarine base of La Graña. But El Ferrol is not a first-class commercial port because of the competition of La Coruña and because the railway from Betanzos was not built until 1904.

The exports are insignificant, mainly pit props, and imports are coal, cement, timber, iron and machinery, for use in the shipping industries.

El Ferrol was no more than a fishing village in 1726, when Philip V chose it as the site for a naval base; later Ferdinand VI (1746–1759) set up shipbuilding yards there. Charles III developed it as a naval arsenal and erected fortifications between 1769 and 1774. The British tried but failed to capture the port in 1800; they blockaded it from 1803 to 1805.

FERROMAGNETISM is the kind of magnetism associated with iron, cobalt and nickel and some alloys and compounds containing one or more of these elements or manganese. It is characterized by the strong attraction of one magnetized body to another, a phenomenon known to the ancient world.

In contrast to other substances, ferromagnetic materials are magnetized easily, and in strong magnetic fields the magnetization approaches a definite limit called saturation. When a field is applied, and then removed, the magnetization does not return to its original value—this behaviour is referred to as hysteresis (*q.v.*). When heated to a certain temperature called the Curie point, different for each substance, ferromagnetic materials lose their characteristic properties and cease to be ferromagnetic; however, they become ferromagnetic again on cooling.

Ferromagnetic materials are essential parts of the machines of modern civilization; *e.g.*, electric motors and generators, transformers, telephones, loud-speakers and many others. Useful materials consist of two classes: those which are magnetized in weak fields and lose their magnetism easily (high permeability materials) and those requiring rather strong fields for magnetization but retaining their magnetism with tenacity (permanent magnets). *See* Magnetism; *see* also references under "Ferromagnetism" in the Index volume. (R. M. B.)

FERRUCCIO (Ferrucci), **FRANCESCO** (1489–1530), Florentine military captain remembered for his service to his city's republic in its last days, was born in Florence on Aug. 14, 1489. After holding various administrative posts, he joined the mercenary forces of the Bande Nere in 1527. In 1529, when Pope Clement VII and the Holy Roman emperor Charles V declared war on Florence in order to reinstate the Medici, Ferruccio was appointed Florentine military commissioner at Empoli, from which he organized surprise attacks on the emperor's forces. When Volterra, south of Empoli, declared itself for the emperor, Ferruccio recaptured it (April 27, 1530), but during his absence Empoli itself was captured by the emperor's forces. Ferruccio, planning to attack the enemy in the rear from the west, left Volterra for Pisa, but was detained there by illness. When he moved from Pisa with about 4,000 men (July 31), imperial troops under Philibert de Chalon, prince of Orange, were already advancing against him. At Gavinana, near Pistoia, on Aug. 3, 1530, Ferruccio's army was defeated. He himself was captured and killed by Fabrizio Maramaldo.

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FERRY, JULES FRANÇOIS CAMILLE (1832–1893), French republican statesman, notable both for his anticlerical education policy and for his success in extending the French colonial empire, was born at St. Dié (Vosges) on April 5, 1832. Pursuing his father's profession of the law he was called to the Paris bar in 1855, but soon won greater eminence in politics as one of the most biting critics of the second empire, especially by his articles (1867–68) in the *Temps* attacking Baron Haussmann's administration of Paris. In June 1869 he became republican deputy for Paris in the *corps législatif,* where he violently attacked the policies of Émile Ollivier, not the least his drift into war with Germany in 1870. Yet, along with Léon Gambetta, Ferry voted credits for national defense once war broke out.

Under the government of national defense, set up on Sept. 4, 1870, Ferry was entrusted with administration of the *département* of Seine. He held the powers of prefect of Seine and, on Nov. 16, was appointed mayor of Paris. He threw all his energies into the task of administering a besieged and hungry capital, incurring unjustified unpopularity as "Ferry-la-Famine," which haunted the rest of his career. Returning as deputy for Vosges in Feb. 1871, he was maintained in his administrative duties by the government of Adolphe Thiers, but was driven out by the rising of the Commune of Paris and gave up office on June 5, 1871.

In May 1872 Thiers sent Ferry as minister to Greece, whence he returned in 1873. For the next six years he took part in the republican opposition to the conservative governments and to the presidency of MacMahon. In the "republic of the Republicans" of 1879 he took office, for the first time in normal conditions, as minister of public instruction and fine arts.

Thus began a period of six years during which Ferry held office several times and was twice (1880–81 and 1883–85) premier. His achievements lay primarily in two fields: (1) in the establishment of free, compulsory secular education, brought about mainly

by the law of 1882, but accompanied by other anticlerical measures, notably decrees of 1880–81 dissolving the Jesuits and other congregations not authorized under the concordat and forbidding their members to direct or teach in any educational establishment; and (2) in the dramatic extension of France's colonial territories. In this latter field it was largely through the work of Ferry and a few enthusiastic colonialists in the face of popular apathy or hostility that France acquired Tunisia (1881), Tongking (1885) and Madagascar (1885). French explorations in the Congo basin led to formal recognition of the French Congo at the congress of Berlin (1884–85). An outburst of public anger against Ferry's Tongking policy swept him from office in March 1885. "Ferry-le-Tonkinois" was even more hated than "Ferry-la-Famine."

Despite continuing unpopularity, Ferry was elected to the senate by Vosges in 1891 and became its president in 1893. He died of wounds inflicted by a gunman in Paris on March 17, 1893. His *Discours et opinions* were edited by P. Robiquet, seven volumes (1893–98).

See A. N. Rambaud, *Jules Ferry* (1903); M. Reclus, *Jules Ferry* (1947). (D. Tn.)

FERRY, a place where passengers, freight or vehicles are carried by boat across a river, lake, arm of the sea or other body of water. The term applies both to the place where the crossing is made and to the boat used for the purpose. By an extension of the original meaning, ferry also denotes short overwater flights by airplanes carrying passengers or freight, or the flying of planes from one point to another as a means of delivering them.

The term has a long history extending back to Greek mythology. It includes a wide variety of vessels, from the most primitive canoes or rafts to large motor-driven ferries capable of carrying large motor trucks and railway cars across many miles of water. It is frequently used in combination with other words, as in the expressions train ferry, car ferry and channel ferry.

Ferries were of great importance in ancient and medieval history, and their importance continued well into the period of modern history. Before engineers learned to build permanent bridges over large bodies of water or construct tunnels under them, ferries offered the only means of crossing. In the early history of the United States the colonists found that the coasts of the new world were broken by great bays and rivers, and that the interior of the continent was divided by rivers that defied bridging for many generations. Yet crossing these rivers and bays was a necessity. At first, small boats propelled by oars or poles were the most common form of ferry. They were replaced later by large flatboats propelled by a form of long oar called a sweep. Sails were used when conditions were favourable and in some rivers the current itself provided the means of propulsion.

Horses were used on some ferries to walk a treadmill geared to paddle wheels; in others, horses were driven in a circle around a capstan that hauled in ropes and towed the ferry along its route.

The first steam ferryboat in the United States was operated by John Fitch (*q.v.*) on the Delaware river in 1790 but it was not financially successful. The advent of steam power greatly improved ferryboats; they became larger, faster and more reliable, and began to take on a design different from other steamers. At cities divided by a river and where hundreds of people and many horse-drawn wagons had to cross the river daily, the typical U.S. ferryboat took shape. It was a double-ended vessel with side paddle wheels and a rudder and pilothouse on both ends. The pilothouses were on an upper deck, and the lower deck was arranged to hold as many vehicles as possible. A narrow passageway ran along each side of the lower deck with stairways to give passengers access to the upper deck. A narrow casing on the centre line housed the engine space. The engine was of the walking-beam type with the walking beam mounted on a pedestal so high that it was visible above the upper deck.

Terminals to accommodate such ferries were built at each end of their routes. In order to dock promptly and permit wheeled vehicles to move on and off quickly a floating bridge was sometimes provided. This was a platform with one end supported by a pivot on land and the other end supported by floats in the water. Such an arrangement adjusted for changes in the tide, and the bridge was always nearly flush with the deck of the ferry.

As roads improved and the use of automobiles and large motor trucks increased, ferries became larger and faster, but the hull arrangement remained the same. High-speed steam engines with propellers on both ends of the ferry were used. Steam engines gave way to diesel engines and to diesel-electric drive. Several states organized commissions which took over ferries from private ownership and operated them for the public; these commissions frequently also operated bridges, public roads and vehicular tunnels. Increase in the use of motor vehicles so overtaxed many ferries that they could not handle the load. As a result, more bridges and tunnels were built, and ferries began to disappear from U.S. coasts, but their use on some inland rivers and lakes still continues. A modern type of ferry service transports large motor trucks between the United States and islands of the West Indies. Big truck-trailer combinations are driven onto a wharf from which the loaded trailers (disconnected from the truck engines) are hoisted aboard ship and secured for sea travel. Ships large enough to carry more than two hundred 35-ft. trailers are engaged in this trade. On arrival at their destination the trailers are hoisted ashore so they can complete their journey on land.

(M. R. D.)

Channel Ferries.—A special type of cross-channel ferry between England and France was designed to meet the urgent need to supply the British armies in France and Belgium during World War I. A cross-channel barge route was started from Richborough, Kent, to Calais, where the barges continued up the canals to Vendroux, Audruicq, Zeneghem and other points. The 255 steel barges so employed, each carrying about 200 tons of stores, ammunition, etc., were towed across the channel by tugs, of which 67 were available, and provided a reliable service; no barge was ever reported lost on the channel crossing.

However, this method did not suffice for all needs and was from 1917 to 1918 supplemented by three specially built train ferries which sailed from Richborough to Calais and Dunkerque, and from Southampton to Dieppe. Railway vehicles were propelled into the ferry at the stern, the two entry tracks spreading into four tracks on the deck of the vessel itself; the capacity in terms of four-wheeled freight cars was 54 per ferry. Rail-mounted guns and locomotives could be carried on the two centre tracks. About 1,000 locomotives were thus dispatched from Richborough to Audruicq shops, almost ready for instant service.

Nearly all these locomotives were returned to England in 1919 by these same train ferries, together with passenger coaches which had been employed on ambulance trains or leave and demobilization trains in France, Belgium, Germany and Italy. In 1919 the train ferries were adjusted to take motor vehicles instead of freight cars, if required.

After World War I the ferry services were discontinued but, after a few special voyages carrying British-built rolling stock for export to the continent, they were acquired by Great Eastern Train Ferries, Ltd., and placed in service between Harwich and Zeebrugge, where suitable aprons (in effect, hinged lifting bridges) were constructed for loading and unloading purposes. The tidal range at Harwich is only 12½ ft. and therefore the necessity of passing through locks was obviated at that port. This service was inaugurated in April 1924 and required the close co-operation of the London and North Eastern railway. The service acquired traffic in vegetables, cheese, eggs, fruit, machinery, silk and rolling stock.

In conjunction with Great Eastern Train Ferries was the Anglo-Belge Ferry Boat company, which owned many of the freight cars employed on the train ferry service. Later the three former wartime train ferries, operating between Harwich and Zeebrugge, became part of the London and North Eastern railway fleet.

Further train ferry developments across the channel were delayed by the proposal to build a channel tunnel, but that project was turned down by the British government in 1930.

The Harwich-Zeebrugge freight service permitted traffic to move without transshipment between all parts of England, Scotland and Wales and any station served by the standard-gauge railways of continental Europe, stretching from Narvik to Sicily and from the Spanish frontier to Istanbul. The success of the Harwich-Zee-

brugge freight service led the Southern railway to start in Oct. 1936, in conjunction with the then Nord railway of France, a train ferry service from Dover to Dunkerque.

Three vessels, with a gross tonnage of 2,989 each, were specially built in Great Britain—the "Twickenham Ferry," the "Hampton Ferry" and the "Shepperton Ferry"; they were designed to carry passenger coaches and sleeping cars as well as freight cars across the English channel.

Difficulties were experienced in the construction of the train ferry dock at Dover because of faults in the chalk formation, but on completion a night ferry service for passengers was started between London (Victoria) and Paris (Nord), as well as other services for freight traffic.

As a consequence of World War II the London and North Eastern railway train ferry was reduced, but the two fleets, Harwich-Zeebrugge and Dover-Dunkerque, received new vessels, a French one being employed on the latter.

The Dover-Dunkerque night ferry passenger service between London and Paris proved exceedingly popular. The Harwich route continued to cater for freight traffic only.

Other Train Ferry Services.—A famous example is the train ferry across the Great Belt in the Baltic sea, operated by the Danish State railways, which carries diesel trains, sleeping cars and passenger coaches on the Copenhagen-Paris and other international services.

In conjunction with the Swedish State railways, a ferry route is operated between Malmö and Copenhagen; another route is between Helsingor and Hälsingborg. Before World War II a joint German-Swedish service ran between Sassnitz and Trelleborg and a Danish service between Gjedser and Warnemünde, Ger. Developments after 1948 included a new route from Grossenbrode, Ger., to Gjedser. Italian State railways operate fine motor vessels as train ferries across the strait between Reggio di Calabria and Messina in Sicily.

Outside Europe, Japanese National railways has a number of train ferries in service between the several islands, and in North America the Canadian National operates a train ferry to Prince Edward Island as does the Canadian Pacific to Vancouver Island. Train ferries provide services across Lake Michigan, between Ludington and Frankfort in Michigan and Milwaukee, Manitowoc and Kewaunee in Wisconsin; they are operated by the Chesapeake and Ohio and other railways including the Ann Arbor, controlled by the Wabash railway. Railway equipment is regularly ferried across the harbours of New York and San Francisco.

(C. E. R. S.)

FERSEN, FREDRIK AXEL, Count von (1719–1794), Swedish soldier and parliamentary leader, son of Count Hans von Fersen (one of the founders of the Hat party), was born in Stockholm on April 5, 1719. Fersen was taught privately by the brilliant Sven Lagerbring and studied at Swedish and foreign universities before entering the army in 1737. Permitted to take service in France in 1739, he fought for the French in the War of the Austrian Succession and proved himself an able and courageous officer. On his return to Sweden he joined the Hat party, then in power in the *riksdag*, and rapidly made his mark in parliamentary life. He was favoured by his family and marriage connections, having married in 1752 into the influential Hat family of de la Gardie, but also by his own aptitude for politics. He was intelligent and energetic, and made skilful use of all possible means, including bribery, to further his party's interest. His manner was impressive, if haughty; he was eloquent in speech and fluent in debate. With a temperament both patriotic and aristocratic, his fundamental belief was in the value of a free constitution, with political power in the hands of the aristocracy and bureaucracy rather than the crown.

Fersen's election as *lantmarskalk* (speaker of the first estate, the nobility) in 1756 meant defeat for the court's attempt to increase the crown's influence on politics; but after the Seven Years' War—in which Fersen saw distinguished active service—he was prepared to ally with the court to checkmate his political opponents, the younger Caps, at a critical time for the Hat party.

His inability to carry the majority of the Hats with him in a program of moderate increase in the powers of the crown rendered him suspect both with his own party and with the court, as did the failure in 1772 of the plan for a patriotic reconciliation of Hats and Caps which Gustavus III desired and to which Fersen pledged his support. The king's subsequent actions and the war against Russia (1788–90) brought Fersen once more into the antiroyalist camp and he finally led the nobility into open defiance of Gustavus. He lost the ensuing struggle for control of the *riksdag*, however, and retired from politics in 1789, devoting his time to the Swedish Academy and his memoirs, which are bitterly critical of Gustavus III. He deplored unconstitutional action and had no part in the successful assassination plot (March 16, 1792) against the king. Fersen died on April 24, 1794.

Although judged the ablest parliamentarian of his time, Fersen has generally been regarded as lacking in some of the qualities of a statesman. He was too unwilling to take risks and he lacked boldness of vision. *See* also Sweden: *History*. (R. M. Ha.)

FERSEN, HANS AXEL, Count von (1755–1810), Swedish diplomat and statesman remembered for his association with the French royal family during the Revolution as well as for his role in his own country's affairs, was born in Stockholm on Sept. 4, 1755, the son of Fredrik Axel Fersen. Educated at home and at the military schools of Brunswick and Turin, he entered the Swedish military service in 1770 but was later transferred to the French. Promoted colonel (*mestre de camp*) in the German infantry in France in 1780, he was sent to America as adjutant to the comte de Rochambeau (*q.v.*) during the American Revolution and distinguished himself at the siege of Yorktown in 1781. Returning to France, he became colonel of the Royal-Suédois regiment in 1783. The queen, Marie Antoinette, liked Fersen for his grace and wit; and he might well have passed his life at Versailles had he not been summoned to join his own sovereign, Gustavus III of Sweden, with whom he toured Italy. Back in Sweden in 1784, Fersen was sent with a regiment to Finland in 1788.

In the autumn of 1788, however, Fersen was sent back to Paris, where Gustavus needed an agent enjoying Louis XVI's confidence. After the outbreak of the Revolution, Fersen saw, by the end of 1790, that nothing could be done for the French monarchy so long as the king and queen were captives in Paris. He therefore raised money for their escape and organized the journey that was to end disastrously at Varennes: he himself drove the fiacre that took them from the Carrousel in Paris to the Porte Saint Martin (June 1791).

Fersen was next sent to Vienna to induce the emperor Leopold II to intervene actively against revolutionary France, but soon saw that Leopold would do nothing immediately. He was then transferred to Brussels, where he could be of more service. In Feb. 1792, he reached Paris with counterfeit credentials as minister plenipotentiary to Portugal, but his several interviews with the royal family came to nothing and he returned to Brussels.

While Charles, duke of Sudermania, was regent of Sweden (1792–96), Fersen, like all the late king's adherents, was in disgrace. When Gustavus IV came of age Fersen was reinstated. He was the Swedish delegate at the congress of Rastatt in 1797 but left Rastatt in March 1798 because of a conflict with the French delegate, Napoleon Bonaparte. In 1801 he was appointed *riksmarskalk* (earl marshal) of Sweden. On the outbreak of the war with France (1805) he accompanied Gustavus IV to Germany as adviser on foreign affairs. He grew, however, more and more dissatisfied with the king's policy; and for the rest of the reign he was in semidisgrace, though generally a member of the government when the king was abroad.

Fersen stood aloof from the revolution of 1809 (*see* Sweden: *History*). His sympathies were entirely with Gustavus IV's son, Prince Gustavus. Consequently, when Christian Augustus of Augustenburg, the newly elected successor to the throne, died suddenly in Skåne in May 1810, the rumour spread that he had been poisoned and that Fersen was an accessory to the crime. On the transfer of the corpse to Stockholm (June 20, 1810) Fersen, as *riksmarskalk*, received it at the gate and led the funeral procession into the city. Suddenly the mob attacked him. Two officers, trying to save him, volunteered to conduct him to the town hall

and to put him under arrest there, but when he appeared on the steps, the crowd closed in and kicked and trampled him to death. The troops, drawn up in Riddarhus square, made no attempt to rescue him. His diary, *Axel von Fersens dagbok,* four volumes, was published in 1925–36.

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FERTILE CRESCENT, a term popularized by the U.S. orientalist James Henry Breasted for the region in the middle east where civilization began. It includes a crescent-shaped area of relatively fertile land enjoying a Mediterranean climate, with alternating rainy winters and dry summers. Situated between the Arabian desert on the south and the mountains of Armenia on the north, it extends from Babylonia and adjacent Susiana (the southwestern province of Persia) up the Tigris and Euphrates rivers to Assyria. From the Zagros mountains east of Assyria it continues westward over Syria to the Mediterranean, and extends southward to southern Palestine. The Nile valley of Egypt is often included as a further extension, especially since the short interruption in Sinai is no greater than similar desert breaks which disturb its continuity in Mesopotamia and Syria. Throughout the region irrigation is necessary for the best agricultural results, and indeed is often essential to any farming at all.

The Fertile Crescent in its wider extension corresponds exactly to the region which plays a dominant role in the Hebrew traditions of Genesis; it also contains the countries (Babylonia, Assyria, Egypt, Phoenicia) from which the Greeks and Romans derived civilization. This age-old belief that the earliest culture known to mankind originated in the Fertile Crescent has been confirmed by the development of radiocarbon dating since 1948. It is now known that incipient agriculture and village agglomerations there must be dated back to about 8000 B.C., if not earlier, and that the use of irrigation followed rapidly. *See* also ARCHAEOLOGY: *Prehistory; Egypt and Western Asia.* (W. F. A.)

FERTILITY AND FECUNDITY. Fertility is the power to beget living offspring; fecundity the power to produce functional gametes (sex cells, eggs, or ova, and sperm in higher animals). The reproductive rate of a mating (or of a generation) is determined both by the fecundity of the individuals composing it and by the fertility of their matings.

There is some meaning in viewing fecundity as what a species can do in terms of maximal reproduction, and fertility as what a species actually does. Organisms that have a high fecundity usually live exposed to more rigorous environmental conditions than those having a lower fecundity, whose environments, frequently in part of their own making, are more protected. In other words, fecundity generally is in direct relation to the chances of death; those species that produce many eggs are usually those that have many enemies and face many hazards. (There are numerous exceptions to this rule, however.)

It has been estimated that the Pacific herring of the Strait of Georgia (between Vancouver and the mainland of British Columbia) has a population on four spawning grounds of 1,000,000 to 9,000,000 fishes. These produce annually from 8,000,000,000 to 75,000,000,000 eggs, of which about 95% may hatch but only about 0.1% survive to maturity. On the other hand, a mammal such as man has a low fecundity but a high degree of reproductive success in terms of reproductive effort.

David Lack has emphasized subtle differences in the fecundity of various birds. Within a single species, clutch size often varies with latitude. He attributes these variations to differences in the effective food supply, and considers clutch size as an adaptive feature in the birds' life cycle. According to his thesis, clutch size, under the influence of natural selection, has become so adjusted that a maximum number of birds are produced in the next generation.

Fecundity potentials can assume startlingly high values. An individual oyster can produce 55,000,000 to 114,000,000 eggs during its lifetime. It is estimated that the blue crab of the western Atlantic carries as many as 1,750,000 eggs at one time. Among fishes the shad is reputed to lay from 30,000 to 100,000 eggs per year, the Atlantic cod from 4,000,000 to 9,000,000 and the American eel from 5,000,000 to 20,000,000. An old speculation suggests that the tapeworm *Taenia* produces at least 8,800 eggs in a single proglottis ("segment") and liberates as many as 13 or 14 proglottids from the free end of the body each 24 hours. Even these prodigious production records are dwarfed by those of certain lower plants: a large puffball is estimated to produce as many as two trillion spores!

Fecundity.—Fecundity is ultimately determined by the functional ability of the gametes and by the temporal distribution of their production. (Commonly only female gametes are considered in ascertaining fecundity, since sperm are usually superabundant.) The gametes of many interspecific hybrids, such as the mule, are inherently incapable of functioning normally in fertilization. Commonly such sterility can be traced to irregularities in the process of reduction division (meiosis) that leads to the production of nonfunctional sex cells (*see* CYTOLOGY). Toxins and X-rays and other penetrating radiations can also cause gametes to be nonfunctional. Production of normal gametes generally depends on the interaction of hormonal and other physiological mechanisms of the organism with the external environment. It is therefore common experience that organisms removed from their natural surroundings, as those in zoos, may fail to produce gametes, even though they are otherwise apparently healthy. In certain animals ovulation (egg production) is totally or partly dependent on copulation or the presence of sperm. In many mammals the production of potent sperm can occur only at temperatures lower than that of the normal body, so that animals with intro-abdominal undescended testes (*e.g.* the so-called "rigs" in horses) are sterile.

The reproductive pattern can be separated into several significant components: the length of life; the duration of the reproductive period; the timing of individual reproductive efforts; and the number of progeny produced per litter or clutch. Among most animals (and the higher plants) the reproductive pattern varies widely, from that in the mayflies (Ephemeroptera), where only the last 0.14% of the life span is reproductive, to that of man or the fruit fly *Drosophila,* where reproduction can occur during the greater part of life. A post-reproductive, senescent period occurs in some species, but is usually restricted in length in organisms in the wild.

Little can be stated generally about the changes in fecundity during an individual's life span. Organisms that reproduce only once are almost as common as those that reproduce repeatedly. Where clutches are produced repeatedly and clutch size is variable, the primiparous organism (one bearing young for the first time) usually produces fewer ova than an older one. In many animals the maximum number of eggs for a given body weight is reached rather quickly. A later gradual decline in clutch size often occurs, but is far from universal. In fishes the number of eggs produced per unit weight is commonly considered independent of age, once the fish is of reproductive age. Where egg size varies within a species, there is a strong inverse relationship between egg size and egg numbers; *i.e.,* the larger the eggs, the fewer produced, and conversely. In most vertebrates and many invertebrates and plants, reproduction is seasonal, although species in which eggs are produced throughout the year are not uncommon. Frequently these latter are short-lived organisms that have several generations per year. Domestication has led to the selection of animals with a prolonged breeding season (*e.g.,* the domestic hen as compared with its wild gallinaceous relatives). Among seasonal reproducers ovulation is usually triggered by various factors that are related to the normal mode of life of the organism: *e.g.,* photoperiod (duration of exposure to light) in many vertebrates and seed plants; temperature in some invertebrates; carbon dioxide pressure in the fresh-water *Hydra;* etc. The size of the clutch and the frequency of ovulation is ultimately determined by the genetic endowment of an organism, the full expression of which depends on many varied environmental factors including the quantity and quality of available food.

LaMont Cole has emphasized the major effect of the timing

of ovulation on the potential growth rate of the population. Fecundity is, in essence, a production rate that increases with each succeeding generation. Very large increases in the effective fecundity of a population can be achieved by shortening the prereproductive period, thus bringing more organisms to the reproductive age more quickly, even though the total number of ova produced per female life span is constant. In a species that produces a certain number of eggs per female, the fecundity will be much higher if these eggs are produced, say, at the age of one year rather than at the end of the second year of life, especially when a significant proportion of individuals would die before they reached their normal reproductive age.

Fertility.—This may be regarded as the product of three related factors: (1) fecundity; (2) the probability that an egg will be fertilized; and (3) the probability of embryonic survival of the fertilized egg. This definition implies that in those organisms where fertilization is external, as it is in most marine animals, fecundity is much more simple to estimate than is fertility. Conversely, in organisms where fertilization is internal, and especially in the viviparous (live-bearing) mammals, fertility is readily determined, whereas fecundity is often difficult to estimate.

Any factor that decreases the probability of a successful union of gametes reduces fertility. There is little doubt that, among animals, the human species has an unusually small ratio of fertilization to ovulation. Such relative infertility is, however, also encountered in some seed plants. Because of the difficulties of measurement, there are few good estimates of the extent to which the ova of various animals remain unfertilized. Low fertility from this cause might be expected especially in animals with external fertilization involving no courtship; however, in some of these, since synchronization between release of sperm and eggs has been well documented, fertility is undoubtedly high.

Death during embryonic life, another cause of a reduction in fertility, does not differ fundamentally from death at other times during the life cycle. Both environmental and hereditary factors play a part. Since the developing organism is untested and undergoes much more rapid and profound changes than it does after birth, it is not surprising that embryonic death rates, where they are known, are generally higher than juvenile death rates.

Fertility and fecundity measure the intensity of the reproductive process as a function of individual or population age. Numerical values therefore can be interpreted completely only if they are available for all pertinent ages of individuals. If a concise, informative statistic measuring fecundity or fertility of a population is needed, this should be referred to a fixed (preferably the stable) age distribution (Lotka, 1925).

See REPRODUCTION; *see* also references under "Fertility and Fecundity" in the Index volume.

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(P. W. F.)

FERTILIZATION. A new organism, animal or plant, usually arises from a fertilized egg. Fertilization is the union of an egg cell (ovum) from the female, with a sperm cell (spermatozoon) from the male. In the process of fertilization, two main functions are served: (1) the egg is activated to development by the spermatozoon and (2) the hereditary characters of both mother and father are combined in the new organism. The activation of the egg by the spermatozoon is in the nature of a chemical reaction and results in a change in the surface and in the substance (cytoplasm) of the egg cell. The combination of the hereditary characters is accomplished by the nuclei, small bodies within the cells, or more specifically by the chromosomes within the nuclei.

Egg cells are formed in the ovary and are typically large cells rather simple in appearance, each consisting of cytoplasm and a nucleus. The cytoplasm is enclosed in a cell membrane and consists of a liquid matrix or "ground substance" in which are embedded yolk and other granules of different sizes, weights and chemical composition. The nucleus is a small spherical body within the cytoplasm enclosed by a nuclear membrane and consisting of a liquid matrix (nucleoplasm) and the chromatin material which in certain stages is in the form of very definite bodies or chromosomes in which lie the genes, which determine the hereditary characters. Each species of animals and plants has a definite number of chromosomes. In the fruit fly *Drosophila melanogaster*, on which so much genetic work has been done, there are eight chromosomes in the body cells and early egg and sperm cells. The normal chromosome number in man, long thought to be 48, has been, since 1956, placed at 46.

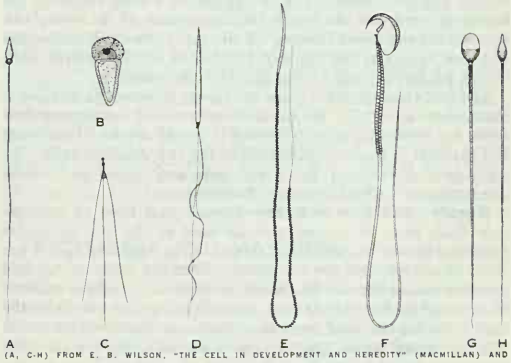
The spermatozoa are very specialized small cells adapted to their function of finding and attaching themselves to the egg. The spermatozoa develop in the testes from cells originally much like primitive egg cells. Whereas the egg cell increases greatly in size without much change in form as it matures, the sperm cell actually becomes smaller and very complicated in structure. They differ in shape in different animals (*see* fig. 1). The most common type is a free-swimming form consisting of: (1) a head containing the chromosomes, now massed together, but of the same number as those in the mature egg cell; (2) a middle piece in which lie certain bodies, centrosomes, which probably function in the subsequent division of the egg; and (3) a long tail which is very motile and enables the sperm to swim.

The spermatozoa of some animals (*e.g.,* crabs and lobsters) have no tails, but several spinelike processes by which they move slowly to the egg.

Since, in fertilization, the chromosomes which come from both the male and the female are added together and would double in number in each generation, there is a special mechanism by which this is prevented. Just before the egg cell becomes mature and ready for fertilization, the chromosomes become associated in pairs, so that apparently only half the number is present. Now the cell (oöcyte) divides twice, very unequally, into one large and one very small cell. These two small cells, known as polar bodies (fig. 2), are discarded. But in the process of throwing off the polar bodies, one-half of each paired chromosome is discarded also, so that the mature egg is left with one-half the number of chromosomes (haploid number) that are present in each of the body cells and early germ cells (diploid number). Likewise the sperm cell (spermatocyte), in maturing, divides twice but into equal cells, each with half the original number of chromosomes (now haploid number), and all four of these cells form spermatozoa. Thus when the egg and sperm unite in fertilization, the somatic (diploid) number characteristic of the species is restored.

Since all the cells of the body, including the germ cells, arise by division of the original fertilized egg cell, each cell has the same number of chromosomes.

The sex of an individual is determined at fertilization by the



(A, C-H) FROM E. B. WILSON, "THE CELL IN DEVELOPMENT AND HEREDITY" (MACMILLAN) AND (B) W. E. KELLICOTT, "A TEXTBOOK OF GENERAL EMBRYOLOGY" (HENRY HOLT)

FIG. 1.—SPERMATOZOA OF VARIOUS ANIMALS AND MAN

A. Sea urchin. B. Round worm. C. Crab. D. Toad. E. Pigeon. F. Field mouse. G. Man, face view. H. Man, side view

sperm in man and many other animals because half of the spermatozoa differ from the other half in one of the chromosomes. In butterflies, moths and birds, the sperm are all alike but the eggs are of two slightly different types with regard to one chromosome and here the female determines the sex of the next generation at fertilization. (*See* CYTOLOGY; HEREDITY; GENE.)

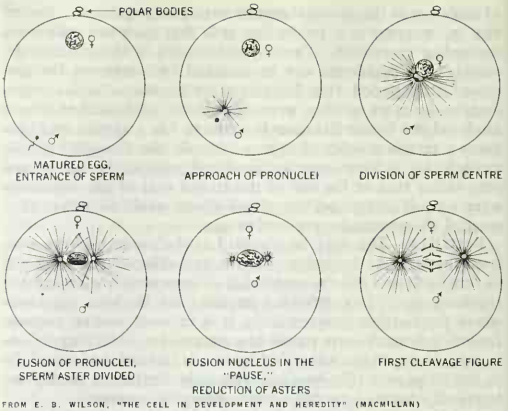
Fertilization in the Sea Urchin.—Whereas it is difficult to obtain human eggs, certain marine eggs can be obtained in abundance and the actual process of fertilization, that is, the union of the egg and sperm, can be best studied here (*see* fig. 2). One can put the eggs of a sea urchin, *Arbacia punctulata*, in sea water in a small glass dish and add some sperm. Under a microscope one can watch the sperm cells collect around each egg. The meeting of the egg and sperm is generally believed to be by chance in animals, not by chemical attraction, but having reached the egg, the sperm are held there by the surrounding jelly (*see* EMBRYOLOGY, CHEMICAL). Though there may be thousands of sperm present, only one sperm enters the egg, and, in *Arbacia* (also in mammals), at any point on the surface. In some animals several sperm normally enter but only one takes part in the union with the egg nucleus (*e.g.*, in the hen's egg). Within two minutes, in *Arbacia*, a membrane, the fertilization membrane, is thrown off a small distance from the surface of the egg; it removes the unsuccessful sperm from the surface of the egg and probably protects the egg as it develops.

Some of the details of the succeeding events can be seen in the living egg but they are better seen in stained sections, that is, thin slices of the eggs which have been killed and stained and mounted on a glass slide. About five minutes after fertilization the sperm head is seen inside the egg, accompanied by a small star-shaped figure, the sperm aster. This is generally believed to arise from the centrosome brought in by the middle piece. In this case the tail of the sperm is left outside, though in some eggs (*e.g.*, the guinea pig) the tail also enters the egg. The head of the sperm becomes the male pronucleus, enlarging somewhat as it approaches the egg nucleus (female pronucleus), which itself moves slightly toward the male pronucleus.

The two pronuclei unite near the centre of the egg and the astral radiations extend throughout the cell; this is the monaster, readily visible in the living egg. In the fusion nucleus of *Arbacia* the male and female components become indistinguishable. Soon (about 30 min. after fertilization) the nuclear membrane breaks and a typical division figure, the mitotic figure, then forms. The chromatin material from the nucleus forms into definite bodies, the chromosomes, which become arranged at the equator of a spindle, at each of whose poles is an aster; this figure is called the amphiaster. The chromosomes in this egg are small and numerous: probably there are 38 (diploid number). The chromosomes then divide, half of each chromosome going to each pole; then they reform into new nuclei. The two asters are readily visible in the living egg, and one can watch the indentation of the cytoplasm between the two asters forming the cleavage furrow, which deepens and soon separates the egg into two halves or blastomeres, each with a nucleus formed by the daughter chromosomes.

The first cleavage takes place in this egg in about 50 min. after fertilization at 23° C. In this division, as in all subsequent divisions, the chromatin material, which is a combination of maternal and paternal, is equally distributed to the two daughter cells. By subsequent divisions, 4, 8, 16, etc., cells are formed with clock-like regularity. (*See* CYTOLOGY; EMBRYOLOGY.)

Number and Size of Eggs.—The simplest form of fertilization takes place in marine animals such as the sea urchin, as described above, mollusks and worms. The eggs and sperm are shed, when ripe, into the sea water. Since the union of egg and sperm is almost entirely by chance, each animal produces millions of eggs and sperm. In the frog the male clasps the female as the eggs are being laid, and sheds his sperm over them. There are in this case many fewer eggs. In the higher animals, including the mammals, the eggs are fertilized inside the body of the female, on their way down from the ovary to the outside. There are still fewer eggs provided in this case. The eggs of some animals (*e.g.*, birds) are laid soon after fertilization, and since they must develop to a free-living form before hatching, they are supplied with a large amount of nourishment in the form of yolk. In the hen's egg the young embryo is a small white disc on the surface of the yolk, and all the rest of the egg, yolk and white, is nutrient material. In most mammals, including man, the young embryo is nourished within the mother by her tissues, so that the egg requires no reserve material and is relatively small and simple. (*See* EGG: *The Egg in Biology*.)



FROM E. B. WILSON, "THE CELL IN DEVELOPMENT AND HEREDITY" (MACMILLAN)

FIG. 2.—DIAGRAM OF SEA URCHIN TYPE OF FERTILIZATION (MAGNIFICATION 200 X)

Fertilization in Man and Other Mammals.—The mature human egg, as well as that of a dog and cow, is approximately 100μ in diameter (= 0.1 mm. or 1/250 in.), excluding the zona pellucida; it is the largest cell in the body, about the size of a very fine grain of sand, just visible to the naked eye. It is essentially like the sea urchin egg, consisting of a mass of granular cytoplasm with a nucleus which cannot be seen in the living egg, but can be readily seen in stained and sectioned material; in the clearer rabbit egg, the nucleus can be seen in the living cell. There is a clear translucent zone, the zona pellucida, just outside the real cell membrane, about 20μ thick (function unknown, probably protective). It has been estimated that there are about 400,000 eggs, mostly immature, in the two ovaries of a young woman. It is believed by most authorities that all the eggs which will function in life are already present in the new-born girl, though some anatomists think new eggs are formed continuously in the ovary of the adult and that these are the functional ones. Since a woman usually sheds only one egg a month (none during pregnancy) from about 12 to 48 years of age, she needs only about 430 eggs during her lifetime, so that she has, potentially, nearly 1,000 times more than are necessary.

As the egg ripens in the ovary, cells multiply around it to form a follicle. The follicle (about 12 mm. diameter when mature) pushes its way to the surface of the ovary, bursts and releases its contents including the egg; this is ovulation. The egg now leaves the ovary, probably after the first polar body has been formed, and is received by the open end of one of the two oviducts or Fallopian tubes, usually the one on the same side of the body. It passes through the Fallopian tube, which is about 11.5 cm. long (= 4½ in.), probably both by means of the current made by the little hairs or cilia lining the tubes and by contraction of the muscle fibres in its walls. The egg takes four days to travel through the Fallopian tube on its way to the uterus.

The mature human spermatozoon is much like that of a rat or a rabbit or even a sea urchin (fig. 1). It has an over-all length of about 60μ (= 0.06 mm. or $\frac{1}{400}$ in.). The head, which contains the nucleus, is rounded and asymmetrical, being somewhat flattened; it is about 5μ long, 3μ wide and 1.5μ thick. The tail is about 50μ long and 0.3μ in diameter. It is among the smallest cells in the body. The volume of the human sperm is about

$\frac{1}{500,000}$ that of the egg. It has been estimated that all the spermatozoa necessary to produce the next generation in North America could be contained in the space of an ordinary pinhead. The eggs necessary for the next generation could be put in a pint jar. The sperm cells are formed continuously after puberty throughout life. It is estimated that there are 300,000,000 sperm in each ejaculation (4 cc.), and since it takes only one sperm to fertilize an egg, the waste is enormous.

Sperm cells deposited in the vagina by the male make their way in a few hours through the uterus, probably by muscular contraction of the wall, and up into the Fallopian tubes. They swim at the rate of about 2.7 mm. per minute which is near the rate of a good swimmer, length for length. It is in the upper part of the Fallopian tubes that fertilization takes place, that is, if there happens to be a ripe egg present. Fertilization probably takes place within a day after ovulation; if not fertilized, the egg degenerates after a day. Ovulation usually occurs about 14 days before the onset of the next menstruation. On the third or fourth day after fertilization, probably when in the four or eight cell stage, the developing egg passes into the uterus. It becomes attached to the uterine wall on about the seventh day after fertilization. The empty follicle in the ovary has meanwhile been transformed into the corpus luteum, an organ which produces the important hormone progesterone. (*See* REPRODUCTION; REPRODUCTIVE SYSTEM.)

Sperm can be introduced into the mammalian body artificially, with a pipette, and are functional in fertilizing the eggs. This has been done with horses, dogs and sheep, and was practised by the Arabs in the 14th century. It is now a common practice to take the sperm from a particularly good bull and send it (with a small amount of glycerine) packed in dry ice to breeders to fertilize their cows. Some bull sperm has been kept frozen in this manner for four years and has retained its fertilizing capacity. Human sperm, likewise frozen, may be kept in dry ice for three months and still retain its fertilizing power.

Fertilized mammalian eggs (rabbit and monkey) have been recovered from the Fallopian tubes, and motion pictures have been taken of their development for several days after fertilization. Development of the human egg outside the body (in vitro) is much more difficult to obtain, but there is no fundamental reason why this should not be done. The very complicated later development of any mammalian egg, including the human, will be almost impossible to obtain in vitro.

Hybrids.—In most cases the female of one species cannot be fertilized by the male of another. Well-known hybrids, however, do occur, but are usually sterile, *e.g.*, the mule (*see* HYBRIDISM).

Parthenogenesis.—There are a few animals in which the egg develops naturally without fertilization; such is the case in the plant lice (aphids) and the male bees (drones). There are a number of eggs, notably those of the sea urchin and starfish, which can be made to develop to normal larvae by artificial means instead of by fertilization. Heat, cold, various salts, hypotonic and hypertonic sea water have all been used to cause parthenogenesis in eggs of various animals. In the case of the frog, the eggs can be activated by pricking with a needle. Even mammalian (rabbit) eggs have been reported to develop parthenogenetically, by cooling the unfertilized eggs and then incubating them (G. Pincus and H. Shapiro, 1940). In artificial parthenogenesis, there is, of course, only one set of chromosomes, derived from the mother (*see* PARTHENOGENESIS).

Merogony.—This is the term applied to the fertilization of a nonnucleate egg or egg fragment. It is possible to shake apart or cut certain marine eggs so that one part contains the nucleus and the other part has none; eggs can also be broken into two parts by rapid centrifuging. On fertilization, both these fragments, the nonnucleate as well as the nucleate, may develop into larvae. These merogonic eggs have, like the parthenogenetic eggs, only one set of chromosomes, but in this case it is the paternal set.

Parthenogenetic Merogony.—A combination of parthenogenesis and merogony can be made by treating nonnucleate fragments with a parthenogenetic agent. These completely nonnucleate egg fragments (of *Arbacia*) have passed through successive cleavages in a fairly normal fashion to the blastula stage (E. B. Harvey, 1956). The very early development of an egg can, therefore, take place without fertilization and without any nucleus.

Fertilization in Plants.—In plants as in animals a union of male and female cells takes place in fertilization; but only among the lower plants such as the algae, and in the mosses and ferns, is a large cell fertilized by a small free-swimming sperm cell.

In the flowering plants fertilization takes place in the pistil (often a vase-shaped structure present in the centre of the flower), within which lies the ovule, and in it the egg cell. The pollen grains are carried by the wind or insects to the pistil; there they elongate into pollen tubes, which grow down into the ovule. One of the nuclei of the pollen tube combines with the nucleus of the egg, thus ensuring inheritance from both parents. The fertilization process, as thus simplified, is somewhat complicated by an alternation of generations, a nonsexual generation alternating with the sexual generation. (*See* PLANTS AND PLANT SCIENCE; ANGIOSPERMS.)

Subsequent Investigations.—Knowledge of the process of fertilization increased considerably after the main facts were established as outlined above. This was largely the result of the development of the electron microscope. Of special interest was the observation of acrosomal filaments of many sperm cells.

In many eggs the cortex, a layer just beneath the surface of the egg, contains special granules which disappear at fertilization and help form the fertilization membrane. In the sea urchin about 15 to 20 seconds after the attachment of the acrosome filament of the sperm to the egg surface these cortical granules begin to explode in a wave which encompasses the egg surface. The vitelline membrane lifts off the surface because of the colloid osmotic pressure of the substances released by the cortical granules. The remaining material from these granules becomes incorporated into the fertilization membrane when it hardens, and into the hyaline layer which soon appears over the egg surface. There seems to be no doubt that the fertilization membrane is of dual origin, and is a combination of the vitelline membrane and material from the cortical granules.

Studies continued on the method of sperm entry into the egg, the movement of the nuclei within the egg, the fertilization cone and fertilization membrane and polyspermy, and special emphasis was placed upon the chemical changes, probably due to enzymes, that occur during and after fertilization. Since much of this work remains unsettled, definite conclusions cannot be drawn on many of the details of fertilization, especially from the chemical standpoint. *See* also references under "Fertilization" in the Index volume.

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FERTILIZERS AND MANURES. Fertilizers include both natural and artificial substances that increase the productiveness of plants. In many countries of the world, including the United States and all of Europe, fertilizers stand in the way of widespread starvation. In areas such as China and India where famines have been commonplace, extensive use of fertilizer where needed could significantly reduce the incidence of food shortages. It was estimated that by the second half of the 20th century at least 20% of the food produced in the United States was due directly to commercial fertilizers.

It had become clear that the rapidly growing population of the world must depend increasingly upon commercial fertilizers for its food and fibre.

This article is divided into 14 broad sections dealing with the history and use of fertilizers and manures and providing detailed information about the various kinds of fertilizers. Fertilizer applicators and manure spreaders are described in the article TILLAGE MACHINERY.

In addition to the related articles referred to in the following sections of this article *see* also AGRICULTURAL EDUCATION AND RESEARCH; PLANTS AND PLANT SCIENCE.

The following are the main divisions of this article:

I. History
II. Essential Elements
III. Determining Fertilizer Needs
IV. Influence of Fertilizers on Livestock and Human Food
V. Analyses, Grades and Ratios
VI. Fertilizer Injury to Crops
VII. Foliar Applications
VIII. Nitrogen Fertilizers
  A. Natural Organics
  B. Naturally Occurring Chemical Nitrogen Fertilizers
  C. Synthetic Nitrogen Fertilizers
IX. Phosphorus-Supplying Fertilizers
  A. Reserves and Production
  B. Processing Phosphate Rock
X. Potassium Fertilizers
  A. World Reserves
  B. History of Potassium Fertilizers
  C. Mining and Processing
  D. Potassium-Supplying Fertilizers
XI. Mixed Fertilizers
XII. Secondary Elements
XIII. Manures
XIV. Compost

I. HISTORY

When there were large areas of unused frontier land in the world it was often more economical for farmers to move onto new, unfarmed land than to invest additional money in fertilizers for the land they were then farming, a practice continued into the second half of the 20th century in some underdeveloped areas of the world (*see* TROPICAL AGRICULTURE). However, some use of manure and composts is probably almost as old as agriculture itself and many other materials, such as ground bones, wood ash from burning the felled trees, dried blood, saltpetre, guano and fish were employed long before the chemistry of soils and crops was understood (*see* AGRICULTURE, PRIMITIVE). The disappearance of the frontiers combined with improvements in the technology of fertilizer manufacture and more effective transportation led to a growing role of fertilizers for producing the needed food and fibre.

The first prerequisite to the use of fertilizers was an understanding of the function of plant nutrients in plant growth. In the light of present knowledge of plant growth, it is difficult to understand some of the concepts that were set forth by the scientists of a few hundred years ago. The milestones in the development of understanding of plant growth and nutrition rank in significance to mankind with the greatest achievements in chemistry, physics, mathematics, astronomy and other disciplines. The Romans, beginning with Cato about 200 B.C. through Columella in the 1st century A.D., knew enough about soil fertility to recommend crop rotations, liming acid soils, adding manure and growing legumes which fix atmospheric nitrogen. Jan Baptiste van Helmont (1577–1644) conducted a classic experiment with a willow tree as one of the earliest attempts to find the principle underlying plant growth. He planted a 5-lb. tree in 200 lb. of soil. Five years later the tree had grown to 169 lb. but the soil had lost only 2 oz. He concluded that water was the sole nutrient utilized.

A German, J. R. Glauber (1604–68), found large crop responses to saltpetre (potassium nitrate) and believed it to be the principle of life. In 1699 John Woodward grew plants in (1) rain water, (2) water from the Thames river, (3) effluent from the Hyde Park (London) conduit and (4) the effluent plus garden mold. The amount of plant growth increased with greater sediment in the water. He concluded that the soil contained the long-sought principle. About 1750 to 1800, trained chemists began to study plant nutrition. In 1804, Théodore de Saussure introduced quantitative methods and established several important principles. In 1834 Jean Baptiste Boussingault established the first field experiments.

In 1840 Justus von Liebig (*q.v.*) drew wide attention to agricultural fertility investigations with several striking theories contradicting the old notion that plants derive their nourishment from humus. He also proved that strong acid treatment increased the availability to plants of nutrients in bones (see *Processing Phosphate Rock*, below). In 1886 Hellriegel and Wilfarth determined that certain microorganisms in combination with leguminous plants obtained nitrogen from the air. From the late 1880s research continued at an accelerated rate on the determination of additional essential elements, on the best time, rate and method to apply fertilizers, and on fertilizer formulations.

II. ESSENTIAL ELEMENTS

Of the slightly over 90 chemical elements that occur naturally in the earth's crust or atmosphere at least 15 are known to be essential for normal plant growth. Another element is added to the list on an average of about every 10 or 20 years as new techniques are devised for producing more nearly chemically pure sources of nutrients for plant nutrition studies. The identification of several elements which are needed in almost infinitesimal amounts was long overlooked because the elements were contained as traces of impurities in the chemicals used to supply other nutrients known to be needed, or were dissolved in adequate quantities from the glass containers.

TABLE 1.—*Elements Essential for Normal Plant Growth*

Used in large amounts	Symbol	Source	Used in small amounts	Symbol	Source
Carbon	(C)	From air	Boron	(B)	From soil solids
Hydrogen	(H)	" "	Copper	(Cu)	" " "
Oxygen	(O)	" "	Iron	(Fe)	" " "
Nitrogen	(N)	From soil solids	Manganese	(Mn)	" " "
Phosphorus	(P)	" " "	Zinc	(Zn)	" " "
Potassium	(K)	" " "	Molybdenum	(Mo)	" " "
Calcium	(Ca)	" " "	Chlorine	(Cl)	" " "
Magnesium	(Mg)	" " "			
Sulfur	(S)	" " "			

The essential elements and their sources are indicated in Table I. Each element has a specific biological role to play in normal plant growth. Some nutrients become part of the structure of the plant; others are required for normal growth but do not become a structural part of the plant. Several of the minor elements appear to be needed for proper functioning of the enzyme systems which regulate plant growth.

III. DETERMINING FERTILIZER NEEDS

The determination of the fertility needs of economic plants has received more attention from soil and plant scientists than any other aspect of plant growth. Several approaches are used.

Nutrient Deficiency Symptoms.—Many plants exhibit easily recognized symptoms of certain nutrient deficiencies. To the trained person these symptoms are helpful in indicating nutrients to be applied. Relying heavily upon deficiency symptoms has, however, three weaknesses: a profitable response to fertilizer is often possible before the plant shows the symptom; by the time the symptom is recognized it is frequently too late in the growth of the crop to prevent a serious loss of yield; many crops never exhibit identifiable symptoms.

BY COURTESY OF SAMUEL R. ALDRICH

ALFALFA PLANT EXHIBITING CHARACTERISTIC POTASSIUM DEFICIENCY

Soil Tests.—Soil tests care-

fully made on representative samples and interpreted by a trained soils expert are an important tool in planning a sound soil fertility plan. Soil tests measure the general fertility level and, when made systematically over a period of years, show whether fertility is being maintained, increased or is declining. (*See* also SOIL TESTING AND ANALYSIS.)

Plant Tissue Tests.—Chemical tests of the tissues of growing plants are sometimes helpful in diagnosing deficiencies, but the interpretation must be made by a trained person because of the complex interplay of soil moisture, temperature and fertility and the effect of one nutrient on another.

Soil Classification.—Soil maps are available for many important soils of the world. The description of the soils frequently gives valuable information on the inherent nutrient status.

Field Experiments and Farm Trials.—In the final analysis actual field experiments are the best guide to fertilizer response. Other techniques are mostly substitutes that are used because they are less costly than widespread field experiments. Many farmers and gardeners can conduct small trials on their own situations.

IV. INFLUENCE OF FERTILIZERS ON LIVESTOCK AND HUMAN FOOD

Fertilizers influence plants that are consumed by livestock and humans in several ways: (1) by increasing the yield and thus the amount of plant available; (2) by making it possible to grow different species of plants on a soil; and (3) by changing the chemical composition of the individual species with respect to minerals, vitamins, proteins or hormones. When a nutrient that is extremely deficient in a soil is added in small amounts the plant usually responds first in increased growth; as the nutrient is added in greater amounts it is likely to accumulate in the plant, frequently in excess of the amount required for optimum growth. Wide variations in inherent soil fertility or fertilizer applications often change yield but do not markedly affect the chemical composition of fruits and seeds although an abundant supply of nitrogen raises the protein content of grains. Data on the effect of fertilizers on vitamins, protein quality and hormones are much less extensive than for mineral composition. Research indicates that climatic factors are more influential than soil factors.

Since grazing livestock obtain all of their food directly from the soil, the nutritional deficiencies related to soil fertility and fertilizers are more common in such livestock. According to Kenneth Beeson: "An abnormally low level of phosphorus in the soil and in forage crops is the most widespread and economically important factor in nutritional troubles in grazing animals" (*American Plant Food Journal*, 5:6–11, National Plant Food Institute, Washington, D.C., 1951).

The "styfsiekte disease" common in the Republic of South Africa is due to a deficiency of the herbage in phosphorus and calcium. Phosphorus deficient forage has been found in Alabama, Florida, Michigan, Minnesota, Montana, Tennessee, Texas and Wisconsin in the United States. Cobalt deficiencies for livestock are known to exist in several areas of the world. The effect of fertilizers and soil fertility on the quality of livestock products is an important consideration because meat, milk and other livestock products contribute a substantial part to human food. Further research is needed but it appears that when enough fertilizers are used to grow desirable species and adequate quantities of plants the nutritive quality of the foods is generally acceptable. Livestock are more directly affected by fertilizer and soil fertility than humans because humans eat mostly the fruits and grains of plants, which are less influenced by soil fertility than the leaves and stems which make up a large part of livestock feed; the diet of humans includes foods brought in from other geographical areas, and many humans eat livestock products which are little affected in quality by changes in the diet of the animal. A notable example of a direct relationship between soil and human health is goitre, caused by a deficiency of iodine. There have also been reported cases of selenium toxicity in some areas of Mexico.

Organic and Inorganic Fertilizers.—Some persons have advanced the claim that chemical fertilizers jeopardize the health of animals and humans. A comprehensive study by the house of representatives of the United States led to the following committee report: "No reliable evidence was presented that the use of chemical fertilizers has had a harmful or detrimental effect on the health of man or animals." Scientific evidence indicates that nutrients actually enter living plants in the same chemical form whether the nutrients are from organic or inorganic sources. It is possible to add certain harmful elements to the soil and have them absorbed by plants with a subsequent deleterious effect on animals. Selenium, for example, occurs in such abundance in some soils in the Great Plains region of the United States from Montana to New Mexico that grazing animals develop alkali disease. The effects of using chemical fertilizers should not be confused with the effects of certain chemical insecticides and fungicides which may be retained as residues on harvested crops and eventually be consumed by humans as plant or animal products.

The effect of fertilizers on bacteria, earthworms and other forms of life within the soil is of considerable importance. The consensus of soil scientists is that fertilizers judiciously used are not harmful and in fact may benefit soil life through an increase in the amount of plant residues returned. (*See* also FEEDS, ANIMAL; NUTRITION.)

Nutrients Removed in Crops.—The number of pounds of some important nutrients that are contained in the above-ground parts of selected crops are shown in Table II.

V. ANALYSES, GRADES AND RATIOS

The standard order to list the nutrients in a mixed fertilizer is nitrogen, phosphorus and potassium. The analysis or grade commonly refers to the percentage composition of the fertilizer in total N (nitrogen), available P_2O_5 (phosphorus anhydride) and water-soluble K_2O (potassium oxide); for example, a 12–12–12. In fertilizer terminology P_2O_5 is called phosphoric acid and K_2O is called potash. These terms have been used since the mid-1880s. Some European countries use the elemental system, N, P and K, and it is likely that the rest of the world will adopt this system. Fertilizer recommendations for specific soils and crops are frequently given in terms of the desirable ratio. The ratio of a fertilizer expresses the relationship among the three major nutrients, nitrogen, phosphoric acid and potash, $N\text{-}P_2O_5\text{-}K_2O$, and in some cases additional nutrients. A 12–12–12 fertilizer has a 1–1–1 ratio. A mixed fertilizer is one that contains more than one of the three principal nutrients, N, P and K. Fertilizer materials are considered to be the basic materials which may either be applied directly to the soil or be combined with other materials to produce a mixed fertilizer.

TABLE II.—*Some Plant Nutrients Contained in Crops*

Crop	Nutrients in above-ground parts (in lb.)					
	Nitrogen	Phosphorus anhydride (phosphoric acid)	Potassium oxide (potash)	Calcium oxide	Magnesium oxide	Sulfur
Barley*, 100 bu.	120	50	100	26	16	16
Cabbage, 1 ton	6	2	8	1	1½	1½
Corn*, 100 bu.	160	66	110	42	18	18
Cotton, 1,500 lb. seed, lint; 2,500 lb. stalks, leaves, etc.	81	29	47	51	25	2
Oats*, 100 bu.	88	34	78	26	12	14
Onions, 100 bu. bulbs	15	7	14	2	5	2
Peanuts, 1,000 lb. nuts plus vines	73	12	50	30	10	15
Potatoes, 100 bu. tubers	31	9	30	2	4	2
Soybeans*, 100 bu.	350	80	150	15	25	25
Sugar beets, 1 ton beets	5	1½	4	2	1	½
Tobacco, 1,000 lb. leaves	74	11	102	89	15	10
Wheat*, 100 bu.	152	64	92	28	20	24
Alfalfa hay†, 1 ton	45	11	45	52	12	5
Clover hay†, 1 ton	41	8	33	40	9	5

*Grain crops cannot be compared on a bushel basis because the weight per bushel varies among crops.
†Composition, especially nitrogen, varies with the maturity of the crop.
Source: *Our Land and Its Care*, American Plant Food Council (1955).

Throughout most of the first 100 years of the use of commercial fertilizers, they were manufactured and sold only in the dry solid form. In the mid-1940s anhydrous ammonia gas, NH_3, was first used and in the mid-1950s liquid mixed fertilizers were introduced.

This period was noted for especially rapid changes in fertilizer manufacturing technology and agricultural use.

VI. FERTILIZER INJURY TO CROPS

Persons who are inexperienced in the use of fertilizers frequently observe brown or "burned" spots when they fertilize their lawns, and poor stands of vegetables when they fertilize their gardens. Fertilizer nutrients are, chemically speaking, supplied as soluble salts. A high concentration of soluble salts in contact with succulent plant tissues, leaves or roots kills the tissue by removing water from it. Injury may be reduced or avoided by applying less fertilizer, by mixing it through the soil surface or applying it in bands not in contact with seeds, by sprinkling a lawn immediately after fertilizing in order to wash the fertilizer off the leaves or by utilizing more costly but safer organic forms of nitrogen.

VII. FOLIAR APPLICATIONS

Plants can absorb nutrients through tiny openings (stomata) in the leaves and in some cases through the stems also. This fact led to speculation that perhaps feeding plants through leaf applications could replace soil applications. Extensive research showed that this was possible but that, with few exceptions, it is economically practical only in the case of minor elements which are required in very small amounts. Often foliar applications of minor elements are more efficient than soil applications because certain soils render the elements unavailable through chemical action.

VIII. NITROGEN FERTILIZERS

A. Natural Organics

The most important natural organic materials used in fertilizers are tankage (meat or garbage waste products), sewage sludge, castor pomace, cottonseed meal, fish scraps and dried animal manures including guano. Prior to 1850, nearly all nitrogen fertilizer came from such organic sources. By the second half of the 20th century natural organics had declined to a minor place in supplying the nitrogen fertilizer of the world. (*See* also Nitrogen, Fixation of.)

B. Naturally Occurring Chemical Nitrogen Fertilizers

Sodium and Potassium Nitrates.—Sodium nitrate, soda nitre or Chile saltpetre, $NaNO_3$, and potassium nitrate, nitre or saltpetre, KNO_3, were the first sources of chemical nitrogen fertilizer to be developed. They were discovered in 1809 by Thaddeus Haenke between the coastal range and the Andes mountains in Chile. Spaniards began to mine the deposits about 1813. The sodium nitrate layer, known as *caliche*, ranges from a few inches to 14 ft. in thickness. The Guggenheim process used in refining the ore can economically utilize ore as low as 8% in $NaNO_3$ and can extract 75% of the sodium nitrate. Potassium nitrate is produced as well as some iodates, borates, chlorides and sulfates of commercial value.

Coke Oven Ammonia.—Coke is extensively used by the steel industry. Coke is made by heating coal to 1,800° F. in the absence of oxygen. In this process ammonia gas, NH_3, is driven off and reacted with sulfuric acid to produce ammonium sulfate, a dry crystalline fertilizer containing 20.5% nitrogen.

C. Synthetic Nitrogen Fertilizers

Since about 80% of the air is nitrogen, there is a reserve of approximately 2,000,000 tons over each square mile of earth surface. Although this was utilized in a small way through atmospheric fixation by lightning discharges, by symbiotic bacteria mainly associated with the roots of leguminous plants and by nonsymbiotic bacteria, the vast reserve was essentially denied to man until techniques were developed to fix nitrogen from the air. In the arc process an electric spark is passed through a mixture of nitrogen and oxygen gases to combine the two elements. In the cyanamide process the final step involves combining nitrogen with calcium carbide at high temperature to yield calcium cyanamide, $CaCN_2$, containing 22.0% nitrogen. The third and by far the most important method is the Claude-Haber process for producing synthetic ammonia (NH_3).

Developed by Fritz Haber, Walter Nernst and others in Germany following the first laboratory production in 1910, and later modified by a Frenchman, Georges Claude, the process is represented by the equation:

$$3H_2 + N_2 \xrightarrow[\text{catalyst}]{400°\text{-}500°\,\text{C.}} 2NH_3$$

In 1947 patents were assigned to the Wisconsin Alumni Research foundation for a process involving direct oxidation of nitrogen in gas-fired furnaces.

The most common sources of chemical nitrogen fertilizer are listed in Table III.

Table III.—*Chemical Nitrogen Fertilizers*

Fertilizer	Per cent Nitrogen	Form	Equivalent acidity (A) or basicity (B)*
Ammonium nitrate	33.5	Solid	180 (A)
Ammonium sulfate	20.5	Solid	535 (A)
Anhydrous ammonia	82.0	Gas	180 (A)
Calcium cyanamide	22.0	Solid	285 (B)
Calcium nitrate	15.5	Solid	135 (B)
Potassium nitrate	13.0	Solid	200 (B)
Sodium nitrate	16.0	Solid	180 (B)
Urea	42.0-46.0	Solid	180 (A)

*Equivalent acidity is the amount of calcium carbonate required to offset the acidity caused by 100 lb. of nitrogen supplied in the fertilizer. Basicity indicates a basic rather than acidic effect.

Ammonium Nitrate.—Ammonium nitrate, NH_4NO_3, with 33.5% nitrogen is produced by reacting ammonia gas with nitric acid. It may be used for direct application or as an ingredient in either liquid or dry mixed fertilizers.

Ammonium Sulfate.—Ammonium sulfate, $(NH_4)_2SO_4$, with 20.5% nitrogen can be produced from by-product ammonia from the coking process or with synthetic ammonia, and reacted with sulfuric acid. In Europe ammonium sulfate is produced by reacting aqueous ammonium carbonate, $(NH_4)_2CO_3$, with gypsum, $CaSO_4$, to yield ammonium sulfate and calcium carbonate ($CaCO_3$). It is used for direct applications, as an ingredient in mixed fertilizers, and in bulk blends which are physically mixed immediately before applying.

Anhydrous Ammonia.—Anhydrous ammonia, NH_3, has 82% nitrogen. The synthetic fixation of ammonia has been previously described. W. B. Andrews initiated research in Mississippi in 1947 which quickly led to widespread use of ammonia in the United States for direct application to the soil. Since anhydrous ammonia is a gas with 211 lb. per square inch pressure at 40° C. (104° F.) and is also highly irritating, it is necessary to use special handling equipment and to insert the gas under several inches of moist soil in order to prevent extensive loss. The principal advantages are that it is the most concentrated source and thus can be transported most cheaply, and it requires no further processing before being applied. It may be metered into irrigation water for rill, that is, surface, but not overhead irrigation.

Anhydrous ammonia is widely used in the manufacture of other nitrogen fertilizers. It is also reacted with phosphoric acid to produce monoammonium phosphate (11% nitrogen and 48% phosphoric acid, or P_2O_5) and diammonium phosphate (21% nitrogen and 54% phosphoric acid).

Calcium Cyanamide.—The production of calcium cyanamide, $CaCN_2$, has been previously described. It is extensively used in Europe. The only producing plant on the North American continent is located in the province of Ontario, Can., near Niagara falls. When added to the soil, calcium cyanamide undergoes a series of chemical changes not all understood, but finally resulting in urea. A very dry soil or a high pH in the soil is conducive to the formation of a chemically stable, toxic compound, dicyanamide, $(H_2CN_2)_2$. The toxicity of intermediate breakdown compounds is utilized in weed control and in defoliating certain crops prior to harvesting. Because of these toxic compounds cyanamide must be applied to soil a minimum of two to three weeks before a crop is to be planted.

Calcium Nitrate.—Calcium nitrate, $Ca(NO_3)_2$, is produced

by neutralizing nitric acid with limestone. It is manufactured mainly in Europe.

Sodium Nitrate.—The mining and processing of naturally occurring sodium nitrate, $NaNO_3$, has been described. Synthetic sodium nitrate production in which sodium carbonate is reacted with nitric acid began in 1929. It is used mainly for direct application as a side dressing or top dressing.

Urea.—Urea, $CO(NH_2)_2$, is prepared by reacting anhydrous ammonia with carbon dioxide gas under high pressure in the presence of a suitable catalyst. Rapidly converted in the soil by the enzyme urease into ammonium carbonate, $(NH_4)_2CO_3$, it is used for direct application and mixed fertilizers including liquids.

Nitrogen Solutions and Aqua Ammonia.—Several combinations of water, ammonia, ammonium nitrate and urea are prepared mainly as nitrogen sources in the preparation of mixed fertilizers, either dry or liquid, but are used to some extent for direct application.

Urea-formaldehyde.—About 1950 research workers in the United States department of agriculture produced urea-formaldehyde combinations in varying ratios of the two ingredients in order to produce a chemical nitrogen fertilizer that would react slowly in the soil and thus be resistant to leaching and available over a longer period of time than earlier sources.

IX. PHOSPHORUS-SUPPLYING FERTILIZERS

A. Reserves and Production

World-Reserves.—The estimated world reserves of phosphate rock and apatite are given in Table IV. Additional extensive reserves not yet accurately estimated occur in Chile, China, Ireland, west Africa, Indonesia, Korea, Nigeria, Rhodesia, Uganda, Republic of South Africa and Venezuela. The principal supply of commercially used phosphates is the calcium phosphate mineral apatite (*q.v.*), of which the most common crystalline form is fluorapatite, $Ca_{10}(PO_4)_6F_2$. Iron ore is a minor source of phosphorus-carrying fertilizers, and animal bones supply smaller amounts.

Production and Consumption.—The leading countries in the production of phosphate rock are the United States, Morocco, the U.S.S.R., Tunisia, Nauru Island, Algeria, Egypt, the Christmas Islands, Makatea Island and Japan. The principal consuming areas are the United States, the U.S.S.R., Great Britain, France, Australia, Italy, Germany, Japan, the Netherlands and Canada.

Geological Formations.—Igneous apatite occurs as an intrusive sheet on the Kola peninsula of the U.S.S.R., in eastern Uganda and in eastern Transvaal. The predominant mineral is fluorapatite, which may contain up to 30% phosphoric acid, P_2O_5, equivalent. Marine phosphorites are sometimes deposited on continental shelves when cold water, rising from great depths, warms as it nears the surface and becomes less acid as it loses carbon dioxide, CO_2; phosphates are then precipitated. The large deposits in Montana, Idaho, Utah and Wyoming represent a formation called geosynclinal; the Tennessee blue rock phosphate is a platform deposit. Residual phosphorites arise from the weathering of marine-deposited phosphatic limestones. The phosphoric acid ranges from 15% to 35%. Tennessee brown rock deposits are of this type. River pebble deposits occur on stream bottoms where they accumulate from runoff from weathering phosphatic limestone. These usually are too low in phosphorus to be mined competitively. Phosphatized rock deposits are formed when phosphate that is being leached in acid water comes into contact with limestone or with rocks rich in iron or aluminum and is precipitated as crusts on the surface of joints and cavities. Tennessee white rock and Florida hard rock deposits are of this type and may contain up to 35% phosphoric acid.

TABLE IV.—*World Reserves of Phosphate Rock and Apatite (4)*
(in 000,000 metric tons)

Country	Reserves
Morocco	21,000
United States	13,526
U.S.S.R.	7,568
Tunisia	2,000
Algeria	1,000
Brazil	572
Islands of Pacific and Indian oceans	182
Egypt	179
23 other countries	670
Total	46,697

Guano is a source of both phosphorus (up to 20% phosphoric acid) and nitrogen (10% to 13%). (*See* GUANO.)

Mining.—Strip mining is practised on most phosphate deposits although there is some shaft mining. Mining started on the North American continent in the provinces of Ontario and Quebec in Canada in 1863. Phosphates had been previously discovered in South Carolina in 1837 but the first mining company in the United States was not formed until 1867. In 1882 phosphate rock was discovered in Florida and from then until World War I the principal market was in Europe, South Africa, Australia and New Zealand. In 1893 and 1896 blue rock and brown rock deposits were found in Tennessee. Smaller deposits occur in Alabama, Arkansas, Kentucky, North Carolina, Pennsylvania, Virginia and other states. Following World War I, production developed in the Pacific and Indian ocean islands and in north Africa.

B. Processing Phosphate Rock

The mineral apatite is relatively unavailable to plants until changed chemically. In fertilizer terminology available phosphoric acid, or P_2O_5 (43.7% phosphorus), is that which is water soluble plus that which is soluble in an ammonium citrate solution (citrate soluble). Justus von Liebig demonstrated in 1840 that the availability to plants of the phosphorus in bones was greatly increased by treatment with acid. In 1842 John B. Lawes, cofounder of Rothamsted Experimental station (*q.v.*) near London, patented a process for sulfuric acid treatment of phosphate rock to produce superphosphate, and essentially the same process was still used over 100 years later to produce most of the available P_2O_5 in fertilizers. The findings of Liebig and Lawes marked the beginning of the phosphate fertilizer industry.

There are two general procedures for breaking the apatite structure and making the phosphorus more available: treating the rock with strong mineral acids and subjecting it to high temperatures.

Acid Processes.—Strong acids break the apatite bond and remove 30% to 40% of the fluorine. Phosphate rock plus sulfuric acid produces ordinary superphosphate with 16% to 20% available phosphoric acid, or P_2O_5. This is the most important supply of phosphorus-carrying fertilizer, used both for direct application and for manufacturing relatively low-analysis mixed fertilizers. Phosphate rock plus orthophosphoric acid, H_3PO_4, produces triple or treble superphosphate with 44% to 48% available P_2O_5, used for direct application and to an increasing extent in high-analysis mixed fertilizers and bulk blends.

Prompted by the shortage of sulfuric acid during World War II, the Tennessee Valley authority (TVA) developed two processes: Process I uses nitric and phosphoric acid to yield phosphoric acid, monocalcium phosphate, $CaH_4(PO_4)_2$, and calcium nitrate, $Ca(NO_3)_2$. This is ammoniated to convert the highly deliquescent calcium nitrate to dicalcium phosphate, $Ca_2H_2(PO_4)_2$, and ammonium nitrate, NH_4NO_3. Process II uses a nitric-sulfuric acid combination and yields phosphoric acid, gypsum and calcium nitrate. As in Process I it is ammoniated and yields similar products plus gypsum.

Heat Processes.—Subjecting phosphate rock to high temperature breaks the apatite bond and drives off nearly all fluorine. Coronet phosphate is named for the company that developed the process. A slurry of ground rock, silica and water is fed into a rotary kiln at 1,500° C. After 20 minutes the mass is quenched with water jets. The product contains 21% phosphoric acid, P_2O_5, with 18% available. Fused tricalcium phosphate, developed by TVA, contains 22.3% available P_2O_5 but is not used commercially. Phosphate rock-magnesium silicate glass involves heating to fusion temperature phosphate rock with olivine or serpentine. It contains 19% available P_2O_5. Rhenania phosphate, developed in Germany, has been used since 1917. Phosphate rock, soda ash, Na_2CO_3, and silica are calcined at 1,100° C. to 1,200° C. for two hours, quenched with water before being discharged from the kiln, and ground to 180 mesh. The product carries 27.5% available P_2O_5. Calcium metaphosphate, $Ca(PO_3)_2$, was patented in Germany in 1929. TVA began production in the United States less than ten years later. It is of particular significance because of the extremely high concentration of available P_2O_5 (60% to 65%) which makes it economical to transport long distances. To make it, elemental phosphorus is burned in the presence of finely ground rock. The P_2O_5 produced from the burning phosphorus reacts

with the rock. Potassium metaphosphate, KPO_3, was developed and carried to pilot-plant stage by TVA. The fertilizer contains 35% to 38% potash, K_2O, and 55% to 58% P_2O_5. Disposition of the hydrochloric acid used in the process is a problem.

Raw Rock Phosphate.—As previously mentioned, untreated phosphate rock is low in available phosphorus for plants, one-sixth to one-twentieth being citrate soluble. Given adequate time, soil acids accomplish the same purpose as mineral acids, namely, to break the apatite bond. The rate of reaction is increased by fine grinding (100 mesh or finer), by moderate soil acidity and by large amounts of decaying plant residues which produce organic acids. Where it is favourably priced, rock phosphate is economically utilized to build the basic soil supply of phosphorus. More readily available sources are used to meet crop needs during the first few years. Long-season forage legumes utilize rock phosphate best. Rock phosphate is not suited to alkaline soils because of inadequate soil acids. The best grades of rock phosphate contain 30% to 36% total phosphoric acid, P_2O_5, and 3% to 6% citrate-soluble P_2O_5. The very fine material that settles out in waste ponds is sometimes marketed as colloidal phosphate containing 20% to 24% total P_2O_5.

Other Sources.—Basic slag, a by-product of the steel industry, usually from the Thomas and Gilchrist process, is rich in soluble calcium phosphates and is of commercial importance as a source of phosphorus mainly in Germany, France, Great Britain and other European countries where the slag often carries 17% to 20% phosphoric acid, or P_2O_5. In the United States only the slag from the open-hearth furnaces at Birmingham, Ala., is rich enough in phosphorus (9% to 10% P_2O_5, with 60% to 90% of this being available) to be competitive with other sources. Bone meal was once an important source of phosphorus fertilizer but now is used mainly by the feed industry. Liquid phosphoric acid, wet-process, is produced by treating rock with sulfuric acid. Calcium sulfate results as a precipitate and is separated out, leaving acid with 20% to 54% P_2O_5 depending upon the method used. Thermally produced acid comes from the reduction of phosphate rock in an electric furnace to produce elemental phosphorus which is burned to P_2O_5 and dissolved in water to make orthophosphoric acid, H_3PO_4. Liquid orthophosphoric acid is used on alkaline soils of the western United States mainly in irrigation water.

When orthophosphoric acid is neutralized with ammonia, monoammonium phosphate forms. Fertilizer grades contain 11% nitrogen and 48% P_2O_5. Sometimes this is mixed with ammonium sulfate to produce a nitrogen, phosphoric acid, potash ratio of 16–20–0. When the ammoniation of phosphoric acid is continued and the slurry kept at pH. or acidity, of 5.8 to 6.0, diammonium phosphate is formed. It has 21% nitrogen and 54% P_2O_5.

X. POTASSIUM FERTILIZERS

A. World Reserves

Major Producing Countries.—The potassium reserves of the world are very large but they are not precisely estimated. In the second half of the 20th century estimated world reserves of potash in lake brines and soluble salt deposits in millions of metric tons of K_2O were: Germany, 2,500 to 438,000; the U.S.S.R., 700 to 18,400; Israel, 1,200; the United States, 325; France, 300; and Spain, 270. Additional good quality reserves are also found in Japan, Australia, South Africa, India, and in the more recently discovered deposits in Saskatchewan, Can. Vast mineral reserves of lower quality may be utilized when new processes are developed. The ash of giant kelp, a seaweed along the western coast of North America from lower California to Alaska, contains 30% potash or K_2O. The greatest reserve outside the soil itself is sea water, which contains about 2,000,000 tons of potash per cubic mile.

Germany.—The largest known reserves in the world, covering an area of about 24,000 sq.mi., lie in the area from Thuringia to Mecklenburg and westward to Hanover. The potassium-bearing strata are 1,200 to 4,000 ft. below the surface. The deposits are largely carnallite, sylvite, kainite and kieserite, and average 13% potash, K_2O, equivalent.

U.S.S.R.—The second largest reserves were discovered in Perm on the west side of the Ural mountains. Information on the size of reserves and their commercial development is meagre.

Israel.—The resource is in the high salt concentration of the Dead sea.

United States.—The main potassium supply is in the Carlsbad deposits of the Permian basin area along the Texas-New Mexico border and extending north across Oklahoma and into Colorado and Kansas. The basin was an old inland sea in which potassium salts were concentrated and later buried under sand and shale to a depth of 800 to 1,000 ft. This area supplies 85% or more of the potassium produced in the country. Other reserves include beds in eastern Utah and brine from salt flats at Bonneville, Utah, brine wells at Midland, Mich., and Searles lake brines in California.

France.—The reserves are located in Alsace along the Rhine river about 25 mi. north of the Swiss border. These are among the highest quality ores in the world. The predominant mineral is sylvite. An extensive deposit has been discovered near Dax.

Spain.—Deposits are northwest of Barcelona and about 18 by 75 mi. in area. Strata vary from 8 to 70 ft. in thickness and occur at depths of 70 to 200 ft. below the surface. They are mainly carnallite and sylvite.

Poland.—The deposits are north of the Carpathian range from Kahurz to Stebine. The potassium is in four horizons in beds to 20 ft. thick and consist mainly of kainite, langbeinite, sylvite and carnallite. Rich deposits have been found in the Kujawy district of western Poland.

Canada.—Deposits were discovered in Saskatchewan in 1947. They occur at 4,000 to 12,000 ft. and may cover an area up to 500 sq.mi. when exploration is completed.

Italy.—There are large areas of leucite lava ranging from 7.5% to 10.0% potash equivalent.

Great Britain.—Deposits of sylvite and polyhalite in Yorkshire at a depth of 3,600 to 4,800 ft. appear to be a continuation of the salt basin of the German and French beds.

B. History of Potassium Fertilizers

Potassium fertilizer in the form of manure, potassium nitrate and ashes was reported in 300 B.C. The name potash comes from "pot ashes." The settlers in North America found Indians applying wood ashes as fertilizer. The production of potash from wood ashes was common in New Hampshire by 1632 and potash was exported to England for 100 years, reaching a peak in 1825. Potassium salts were discovered in well brine in Germany in 1839 and by 1861 commercial production was well established. Potassium was found in 1912 in a well drilled for water at Spur, Tex. Exploration for potassium in the United States was greatly stimulated by the loss of the German supply during World War I. The first significant discovery in the great Permian basin deposit was made in an oil-well drilling in 1921 and sylvite was identified in 1925. The first commercial shipment from Carlsbad was in 1931. In 1934 and 1940 two more companies began production and by 1950 the United States had become one of the world's leading producers.

C. Mining and Processing

The operations at Carlsbad, N.M., illustrate mining and processing techniques. Langbeinite, a sulfate of potassium and magnesium, $K_2SO_4 \cdot 2MgSO_4$, is mined at 800 and 850 ft.; sylvinite, a mixture of potassium and sodium chlorides, at 900 ft.; beds are 5 to 12 ft. thick. The ore is drilled, blasted, loaded and hoisted above ground. The principal impurity is sodium chloride from which it is separated by selective dissolving with water. The mass is centrifuged, kiln dried and sold under the trade name Sul-Po-Mag, which contains sulfur, potassium and magnesium. Sylvinite is ground and sized (the coarse fraction being treated on an agglomerating table), deslimed to remove clay, subjected to a flotation process and concentrated on gravity tables.

The potassium chloride is removed from the brine by centrifuging, then kiln dried and sold as 50% K_2O granular muriate of potash. The fine fraction is also deslimed, then incorporated with flotation reagents and processed in a series of flotation cells. The concentrate is centrifuged, kiln dried and marketed as 60% muriate of potash.

D. Potassium-Supplying Fertilizers

Potassium content in fertilizers is commonly expressed as water-soluble K_2O, or potash (83% potassium), although some European countries express it on an elemental basis.

Muriate of Potash.—The term muriate comes from muriatic acid, the common name for hydrochloric acid of which muriate of potash, KCl, is a salt. Muriate, 50% or 60% potash, K_2O, is used for direct application and to make mixed fertilizers, both liquid and dry. It is readily soluble in water.

Potassium Sulfate.—Composed of K_2SO_4 and containing 48% to 50% potash, or K_2O, equivalent, it is prepared by dissolving langbeinite in water and adding a concentrated muriate of potash (KCl) solution or by treating muriate of potash with sulfuric acid.

Sulfate of Potash-Magnesia.—It is prepared from langbeinite as previously described. The German product differs from the U.S. product in having one molecule of magnesium sulfate, $MgSO_4$, rather than two for each molecule of potassium sulfate, K_2SO_4. It is made by dissolving kieserite in hot water and adding KCl.

Manure Salts.—This is the fertilizer trade name for crude potassium salts that are crushed, screened and bagged with no attempt being made to remove sodium chloride and other salts.

Kainite is a term often applied to low-grade potassium salts ranging from 14% to 20% potash, but technically kainite is a mineral consisting of a hydrated sulfate and chloride of potassium and magnesium, $KCl{\cdot}MgSO_4{\cdot}3H_2O$.

Potassium Nitrate, having the formula KNO_3, is from the Chilean nitrate deposits described in the section on nitrogen. It is little used as a fertilizer but is of interest agronomically because of the unique balance of nitrogen and potassium (13% nitrogen-0% phosphoric acid-44% potash).

Potassium metaphosphate was previously discussed under phosphorus-supplying fertilizers.

XI. MIXED FERTILIZERS

The term mixed fertilizer indicates more than one of the three major nutrients, nitrogen, phosphorus and potassium. Mixed fertilizers are formulated in hundreds of ways and there is no single typical technique. Of the many chemical reactions that take place, the most significant by far is the ammoniation of phosphates with anhydrous ammonia or ammoniating solutions. The chemical reactions affect both the availability of certain nutrients and the physical condition of the fertilizer. There is a strong trend toward higher concentrations of nutrients in mixed fertilizers in order to save costs in handling and transporting. Prior to 1950 most mixed fertilizer was pulverized or powdered, but since then an increasing proportion has been made into pellets or granules, which are less dusty and less likely to cake. Home mixing of fertilizers was widely practised until the 1940s but has since rapidly declined. In European countries fertilizers are generally applied as individual materials but in the United States mixed fertilizers are more popular. Bulk blending of fertilizer materials increased in the second half of the 20th century.

XII. SECONDARY ELEMENTS

Calcium, magnesium and sulfur are referred to as secondary nutrient elements but this does not mean they are less essential.

Calcium.—The main importance of calcium (Ca) in humid regions is its role in regulating soil acidity. In subhumid and arid regions with between 15 and 25 in. annual rainfall, calcium accumulates within the soil profile; in humid regions it tends to leach from the surface. Within humid regions there is great variation in the calcium supply of the surface and subsoil depending upon the amount of limestone or other calcium-bearing rock in the soil parent material and the extent of weathering and leaching. Deficiencies are corrected by applying liming materials.

Magnesium.—Magnesium (Mg), like calcium, is related to soil pH or acidity. It is a basic part of chlorophyll, which imparts to green plants the ability to utilize sunlight in the photosynthetic process. Deficiencies are most likely to occur on acid soils. It may be supplied in the form of dolomitic limestone or for more immediate effect in the soluble forms such as Sul-Po-Mag and magnesium sulfate (Epsom salts).

Sulfur.—Sulfur (S) is added to the soil in plant residues and manures, in precipitation that carries down sulfur exhausted into the air in smoke from many industries, in commercial fertilizers in which sulfuric acid is involved and by soil organisms that utilize sulfur dioxide gas. Sulfur is used to acidify soils for acid-loving plants including rhododendrons and azaleas.

Minor or Trace Elements.—Some elements, though absolutely essential to plant growth, are utilized in minute quantities. Research on deficient areas and plant responses is much less complete than for the major nutrients.

Boron is important for cell division in the actively growing portions of plants. Boron (B) deficiencies cause stunting, discoloration and dying of the growing tips; are most likely to occur on sandy soils; and are aggravated by liming because the solubility of boron compounds decreases with increasing pH. Borax, $Na_2B_4O_7{\cdot}10H_2O$, with 11% boron, is commonly used to correct deficiencies and is applied in amounts from 25 to about 80 lb. per acre. Water-soluble types are sometimes applied as foliar sprays. Boron is found in Chilean nitrate, in the Searles lake brine in California and in other southwestern states.

Copper, as needed by plants, is deficient in only a few scattered areas of the world. It is supplied mainly as copper sulfate, $CuSO_4{\cdot}5H_2O$, and to some extent as cupric oxide, CuO, and in other copper compounds.

Iron is one of the most common elements in the earth's crust and is deficient usually only under alkaline conditions where its solubility is low. It is applied as ferrous sulfate, often in foliar spray. It is especially needed by acid-loving plants.

Manganese is most often deficient on alkaline soils because of low solubility of manganese (Mn) compounds. Foliar sprays are therefore often more effective than soil applications. Manganese sulfate, $MnSO_4$, is the main salt applied.

Molybdenum is one of the most recent elements to be proved essential. Soil molybdenum (Mo) supplies become more available as soil acidity increases. It is widely used in New Zealand and Australia on legumes. Cauliflower is especially sensitive to deficiency as are the related species, broccoli and Brussels sprouts. Sodium molybdate, $NaMoO_4{\cdot}2H_2O$, and ammonium molybdate are common sources. Deficiencies occur in citrus in Florida.

Zinc is commonly deficient for certain tree fruits in Florida and for corn in a few small areas in the United States. It is usually supplied in fertilizers as the sulfate $ZnSO_4{\cdot}7H_2O$ and is most effective as a foliar application.

Chelates and Frits.—Minor or trace element deficiencies are frequently caused not by a lack of the element in the soil but rather by a low availability because the nutrient is tied up in insoluble compounds. Minor elements have been formulated as frits (glass) and chelates (organic materials), in which forms they are not subject to soil fixation and are slowly available over a long period.

XIII. MANURES

Farm manure usually consists of animal feces and urine plus bedding materials. Of the nutrients consumed by farm animals about 75% of the nitrogen, 80% of the phosphorus and 90% of the potassium is voided and this constitutes an enormous fertility resource, although in comparison with chemical fertilizers it is low in concentration and subject to large nutrient losses when improperly handled. Approximately half the nitrogen and nearly all of the potassium is leachable if the manure is exposed to rainfall before being applied to the field. Part of the nitrogen in urine readily converts to ammonia and is lost by volatilization. Much of the organic matter may be oxidized and lost when the manure is stacked for several months. Effective techniques for reducing losses include the use of adequate bedding in the stable to absorb the urine; stacking the manure under cover or in pits to prevent leaching; spreading it on fields and incorporating it into the soil as soon as is feasible; and spreading preservative materials in the stable. The most widely used preservative is ordinary superphosphate which contains gypsum, $CaSO_4$, that reacts with ammonium carbonate, $(NH_4)_2CO_3$, to form ammonium sulfate from which the ammonium is not volatilized.

Home gardeners like to use well-rotted manure. It is less

odorous, more easily spread and less likely to "burn" plants. The production of rotted manure is wasteful of the organic matter and also results in great losses of soluble nitrogen and potassium unless it takes place under cover. Manure is a highly variable product depending upon kind of livestock as well as handling and storage methods. Widely used figures are ten pounds of nitrogen, five pounds of phosphoric acid, P_2O_5, and ten pounds of potash, K_2O, per ton of average stable manure including bedding. Sheep, goat and poultry manures average higher in all nutrients than these figures and these manures are often further concentrated by drying and sometimes by enriching with chemical fertilizers. Animal manures are lowest in phosphorus and this is the first element to consider adding. Typical rates to apply fresh stable manures are 8 to 20 tons per acre. (*See* also GUANO.)

In some of the most densely populated areas of the world, human excrement is an important source of fertilizer nutrients. A typical example is the "night soil" of China which has been used for centuries. Human excrement also makes up part of the sewage of large cities which is sometimes processed and sold as sewage sludge.

XIV. COMPOST

Home owners often have leaves, lawn clippings and garden refuse which may be effectively converted to compost, a product similar to well-rotted animal manure. Compost is made with plant residues, soil, fertilizer and sometimes limestone. The first three materials should be placed in alternate layers of four to six inches of residues, two to four inches of soil and one pound of a complete fertilizer for each eight to ten pounds of plant residues. One-half pound of limestone per pound of fertilizer will maintain a favourable pH for the microorganisms that decay the residues. The compost pile should be straight-sided, located preferably in a damp, shady place and kept moist but not saturated enough to leach soluble nutrients. Several months of summer weather are needed to fully decay the compost heap. The rate of decay may be accelerated by turning and mixing the pile at two-month intervals. Compost of this type is excellent for fertilizing or mulching shrubs and gardens.

See also references under "Fertilizers and Manures" in the Index volume.

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FÈS (FEZ; FAS), one of the four traditional capitals of Morocco and headquarters of Fès province, lies in the basin of the Sebou river 199 km. (124 mi.) E. of Rabat by road, and on the main rail and road routes between the Atlantic coast and Algeria. Pop. (1960 census) 216,133, including 9,390 foreigners.

Except to the southward, Fès is surrounded by low hills whose slopes are covered with olive groves and orchards growing oranges, apricots and pomegranates. The Fès wadi flowing northward to join the Sebou divides the old city, Fas al Bali or Fès Medina, into two parts: the Adwa al Andalusiyiu to the east and the Adwa al Qarawiyin to the west. On a plateau to the west stands Fas al Jadid or Fès Djedid (new Fès), founded in the 13th century and containing the royal palace and the Mellah, or Jewish quarter. To the southwest beyond the railway on another plateau is the modern city built by the French in the 20th century. The climate is pleasant from October to May but extremely hot in midsummer.

The old city has steep, narrow and sunless streets which are, however, kept fairly clean by periodically sluicing from conduits supplied from the abundant surface water; the dampness, however, renders Fas al Bali unhealthful. The remains of ancient battlement walls flanked by stone towers surround the two older quarters.

The Karouiine (Karaween or Karuwiyin) mosque, enlarged to its present form in the 12th century, is the largest in north Africa and can accommodate about 22,000 worshipers. Only Muslims are admitted but glimpses of the interior can be obtained through the 14 doors. The roof is supported by 270 pillars forming 16 naves each of 21 horseshoe arches; because of the vast area (about seven acres) covered, it appears very low. The large lamp, reputed to be the spoil from some Christian church, is said to weigh 1,763 lb. and to have 509 lights. Just westward of this mosque is the *zaouïa* (sanctuary) of Mulai Idris. Its sanctity is such that wooden beams are placed across the roads to deny approach to animals and to force pedestrians to bow. The sanctuary, which was rebuilt in 1437, contains the tomb of Idris II.

The Karouiine mosque is the centre of the university founded about 850, several of whose *medersas* (schools) are grouped around it. During the middle ages it had a great reputation as a centre of Islamic culture. When in the 13th century the Moors were expelled from Spain, many came to Fès bringing knowledge of European arts and sciences. By the 14th century there were said to be 8,000 students, most of whom lodged in tiny rooms in the *medersas*. The university, whose traditional studies are Islamic law, theology and literature, gradually declined and by 1950 retained a mere shadow of its former greatness. However, following Moroccan independence (1956) much was done to modernize it; a university housing estate was built, a new faculty of law inaugurated, women students were admitted for the first time and the tuition was progressively reorganized. Nevertheless, it remained somewhat eclipsed by the modern University of Rabat.

The Great mosque, one of the most beautiful in the city, with a 13th-century polychrome minaret, is located in Fas al Jadid; it is directly connected with the royal palace. Just south of the palace the Mellah contains amid its narrow crowded streets a number of synagogues and the numerous booths of Jewish goldsmiths, silversmiths and jewelers. The modern town, founded in 1916 by Marshal Louis Hubert Gonzalve Lyautey (*q.v.*) so as to leave unspoiled the character of the ancient city, dates mostly from the late 1920s; its industrial quarter adjoins the railway station. Most of the traditional crafts are pursued in the older quarters, such as the Quartier des potiers in the east of the Adoua al Andalous (pottery and glazed tiles). Until the late 19th century Fès was the sole manufacturer of the fez, the brimless, cylindrical, red felt hat worn by male Turks, for which the dull crimson dye was once obtained exclusively from a local berry also used in preparing Morocco leather.

Fès is linked by standard-gauge railways through Meknes to Tangier, Rabat, Casablanca and Kenitra and eastward with the Algerian system. Saiss airport lies 14 km. (8½ mi.) S.E.

FÈS PROVINCE stretches northward to the foothills of Er Rif, southward to the Middle Atlas and eastward to the Taza region. Pop. (1960 census) 830,999, including 11,488 foreigners. It includes the suburbs of Fès, the districts of Karia-ba-Mohammed and Taounat in the north and the districts of Sefrou and Boulemane in the south. Sefrou, 28 km. (17 mi.) S.S.E. of Fès by road, is an attractively situated town at the foot of the Middle Atlas, surrounded by orchards and having a large Jewish population.

History.—Modern historians believe that the first settlement was founded in 790 on the right bank of the Fès wadi by Idris the Elder. His son Idris II in 808 founded the left-bank settlement; soon afterward he installed about 8,000 refugee families from Córdoba in Andalusia, Spain, on the right bank (whence Adoua al Andalous); later about 3,000 Arab refugees from Kairouan in Tunisia were settled on the left bank (whence Adoua al Karouiine). These parts were united by the Almoravid sultans in the 11th century, and as the centre of an independent kingdom became one of the first cities of Islam. Under the Marinid sultans Fès reached its zenith, having about 200,000 inhabitants in mid-14th century. It declined under the Sa'adi and Filali dynasties, who chose Marrakech (Marrakesh) as their capital. The French writer Pierre Loti described Fès as a dead city in 1889. In 1911 the French entered Fès at the request of the sultan, who sought aid in quelling a Berber rebellion. There on March 30, 1912, was signed the treaty of Fès establishing the French protectorate; this was terminated on April 7, 1956. During the later years of the protectorate Fès lost ground economically to Casablanca and following Moroccan independence was politically overshadowed by Rabat, retaining only its religious primacy.

See R. le Tourneau, *Fès avant le Protectorat* (1949). (A. Am.)

FESCENNINE VERSES (Lat. *Fescennini versus*, also called *carmina Fescennina*), a native Italian form of poetry. At vintage and harvest, according to Virgil and Horace, and probably at other rustic festivals, according to Tibullus, masked dancers sang jocular dialogues in verse. Festus and Symmachus state that similar songs were in use at weddings. Horace states that they became so abusive that a law was passed to check them; apparently the provision of the Twelve Tables which forbade a *malum carmen* (evil song; *i.e.*, charm intended to hurt) was stretched to include libelous verses. Macrobius refers to *Fescennini* written by Augustus attacking Asinius Pollio. It is also clear from the literary imitations by Catullus (in lxi) and Claudian (xi–xiv) that they were very free, even obscene, in language. Festus says that they averted the evil eye and that therefore some connected the name with *fascinum*. This derivation is supported by G. Michaut in *Histoire de la Comédie romaine: sur les tréteaux latins* and by other scholars, but they suppose *fascinum* to have the sense of "phallus," not "evil eye."

The true derivation may be from Fescennia, an Etruscan city, but it may reasonably be supposed that in their origin they had a magico-religious intent, abuse, buffoonery and obscenity being well-known fertility or luck charms. That they developed into the dramatic satura and thus gave birth to the beginnings of a native drama is implied by Livy but has been seriously doubted in modern times.

See E. Paratore, *Storia del teatro Latino*, pp. 11–14 (1957).
(Wm. Be.)

FESCH, JOSEPH (1763–1839), French cardinal chiefly remembered for his role in the troubled relationship between the first empire and the papacy, was born at Ajaccio in Corsica, on Jan. 3, 1763, the half brother of Napoleon Bonaparte's mother, Letizia Ramolino. Ordained in 1785, Joseph Fesch became archdeacon and canon of Ajaccio in 1787, in succession to his uncle Lucien Bonaparte. A supporter of the Revolution, he obtained municipal office and, having taken the oath to the civil constitution of the clergy (1790), became episcopal vicar.

Proscribed by Pasquale Paoli's followers, to whom the Bonapartes were opposed, Fesch took refuge with the latter at Toulon in 1793. He then left the church and became an army storekeeper. Accompanying his nephew Napoleon, now General Bonaparte, on the Italian campaign, he made some lucrative deals, so that after the *coup d'état* of Brumaire (Nov. 1799) he was able to live in luxury in Paris in a magnificent house that he had built. After the concordat of 1801 with the papacy, Fesch was appointed archbishop of Lyons (1802). This entailed his return to the church and he underwent a genuine conversion due to the influence of Jacques André Émery, superior of the Compagnie de St. Sulpice. Fesch proved a good administrator and devoted himself especially to the work of the seminaries and missions. In 1803 he was created cardinal. He was then appointed French ambassador to Rome.

Undiplomatic and unstable in character, Fesch failed to ease a situation that Napoleon's demands made ever more difficult. He mismanaged the preliminary negotiations over Napoleon's consecration as emperor, and his behaviour stiffened resistance to Napoleon's enterprises against the neutrality and independence of the Holy See. He quarreled with Chateaubriand, then secretary of the French legation, and indulged in a most ill-advised campaign against the cardinal secretary of state, Ercole Consalvi (*q.v.*), whose resignation he provoked. Recalled to France in 1806, he made a final scene at his farewell audience with Pope Pius VII. He had already accepted appointment as coadjutor to Karl von Dalberg, prince bishop of Regensburg and primate of Germany.

From 1809, however, when the pope was a prisoner in France, Fesch rallied to the defense of his cause. He refused to accept nomination by Napoleon to the archbishopric of Paris (1809) and opened the council of the Gallican Church in 1811 with a declaration of loyalty to the pope. Napoleon soon dissolved this council, and Fesch was sent to his diocese. When the police intercepted a secret letter of his to the pope, he was threatened with internment.

After the Hundred Days (1815) Fesch retired to Rome, where he died on May 13, 1839, still archbishop of Lyons, since the pope would not comply with the Restoration government's demands for his deposition.

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FESCUE, the name given to the numerous and widely distributed perennial grasses of the botanical genus *Festuca*, found chiefly in temperate and cold regions, among which are several pasture and fodder grasses of agricultural importance and a few grasses used in lawn mixtures.

The most important as a pasture grass is the tall or meadow fescue (*F. elatior*) common throughout Europe and in parts of Asia, and widely cultivated and naturalized in the United States and Canada. It grows to a height of from two to five feet and is regarded as one of the most valuable grasses for both fodder and permanent pasture.

The red fescue (*F. rubra*), found throughout cool north temperate regions, is sometimes grown in meadows. The sheep's fescue (*F. ovina*), native to the Himalayas and certain mountainous districts of North America and Europe, and widely naturalized in north temperate regions, is sometimes used in dry pastures. A form called the blue fescue (var. *glauca*), with silvery glaucous leaves, is grown for ornament. *Festuca ovina capillata*, alone or in mixtures, is a good lawn subject for shaded areas.

Grasses closely related to *Festuca* include bluegrass and brome grass (*qq.v.*).

See also Grasses.

FESSENDEN, WILLIAM PITT (1806–1869), U.S. senator and cabinet member, was born in Boscawen, N.H., on Oct. 16, 1806. In 1823 he graduated from Bowdoin college, Brunswick, Me., and began to study law. He was admitted to the Maine bar in 1827 and soon established himself as one of the most successful lawyers in the city of Portland. In 1841 he went to Washington as a Whig representing the 2nd Maine district (Portland area) in the U.S. house of representatives. But congressional life proved not at all to his liking and he left the capital in disgust in 1843, determined never to return. During the late 1840s and early 1850s, however, the rising controversy over slavery caused him to abandon his earlier resolve.

In 1854 he returned to Washington to represent Maine in the senate, a position he held (save for a few months when he was in Lincoln's cabinet) until his death 15 years later. During the critical years preceding the American Civil War, Fessenden was a member of a small band of northern senators who opposed the extension of slavery into the territories. He was in the forefront of the movement that resulted in the formation of the Republican party.

Fessenden served during the war as chairman of the important senate finance committee. Upon the resignation of Secretary of the Treasury Salmon P. Chase in mid-1864, Fessenden reluctantly accepted President Lincoln's appointment to the treasury post, where he served for the next eight months. With the war's end already in view at the time of his appointment, Fessenden for the most part adhered closely to the policies of his predecessor.

In March 1865 Fessenden returned to the senate where he took issue with those who advocated more severe reconstruction measures. He was especially opposed to the impeachment of President Johnson in 1868, and his vote for Johnson's acquittal virtually alienated him from the party he had done so much to form. He died on Sept. 8, 1869, at Portland.

See Charles Jellison, *Fessenden of Maine* (1962). (C. A. J.)

FESTIVAL: *see* Feast and Festival; Church Year; Holiday; Jewish Holidays; Music Festival.

FESTOON, an ornament developed from the representation of a garland of leaves, fruit or flowers, cloth or ribbon, supported at two or more points and hanging in curves between. The festoon appears occasionally in late Greek work, particularly as a decoration for Hellenistic altars, but it was the Romans who gave it definite form. Roman festoons are usually made of fruit, grain,

leaves and flowers, treated with extreme naturalism, although in wall paintings and stucco decoration simpler and more conventional types are found. The festoon was a favourite motive of the early Italian Renaissance. In baroque work throughout Europe many fantastic treatments of the cloth festoon exist.

FESTUS, SEXTUS POMPEIUS (2nd or 3rd century A.D.), Latin grammarian, probably born at Narbo in Gaul, who made an abridgment in 20 books of Marcus Verrius Flaccus' *De verborum significatu.* In this work Festus made a few insertions and comments of his own. The first half of it is lost but a further abridgment of it, made by Paulus Diaconus in the 8th century, survives. Latin words which had long been obsolete he removed with the intention of including them in a separate work (*Priscorum verborum cum exemplis*), but whether this was ever written is doubtful. The remains of Festus' abridgment exist in only one manuscript, the *Codex Festi Farnesianus* at Naples, of which a facsimile was published at Budapest in 1893 by A. Thewrewk de Ponor.

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FET (Foeth), **AFANASI AFANASIEVICH** (1820–1892), Russian pantheistic, lyrical poet and translator, who assumed by decree in 1876 the name of Shenshin, was born at Novoselki, Orel *oblast,* on Dec. 5 (new style; Nov. 23, old style), 1820, the illegitimate son of a landowner named Shenshin. He was still a student at Moscow university when, in 1842, he published several admirable lyrics in the *Moskvityanin.* In 1850 a volume of his poems appeared, followed by another in 1856. He served several years in the army, retiring in 1856 with the grade of captain. In 1860 he settled on an estate at Stepanovka, where he was often visited by Turgenev and Tolstoi. Fet's sincere and passionate lyric poetry strongly influenced later Russian poets, particularly the symbolist Aleksandr Blok (*q.v.*), but during his lifetime he was decried because of his reactionary political views and somewhat unattractive personality. He published very little after 1863, but he continued to write nature poetry and love lyrics which were published in a collected edition (four volumes, 1894).

Fet also made some fine translations from Latin: Horace, Catullus and Tibullus; and from German: Schopenhauer and Goethe's *Faust* and *Hermann und Dorothea.* He died in Moscow on Dec. 3 (N.S., Nov. 21, O.S.), 1892.

See a paper on Fet in Oliver Elton's *Sheaf of Papers* (1922), which includes several translations.

FETAL DISORDERS, or disorders affecting the unborn human fetus, may be responsible for premature delivery, for the birth of a sick or malformed infant, or may cause death before birth, depending on the severity and variety of the disturbance.

Abortion, Stillbirth, Premature Birth.—The expulsion of a dead fetus in the first half of pregnancy is generally called an abortion; in the latter half of pregnancy it is designated a stillbirth or a late fetal death. The distinction between abortions and stillbirths has never been definitely settled and is based largely on state requirements for reporting, often 20 to 22 weeks. These subjects are discussed in separate articles Abortion; Stillbirth; and Premature Birth.

Postmature Birth.—On rare occasions pregnancy may be prolonged sufficiently to damage the child. If pregnancy does not end within three or four weeks of the normal time, the placenta may begin to degenerate and may not be able to supply the fetus with the materials it needs for survival and growth; in such cases death may occur before or during labour. The fetus is ordinarily not unusually large, but its skin may be dry and wrinkled, its fingernails and hair unusually long, and it may seem to be unusually mature. In some instances of prolonged pregnancy, however, the fetus becomes unusually large; this is a hazard to the fetus because delivery is often difficult, and the likelihood of injury is greater than when it is of normal size.

Growth of the fetus to an excessive size (over 4,500 grams or 10 lb.) during the normal length of pregnancy is rare except when the mother suffers from diabetes mellitus or is prediabetic. It has been shown that symptoms of diabetes generally appear within a few months or years following the delivery of an excessively large child, in a woman previously apparently nondiabetic. Any woman giving birth to an unusually large infant should be examined to determine whether or not she may be developing diabetes.

Erythroblastosis Fetalis.—Erythroblastosis fetalis is a disorder which has its origin during intra-uterine life as a result of incompatibility of the blood of the mother and the fetus. This is most often on the basis of the Rh factor, although the AB blood group is sometimes responsible.

Fetal blood cells are thought to escape from the placenta into the maternal circulation during any pregnancy. If the blood groups of the mother and the fetus are compatible, no harm results. If the mother is Rh-negative and the fetus is Rh-positive (by inheritance from its father), the mother may be stimulated to produce antibodies against the Rh-positive cells. Since Rh-positive blood cells are not normally present in her body, the response is the same as it would be to bacteria or any other foreign substance, and antibodies are produced for the specific purpose of destroying Rh-positive cells. These antibodies against Rh-positive cells are so minute that they are able to penetrate the placenta and get into the blood of the fetus. Since their function is to destroy Rh-positive cells, they destroy varying amounts of fetal blood. This may result in anemia. If the fetus is able to produce enough blood cells to compensate for the destruction, anemia will not develop or will be mild. If the fetus cannot produce enough blood to keep pace with the destruction, it will be anemic at birth and will require immediate blood transfusions if it is to survive. Blood destruction continues after birth, producing excessive bilirubin, which gives the skin a yellow colour known as jaundice or icterus; parts of the brain may be injured if jaundice is severe and prolonged. A form of treatment designated "exchange transfusion," in which the Rh-positive blood of the infant is removed and Rh-negative blood substituted, removes the bilirubin from the circulation and prevents brain damage. Only 5% of Rh-negative women give birth to infants affected by erythroblastosis. A few fetuses are so severely affected that they die before birth and are stillborn, but the majority are born alive and most of these can be saved by modern treatment; a short time after birth they are entirely normal infants.

Pneumonia.—A fetus may develop pneumonia before birth. Throughout intra-uterine life the fetus normally inspires small amounts of the amniotic fluid by which it is surrounded. This is ordinarily sterile until labour begins or until the sac containing the fluid ruptures. Then bacteria enter, and if labour is very prolonged or if the bag of waters breaks before labour begins, enough bacteria may be inhaled by the fetus to cause pneumonia. Although this may be responsible for death before birth, more often the infant is ill when it is born but does not die for several hours, or may recover.

Malformations.—Malformations may be the cause of late fetal deaths or stillbirths, just as they may be responsible for early fetal deaths or abortions. The agents responsible for malformations in the human infant are almost entirely unknown, although many of the conditions that may be responsible for abortions are thought also to cause malformations. Thalidomide, a tranquilizer, was shown in 1962 to cause phocomelia in the infant if taken by the mother early in pregnancy.

See also Abortion; Monster; Stillbirth; Premature Birth; Placenta and Fetal Membranes, Diseases of; Maternal and Child Health; Embryology, Human; Obstetrics; Heredity.

See Edith L. Potter, *Pathology of the Fetus and the Newborn* (1952); J. Edgar Morison, *Foetal and Neonatal Pathology* (1952).
(E. L. Po.)

FETISHISM, a term denoting two quite different phenomena: (1) the use of magic charms by peoples in west Africa and the Congo region; (2) a form of sexual deviance involving erotic attachment to an inanimate object or an ordinarily asexual part of the human body, such as the foot.

Derivation.—The word fetish (or fetich) had its origins in *feitiço,* literally "something made," a Portuguese word referring to the magic charms used by Europeans in the latter half of the

15th century, when Portuguese explorers first arrived in west Africa. They applied the term to the charms and amulets of the indigenous peoples. It was taken into French as *fétiche,* also in regard to west Africa. Auguste Comte characterized primitive religion in general as fetishism, which he thought of as the attribution of human mental qualities to nonhuman bodies. E. B. Tylor (1873) gave the name animism to this general characteristic, restricting fetishism to the doctrine of spirits embodied in, or attached to, or conveying influence through certain material objects. The latter concept of fetishism was the one most commonly used in anthropological writings of the late 19th and early 20th centuries. That it also influenced psychiatric usage is indicated by Sigmund Freud's reference, in his *Three Contributions to the Theory of Sex,* to the sexual object substituted by the fetishist as being comparable to "the fetich in which the savage sees the embodiment of his god."

Anthropological Usage.—Professional anthropologists have stopped using the word fetishism, partly because it has been applied indiscriminately in descriptions of west African religions, partly because the anthropological study of religion has come to place less emphasis on material artifacts than on the systems of supernatural belief and ritual in which these artifacts play a significant but minor role. M. J. Herskovits states:

> The magic charm takes many forms. It most often includes some part of the object or individual over which its power is to be exerted; or some element that, because of outer resemblance or inner character, habitually achieves the result the charm is supposed to bring about. One word that has been applied to charms is *fetish,* and no term has proved more troublesome than this and its companion *fetishism.* . . . These terms are mentioned here because they are encountered so often in the literature, as when it is said that "fetishism is the religion of Africa." When used at all, they should be employed in the sense of "charm" and "magic"; but they are far better omitted from any discussion of the means whereby man controls the supernatural. (M. J. Herskovits, *Man and His Works,* p. 368, Alfred A. Knopf, Inc., 1948).

Psychiatric Usage.—Fetishism as a mental condition may be defined as the necessity to use a nongenital object in order to achieve sexual gratification. The object may be some other body part, an article of clothing or, less frequently, some more impersonal object. The condition occurs almost exclusively among men, and most of the objects used relate to the female body or female clothing. Long hair or the foot may be the primary object of sexual attention; cases in which a certain hair colour or type of body blemish is required for sexual stimulation are also generally classified as fetishism. The articles of clothing most commonly used are shoes, corsets and other items of female underclothes. Olfactory sensations are also frequently important. A certain degree of fetishism is sometimes found in normal premarital sex lives, especially during those stages of courtship when the normal sexual aim seems inaccessible or its realization deferred. In this connection Freud quotes a line from Goethe's *Faust:* "Get me a handkerchief from her bosom—a garter of my love." It is when contact with the fetish becomes an end in itself that it is considered pathological.

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FETTERS AND HANDCUFFS: *see* Handcuffs and Fetters.

FETTI (Feti), **DOMENICO** (1588/89–1624), Italian painter of the baroque period, was born in Rome and died in Venice, apparently as the result of dissipation. In Rome he was a pupil of Lodovico Cigoli but was principally influenced by the followers of Michelangelo Merisi da Caravaggio and also by Adam Elsheimer. Through Cigoli he attracted the attention of Ferdinando Cardinal Gonzaga. The cardinal went to Mantua to become Duke Ferdinando II, and Fetti became his court painter about the end of 1613. At Mantua he saw the works of Rubens as well as those of Giulio Romano, and his style was considerably modified. Later, the influence of Venetian art was even more marked although he probably first visited the city about 1621 to buy works of art for his patron. At the end of Aug. 1622 Fetti left Mantua, apparently very hurriedly, and went to Venice, refusing to return in spite of the duke's efforts.

Fetti's best-known works are small, with small-scale figures, and painted in bright, rich colours, many of the most popular being representations of the biblical parables as scenes from everyday life. There are examples in Hampton court, Dresden, Mantua, Venice and Vienna of these and of other works.

See Baglione, *Vite de' Pittori . . .* (1642); M. Endres-Soltmann, *D. F.* (1914); R. Oldenbourg, *D. F.,* mainly pictures (1921). (P. J. My.)

FETUS, the unborn young of any vertebrate animal, particularly of a mammal. Biologists arbitrarily speak of the earliest stages of development of the fertilized egg (ovum) as the embryonic period. This period ends when the external form of the embryo begins to resemble clearly the newborn of the group to which it belongs. The next period, culminating in birth, is spoken of as the fetal period. Likewise a distinction is made between the embryo and the fetus. In human development this transition occurs at approximately the end of the ninth week after fertilization. At this time the embryonic clefts (harelip) of the face disappear, the paddlelike embryonic limb buds develop free fingers and toes and so take on the form of the human limbs, and the relatively long embryonic tail has nearly disappeared. After these changes and until birth the distinctly human-appearing embryo is technically a fetus.

See Embryology; Embryology, Human; Fetal Disorders; Pregnancy; Embryo. (H. W. Mn.)

FEU, a Scots variant of fee (*q.v.*), the common and essentially feudal mode of landholding which, despite much legislative change, is still prevalent in Scotland. The crown is the prime owner or "superior" of land and makes grants to "crown vassals" who in turn may feu their land to others. There is thus a chain of subinfeudation, which in theory may be prolonged indefinitely. In feu holding proper, as distinct from blench and burgage holding, which are less important and which involve the performance of certain services or the payment of a nominal sum, the vassal annually pays a substantial feu duty, and failure to pay may lead to forfeiture of the holding. *See* Scots Law: *Land Tenure.* (A. D. G.)

FEUCHÈRES, SOPHIE DAWES, Baronne de (1795?–1840), English adventuress, mistress of the last survivor of the princes de Condé (*q.v.*), was born a fisherman's daughter at St. Helens, Isle of Wight. After a miserable childhood, she became a servant in London, where the *émigré* Louis Henry Joseph, duc de Bourbon, made her his mistress. He gave her a good education, and she followed him to France (1815) at the Restoration. In 1818 she was married in London to Adrien Victor de Feuchères, who next year was given the title of baron and made aide-de-camp to the duke. Feuchères, who had been assured that Sophie was the duke's daughter, discovered the facts of the relationship and in 1824 abandoned her, and Louis XVIII forbade her to appear at court. Though the duke made a will in 1824 leaving to Sophie the domains of St. Leu and Boissy, the income from which she was to enjoy in advance, she sought to secure her future by coming to an understanding, in 1827, with the house of Orléans (*see* Bourbon) and was chiefly instrumental in procuring the duke's will of 1829, whereby he, the former royalist *émigré,* took as his principal heir Henri, duc d'Aumale, fifth son of Louis Philippe and a grandson of that Philippe Égalité who had voted for Louis XVI's death. In 1829 the duke had given his mistress the forest of Enghien. Legally separated at last from Feuchères, Sophie was readmitted to court in 1830 by Charles X, thanks to Louis Philippe's influence. After the July revolution of 1830, when Louis Philippe became king of the French, relations between Sophie and the duke seem to have deteriorated. He may have thought of emigrating again, but on Aug. 27, 1830, he was found hanged from a window at St. Leu. Vain attempts were made to upset his will. The *baronne* left France, to die in London on Dec. 15, 1840. (Je. V.)

FEUCHTWANGER, LION (1884–1958), German novelist and playwright known for his historical romances in which, as he says, he has taken from the past "the fire . . . not the ashes,"

was born in Munich on July 7, 1884, of a Jewish family. He studied philology and literature at Berlin and Munich (1903–07) and took his doctorate in 1918. He had already begun his career, working on a periodical, *Die Schaubühne* (1908–11), and writing and translating several plays, mainly with political themes, and in 1918 he founded a literary paper, *Der Spiegel*. His first historical novel, *Die hässliche Herzogin* (1923, *The Ugly Duchess*, 1927), about Margarete Maultasch, duchess of Tirol, showed the detailed knowledge and imaginative power that enabled him to make the past come alive for modern readers. In *Jud Süss* (written 1921, published in 1925; *Jew Süss*, 1926), set in 18th-century Germany, he was even more successful, revealing a depth of psychological analysis that remained characteristic of his best work—the *Josephus-Trilogie* (*Der Jüdische Krieg*, 1932, Eng. trans. *Josephus; Die Söhne*, 1935, Eng. trans. *The Jew of Rome; Der Tag wird Kommen*, 1945, first published in England as *Josephus and the Emperor*, 1942); *Die Geschwister Oppenheim* (1933; *The Oppermans*), a novel of modern life; and *Der falsche Nero* (1936; *The Pretender*, 1937).

Feuchtwanger had traveled in Italy and north Africa (1912–14) and in France and Spain (1926). In 1933 he was exiled and moved to France, from which he escaped to the United States in 1940 after some months in a concentration camp, described in *The Devil in France* (1941). Of his later works the best known are *Proud Destiny* (1947), *Goya oder der arge Weg der Erkenntnis* (1951; *This Is the Hour*, 1952) and *Jephthah and His Daughter* (1958), which, although vivid, show a tendency to verbosity and historical inaccuracy. In Germany he continued to be remembered for his plays, which, banned during World War I, later achieved success. He died at Los Angeles, Calif., on Dec. 21, 1958.

FEUDALISM, in the limited, technical sense to which some scholars would restrict the term, means a social system of rights and duties based on feodo-vassalitic relations; *i.e.*, a system of land tenure and personal relationships in which land (and to a much lesser degree other sources of income) is held in fief by vassals from lords to whom they owe specific services and with whom they are in a bond of personal loyalty, having done homage to them before being invested with their fief. In a broad sense the term denotes what some scholars would prefer to call "feudal society," a form of civilization and a type of society with certain general characteristics beside the mere presence of lords, vassals and fiefs. In such a society those who fulfill official duties, whether civil or military, do so not for the sake of an abstract notion of "the state" or of public service but because of personal and freely accepted links with their overlord, finding their remuneration in fiefs which they hold hereditarily (this is especially the case with military functions, an upper layer of professional soldiers and a martial outlook being conspicuous feudal traits). The idea then is accepted that various public functions are linked with the fief rather than with the person who holds it, so that public authority becomes fragmented and decentralized. Historically linked with feudalism, moreover, though itself a different phenomenon, is the manorial or seigniorial system in which landlords exercise over the unfree peasantry a wide variety of police, judicial, fiscal and other rights (*see* MANOR; SERFDOM). The military aristocracy, largely autonomous, wielding wide powers over dependent peasants, is the most striking social aspect of feudalism, which flourishes especially in a closed, agricultural economy.

Comparative history has revealed that several of the great civilizations of the world have passed through a feudal period in the course of their history; and the sequence "feudalism-capitalism-socialism" is a well-known feature of the Marxist doctrine on economic and social development. Some of these feudalisms, for instance the Japanese (*see* DAIMYŌ), are indeed quite comparable with the feudalism of western Europe and of the Latin east, with which this article is concerned. From this comparative study it seems that certain political and mental factors have played an important role in bringing feudalism about. Feudalism, for example, may emerge when a large empire has been built without the various psychological and material factors required for its central administration and defense, such as a mentality able to grasp the notion of the state, an adequate fiscal system or a sufficient net of road communications. The difficult period of transition from tribe to modern state seems particularly fertile soil for feudalism. Even so, feudalism is only a possible, not a necessary stage in the development of civilizations or nations.

HISTORICAL DEVELOPMENT

Origins.—The origins of European feudalism are to be found in the early Carolingian period of the Frankish kingdom, in the 8th century A.D., when the granting of fiefs on the one hand and the establishment of personal vassalitic bonds on the other were linked together. This linking finally established the feodo-vassalitic system and may safely be stated to have inaugurated feudalism, even though remote roots of the system may be detected in certain institutions of the late Roman empire and of the Germanic invaders.

Such roots were the Roman *patrocinium*, whereby lesser men (*clientes*) depended on powerful personalities (*patroni*); the Roman *immunitas*, a privilege which placed certain private estates outside the state's authority (at least to some extent); and the Germanic *Gefolgschaft*, the band of devoted soldiers surrounding a war leader (for the royal *trustis* see ANTRUSTION). On the basis of these traditional elements the Frankish kingdom had seen the development of vassalitic relations. Through a formal act of *commendatio* (recommendation) able men of lesser social status put themselves under the authority and protection of a powerful person, who might be the king himself; variously designated as *vassi, gasindi, pueri*, etc., they conserved their free status but promised loyal service and expected to be fed and clothed in return. On the other hand, in this same period land was being given out in benefice (*beneficium*), a form of tenure on terms very favourable to the tenant. Great ecclesiastical landowners, especially, used this form in order to get persons to cultivate the landed wealth that they could not themselves directly exploit; and the term *beneficium* is found used for tenures given out on the basis of a *precarium* contract—that is, granted to a tenant for his lifetime only and at his request.

From the early centuries are found examples of benefices being granted occasionally by lords to their *vassi*, but it was not until the second half of the 8th century that the important development occurred; viz., that the linking of vassalage and benefice became normal in the sense that benefices were normally given to vassals and to them as vassals of the grantor. Moreover, it was in this period that the Frankish kings adopted the system. Whereas previously their grants of land to their followers had been in full ownership, now they began more and more to grant land in benefice only; *i.e.*, they kept the ownership to themselves and granted only a wide right of use and exploitation. The process had started during the rule of Charles Martel, who, in the emergency of the Saracen threat, took church lands and granted them to his vassals so that they could equip themselves and be free for warfare. The church had protested, but toward the middle of the 8th century a settlement had been reached whereby these lands were acknowledged to belong to the church but were for the most part left in the actual possession of the royal vassals, with the proviso of a recognitory payment to the ecclesiastical owner. The Frankish kings then started systematically to grant land in benefice out of their own property to their own vassals, normally for life; they retained to themselves ownership and the right to grant the land to someone else at the end of the vassalitic contract. About the same time public functions were also being given in benefice to royal vassals. The king's example was quickly followed by various lesser lords.

Expansion and Maturity.—Feudalism spread with the Frankish conquests into northern Italy and into Germany and was later carried farther eastward from Germany into the Slav territories. In Spain the Franks introduced it into the northeastern territories, whence it went ahead as the country was reconquered from the Muslims. When the Norsemen settled in what came to be known as Normandy they adopted and developed feudal institutions, which their descendants took to England in 1066 and to southern Italy and to Sicily a few years later. From England feudalism spread to Scotland and to Ireland. Finally the terri-

tories the crusaders conquered in the east were given a strong feudal organization (*see* CRUSADES). Certain areas of Europe, however, escaped feudalism and passed directly from an archaic communal system to modern absolutism; *e.g.*, most of Scandinavia, Frisia and tracts along the North sea in the Low Countries.

Internally the system developed greatly in the course of the 9th century, as its institutions were ever more widely applied and more generally recognized. Of particular importance was the transformation of the benefice into a hereditary fief. By the end of the century the centrifugal tendencies of feudalism were already evident. Royal power declined and local dynasties of vassalitic dignitaries became in fact independent and started to build up small territorial states for themselves. The anarchical side of feudalism gained the upper hand—an evolution that started in the west and spread eastward in the Old Frankish lands. From the 10th to the 12th century feudalism was at its zenith and came to permeate and shape almost every aspect of society.

Decline.—It was likewise in the west that feudalism began to decline as a social force, from the 12th century onward, but there was a notable interval before the decline spread eastward (Frederick I Barbarossa in the second half of the 12th century had tried to use feudalism on a large scale in order to give his large empire a greater cohesion). Feudalism came, indeed, under the attack of various rival forces. The centralized state with its salaried officials and its mercenary armies was being built on Roman ideas about sovereignty and the safeguard of public order; also the relation of subject to sovereign was taking the place of the relation of vassal to lord as the basis of ordered society. The towns, growing in economic power and even forming their own militias, were able to a large extent to impose their own concepts about society against those of the knights (*see* COMMUNE [MEDIEVAL]). The manorial system, material basis of the knightly class, was undergoing in the 12th and 13th centuries a deep economic crisis. The church also was dealing feudalism some heavy blows, because feudal institutions had resulted in that entanglement with lay authority against which ecclesiastical feeling ran so high, especially in the case of the investiture by kings of bishops and abbots with their ecclesiastical dignities and their consequent homage to the king (*see* INVESTITURE CONTROVERSY). Finally the renewed study of Roman law sapped the legal concepts that were at the basis of feudalism and fostered their replacement by superior ones.

If it is true that the 13th century was the last great century of feudalism as a political and social force, it must nevertheless be remembered that feudalism survived for a very long time as a system of land tenure with its own rules of acquisition, transfer and inheritance. Thus feudal lands, for instance, came to be acquired by members of the *bourgeoisie* like any other capital wealth; several feudal institutions remained in land law well into the 20th century. The feudal class became a nobility serving the crown in various capacities and dependent on the crown for its economic and social privileges.

FEODO-VASSALITIC INSTITUTIONS

Many of the institutions of feudalism in its limited sense betray the general outlook of an age when men were not much given to abstract thinking on practical matters but sought to symbolize legal realities by some concrete, observable object or movement and preferred to owe and to give allegiance to individuals rather than to any less tangible entity.

The Lord and the Vassal.—The lord (Lat. *dominus, senior*) accepted someone as his vassal and invested him with his fief. Originally the fief was only a means to an end, the loyal and exclusive personal service of the lord, whence it followed that one could only be the vassal of one lord. Toward the end of the 9th century, however, instances occurred in France of individuals becoming the vassals of more than one lord, apparently because the thirst for fiefs was strong. This practice was a threat to the basis of feudalism, since it undermined the loyalty of the vassal who could all too easily play off one lord against another. Hence a distinction came to be established between the ordinary lords of a vassal who had many fiefs and his principal lord, to whom he owed allegiance above all others. This is the liege lord (*dominus ligius*) and the fief held of him is the liege fief (*feodum ligium*). This system (*ligantia*) appeared in the middle of the 11th century in France and may have originated in Normandy. Even so, the desire to acquire more fiefs sapped this institution in its turn, and from the 12th century onward one person might be the liege vassal of several lords. The king, however, was considered always to be the liege lord, and the proviso "save my fealty due to the king" became widely used in feudal contracts. It was compulsory in England from early in the 12th century and became general in France in the 13th, but attempts by the crown (Frederick Barbarossa) to introduce the same formula into Germany in the 12th century failed.

The word vassal is of Celtic origin; early Latin forms were *vassus* and *vassallus* with *homo* (man), *miles* (soldier) and *fidelis* (faithful) as alternatives, *homo* and *vassallus* being the terms that finally survived. Most vassals were *vassi casati; i.e.*, provided with a fief which they caused to be exploited for themselves. A minority, however, were not thus provided (*vassi non casati*) and lived at their lord's court as his household knights. Certain vassals who held their fiefs directly of the crown were tenants in chief and formed, to speak generally, the most important feudal group, the barons (*see* BARON). A fief held by tenants of these tenants in chief was called an *arrière-fief*, and when the king summoned the whole feudal host he was said to summon the *ban et arrière-ban*. The name vavassor (*q.v.*) was often used to designate the modest knights who held their fiefs from territorial princes or other important lords, in contrast with the king's barons. Female vassals occur as early as the 10th or even the late 9th century in France, their services being fulfilled by their husbands.

The Fief.—The fief (*beneficium;* later *feodum*, from Old Frankish *fehu-od*, "cattle," a valuable movable good) was the central institution from which the word feudalism is derived. The fief was the source of income which the vassal held of his lord. The opposite of the fief was the allod (*allodium*), property freely owned and held of nobody. The fief consisted normally in land to which unfree peasants were attached and which was supposed to support the vassal. Hence arose the idea of the knight's fee (in England, *feodum militis;* in Normandy, *feodum loricae*), supposed to be sufficient for the upkeep of one knightly family; *i.e.*, for securing one knight service (*q.v.*) to the lord of whom the fief was held. Its size varied greatly, the income being the criterion; in England, for example, in the 12th century a yearly income of £20 was deemed sufficient. It has been calculated that about 15–30 peasant families were needed to keep one knightly household. Fiefs varied widely in extent, ranging from huge estates and whole provinces to a plot of a few acres. Beside land, dignities and offices and also money rents were given in fief. The latter (*feodum de bursa*) were used on a large scale by the English kings to bind territorial princes on the European continent to their cause.

Homage.—Homage (*commendatio;* later *hominium, homagium*) was the solemn ritual act by which the vassalitic bond was established. It consisted of a symbolic gesture and a declaration and was followed by an oath of fealty to the lord (*fides, sacramentum fidei*), accompanied in certain areas by a kiss (*osculum*). After it the lord performed the symbolic investiture (*investitura, infeodatio*) of the new vassal, handing over to him some object representing his fief. (*See* HOMAGE.)

Duties and Rights.—Under the vassalitic contract the lord had the duty to provide the fief for his vassal, to protect him and to do him justice in his court. In return he had the right to demand the services attached to the fief (military, judicial, administrative, etc.) and a right to various "incomes," known as feudal incidents. Such were relief (*relevium*), on the transfer of the fief to an heir or on alienation of his fief by a vassal; scutage (*q.v.*), a tax replacing military service, and various aids (*see* AID); wardship, that is, the lord's right to take back into his demesne the fief of a minor whom the lord had to look after; and marriage, an income based on the right of the lord to marry the tenant's daughters. To speak generally, arrangements of an arbitrary character were gradually replaced by a system of fixed dues on occasions limited by custom. (*See* also SERJEANTY.)

The vassal, conversely, owed fealty to his lord. A breach of

this duty was felony (*q.v.*), which was regarded as so heinous an offense that in England all serious crimes, even those that had nothing to do with feudalism proper, came to be called felonies, since in a way they were breaches of the fealty owed to the king, guardian of the public peace and order. The vassal was likewise bound to render *auxilium et consilium* (effective help and counsel) to the lord, with particular reference to the special requirements of the fief. The possibility of a vassal's holding separate fiefs of several lords has already been mentioned.

The vassals' rights over the fiefs grew larger and larger in course of time, as the feudal element took precedence over the vassalitic, the material over the personal. Thus fiefs soon became in fact hereditary (a process which began in the second half of the 9th century, especially in France and Italy) in the sense that investiture could not be withheld from an heir who was willing to do homage. This right came to be protected in England by a special enactment, the assize of *mort d'ancestor*. The rules of inheritance tended on the whole to safeguard an undivided fief and preferred the eldest among the sons (primogeniture). Thus Ranulf de Glanville toward the end of Henry II's reign could state: *Primogenitus filius patri succedit in totum* ("The eldest son succeeds the father in all," *Tractatus*, vii, 3). The principle, however, was far from absolute; under pressure from younger sons, parts of an inheritance might be set apart for them in compensation, to constitute the so-called appanages (*apanagia*). Vassals also acquired the right to alienate their fief, with the proviso, first, of the lord's consent and, later, on payment of a certain tax (*relevium, laudationes et ventae*). Similarly, they obtained the right to subinfeudate (*subinfeodare*); *i.e.*, to become lords themselves by granting parts of their fiefs to vassals of their own.

When one of the partners in the vassalitic contract was guilty of serious shortcomings toward the other, the injured party could dissolve the link by a solemn gesture of "defiance" (*diffiduciare, diffidatio*). When a vassal died without an heir or committed a felony, his fief went back to the lord (by escheat).

Systematization by Jurists.—Feudal law was mainly established by custom. Legislation was rare and late. Not until feudalism was on the decline did treatises, more or less systematic expositions of feudal law, come to be written. Thus the *Libri feudorum* were written in northern Italy in the 12th century and became very important; they were much glossed and commented. Treatises on feudal law were written by lawyers trained in Roman law, such as Jacobus Columbi, Baldus, Jacobus de Belvisio and Alvarottus, who tried to apply various Roman concepts and categories to feudal law and so invented the distinction between *dominium directum* (for the right of the lord on the fief) and the *dominium utile* (the right of the vassal).

FEUDALIZATION OF THE STATE

Feudal government is commonly regarded by historians as standing for decentralized government, for the fragmentation of public authority among local potentates. It is true that feudalism in many cases had that effect. Too much depended on the personality of the man at the top of the system, as the upsets of the reign of Charlemagne's son Louis the Pious and the "anarchy" in England under Stephen show. Yet feudalism was not inherently anarchic. Several great rulers (some of the early Carolingian kings and Frederick I Barbarossa) saw it as a positive element that could serve to cement the unity of the realm in circumstances where personal ties alone seemed enough to hold vast empires together; the Norman and Angevin kings of England who succeeded in controlling feudalism did in fact use it for this purpose. It should also be remembered that the French kings from the 12th and 13th centuries onward made a clever use of existing feudal ties to centralize France and to regain control of frontier provinces that had in fact escaped their authority.

In the field of law and justice feudalism meant replacing the ancient courts of local dignitaries by courts composed of the vassals of a common lord. The consequent dispersal and multiplication of courts made the judicial apparatus extremely complex. Moreover, since judicial revenues were a normal part of the feudal court which any lord could set up, the administration of justice was to some extent bound up with fiscal interests. Here more than anywhere else the feudal system of government appears as part of the law of private property.

Feudal concepts and money-raising techniques played a great role in the public finances of the feudalized states. Up to the 12th century most kings and princes disposed of no financial resources other than those they drew as important feudal lords; viz., the income from their demesne lands and what they could expect from their vassals on various occasions. Even later, indeed, when various direct taxes were granted to the crown by the country, feudal ideas about what a lord could ask from his men played a role in the preliminary negotiations between crown and country.

In the constitution of armies feudalism brought about a basic change. The old national militias gave way to the professional feudal formations, which proved themselves highly effective. The history of the Normans in Europe shows what military strength was produced when natural talent was organized feudally.

The church, in such an environment, was to a large extent feudalized. Secular lords in return for homage would invest bishops and abbots with their ecclesiastical offices and with the temporalities that went with them; and for their temporalities bishops and abbots owed the crown various services, even military. There was also tenure by divine service, when churchmen were enfeoffed with lands in return for fealty and for the performance of spiritual services. Many churches, moreover, were proprietary and were part and parcel of large feudal estates. Ecclesiastical dignitaries, in fact, were among the king's chief feudal advisers, so that their appointment had to rest with the crown. It was a reaction among churchmen against this state of affairs that led to the investiture conflict (*see* EUROPE: *History;* PAPACY).

Feudalism left deep marks on European civilization and society. Certain vassalitic concepts about personal fidelity and the loyal service of a free man to his lord were a positive contribution, as also was the chivalrous code of honour rooted historically in feudalism. Yet the establishment of a military aristocracy, a social upper layer of professional warriors, not only lowered the status of the common man, especially the peasant, but also encouraged aggression. While it contributed both to the defense of the west against external enemies and to the expansion of European influence, feudalism at the same time gave rise to much disastrous petty warfare between vassals. The dispersion of authority was a serious drawback to Europe's economic development.

It is in the elaboration of modern forms of constitutional government that feudalism has exercised the deepest influence. Ideas about consent to aids and about resistance to and defiance of the lord, the combination of subjection and obedience with personal freedom and the whole balance of rights and duties between lords and vassals played a great role in the establishment of important constitutional charters and in colouring the outlook of early representative institutions.

FEUDALISM IN DIFFERENT COUNTRIES

In spite of an underlying similarity, feudalism assumed different aspects in the different countries of Europe. These national variants must now be analyzed.

England.—England did not become a feudal state until after the Norman conquest (1066). There is, however, some controversy as to the extent to which a nascent feudalism existed in Anglo-Saxon times. Certain forms of Old English land tenure, based on the obligation to perform agreed services, are known to have existed as early as the reign of Ine of Wessex (688–726); the economic dependence of tenant upon lord which this implies became increasingly common after the disruptive period of the Danish wars. The practice of leasing land to certain men and to their heirs on condition of performance of various services for the grantor was frequently adopted by ecclesiastical landlords, such as St. Oswald (d. 992), bishop of York and of Worcester, who had spent some time at the monastery of Fleury in France. He created leasehold tenures limited to three generations for tenants who owed him various services, especially riding services as messengers and escorts. Some of the estates so granted were exten-

sive and must have been held by people of importance and of noble birth who had perhaps done fealty to the bishop. It is therefore clear that the relationship of lord with client and the connection of tenure with service and fealty were already known in Anglo-Saxon England.

Public administration in England, however, remained untouched by feudalism until after the Conquest. It had no part in the fiscal and judicial systems, and even the military institutions bore no trace of its characteristics. Men served in the national levy, the fyrd, by personal obligation and not in order to fulfill the service due for a military fief; any land that a thegn (nobleman) might subsequently receive was merely the reward for faithful service already performed.

Feudalism proper, with its complicated network of rights and obligations, and in particular tenure by knight-service, was introduced by the Normans into England. There it rapidly assumed a stabilized form, the workings of which were well documented. Domesday Book (compiled 1086) has sometimes been regarded as a book of fiefs, and the *cartae baronum* (1166), the answers made by the barons to Henry II's inquiries about the numbers of tenants enfeoffed by them, provide information about the development of subinfeudation in the first century after the Conquest.

Feudalism in England, however, was profoundly modified by institutions surviving from the Anglo-Danish state, institutions which it was to the advantage of the Norman kings to retain. Despite the weakness of individuals, considerable prestige had been attached to the Old English monarchy; this made the Anglo-Saxon king much more than a feudal suzerain. In this tradition William I, at Salisbury (1086), insisted on taking oaths of fealty and acts of homage from all the landowners of England, not only from his tenants in chief. In England, too, the *curia regis*, the court which in feudal theory every king held with and for his tenants in chief just as every mesne lord held court for his tenants, was to some extent merged with the old Anglo-Saxon witan, the body of wise men who formed the king's advisory council and to which he could summon whom he would. The national militia was never superseded by the feudal host, and the old royal courts remained side by side with baronial franchises and manorial courts. (*See* COURT LEET.) The shire courts continued to be presided over by the sheriff, the king's official; despite attempts on the part of various great families, this office rarely became hereditary and the post-Conquest monarchs usually retained strict control over it.

Feudalism was responsible for the basic formation of English land law (*see* ENGLISH LAW: *Norman Feudal Land Law*). After the Conquest no allodial land was left and the humblest tenure in socage as well as the largest knight's fee was held of an overlord. Thus directly or indirectly all land was held of the crown. Another particular trait of English feudalism was the absence of a basic distinction of land law into two bodies, one feudal and one non-feudal, as was the case in Germany, where the *Sachsenspiegel* exposed in two separate treatises the *Lehnrecht* (feudal law) and the *Landrecht* (customary law) of the Saxons. In England the distinction lay merely between free and unfree tenures, since all the former came under the competence of the royal courts, which applied for them one common law (*q.v.*). The royal court's authority was based on a series of protective measures taken by Henry II, which concerned all free tenures and those only. The most important among these measures were devised to protect peaceful possession (assize of *novel disseisin*), to guarantee lawful heirs a regular succession (assize of *mort d'ancestor*) and to ensure a fair trial to tenants of free tenures, who could reject the hazardous trial by battle and demand trial by a jury of knights in the grand assize (*see* ASSIZE). On the other hand, the stern exclusion of all unfree tenures from the royal courts' competence contributed to the depression of the unfree peasant population, who could obtain no hearing outside their manorial courts.

France.—After centuries of thorough feudalization the French kings started to build a modern centralized state. They had first to deal with the feudal lords in the royal domain around Paris and Orléans which had remained under their own direct control. Louis VI and his successors were able to subjugate these lords, thanks in great part to the support of the communes. Once they had established firm control over the central parts of the realm, the kings set about to attack the *de facto* independence of a number of French principalities (Flanders, Normandy, Toulouse, etc.). In this military and diplomatic enterprise they observed and exploited the legal ties of feudalism and won considerable success, except in Flanders. In the 15th century, however, great appanages such as Burgundy became the starting points of independent and even inimical states. The old feudal class developed into a nobility, politically weak and tied to the crown (various attributes of sovereignty such as legislating and minting money had been taken away from the feudal lords and princes) but socially prominent, keeping a large unfree peasantry in their service, until the outbreak of the French Revolution. In the night of Aug. 4, 1789, the National Assembly voted the abolition of feudalism in France; and in 1793 the Convention abolished all claims arising from feudal titles and ordered the destruction of all feudal deeds. (*See* FRANCE: *History.*)

Germany.—Germany was more slowly feudalized than the western areas of the Old Frankish empire. The kings wielded much more real authority there and royal officials did not hold their offices as royal vassals. Frederick I Barbarossa tried to buttress the unity of the Holy Roman empire by linking the high dignitaries, who were given extensive powers, to his person by the bond of vassalage, but the weakness of the subsequent kings and emperors was fatal to this policy. The German kingdom was split into quasi-autonomous states and cities that were tied to the sovereign by formal ties only.

The German feudal world, meanwhile, was strictly graded in a formal hierarchy known as the *Heerschildordnung*. The king stood at the top of the feudal pyramid, the second *Heerschild* was composed of the ecclesiastical princes, the third of the lay princes who held fiefs of the king or of ecclesiastical princes, and so on. Another German development was the important distinction between territories and cities that were *reichsunmittelbar*, or "immediate," in the sense of depending immediately or directly from the crown; and those that were *reichsmittelbar*, or "mediate," that is, depending on some lesser prince. The criterion in this question was not uniform. Great territories could be *reichsmittelbar* and quite small towns *reichsunmittelbar*. Germany remained feudal until the disappearance of the Holy Roman empire in 1806. (*See* GERMANY: *History.*)

Italy.—Feudalism penetrated into northern and central Italy with Charlemagne's Franks. After the dissolution of the Carolingian power and under the Ottonian emperors large feudal principalities such as the duchy of Spoleto flourished. The emperors tried to counteract this feudal disruption, but the decline of feudalism was accelerated chiefly by the rise of the towns (*see* COMMUNE [MEDIEVAL]). In southern Italy feudalism was introduced by the Normans and kept alive by the various succeeding dynasties that ruled the Neapolitan-Sicilian kingdom. In the later middle ages most of the great cities in northern Italy became city-states ruled by princes who held their states formally from the Holy Roman emperor. The fief as a form of land tenure was known in Italy, though the influence of Roman law prevented its ever becoming prominent. The French Revolutionary Wars brought feudalism to an end in Italy.

Spain.—In the north of Spain feudalism was implanted by the Franks in the Carolingian period. Elsewhere it was introduced as the country was gradually reconquered from the Muslims. It became a well-established institution in public and in private law. The struggle against the Muslims not only gave Spanish feudalism a very strongly military and religious character but also prevented extreme decentralization, since unity under a powerful monarchy was indispensable in that protracted fight. The Spaniards imported certain feudal forms into their American territories.

The Low Countries.—The great majority of the principalities of the Netherlands were fiefs of the Holy Roman empire or of the German kingdom, though the county of Flanders was a French fief. Thus, to speak generally, feudalism followed the French pattern in the west of the Netherlands and the German in the east. Except for certain regions such as Frisia, the Low Countries were thoroughly feudalized. A reaction began in the 12th century,

when the territorial princes started to make great progress in erecting modern centralized states, curtailing the power of various local magnates. The communal movement, moreover, was very strong in the Low Countries and exerted a notable influence against feudalism. The princes meanwhile exploited their geographical position and their autonomy to play a refined diplomatic game and to sell their services very dearly to the kings of neighbouring countries; and English money fiefs were eagerly sought after—the first instance being when the count of Flanders, Robert II, concluded the military treaty of Dover with Henry I of England in 1101, promising an impressive contingent of Flemish knights (apparently to serve against Robert Curthose, the king's elder brother) in return for a money fief.

The formal feudal tie between the county of Flanders and the French crown was severed in 1526, and the emperor Charles V united the Low Countries in one indivisible "circle" (*Kreis*) of the empire. Though the feudal links between the Netherlands and the empire had early lost nearly all their political significance, they still had some importance in the judicial field, appeals to the *Reichskammergericht* not being unknown. Politically and socially, however, feudalism in the northern Netherlands hardly survived the establishment of the independent United Provinces in the second half of the 16th century, though it was still recognized in land law until 1798; and the feudal links between the United Provinces and the empire disappeared in the 17th century, though they were never formally undone. In the southern Netherlands feudalism continued to mean more, both politically and socially as well as in law until 1795, when it was abolished under French revolutionary influence.

See also references under "Feudalism" in the Index volume.

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On France and England jointly *see* C. Petit-Dutaillis, *La Monarchie féodale en France et en Angleterre, Xe–XIIIe siècle* (1933); W. Kienast, *Untertaneneid und Treuvorbehalt in Frankreich und England* (1952); J. Boussard, *Le Gouvernement d'Henri II Plantagenêt* (1956). On France in particular *see* F. Lot and R. Fawtier, *Histoire des institutions françaises au moyen âge*, 2 vol. (1957–58). On England *see* J. H. Round, *Feudal England* (1895); F. M. Stenton, *The First Century of English Feudalism*, 2nd ed. (1961); I. J. Sanders, *Feudal Military Service in England* (1956); T. F. T. Plucknett, *A Concise History of the Common Law*, 5th ed. (1956); R. C. Van Caenegem, *Royal Writs in England from the Conquest to Glanvill* (1959); Bryce Lyon, *A Constitutional and Legal History of Medieval England* (1960).

For other countries *see* J. L. La Monte, *Feudal Monarchy in the Latin Kingdom of Jerusalem* (1932); G. W. S. Barrow, "The Beginnings of Feudalism in Scotland," *Bull. Inst. Hist. Research*, xxix (1956). (R. C. v. C.)

FEUERBACH, ANSELM (1829–1880), German painter who was, apart from Arnold Böcklin, the most important representative of late classicism in Germany. Nephew of the philosopher, L. Feuerbach, he was born at Speyer, Bavaria, on Sept. 12, 1829. He began to study art in 1845 at the Düsseldorf academy under F. W. Schadow (*q.v.*). From 1848 to 1850 he worked under Karl Rahl in Munich and during 1851–54 twice stayed for some time in Paris. There Thomas Couture exerted a great influence on him, one which was to be decisive in his subsequent development. Two early works painted in Paris show his dependence on Couture: "Hafiz at the Well" (1852) and the "Death of Aretino" (1854). Idealistic, philosophical figure compositions, the intrinsic values of which were lyrical and elegiac, later became his main interest. During a stay of many years in Italy (1855–73), first in Venice, then in Florence and Rome, Feuerbach came under the influence of the Renaissance painters, chief among them Titian—whose "Assumption" he copied in Venice—and Paolo Veronese.

The principal works of the Italian years of his maturity are "Dante Walking with the Noble Ladies of Ravenna" (1858), the two pictures representing "Iphigeneia" (1862, 1871), "Paolo and Francesca" (1864), "Plato's Symposium" (1869, second composition 1873), the "Judgment of Paris" (1870), the "Battle of the Amazons" (1869–73), and various compositions on the "Medea" theme (1866–70). A uniform dark tone with little contrast in colour matches the lyrical, secretly tragic basis of these works. Feuerbach's gifts were not suited to dramatic action and consequently the "Fall of the Titans," the ceiling piece in the hall of the Vienna Academy of Fine Arts (where he became a professor in 1873), is one of his weaker and more derivative compositions. The work was strongly criticized by contemporary critics. This failure in addition to illness caused Feuerbach finally to leave Vienna and return to Italy in 1876. He died in Vienna on Jan. 4, 1880. His greatest and most original accomplishments are his formal, statuesque portraits, including the various ones of his model, Nanna Risi, and his stepmother, Henriette Feuerbach, a few individual "heroic" landscapes and numerous drawings. With his painting may be considered his literary work: *Vermächtnis*, published in 1882, which told the story of his struggles, and his letters to his stepmother, which appeared in 1911.

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FEUERBACH, LUDWIG ANDREAS (1804–1872), German philosopher, fourth son of the eminent jurist (*see* Feuerbach, Paul Johann Anselm), was born at Landshut, Bavaria, on July 28, 1804. His influence was greatest upon the anti-Christian theologians such as D. F. Strauss, author of *Das Leben Jesu*, and Bruno Bauer, who like Feuerbach had passed from Hegelianism to a form of naturalism. After two years in Berlin under Hegel, Feuerbach studied natural science at Erlangen in 1828. His first book, published anonymously, *Gedanken über Tod und Unsterblichkeit* (1830), attacks personal immortality and advocates the Spinozistic immortality of reabsorption in nature. He then published *Darstellung der Geschichte der neuern Philosophie* (2 vol., 1833–37), *Abälard und Heloise* (1834), *Pierre Bayle* (1838) and *Uber Philosophie und Christentum* (1839), in which he claimed "that Christianity has in fact long vanished not only from the reason but from the life of mankind, that it is nothing more than a fixed idea." This attack is followed up in his most important work, *Das Wesen des Christentums* (1841; Eng. trans. by George Eliot, 1853), which aims to humanize theology. He lays it down that man is to himself his own object of thought. Religion is consciousness of the infinite. Religion therefore is "nothing else than the consciousness of the infinity of the consciousness; or, in the consciousness of the infinite, the conscious subject has for his object the infinity of his own nature." Thus God is, so to speak, the outward projection of man's inward nature. In the first part of the book Feuerbach develops the "true or anthropological essence of religion." Treating of God in his various aspects "as a being of the understanding," "as a moral being or law," "as love" and so on, he shows that these aspects correspond to some need of human nature. In the second part he discusses the "false or theological essence of religion," contending that the view which regards God as having a separate existence leads to a belief in revelation and in sacraments, which are pieces of religious materialism. Feuerbach denied that he was rightly called an atheist, but the denial is merely verbal. During the troubles of 1848–49 Feuerbach's attack upon orthodoxy made him something of a hero with the revolutionary party. His *Theogonie* (1857) was followed by *Gottheit, Freiheit und Unsterblichkeit* (1866). He died on Sept. 13, 1872.

Some of Feuerbach's ideas were taken up by those engaged in the struggle between church and state in Germany and by those who, like F. Engels and Karl Marx, were leaders in the revolt of labour against capital.

Feuerbach's *Werke* were published in 10 vol. (1846–66; 1903–11); and the correspondence, ed. by K. Grün, in 2 vol. (1874).

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FEUERBACH, PAUL JOHANN ANSELM, RITTER VON (1775–1833), German jurist, chiefly remembered for his work in the field of criminal law reform, was born at Hainichen, near Jena, on Nov. 14, 1775, and brought up at Frankfurt am Main. At 16, he ran away from home to study at Jena where, despite ill-health and poverty, he took his doctorate in philosophy in 1795. With the birth of a son in 1796, he was forced to turn from philosophy and history to law, which offered better prospects. In 1796 he published *Kritik des natürlichen Rechts* . . . ("Critique of Natural Rights") followed by *Anti-Hobbes,* . . . (1798), a dissertation on the limits of the civil power. Feuerbach, as the founder of a new theory of penal law, the so-called "psychological-coercive or intimidation theory," gave a secular purpose to the rigorous Kantian doctrine that punishment ought only to be given for its own sake; this purpose was to enforce the threat of the law which deters the would-be law breaker. In this he was a fierce adversary of the idea of individual prevention put forward by Karl Grolmann, who was his lifelong friend.

Feuerbach's famous *Lehrbuch des gemeinen in Deutschland geltenden peinlichen Rechts* ("Textbook of Common Law Generally Applied in Germany"; 1801) remained the leading textbook in Germany for half a century. This, and his earlier works, were a powerful protest against vindictive punishment and furthered the reform of the German criminal law. The administration of justice was, before Feuerbach's time, distinguished by two characteristics: the superiority of the judge to all law and the blending of the judicial and executive offices. Feuerbach, using as his chief weapon the *Revision der Grundbegriffe* ("Revision of the Basic Assumption"; 1799), achieved the recognition of the formula, *nullum crimen, nulla poena sine lege* ("no crime and no punishment unless provided by statutory law").

In 1805 he was given a post in the ministry of justice and commanded to draft a penal code for Bavaria (*Strafgesetzbuch für das Königreich Bayern*). Practical reform was begun in Bavaria under his influence with the abolition of torture in 1806. In 1808 appeared the first volume of his *Merkwürdige Criminalfälle* ("Remarkable Criminal Cases"), completed in 1811. In his *Betrachtungen über das Geschworenengericht* ("Remarks on the Jury Principle"; 1812) Feuerbach criticized, from a legal point of view, the defects of the jury, at that time recommended in accordance with the French code, but he was prepared to accept the jury as a political safeguard of civil rights, provided that it fitted into a wider framework of constitutional guarantees and the rule of law. The Bavarian criminal code was promulgated in 1813; distinguished by the clarity of its definitions and its careful classifications, it remained, together with the French *code pénal*, a model for European states until the Prussian criminal code of 1861.

During the war of liberation (1813–14) Feuerbach published several political brochures which, owing to the writer's position, had almost the weight of state manifestoes. In 1814 he was appointed second president of the court of appeal at Bamberg, and three years later he became first president of the court of appeal at Anspach. In the two treatises which he subsequently published in 1821 and 1825, he strongly urged publicity in all legal proceedings and showed himself a forerunner of modern efforts in the field of comparative law. As one of his last activities he championed the cause of the mysterious foundling Kaspar Hauser. He died suddenly at Frankfurt on May 29, 1833.

See *Leben und Wirkens Ans. von Feuerbachs,* 2 vol. (1853), with its occasional notes by his fourth son Ludwig, a distinguished philosopher. *See* also M. Gruenhut, *A. von F. und das Problem der strafrechtlichen* (1922); G. Radbruch, *P. J. A. Feuerbach* (1934, 2nd ed. 1957); E. Wolf, *Grosse Rechtsdenker der deutschen Geistesgeschichte,* 3rd ed., pp. 536–583 (1951). (J. F. LR.)

FEUILLANTS, CLUB OF THE, the name of two political clubs of the French Revolution, both of which met in the former monastery of the Feuillants (reformed Cistercians), near the Tuileries in Paris.

First Club.—The first club's origins are obscure. The founders were Mirabeau, La Fayette, J. S. Bailly and E. J. Sieyès, who, when the "patriotic" party in the constituent assembly split in Aug. 1789, left the Société des Amis de la Constitution—that is, the Jacobins (*q.v.*)—and founded the Société de 1789, with its seat first in the Palais-Royal, then in the monastery of the Feuillants. Gradually it attracted supporters of the royal prerogative; hence the popular feeling against it. When the comte de Clermont-Tonnerre became its president his house was pillaged on Jan. 17, 1791; and the club itself was attacked on March 28. Mirabeau's death (April 2, 1791) marked the decline of the club.

Second Club.—There was probably no continuity between the first club and the better-known one born after Louis XVI's flight to Varennes (June 20, 1791), when the "patriotic" party was split again—this time between the popular faction, led by a minority of bourgeois rallied round the Jacobins and Robespierre, and the constitutional monarchists, together with those bourgeois who had the property qualification for voting. Nearly all the deputies in the constituent assembly who were members of the Jacobin club left that club and joined the new club of the Feuillants. Their act of separation was dated July 16 and their attitude had been expressed by Antoine Barnave in his speech to the assembly on July 15, in which he argued that one more step in the Revolution toward liberty would mean the destruction of the royal power and that one more step toward equality would mean the destruction of property. The Feuillants were responsible for the revised constitution of 1791, which strengthened the system of property qualification for voting.

When the legislative assembly met on Oct. 1, 1791, it included 264 deputies enrolled in the Feuillant club. They sat on the right of the assembly and were directed, from outside the assembly, by Adrien Duport, Barnave and Alexandre de Lameth. As conservatives, the Feuillants opposed the democratic movement and upheld the constitution of 1791. They were, however, progressively overshadowed by the Jacobins, and the club disappeared on the insurrection of Aug. 10, 1792, and the suspension of the monarchy.

See E. D. Bradby, *The Life of Barnave,* 2 vol. (1915); G. Michon, *Essai sur l'histoire du parti feuillant: Adrien Duport* (1924). (A. So.)

FEUILLETON, originally a kind of supplement attached to the political portion of French newspapers. It first appeared about 1800, the most famous of the early examples being the dramatic criticism of J. L. Geoffroy (1743–1814) in the *Journal des débats.* It was usually separated from the political part of the newspaper by a line, and printed in smaller type. In modern French and some other newspapers the *feuilleton,* printed as a separate section, consists of criticism on all the arts and miscellaneous light literature. The term came into English use to indicate the installment of a serial story printed in one part of a newspaper.

FEUQUIÈRES, the name of a marquisate held by a family of Picard origin distinguished in French military and diplomatic history. Its territorial seat was at Feuquières near Beauvais.

ISAAC MANASSÈS DE PAS (1590–1640), marquis de Feuquières, was born at Saumur on June 1, 1590, the posthumous son of François de Pas, who had been killed in the battle of Ivry and whose widow, Madeleine de la Fayette, was pensioned by Henry IV. Service in the Valtellina (1626) and at La Rochelle (1628–29) established him as a lieutenant of Richelieu, who sent him to Germany to promote the negotiations between the Protestant princes and the Swedes culminating in the treaty of Heilbronn (April 1633; *see* THIRTY YEARS' WAR) and the visit to Saxony and Brandenburg. His letters, first published in 1753 in Amsterdam, refer to this mission. He then co-operated with the subsidized German army of Bernard of Saxe-Weimar and was lieutenant general (1637) in Franche-Comté and at the siege of Breisach (1638). He was besieging Thionville with 6,000 French infantry when he was surprised and completely defeated by Ottavio Piccolomini on June 7, 1639; Feuquières was captured and died of his wounds on March 13, 1640, at Thionville.

His eldest son, ISAAC MANASSÈS DE PAS (1618–1688), marquis de Feuquières, was born in Paris on May 10, 1618. In 1672 he was sent as a plenipotentiary to Germany and then as ambassador to

Sweden (1672–85). From 1685 to 1688 he was ambassador to Spain and died in Madrid on March 6, 1688.

The latter's eldest son, ANTOINE MANASSÈS DE PAS (1648–1711), marquis de Feuquières, was born in Paris on April 16, 1648. During the Dutch Wars he had a cavalry regiment in Holland (1672) under his father's friend the duc de Luxembourg, and from 1674 to 1689 an infantry regiment with which he served in the final campaigns of Turenne and Condé. He gained special distinction on Aug. 14, 1678, in Luxembourg's victory at St. Denis near Mons. Sent as minister and general to Turin in 1689 during the War of the Grand Alliance, he won credit for dealing with the Waldensian insurgents in the valleys of the Alps, but he resented his supersession by Nicolas Catinat so openly that he was transferred to the Rhine. Made lieutenant general in March 1693, he was with Luxembourg again at the battle of Neerwinden. His active service practically ended with Luxembourg's death in 1695. Being in disfavour at the beginning of the War of the Spanish Succession (1701), he began the *Mémoires* that have made him famous. They are not so much personal recollections as a critical survey of the campaigns under Louis XIV. The rancour of a difficult and disappointed subordinate pervades the whole work; all the generals other than Luxembourg are his target, and Voltaire concluded that he distorted the facts in order to have more mistakes to censure. First published in 1727 (Eng. trans. 1797), with the author's theoretical study of military institutions and his maxims on the art of war, the *Mémoires* were greatly appreciated and set the fashion for military criticism and theory in the 18th century. Feuquières died in Paris on Jan. 27, 1711.

The *Lettres inédites* of all three men are edited by E. Gallois (1845–46). (I. D. E.)

FEVER is a manifestation of disease, characterized by elevation of the body temperature. Although most often associated with infection, it is also observed in other pathologic states, such as cancer, coronary artery occlusion and disorders of the blood.

Under normal conditions the temperature of deeper portions of the head and trunk does not vary by more than 1°–2° F. in a day, and does not exceed 99° (37.22° C.) in the mouth or 99.6° (37.55° C.) in the rectum. There is a small rhythmic diurnal variation, highest in the late afternoon, lowest in the early hours of the morning. In persons with fever the temperature may rise to 106° (41.11° C.), and daily fluctuations of 5°–9° may occur, with peak levels tending to occur in the late afternoon. Transient elevations to 112°–113° (44.44°–45° C.) have been recorded, but are very rare.

During fever the blood and urine volumes become reduced as a result of loss of water through increased vaporization. Body protein is rapidly broken down, leading to increased excretion of nitrogenous products in the urine.

At a time when the body temperature is rising rapidly the affected person may feel chilly, or even have a shaking chill; conversely, when the temperature is declining rapidly he may feel warm and have a flushed moist skin. Drugs such as aspirin, which reduce fever, seem to exert their effect on the temperature-regulating areas of the brain; they do not influence body temperature in health.

The mechanism of fever appears to involve a disturbance in the brain's control of various processes affecting heat production and heat loss; *i.e.*, muscle tone, flushing, sweating, etc. The generally accepted hypothesis is that in febrile diseases certain products of tissue injury are carried by the blood to the brain, where they disturb the function of the heat-control centres. A material capable of such an effect has been demonstrated in white blood cells. The liberation of products of this type from injured cells may be the cause of fever in disease. *See* also ANIMAL HEAT.

See George W. Pickering, "Regulation of Body Temperature in Health and Disease," *Lancet*, vol. i, pp. 1–9 and 59–64 (Jan. 1958). (P. B. B.)

FEVERSHAM, LOUIS DE DURFORT, 2ND EARL OF (1641–1709), French-born soldier, a nephew of the famous Marshal Turenne (*see* DURFORT), who played a notable role in military and diplomatic affairs in England under Charles II and James II. He made the acquaintance of James, then duke of York, in 1650 and he went to England in 1665 and was naturalized. James made him keeper of his privy purse and colonel of his troop of horse guards in 1667, and he was created Baron Duras of Holdenby in 1673. In 1677, by special remainder, he succeeded to his father-in-law's earldom of Feversham; he also held the French title marquis de Blanquefort. He was appointed master of the horse to the queen, Catherine of Braganza, in 1679, and her lord chamberlain in 1680; he continued in her service until her death in 1705. On James II's accession (1685) he was made colonel of the 1st troop of horse guards and, on the news of the duke of Monmouth's rising, commander of the royal forces in the west, where he defeated the rebels at Sedgemoor (July 6, 1685). He remained in high favour, but he was a firm Protestant and was never associated with the policies that lost James his throne. He was disliked by his English subordinates in the army, but the gravamen of their charge appears to be that he was a sound but unimaginative textbook general, neither better nor worse than scores of others in the armies of Europe. He again took command in the west in 1688, this time against William of Orange, but he was given no opportunity to fight a campaign. His subsequent conduct was cautious but correct; he refused the oaths to the new king, but he would not intrigue on behalf of his exiled master, and he lived out his life in retirement. He died on April 28, 1709, when his titles became extinct. (J. P. K.)

FEYDEAU, the name of two French writers, father and son. ERNEST FEYDEAU (1821–1873) was born in Paris on March 16, 1821. His first novel, *Fanny* (1858; Eng. trans. 1860), won him fame and was ranked by his contemporaries with Flaubert's *Madame Bovary*. Feydeau never repeated this success with his subsequent writings, which include a few plays. He died in Paris on Oct. 29, 1873. GEORGES FEYDEAU (1862–1921), born in Paris on Dec. 8, 1862, was unrivaled as a writer of vaudeville (*q.v.*) and considerably raised its literary standard. He combined with mastery of dramatic technique a fertile imagination, irresistible humour and determination to see only the funny side of human behaviour, good or bad. His favourite theme, the anxious and comic efforts of an unfaithful wife or husband to conceal amorous escapades, and his favourite device of bringing together characters particularly desirous of avoiding each other, are to be found in *Monsieur Chasse* (1892), and in *L'Hôtel du Libre-Échange* (1894), written with Maurice Desvallières (Eng. trans. *Hotel Paradiso*, 1956). As always with Feydeau the action arises out of a misunderstanding. This also forms the basis of the plot of his greatest success, *La Dame de chez Maxim's* (1899), in which figures a "cataleptic sleep-inducing chair." *Occupe-toi d'Amélie!* (1908; Eng. trans. *Look after Lulu*, performed in 1959) offers a caricature of manners as well as a number of fantastic, uproarious situations. It was made into a film in 1949 by Claude Autant-Lara. Feydeau died at Rueil-Malmaison on June 5, 1921. (D. Ks.)

FEZ: *see* FÈS.

FEZZAN (FAZZAN), the ancient Phazania, until 1963 a *wilayat* (province) of the united kingdom of Libya and lies in the central Sahara south of Tripolitania. Pop. (1954 census) 59,315. Its area, mostly desert, is 212,807 sq.mi.

The climate is one of extremes with great diurnal and seasonal ranges of temperatures, extremely hot summers and occasional frosts in winter. Rain falls as irregular showers, sometimes devastatingly heavy, and in some places perhaps only once in several years. Strong local winds and low humidity are other climatic features. For physical geography *see* LIBYA.

Most of the inhabitants dwell in the oases but about 10,000–15,000 are pastoral nomads who live mainly between the central oases and Al Hammadah al Hamra ("red stony plateau") of the north. The majority are racially of Semitic origin but there are substantial Negroid and Berber elements.

As a province, Fezzan was ruled by a wali (governor), who was appointed by the king, with an executive council most of whose members were elected. In 1963 the provincial system was abolished when Libya became a unitary state as opposed to a federal state.

Until the 20th century Fezzan had some importance as offering short caravan routes from the Mediterranean to central Africa,

either due south through Sabhah and Marzuq or (farther west) through Ghudamis and Ghat; but these declined after 1910. Oil discoveries in adjacent areas of Algeria in the late 1950s stimulated prospecting in Fezzan.

In the north, rainfall is more regular and a thin seasonal scrub vegetation allows grazing. Much of Fezzan is, however, barren, with extensive zones of shifting sand, particularly in the central depressions. Water, collected in the porous bedrock of the depressions probably in part as an accumulation from earlier ages, permits oasis cultivation. The chief oases are Sabhah, the capital (pop. 7,298), Marzuq, Brach and Zawilah in the centre of the province and Ghat and Ghudamis near the Algerian border. Fezzan is noted for its date palms, which cover about 300,000 ac. and reputedly number 10,000,000. Dates are the staple diet and some are exported to Cyrenaica; in addition, millet and vegetables are grown. Standards of living generally are extremely low. There is a long-distance bus service from Sabhah to Tripoli.

(W. B. Fr.)

History.—The country formed part of the territory of the Garamantes, described by Herodotus as a very powerful people. Attempts have been made to identify the Garamantes with the Berauna of the Arabs of the 7th century, and to the period of the Garamantes, H. Duveyrier, a French archaeologist who traveled in Fezzan during 1859–61, assigns the remains of remarkable hydraulic works and certain tombs and rock sculptures—indications, it is held, of a Negro civilization of ancient date which existed in the northern Sahara. The Garamantes, whether of Libyan or Negro origin, certainly had a considerable degree of civilization when in the year 19 B.C. they were conquered by the proconsul Lucius Cornelius Balbus (Minor) and their country annexed to the Roman empire. By the Romans it was called Phazania, whence the name Fezzan. After the Vandal invasion Phazania appears to have regained independence and to have been ruled by a Berauna dynasty. At this time the people were Christians, but in 666 the Arabs conquered the country and all traces of Christianity seem speedily to have disappeared. At first the area was subject to the caliphs, but early in the 10th century an independent Arab dynasty was established, with its capital at Zaila.

In 1174 Fezzan was conquered by an expedition sent by Saladin (*q.v.*), but it seems to have reasserted itself. In the 13th century the country became part of the Born empire (*see* Bornu), but it is probable that it was governed by a native tribe of hereditary rulers, who were dethroned in the 14th century by the Khorman, an Arab tribe that reduced Fezzan to slavery. It was rescued in about the middle of the 16th century by a sherif of Morocco, Montasir ibn Mohammed, who founded the dynasty of Beni Mohammed. It was the Beni Mohammed who chose Marzuq as their capital. They became intermittently tributary to the pasha of Tripoli, but within Fezzan the power of the sultans was absolute. The last of the Beni Mohammed sultans was killed in 1811 by El-Mukkeni, one of the lieutenants of Yusef Pasha, the last sovereign but one of the independent Karamanli dynasty of Tripoli. El-Mukkeni then made himself sultan of Fezzan, and became notorious by his slaving expeditions into the central Sudan. In 1831 Abd-el-Jelil, a chief of the Aulad-Sliman Arabs, usurped the sovereign authority. After an unsettled reign of ten years he was slain in battle by a Turkish force under Bakir Bey, and Fezzan was added to the Turkish empire in 1842.

After the founding of the White monastery at Beida (Zawiyat al Bayda), Cyrenaica, by the Senusi order (*tariqa*) in 1843, emissaries following the Saharan caravan routes founded lodges (*zawaya*) in the Fezzan. The Senusi order became the dominant influence under the Abid branch of the Senusi family. But the expansion of French rule from equatorial Africa began to weaken Senusi authority at the beginning of the century and the Italian invasion of Tripolitania and Cyrenaica in 1911 led to its eclipse. The treaty of Ouchy in 1912 ending the Italo-Turkish War (*q.v.*) was quickly followed by the occupation of Fezzan which was then amalgamated with Cyrenaica and Tripolitania under Italian rule and its history became that of Libya (*q.v.*).

(D. C. Cg.; X.)

FFESTINIOG, an urban district of Merioneth, Wales, 19 mi. N. of Dolgellau by road. Pop. (1961) 6,677. It includes the town of Blaenau Ffestiniog and the village of Ffestiniog. The urban district, picturesquely situated at the head of the vale of Ffestiniog in the Snowdonia National park, is 600 ft. above sea level.

The slate mines of Blaenau Ffestiniog are famous. Roman remains have been found in the vicinity. Nearby are the Beddau Gwyr Ardudwy (the graves of the men of Ardudwy), half-legendary memorials of early warfare, and Hafod Ysbyty farm, an old stone-staired monastic hospital or sanatorium. There is a large pumped storage hydroelectric project, the first of its kind in Great Britain, at Blaenau Ffestiniog and a nuclear power station at Trawsfynydd, 4 mi. S., was completed in the mid-1960s.

FIACRE (Fiachrach), **SAINT** (d. *c.* 670), Irish anchorite of noble descent. His *Acta*, which have little historical value, relate that he went to France and with the permission of St. Faro, the bishop of Meaux, built a monastery at Prodilus, the modern Breuil, in the province of Brie. There he received St. Chillen (? Kilian), who was returning from a pilgrimage to Rome, and there he remained until his death. In 1568, at the time of the religious troubles, his remains were transferred to a shrine in the cathedral of Meaux. St. Fiacre is the patron of Brie, and gardeners invoke him as their protector; his feast is kept on Aug. 30.

See O'Hanlon, *Lives of the Irish Saints*, vol. viii, pp. 421–447 (1875–1904).

FIANARANTSOA, the chief town of Fianarantsoa province in the south central part of the Malagasy Republic (Madagascar), lies on the eastern fringe of the forest at an elevation of about 4,000 ft., 259 mi. S. of Antananarivo (Tananarive) by road. Pop. (1956) 33,569, about half of whom were Betsileo and the rest Merina, with about 3,000 Europeans. It consists of upper and lower towns, surrounded by woodland (eucalyptus, fir), and lies on the island's main north-south highway linking it with Antananarivo, Tuléar and Fort-Dauphin; a railway connects it with the port of Manakara, about 40 mi. S.E. The island's principal business houses have branches there.

Fianarantsoa Province (area 39,873 sq.mi.; pop. [1961 est.] 1,471,037) comprises part of the fertile coastal plain of the east which gives way to mountains in the west; it is a prosperous rice-growing and cattle-raising district. The name means the place "where one learns what is good."

(J. Ar.)

FIAT MONEY. In a broad sense, this term denotes all kinds of money that are made legal tender by a government decree or fiat. The term is, however, usually reserved for legal-tender paper money or coins that have face values far exceeding their commodity values, that are not redeemable in gold or silver, and that have purchasing power in the various denominations materially less than that of full-bodied gold and silver coins of equal denominations. The continental currency issued during the American Revolution, the assignats (*q.v.*) issued during the French Revolution, the "greenbacks" of the American Civil War period and the paper marks issued in Germany in the early 1920s are historical examples of fiat money. Excessive issuance of fiat money leads to its depreciation in value. *See* Inflation and Deflation.

(R. P. Ke.)

FIBIGER, JOHANNES ANDREAS GRIB (1867–1928), Danish pathologist and professor at the University of Copenhagen, whose experiments on the production of gastric tumours in rats led to the first experimental production of cancer, and who was awarded the Nobel prize for medicine and physiology for 1926, was born at Silkeborg, on April 23, 1867, and died at Copenhagen on Jan. 30, 1928. While examining tuberculous rats, Fibiger found three with cancer of the stomach. The tumours contained a parasite (afterward named *Gongylonema neoplasticum*) which he was able to trace to a tropical type of cockroach that had come in sugar from the West Indies. When the cockroaches were eaten by rats infesting the particular sugar refinery, the larvae coiled up in their muscles developed into the adult nematodes in the stomachs of the rats. By feeding rats and mice similarly, Fibiger was able to produce stomach tumours of which one in a mouse proved transplantable.

Fibiger's experiments—rightly considered a pattern of methodical research—encouraged K. Yamagiwa to begin tar-painting of animals to produce cancer, a method at once adopted by Fibiger

as superior to his own, and leading into modern chemical cancer research.

It was later shown that Fibiger's animals must have been lacking then-unknown vitamin A; it is now known that a deficiency of this vitamin produces lung lesions corresponding to those interpreted by Fibiger and contemporaries as cancer metastases. Also gastric proliferations similar to those interpreted in Fibiger's time as fully developed cancer will occur under vitamin A deficiency in the presence of the *Gongylonema*, although they will be reduced in degree in the absence of either of those two factors. Thus, most of Fibiger's tumours would not fulfill modern criteria for fully developed cancer. It is true that his thesis of a carcinogenic effect of some parasites has been supported in other ways. However, no detailed analysis nor any final proof of its validity has yet been produced.

See K. Secher, *Johannes Fibiger* (1947); C. R. Hitchcock and E. T. Bell, "Studies on the Nematode Parasite, *Gongylonema neoplasticum* . . . ," *J. Nat. Cancer Inst.*, 12:1345–87 (June 1952). (Js. C.)

FIBONACCI, LEONARDO: *see* LEONARDO OF PISA.

FIBRE. A fibre may be defined as a unit of matter of hair-like dimensions whose length is at least 200 times greater than its width. The principal use of fibres is in the manufacture of textile yarns and ultimately textile fabrics. Fibres also are used as wadding or stuffing for mattresses and upholstery and in the manufacture of paper, brushes and a wide variety of other items; *e.g.*, as the fine cross hairs in microscopes or for mixing with resins to make plastic laminates or bonded webs. Most textile fibres are slender, flexible, relatively strong beams that are elastic in that they stretch when put under tension and partially or completely return to their original length when the tension is removed. Each fibre has its own unique properties and no one fibre can satisfy all manufacturing or use requirements. Fibres are broadly classified as natural or man made. This article deals with natural fibres. For a discussion of the other type *see* FIBRE, MAN-MADE.

Classification of Natural Fibres.—Natural fibres include those of vegetable (cellulose base), animal (protein base) or mineral (mineral base) origin. Examples of each class are cotton, flax, jute and abacá (vegetable); wool, hair and silk (animal); asbestos fibre (mineral). Generally only a few of the many fibre types in each natural class are of commercial importance. Vegetable fibres occur as hairs on the seeds of certain plants, such as cotton or milkweed, or as structural components of the stalks or leaves of plants. Chemically they are composed primarily of cellulose but the various fibre types contain varying amounts of natural lignins, pectins and waxes. Animal fibres, excluding silk, comprise the protective epidermal wool, hair or fur of animals and are composed of keratin, a complexity of amino acids, the most important being cystine. The only naturally occurring mineral fibre is asbestos.

Vegetable Fibres.—Vegetable fibres can be divided into three classes: (1) seed and fruit hair fibres; (2) bast fibres; and (3) leaf fibres. (*See* also FIBRE PLANTS.)

Seed and Fruit Hair Fibres.—Cotton is by far the most important fibre in this class, both in terms of consumption and the enormous variety of products manufactured from it. The cotton plant produces blossoms that ultimately become cotton fibre bolls, or pods. Each fibre formed within the boll is a single elongated cell that protrudes from the epidermal layer of the cotton seed. One seed contains about 10,000 such fibres, which may range in length from about $\frac{3}{8}$ to $2\frac{1}{2}$ in. and in diameter from 12 to 25 microns (μ) depending on the type of cotton. (One micron equals .001 millimetre.) After the bolls mature and burst open the cotton fibre cells die and lose moisture; each fibre collapses into a form that under the microscope looks like a twisted ribbon. (*See* also COTTON.)

The five most common types of commercial cottons are: (1) sea-island, which is fine (small diameter), long, strong and lustrous; (2) Egyptian, also fine, lustrous and of long staple (average fibre) length; (3) American-Egyptian, a hybrid developed from American and Egyptian strains; (4) American upland, the most commonly used cotton, which is less strong, shorter and of more irregular staple length ($\frac{13}{16}$ to $1\frac{1}{4}$ in.) than the first three types mentioned but which is the most practical for use in the vast majority of cotton textiles; and (5) Asiatic, which is coarse, weak and of very short staple length.

Other seed and fruit hair fibres are mudar (akund), kapok (*q.v.*) and milkweed (*q.v.*); all have limited use as stuffing or wadding. Kapok, because of its buoyancy, was used in life jackets during World War II but has largely been replaced by buoyant man-made fibres.

Bast Fibres.—Bast fibres, also called soft fibres, are obtained from the stalks of dicotyledonous plants. The fibre source is the phloem, or inner bark, of the stalk. The fibre, which may be several feet long, is composed of individual elongated cells. Depending on the fibre type, these cells range from about 10 to 30 μ in diameter and from 0.1 to several inches in length. The cells are held together by cellular tissue. Fibre types, in order of their importance, are jute, flax, hemp, ramie, sunn, kenaf, urena and nettle.

Jute (*q.v.*) is the most important bast fibre and is second to cotton in world production. Most of the world's supply is produced by India and Pakistan. Jute is inexpensive, but it has a yellow-brown colour, is difficult to bleach because it tends to disintegrate in water, does not have high strength and is coarse. Because of these qualities it is used primarily for industrial products such as bagging, carpet and linoleum backing, twine and cordage, and electrical insulation.

Flax (*q.v.*) fibre is strong, lustrous and, when bleached to a sparkling white, produces an attractive appearance for apparel goods as well as tablecloths and napkins. Because of its high strength it is also used in fish nets, sewing thread and fire hose. In English-speaking countries both the plant and the fibre are called flax, while the yarn and fabric produced from flax is called linen. In the United States, the word linen is often used to identify tablecloths, towels, chef's aprons and similar articles that may or may not be made of flax fibres. Flax is grown in many parts of the world, particularly in Russia, eastern and western Europe, Ireland and the United Kingdom.

Ramie (*q.v.*), also called China grass, is grown principally in the far east although there are a few western hemisphere varieties. Ramie fibre is strong but rather brittle, can be bleached to a white colour and is easily dyed.

Hemp (*q.v.*), or *Cannabis sativa*, is grown throughout the world. Hemp fibre bundles may be as long as 7 ft. The fibre is strong, varies in colour from yellow to brown and is difficult to bleach because of the presence of lignins and pectins. Hemp is used principally in cordage and industrial bagging. It is a true bast fibre and should not be confused with abacá, which is a leaf fibre.

Sunn (*q.v.*), kenaf, urena and nettle (*q.v.*) are produced in limited quantities for use as cordage, bagging and carpet backing.

Leaf Fibres.—Leaf fibres, also called hard fibres, are obtained from certain leaf portions of monocotyledonous plants. They are harder and have a larger diameter than bast fibres and are used mainly in cordage. The three most important leaf fibres are abacá (often called Manila hemp), sisal and henequen. Other leaf fibres are sansevieria, maguey (cantala), palma or palma istle, fique, phormium, caroa, coir, letona, esparto, mauritius and cabuya. (*See* also ABACÁ FIBRE; SISAL FIBRE.)

The abacá stalk is composed of a series of concentric sheaths that actually are leaves. Fibre bundles (also called fibres) are stripped from the sheaths, sometimes mechanically; they range in length from 3 to 9 ft. Abacá is native to the Philippines and is now grown in Borneo, Sumatra, Central America and many tropical countries.

Sisal and henequen are similar except that henequen leaves have barbs while sisal leaves do not. Fibre strands are 3 to 5 ft. long and cream to brown in colour.

Animal Fibres.—Sheep's wool, by far the most important animal fibre, is used in apparel, decorative fabrics and industrial fabrics. Other fibres derived from the hair or fur of animals are alpaca, Angora, camel's hair, cashmere, llama, mohair, vicuña, mink, badger, beaver and rabbit; all are used in apparel. Cattle, goat and horse hairs are used for stuffing and wadding; hog bristles are used in brushes. Silk, the only natural animal fibre that does

not grow from the skin as a protective covering, is extruded as a long continuous filament by the silkworm.

Sheep's Wool.—Wool is classified into five generally recognized types: fine, medium, long, crossbred and carpet (or mixed). Fine wools are produced by Merino sheep while most medium wools are produced by English breeds such as Cheviot, Dorset, Hampshire, Oxford, Ryeland, Shropshire, Southdown, Suffolk and Tunis. Longwool breeds are Cotswold, Leicester, Lincoln and Romney Marsh. Crossbreeds such as Corriedale, Columbia and Targhee produce medium-fine wools. Carpet wools are obtained principally from Asiatic sheep.

The wool is sheared from the live sheep (although some wool is "pulled" from slaughtered sheep) and is then sorted and graded for fibre length, diameter (or fineness) and colour. Wool fibres may range from ½ to 15 in. (or more) in length and from 10 to 60 μ in diameter.

(*See* also Wool; Sheep; Wool Manufacture.)

Specialty Hair Fibres.—Fibres from the alpaca, cashmere goat, vicuña, llama (*qq.v.*), and Angora goat (mohair [*q.v.*] fibre) are called specialty hair fibres. They are clipped from the animals and then sorted and graded according to staple length and fineness. The specialty fibres are usually light to dark brown or black in colour because of the presence of pigments within the fibre. The fibres usually are used in their natural colour or are dyed a darker shade. Some success has been achieved in bleaching these pigmented fibres without seriously impairing their other properties.

Mohair is a coarser (larger diameter) and more wiry fibre than wool and is sometimes used with wool to improve the resilience of wool worsted fabrics and thereby enhance wool's resistance to wrinkling. It also adds stiffness, making a firmer and crisper fabric. Cashmere, llama and vicuña are fine (small diameter) fibres and are softer and more flexible than wool. Camel's hair and alpaca are coarser and more abundant than cashmere, llama and vicuña.

Rabbit and beaver fur fibres are not normally used for textile fabrics, although rabbit fur is widely used in felts, including hats. Beaver, badger, mink and Angora fibres are expensive and their use is largely regulated by fashion modes.

Silk.—Silk filaments are extruded by the larvae of the mulberry-feeding moth, *Bombyx mori,* as they spin their cocoons. Two distinct filaments are extruded from glands on the larva's lower lip. The filaments, composed of a substance called fibroin, become coated with a protective gum called sericin as they are extruded. The spinning of the cocoon requires about three days, after which the silkworm becomes a dormant pupa. From the pupa develops a moth that breaks out of the cocoon and lives long enough to lay eggs. Few moths are allowed to develop to this stage of their life cycle, however, because many of the silk filaments are cut when the cocoon is broken and cannot be wound as continuous filaments. Most pupae are destroyed by heat or are rendered inert by refrigeration, after which the silk is wound from the cocoon into skeins. (*See* also Silk.)

Mineral Fibres.—Asbestos, the only naturally occurring mineral fibre, is very brittle. Care must be taken to avoid crushing and breaking it during mining and subsequent processing because the long fibre lengths make superior products. Asbestos fibre is widely used in roof shingles, plasterboard, pipe covering, floor tiles and fire-resistant clothing. Because the fibre is brittle, other more flexible fibres, usually cotton, are blended with the asbestos in amounts up to 20% to make coarse yarns.

Refined filaments, or wires, of gold, platinum, silver, tungsten and other metals are not considered to be natural because the refined metal must be processed into filamentous form.

Chemical Composition and Chemical Properties.—*Vegetable Fibres.*—Cotton, flax and ramie are most often used in a purified state; *i.e.,* after the natural waxes, gums or lignins have been removed. The impurities usually are removed by boiling in dilute caustic (sodium hydroxide) solution, followed by bleaching with sodium hypochlorite or hydrogen peroxide. The remaining pure fibre is composed of cellulose $(C_6H_{10}O_5)_x$. Cellulose is composed of cellobiose units bound together in a 1,4-β-glucosidic arrangement. The polymeric cellulose chains are formed when cellobiose units react, or "condense," to form repeating units with the splitting out of water. (*See* also Carbohydrates: *Polysaccharides: Cellulose;* Cellulose: *Chemistry of Cellulose.*)

Leaf fibres also contain appreciable amounts of lignins, pectins and waxes, as well as cellulose. They are almost always used in the natural unpurified state, however, for industrial purposes in which aesthetic properties such as colour, feel ("hand") and comfort are of no importance.

Animal Fibres.—Wool and all similar animal fibres are called keratinous fibres because they are composed of keratin, a protein that in turn is made up of a complexity of amino acids, the most important of which is cystine. In addition to carbon and hydrogen, wool contains 3%–4% sulfur, 16% nitrogen and 0.2% inorganic matter. The sulfur is present as a disulfide S-S cross linkage that is believed to be the basis for wool's resistance to wrinkling.

Silk is composed mainly of simpler amino acids than is wool and contains no sulfur.

Mineral Fibres.—Chrysotile asbestos is a hydrated magnesium silicate; crocidolite is a complexity of iron and sodium silicate; amosite is a magnesium silicate that contains iron. For the chemical composition of other types of asbestos *see* Asbestos.

Physical Properties.—The breaking strength, or the amount of stress that can be withstood without breaking, of fibres is measured in terms of grams per denier (denier is the weight in grams of 9,000 metres of yarn). This permits comparison of strength per weight per length. The breaking strengths (also called tenacities) in grams per denier (g.p.d.) of common fibres are: cotton 3–6, wool 1–2, abacá 6–7.5, flax 3–8, hemp 6–7, jute 3–6, ramie 5–8, silk 3–6, nylon 4–9. In comparison, that of structural steel, if expressed in the same units, would be 0.5–1.5.

Cotton.—Cotton is a strong fibre but is not highly extensible (stretchable). Since cotton fibres are only about 1 in. long they must be spun into continuous yarns. Only about 60% of the potential fibre strength is made available in the spun yarn. Partly because of its low extensibility, the cotton fibre does not recover well after stretching and so cotton fabrics do not exhibit good wrinkle resistance unless chemically treated with crease resistant finishes.

Cotton fibres are about 20% stronger when wet than dry. This property is an obvious advantage in wet uses, particularly for laundering. The higher wet strength increases the resistance of cotton fabrics to the tensions and strains that develop during washing, drying and ironing. Because of its launderability, its ability to absorb water and its nonthermoplasticity (*i.e.,* it does not soften or melt when heated), cotton is particularly useful for diapers and toweling. It can be sterilized by steam or by hypochlorite bleaching; such treatment enhances its whiteness and makes it of value for surgical and sanitary uses.

Linen, Ramie and Jute.—Most of the comments made above for cotton also pertain to linen and ramie. These fibres are somewhat stronger but are more brittle (less extensible) than cotton. Linen is sometimes used in industry when high-strength, low-stretch fabrics are desired. Jute is almost as strong as cotton when dry but tends to suffer microbial decomposition and strength loss when exposed to moisture vapour or liquid water for even relatively short periods.

Abacá, Sisal and Henequen.—These hard fibres are strong and tough, but because of their large diameters they are too stiff for most uses except cordage. While very large quantities of these fibres are still used, part of the cordage market has been taken over by certain man-made fibres that display greater strength, toughness (the ability to absorb energy), uniformity, and chemical, marine, weathering and microbial resistance.

Wool Fibre.—Wool is not a strong fibre but its ability to stretch and then return to its original dimension is good to excellent. This partly explains the reason for wool's good crease retention and resistance to wrinkling and crushing. Wool fibres contain random crimps, or wavy bends, that act as springs and prevent the fibres in a wool yarn from packing closely together. Wool yarns and fabrics therefore are usually soft, thick and resilient. While the wool fibre itself is neither better nor worse than other fibres

as a heat insulator, wool can be made into fabrics that are lightweight, soft and thick and therefore provide high thermal insulation.

Wool Felt.—The wool fibre is covered with a sheath of overlapping scales arranged like the shingles on a roof. Each scale tip points in the direction of the fibre tip. Rubbing the fibre from tip to root consequently meets more resistance and creates more friction than does rubbing from root to tip. The scale arrangement is both an attribute and a disadvantage in that it causes the wool to felt. The combination of moisture, heat and mechanical agitation causes the wool fibres to extend and retract. The scales permit the fibres to slide past each other more easily in one direction than in the other. Thus the fibres become progressively entangled to the point where a compact felt, or fulled, fabric results. Felts can be prepared by the direct entanglement of fibres or by first spinning yarns, weaving cloth and then fulling the cloth with hot, soapy water and agitation. (*See* also FELT.) Felting is a disadvantage because wool textiles shrink continuously if wet laundered. This is why wool garments are mostly dry-cleaned with organic solvents rather than with water.

Physical properties of the other hair fibres are essentially the same as those of wool.

Silk.—The development of man-made fibres has caused a major reduction in the use of silk. Silk is almost as strong as nylon and has almost equal extensibility and toughness. But nylon and polyester fibres are more uniform and are available in a wide range of diameters in unlimited quantities. Consequently they have displaced silk for almost all uses where high strength and energy absorption are required; *e.g.*, in parachutes and women's hose.

Asbestos, a stiff and brittle fibre, is used mainly because of its outstanding heat and fire resistance. Its brittleness limits its textile uses to those applications in which it can be spun into yarns with cotton or other fibres. Because of their greater flexibility, glass fibres have taken some of the markets originally held by asbestos.

Other Properties.—All of the natural fibres, excluding asbestos, are hydrophilic; *i.e.*, they have an affinity for water in both liquid and vapour form. Under so-called standard conditions of 65% relative humidity and a temperature of 70° F. (21.1° C.) all of the vegetable fibres contain 6%–10% moisture. Wool and the other animal hair fibres, as well as silk, contain 10%–15% moisture. The capacity of these natural fibres for absorbing moisture increases their suitability for use in clothing. The fibres can absorb water vapour or liquid from the surface of the body and transfer it to the surrounding atmosphere, thereby making the wearer more comfortable. Many man-made fibres cannot absorb water; thus in a fabric made of man-made fibre a moisture barrier may be created unless the fabric is sufficiently porous to permit the moisture to diffuse through the weave spacings. The moisture in natural fibres also eliminates static electricity in cold, dry weather by preventing the build-up of an electrostatic charge to the point where the fabric clings to the wearer or attracts lint and dust.

A further advantage of the hydrophilic nature of natural fibres is that they can be dyed. Textiles are commercially dyed by dissolving dyestuffs (with other chemicals) in water. The natural fibres absorb the water and the dyestuffs diffuse into and dye the fibres. In cellulose fibres the dyeing mechanism is considered to be a physical attachment of the dye molecules to the cellulose molecules, while for wool and other keratinous materials the dyeing is a chemical reaction between the dye and fibre.

Natural fibres, and the yarns into which they are spun, swell radially (*i.e.*, in diameter) when they absorb water. This causes the fabrics into which they are woven to shrink when laundered. A major cause of cotton cloth shrinkage, for example, is the increase in yarn diameters upon wetting. This increase requires the perpendicular set of yarns, which also swell radially, to traverse a slightly longer path in order to cross over a swollen yarn. Other causes of cotton fabric shinkage are believed to reflect the tendency of fibres and yarns to relax from previously imposed processing stretch.

Untreated cotton and linen fabrics often will shrink progressively for the first three or four launderings and then reach a stable shrunken state. The usual modern commercial practice is to preshrink the fabrics at the mill before they are manufactured into garments or other products. Then the fabric shrinks only an insignificant amount when first laundered. Chemical and resin finishes may be applied to stabilize cotton fabrics. Because of their felting properties, wool and the other animal fibres, excepting silk, continue to shrink upon repeated laundering.

All natural fibres are nonthermoplastic. Decomposition (*e.g.*, charring) starts at 300° F. (148.89° C.) for cotton and 265° F. (129.44° C.) for wool. When used below their decomposition temperatures, natural fibres are not thermally sensitive. They do not shrink or become highly extensible upon heating nor do they become hard, brittle and inflexible at temperatures below 32° F. (0° C.). The cellulosic fibres ignite readily and will continue to burn fairly rapidly. The animal fibres, including silk, ignite and burn somewhat less readily and are considered a lesser fire hazard than the cellulosics. All natural fibres tend to become yellow and to lose strength upon prolonged aging, particularly when exposed to sunlight. This is a slow process, however, and usually is not a problem during the normal life of the material.

Silk, the animal fibres and those cellulosic fibres essentially free of pectins and lignins are impervious to conventional dry-cleaning solvents and other solvents such as carbon tetrachloride, tetrachloroethylene (perchloroethylene), naphtha, alcohols, ethers, esters, ketones and other organic chemicals. Some of these solvents, however, may extract portions of the lignins and pectins from the bast and hard fibres.

Cellulosic fibres have good resistance to alkalies but are severely degraded or even dissolved by mineral acids. Wool and other hair fibres have excellent resistance to acids but are degraded or dissolved by hot alkalies. Silk is attacked and dissolved by both alkalies and strong acids but has fair resistance to weak acids. The type, concentration and temperature of the acid or alkali and the length of exposure all influence the degree of fibre damage.

The natural fibres are particularly susceptible to microbial decomposition; *i.e.*, mildew and rot. Cellulosic fibres are decomposed by aerobic bacteria and fungi, the active enzymes being cellulase, which converts cellulose to cellobiose, and cellobiase, which converts cellobiose to glucose. Cellulose mildews and decomposes rapidly in high humidity and high temperatures, particularly in the absence of light, unless protected by mildew-resisting chemicals. Wool and silk also are subject to microbial decomposition by bacteria and molds. Wool that has been damaged chemically appears to be much more susceptible to subsequent microbial action. The animal fibres are subject to damage by moths and carpet beetles. Termites and silverfish attack cellulose fibres.

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FIBRE, MAN-MADE. This article discusses textile fibres that are man-made; *i.e.*, those manufactured by the alteration of natural fibres (for example, rayon from cellulose) or by the synthesis of polymers (for example, nylon). Man-made fibres can be used separately, together as blends or in combination with natural fibres. For a discussion of silk, wool, cotton and other natural fibres *see* the article FIBRE.

TYPES AND PROPERTIES

Man-made fibres have been grouped in many ways. A convenient grouping includes the following four classes, listed in the order of their commercial importance: (1) cellulosic fibres; (2)

synthetic polymers (sometimes called true synthetics); (3) inorganic and metallic fibres; and (4) protein and rubber fibres. In the United States, where there is a great variety of fibre types, the Federal Trade commission rules and regulations, issued under the Textile Fiber Products Identification act, which took effect on March 3, 1960, specified 16 generic names for manufactured fibres. One of these includes a 17th name as a subgroup. The generic names are rayon, acetate, triacetate (cellulose group); nylon, acrylic, modacrylic, nytril, polyester, saran, spandex, vinyon, olefin, vinal (synthetic polymers); glass, metallic (inorganic and metallic); azlon, rubber (protein and rubber group). The fibre definitions used in this article are based on those contained in the FTC rules and regulations.

Cellulosic Fibres

Rayon and acetate are classed as cellulosic fibres. The rayons, including viscose rayon, cuprammonium rayon and saponified acetate rayon, are composed of regenerated cellulose. Acetate and triacetate fibres are composed of cellulose acetate, a cellulose compound.

The name rayon was adopted in 1924 to replace "artificial silk" for both regenerated cellulose and cellulose acetate fibres, but in 1951, at the request of the rayon industry, the U.S. Federal Trade commission established that "rayon" should be used only for regenerated cellulose, while "acetate" would be used for cellulose acetate. The FTC rules of 1960 defined rayon as "a manufactured fiber composed of regenerated cellulose, as well as manufactured fibers composed of regenerated cellulose in which substituents have replaced not more than 15 per cent of the hydroxyl groups." They defined acetate as "a manufactured fiber in which the fiber-forming substance is cellulose acetate. Where not less than 92 per cent of the hydroxyl groups are acetylated, the term triacetate may be used as a generic description of the fiber."

In each of the processes for manufacturing cellulosic textile fibres different solvents and chemical reactions are used in dissolving the cellulose. The mechanical method of extruding the chemically prepared solution is fundamentally the same. The operation of extrusion is called spinning in reference to the silkworm, which discharges its glutinous liquid from an external orifice called the spinneret located below its mouth, the threads combining into a single strand and hardening as soon as they are exposed to air.

The cellulosic solution prepared for man-made textiles is extruded, or spun, through perforated plates, called spinnerettes, located in the orifices of a bank of nozzles. These spinnerettes are made of metal alloys such as platinum and iridium or platinum and gold. They are perforated with circular, concentrically arranged openings of almost microscopic size (about 0.1 mm. in diameter). The size of the apertures governs the size of the filament extruded.

Miscellaneous Physical Characteristics of Cellulose Fibres.—Cellulose fibres are produced in a number of forms that are duplicated in other man-made fibres.

Filament Yarn and Staple.—The fibres come from the spinnerette and hardening processes in endless strands (continuous filaments). A group of strands may be given a slight twist and sold as filament yarn or the strand may be sold as tow that will be cut into staple; *i.e.*, sections of short, uniform length. The staple is spun in the textile mills by processes similar to those used in spinning cotton and wool. The staple length is determined by the type of spun yarn desired. When man-made fibres were first introduced, fibre lengths were limited by demands of existing equipment, which was designed to handle one or another of the natural fibres. As consumption of man-made fibres increased, textile equipment was altered until a single line of equipment could accommodate a wide range of fibre lengths.

In some cases single filaments (monofilaments) may be used. Fine monofilaments are knitted into hosiery and woven into curtains. Coarse monofilaments are used in place of straw for millinery.

Fibre size, or diameter, is determined by the size of the holes in the spinnerette and the amount of stretch applied in production. By varying the fibre size it is possible to produce, from a single fibre base, fine fibres for the sheerest lingerie or coarse fibres for industrial uses. The relative fineness of man-made fibres or yarns is expressed in denier, which indicates the weight in grams of 9,000 m. of the material. A 1-denier filament is extremely fine. Deniers of 1.5 to 15 are common in man-made fibres. Higher (coarser) deniers per filament are made for special purposes. Continuous-filament yarns are usually 20 through 900 denier for apparel purposes. Heavier deniers, from 1,100 through 4,400, are made for tire cords and other industrial uses. Continuous filament yarns are often described by the denier of the yarn and the number of filaments included in the yarn. For example, 100/40 denier signifies a 100-denier yarn made from 40 filaments. In this case each individual filament would be 2.5 denier.

Yarns spun from staple fibre are frequently described according to the number, or coarseness, of yarns made from the natural fibres that they resemble. It has been standard practice to express coarseness by different systems for cotton, woolen, worsted and linen yarns. Only silk and man-made fibres have been described by denier. International organizations have suggested a standard unit for all fibres and yarns called tex. The tex of a filament or yarn is the number of grams in 1,000 m. of length.

Lustre may be controlled. Most man-made fibres have a high natural lustre. This may be reduced by adding white pigment to the fibre substance before spinning. The various degrees of lustre are expressed as bright, medium dull and dull.

Solution-dyed (*spun-dyed*) *fibres* may be produced by incorporating colour pigments in the fibre substance before spinning. Yarns made from fibres coloured in this way have excellent fastness to washing, sunlight and chemicals.

Rayon.—The production of rayon, the first of the important man-made fibres, surpasses in poundage the production of all the other man-made fibres. (For current production figures *see* the *Britannica Book of the Year.*) In early production, the cellulose raw material was obtained from cotton linters, the short fibres left on cottonseed after ginning. The industry now uses cellulose obtained from soft woods. Three processes are used for making rayon fibres: the viscose, cuprammonium and saponification processes. They differ in their methods of converting purified cellulose into the soluble compound that is dissolved and forced through spinnerettes.

Viscose rayon is the most important of the rayons commercially. Purified cellulose is first treated with caustic soda (sodium hydroxide). After the alkali cellulose is aged, carbon disulfide is added to form cellulose xanthate, which is dissolved in sodium hydroxide. This viscous solution, known as viscose, is forced through spinnerettes. The soft extruded filaments are washed, desulfurized, bleached, washed, oiled and dried. This type of spinning is called wet spinning because the soft filaments are fed through chemical baths for hardening. Usually the wet filaments are wound on packages that are moved from machine to machine for hardening in the desulfurization, or regeneration, baths. In some plants the regeneration takes place continuously as the filaments are run on reels through series of baths.

Viscose rayon is noted for its versatility and economy. It is used alone, or in blends, in almost every type of apparel and household fabric, including carpets. It is the most absorbent of the man-made fibres. This absorbency contributes to comfort when rayon is worn next to the skin. It also makes rayon easy to dye.

Cuprammonium rayon (cupra rayon) is usually produced in the finer diameters. The purified cellulose is immersed in copper sulfate solution, which converts it to a compound that can be dissolved in ammonia. The solution is forced through spinnerettes into an acid bath that neutralizes the ammonia and removes the copper sulfate. As in the case of viscose rayon, the process is classed as wet spinning. Cuprammonium rayon is used to make fine-textured fabrics for wearing apparel.

Saponified acetate rayon is manufactured by the same method used for acetate (see *Acetate*, below) except that the cellulose acetate fibre is deacetylated under tension to form regenerated

cellulose. It is sold as a monofilament and is used for lightweight reinforcing fabrics in industrial belting and similar industrial and military purposes.

Special Varieties of Viscose Rayon.—The manufacture of viscose rayon is varied in many ways to adapt the properties of the fibre for special uses.

High-tenacity rayon is made by special stretching processes that increase the strength and reduce the extensibility of the fibre. All man-made fibres are stretched during or immediately after hardening. The stretching causes the molecules in the fibre to line up in a more linear, parallel arrangement. High-tenacity rayon has about twice the strength and two-thirds of the extensibility of regular rayon of the same weight and size. It is used in tire cords, as reinforcement for conveyer belts and in other industrial uses. A medium-tenacity rayon is also produced with properties midway between those of regular- and high-tenacity rayon. Cross-linked rayon is made by chemically treating the fibre to form chemical bonds between the individual chains of cellulose. When the chains are thus tied together, their freedom of movement is reduced, producing properties that differ from those of ordinary rayon, acetate or cotton. The cross-linked fibres resemble cotton in absorption characteristics but the fabrics made from cross-linked fibres show less shrinkage in repeated washing and greater strength when wet than regular rayon.

Acetate was the second important fibre to be made commercially. Purified cellulose is steeped in a solution of acetic acid and then is mixed with acetic acid, acetic anhydride and sulfuric acid to form a plastic mass of cellulose acetate. The excess acetic anhydride is neutralized and the cellulose acetate is dissolved in acetone. The solution is forced through spinnerettes and the acetone solvent is removed from the filaments with hot air. This system is called dry spinning because no wet treatment is used to harden the fibres.

Acetate fabrics are soft to the touch. They drape gracefully and dry rapidly. They are widely used in apparel and household furnishings. Acetate requires special dyes and this property makes it possible to develop two-tone effects with a single dye on fabrics made with combinations of acetate and other fibres.

Triacetate differs from regular acetate in that the proportion of acetate to cellulose in the fibre base is much greater than in regular acetate. Heat treatments are used in finishing triacetate fabrics to produce resistance to shrinking, stretching and crushing, and to increase the retention of pleats. Triacetate is usually used in apparel fabrics such as lingerie and in sheer curtains where shape retention and shrink resistance are important.

Synthetic Polymers

Most man-made fibres are made by a chemical process called polymerization (*q.v.*), in which many units of simple chemical substances combine to form large molecules whose properties are quite different from those of the basic units. By selecting suitable simple compounds and controlling the degree of polymerization, it is possible to produce new substances whose properties can be predicted. When certain types of simple compounds are polymerized under special conditions the units form long chains. Long-chain polymers can be manufactured into fibres; in nature, cellulose (consisting of long chains of glucose) and wool (consisting of long chains of amino acids) are formed into fibres. This means that it is now possible to produce entirely new fibre types with desired combinations of properties.

Nylon is the generic name for a group of fibres formed from long-chain polyamides. It was the first synthetic polymer fibre to be produced commercially. It can be made in a number of ways from carbon, hydrogen, nitrogen and oxygen. The carbon comes from coal, petroleum or natural gas. Nitrogen and oxygen come from the air and hydrogen from water. (*See* also Plastics: *Synthetic Resin Plastics: Polyamides.*)

In one common process adipic acid and hexamethyl diamine, two compounds derived by the chemical industry from natural products, are combined in water to form a solution of small molecules of amides. These are made to combine in long-chain molecules by polymerization under high temperatures. When the suitable polyamides have been formed, the surplus liquid is removed and the molten mass is cooled into sheets or ribbons that are then cut into fine chips. The chips are remelted, extruded through spinnerettes and the filaments are cooled. The cold fibre is stretched, or drawn, between systems of rollers to impart the desired balance of strength and stretch. This type of synthetic fibre formation is called melt spinning since the base material is spun from a melt rather than from solution. Nylon made in this way is called nylon 66.

$$-\mathrm{OOC(CH_2)_4CO[NH(CH_2)_6NHCO(CH_2)_4CO]_xNH(CH_2)_6NH^{a+}}$$

Nylon 66

The "66" indicates that this form of nylon has two six-carbon constituents—adipic acid and hexamethylene amine. (*See* also Carboxylic Acids: *Specific Carboxylic Acids.*)

Another method of production uses caprolactam as the raw material instead of adipic acid and hexamethyl diamine. This fibre, whose formula is $[-\mathrm{NH(CH_2)_5CO}-]_x$, is referred to as nylon 6 since it has one basic unit with six carbon atoms. The two nylons have similar properties though their molecular structures differ.

Nylon is produced in many physical forms. In its more common form it has extremely high stretch and recovery properties. These, coupled with its great strength and resistance to abrasion, make it suitable for use in a broad range of products, including parachute canopies, hosiery, lingerie, sweaters, carpets and automobile upholstery. It is particularly useful when durability, crush resistance and lightweight strength are important. Heavy filaments are used for industrial purposes. Special forms with reduced stretch are used for tire cord.

Nylon absorbs very little moisture; it retains its shape and creases during washing. It resists crushing under humid conditions and has a luxurious softness, drape and feel, or hand.

Acrylic fibres were first sold in 1950 under the name Orlon (*q.v.*). Others soon followed. The fibre-forming substance of acrylic fibres is the acrylonitrile unit $[(-\mathrm{CH_2CH}(\mathrm{CN})-)_x]$, which is polymerized from simple compounds derived from coal, air, water, petroleum and limestone. Variations of acrylic fibres are made by copolymerization of the acrylonitrile with modifying materials such as vinyl chloride or vinylidene dinitrile. These were once referred to as acrylic, acrylic type, acrylic alloys and similar designations. The Federal Trade commission clarified the terminology in 1960 by defining three separate classes of fibres in this family. Acrylic fibres are defined as those containing 85% of acrylonitrile units by weight. A modacrylic contains between 35% and 85% of acrylonitrile units, while a nytril contains at least 85% of a long-chain polymer of vinylidene dinitrile in which the vinylidene dinitrile appears in no less than every other unit of the polymer chain.

The fibres are made by processes resembling those used in nylon production, except that they are spun from a solution. They are used in the form of staple or tow. The fibres are soft and flexible, producing lightweight, lofty yarns. This characteristic gives fabrics a warm and luxurious feeling in sweaters, socks, baby clothes and other apparel and provides yarns that are an important raw material for carpets and rugs. The acrylics, modacrylics and nytril fibres are available in a variety of capacities for shrinking when they are heated. The natural loftiness of yarns containing these fibres can be increased by combining, in the same yarn, fibres of different shrinking capacities. The high-shrinking fibres shorten the yarn, forcing the unshortened fibres to become displaced into loops that give the yarn extra openness, or bulk. Such combinations are used in pile fabrics to give a surface combination of long and short fibres that resembles the guard hairs and undercoat in fur.

Acrylic fibres are highly resistant to sunlight and weather as well as to many chemicals. They are frequently used in industrial uniforms and filters. Since they soften at moderately low temperatures, especially in the case of nytril fibres, they are usually used in products that do not require ironing, such as sweaters, blankets and carpets.

The modacrylics can be stretched, or drawn, with heat. This property is made use of in molding modacrylic hats that are lightweight, hold their shape and can be cleaned with a damp cloth. (*See* also PLASTICS: *Synthetic Resin Plastics: Acrylic Resins.*)

Polyesters consist of long-chain polymers of certain esters. They were first sold in the United States as Dacron (*q.v.*) and appeared at about the same time in Great Britain as Terylene. The U.S. Federal Trade commission defined polyester as a manufactured fibre in which the fibre-forming substance is any long-chain synthetic polymer composed of at least 85% by weight of an ester of a dihydric alcohol and terephthalic acid ($p-HOOC-C_6H_4-COOH$).

In a standard process for making polyester fibres, dimethyl terephthlate and ethylene glycol are polymerized, cut into chips, melted, forced through spinnerettes and stretched, as in the production of nylon.

The strength and extensibility of the polyester fibres can be varied over a wide range. These fibres are known for their high resilience. Since they do not absorb water, the resilience is maintained while they are wet. Polyester fibres can be softened at high temperatures. This permits durable pleats to be set by heat; heat treatments also are used to control shrinkage, prevent sagging and maintain the shape of garments. Sheer polyester fabrics make excellent curtains. The high resilience of the fibre gives it special value as springy, lightweight filling for mattresses, pillows, comforters, sleeping bags and upholstery cushions. (*See* also PLASTICS: *Synthetic Resin Plastics: Anhydrous Thermosetting Resins;* RESINS: *Synthetic Resins: Polyester Resins.*)

Saran is formed of long-chain synthetic polymers that are composed of at least 80% by weight of vinylidene chloride units $[(-CH_2CCl_2-)_x]$. It is produced as a monofilament. Its preparation resembles the procedures followed with the other polymerized fibres. Ethylene and chlorine are combined to form vinylidene chloride, which is copolymerized with vinyl chloride. The copolymer is melt spun.

Saran wears well and resists stains, fading, mildew and the weather. Saran fabrics can be washed easily and are used for upholstery in public transport systems, cafés and deck chairs. The weight (specific gravity) of saran is too high for the material to be used widely as a general textile material.

Spandex is a synthetic elastomer; *i.e.*, it has rubberlike characteristics. Its fibre-forming substance is a long-chain synthetic polymer comprised of at least 85% of a segmented polyurethane $[(-NHCOOC_2H_4-)_x]$. "Segmented" refers to the fact that the spandex fibre is composed of alternating segments that display different stretch resistance characteristics; the more elastic segments act as springs connecting the stiffer segments.

The outstanding properties of spandex fibres are their extensibility and elasticity. They can be stretched 500% without breaking and do not break down on repeated stretching. They also have good strength, high uniformity and high abrasion resistance; in addition, they resist weathering, chemicals and cosmetics. They are well suited for use in foundation garments, elastic stockings and similar products where elastic support is required. Garments made from filaments of spandex, without the presence of other fibres, may be washed and dried in home-laundering equipment.

Vinyon is defined as a manufactured fibre made of long-chain synthetic polymers that are composed of at least 85% by weight of vinyl chloride $[(-CH_2CHCl-)_x]$. Vinyon fibres soften below the boiling point of water but their chemical resistance makes them suitable for certain industrial uses. (*See* PLASTICS: *Synthetic Resin Plastics: Polyvinyl Chloride Resins.*)

Olefin is formed, according to Federal Trade commission definition, of any long-chain synthetic polymer composed of at least 85% by weight of ethylene, propylene or other olefin units. These fibres have good abrasion resistance and are unharmed by acids and alkalies. They also are extremely resistant to molds and fungi. Since they soften at low temperatures they are not used in garments that are laundered. Their chemical stability makes them suited for use in the chemical industry for filter pads and protective clothing. Their resistance to water makes them useful in fish lines, seines and similar applications. (*See* also OLEFIN; PLASTICS: *Synthetic Resin Plastics: Polyethylene Resins.*)

Vinal fibres are made up of long-chain synthetic polymers composed of at least 50% by weight of vinyl alcohol units $[(-CH_2CHOH-)_x]$; the total of the vinyl alcohol units and any one or more of the various acetal units is at least 85% by weight of the fibre.

These fibres soften at low temperatures and hence cannot be used for garments that are laundered. Because of their high chemical resistance, they are used as filter pads and protective clothing in the chemical industry.

GLASS AND METALLIC FIBRES

Glass fibres are made by spinning melted glass of a special composition consisting of silica sand, limestone, soda ash, borax, boric acid, feldspar and fluorspar. The molten glass is forced through small holes in electrically heated fittings in the bottom of heating kettles. The hot strands are gathered on a rapidly revolving carrier that stretches the fibres into fine, flexible filaments.

Glass fibres are tremendously strong and heat resistant but have little stretch. They can be protected against abrasion by being given special finishes. Glass fibres are difficult to colour, but coloured drapery fabrics are made by coating them with organic resins that hold dyes or pigments. Glass-fibre fabrics are used when heat and fire resistance are important, as in draperies for public places. They also are used as reinforcement for laminated plastics in boats and other molded products. Glass batting is used as thermal insulation for buildings, railway cars, boats and airplanes. (*See* also GLASS MANUFACTURE: *Glass Fibres.*)

Metallic filaments are used for decorative effects in fabrics made primarily from yarns of other fibres. In the most common method of manufacture a sheet of aluminum foil is wound off a roll and coated on both sides with an adhesive. The adhesive-coated foil is heated and a transparent plastic film is applied to each side. The foil with its adhering plastic is then slit into narrow filaments. Colours may be printed on the foil or carried in the adhesive. When given certain plastic coatings, metallic yarns do not tarnish and are not affected by salt water or the weather.

PROTEIN AND RUBBER FIBRES

Azlon is the generic term applied to fibres formed from protein regenerated from such natural materials as casein (from skim milk), peanuts, seaweed, soybeans and zein (from corn, or maize, kernels). Their production in the United States has been discontinued but they are produced in Great Britain and Europe. The fibres are very soft and lose strength when wet.

Rubber fibres are made from natural or synthetic rubber. They are useful because of their high elasticity and stretch. They are usually employed as a core around which other fibres or yarns are wound to protect the rubber from abrasion. They are used in foundation garments, surgical supports and elastic webbing.

(G. E. Ho.)

HISTORY

The first person to visualize the possibility of making an artificial fibre by a process similar to the spinning of the silkworm was Robert Hooke, an English scientist, who included a discussion of the subject in his book *Micrographia,* published in 1665. In 1734 the French scientist René A. F. de Réaumur predicted the manufacture of an artificial textile from gums or resins that resisted heat and solvents. No concrete developments along these lines occurred, however, until the middle of the 19th century. In 1842 an English silk weaver, Louis Schwabe, exhibited a machine for making artificial filaments. This machine used nozzles with fine holes through which the liquid was forced in order to form filaments; this is the principle of the spinnerettes used today. Schwabe spun his filaments of glass, but he was not satisfied with the product and appealed to British scientists to discover a better material from which to manufacture filaments. A third development preparing the way for rayon was the discovery of nitro-

cellulose by C. F. Schönbein, a Swiss chemist, in 1846.

Rayon.—The first-known patent for the manufacture of rayon was issued to George Audemars in 1855. He prepared fibres from the inner bark of mulberry and other trees, which he nitrated and dissolved in a mixture of ether and alcohol and combined with a rubber solution to form his spinning mixture. The filaments were spun by dipping the point of a needle into the solution and drawing out a filament, which was connected with a winding machine. Two years later a patent was issued to E. J. Hughes for an elastic substance made of starch, gelatin, resin, tannins and fats which could be spun into silklike filaments.

A further advance was made by Sir Joseph W. Swan of England who, while searching for a better carbon filament for electric light bulbs, patented in 1883 a process for making a filament by squeezing a nitrocellulose solution into a coagulating medium and denitrating the filament. The fact that nitrocellulose could be denitrated by reducing agents such as ammonium sulfide was known as early as 1863. In 1885 Swan exhibited a few articles made from these filaments, but he did not follow up the textile possibilities of his invention.

Nitrocellulose Process.—The development of rayon as a textile really began with the work of Count Hilaire de Chardonnet (1839–1924) who is frequently called the "father of the rayon industry." Chardonnet began experiments on the making of an artificial textile in 1878 and in 1884 produced his first fibre from a nitrocellulose solution of pulp derived from mulberry leaves, coagulating the filaments in heated air. At the Paris exposition in 1889 he exhibited articles made from these artificial fibres and secured financial backing to build a factory at Besançon, France, where the first commercial production of rayon began in 1891. Chardonnet's process was modified later when a solution of alcohol instead of warm air was used to coagulate the filaments. Production of rayon in the U.S. by the nitrocellulose method began in 1920 and was discontinued in 1934 after the other methods proved superior.

Cuprammonium Process.—A second process for the production of artificial fibres from cellulose, the cuprammonium process, was patented in 1890 by a French chemist, Louis Henri Despeissis. The discovery that cellulose could be dissolved in a cuprammonium solution and then precipitated with sulfuric acid is usually credited to M. E. Schweitzer (1857), although there is some evidence that John Mercer had already performed this operation. And in 1882 Edward Weston had patented a process for making filaments from a cuprammonium solution of cellulose but, like Swan's discoveries in the nitrocellulose field, these filaments were developed in connection with the manufacture of electric light bulbs and were not exploited for textiles. Despeissis himself did not put his patent into commercial production. Several German chemists (H. Pauly, M. Fremery, E. Bronnert and Urban) developed modifications and improvements on this process and put it into commercial production about 1898. This process of rayon production was comparatively expensive and was falling into disuse until a method of stretch spinning, which had been patented by Edmund Thiele, was improved and put into production in 1919. Stretch spinning permitted the manufacture of very fine filaments and revived the use of the cuprammonium process.

Viscose Process.—A third process for the production of rayon grew out of researches on cellulose derivatives by C. F. Cross and E. J. Bevan. These men discovered and patented in 1892 a viscous solution resulting from the dissolution of cellulose xanthate in dilute sodium hydroxide. The manufacture of a textile fibre from this solution was undertaken by C. H. Stearn and C. Topham while they were engaged in the spinning of lamp filaments of this material, but the technical problems of finding a proper solution and a satisfactory method for spinning the yarn required years of research. In 1898 Topham discovered the aging process in preparing the spinning solution, and in 1902 he invented his spinning box, a revolving cylinder in which the very tender filaments were coiled by centrifugal force as they were drawn from the spinning bath. In the same year (1902) Max Mueller discovered that it was possible to convert the cellulose xanthate into regenerated cellulose at the same time that the spinning solution was being coagulated into filaments, instead of by a separate operation. This discovery, permitting the spinning of a yarn strong enough to be wound directly on a spool, greatly stimulated the development of the viscose process. The commercial production of rayon yarn by the viscose process started in 1905. The first U.S. plant using this process began operation at Marcus Hook, Pa., in 1911.

Acetate.—Cellulose acetate (later called acetate) was produced by Laurent Naudin and Paul Schutzenberger in 1865. Cross and Bevan experimented with it and patented a process for its production in 1894. The important discovery that cellulose acetate modified by partial saponification (treatment with sodium hydroxide) was soluble in acetone, instead of the chloroform necessary to dissolve ordinary cellulose acetate, was made by G. W. Miles in 1903.

In the United States, Arthur D. Little of Boston, Mass., had kept abreast of developments in the English experiments and, in partnership with William H. Walker and Harry S. Mork, was using the new acetate compound for electrical wire insulation. In 1902 these three were granted a patent for spinning textile yarn. This first patent on a man-made fibre in the United States led to the first successful manufacture of acetate rayon (now known as acetate).

But the full development of this process on a commercial scale was the work of Henri and Camille Dreyfus, who made use of the acetone-soluble compound discovered by Miles. During World War I, the Dreyfus brothers built a large factory at Spondon, Eng., for the production of cellulose acetate to be used as noninflammable dope for covering airplane wings. A similar plant was started by them in the United States. When the end of the war destroyed the demand for acetate dope, Dreyfus turned to the production of acetate fibres and after several years of research evolved a commercially successful spinning process.

(S. B. H.; X.)

Nylon and Other Synthetic Polymers.—Nylon originated as a result of a laboratory accident. In 1927 the E. I. du Pont de Nemours & Co. set up a program of fundamental research as an activity of the chemical department. One of the earlier studies undertaken was that of polymerization—how and why certain small molecules unite to form giant molecules, such as those found in rubber, cotton and silk. After the work had been under way about two years one of the chemists, in attempting to remove a sample of the molten polymer from the vessel in which it had been prepared, found that it could be drawn out in the form of a long fibre, and that even after the fibre was cold it could be drawn farther to several times its original length. Such a phenomenon had never been observed with a compound of that type. The strand made was strong, elastic, lustrous and silklike. After much more research under the direction of Wallace H. Carothers (1896–1937) a variety of polymer was developed in 1935 that, when drawn through a spinnerette improvised from a hypodermic needle, was actually the first nylon fibre. It was introduced to the public in 1938 as bristles in toothbrushes. The name nylon was dedicated to the public when the material was introduced. In 1939 hosiery knitted of nylon yarn was produced in a pilot plant and made available for limited sale, and in May 1940 nylon hosiery was offered to the public on a national scale.

The research that resulted in the discovery of nylon led to the development of other synthetic polymer fibres, such as Dacron and Orlon (*qq.v.*). (*See* also PLASTICS.)

(M. G. B. A.; G. E. Ho.)

Glass.—A method of spinning glass through fine orifices was developed by two independent U.S. glass companies in 1931. In 1938 the fibre-producing interests of the two companies were combined into one jointly sponsored company for commercial production.

Metallic.—Centuries before fibres were produced by chemical processes, ribbonlike metallic threads were used in the hand weaving of religious robes, carpets and clothing fabrics. The metallic threads produced highly prized decorative effects, but gold was expensive and all other metals tarnished in use. Furthermore, the sharp edges cut adjacent strands and were very

harsh when worn against the skin. The modern metallic filaments and yarns are inexpensive and maintain their bright appearance.

Protein Fibres.—Chemists have sought to arrange proteins from abundantly available raw materials into long-chain molecules in hopes of creating new fibres that might be similar to wool. The raw materials investigated included chicken feathers, skim milk, soybeans, peanuts and corn (maize) kernels.

Shortly before World War II protein fibres were made from the casein in skim milk and the Italian army was partly clothed in fibres made from casein during the invasion of Abyssinia. The first casein-base fibres made in the United States were sold under the trade name Aralac. Later, in 1949, fibres made from zein, found in corn kernels, replaced Aralac in the United States and were sold under the trade name Vicara. Production of both of these fibres has been discontinued, but protein base fibres are still produced in England and on the continent with peanuts, soybeans and casein as the raw materials.

See also references under "Fibre, Man-Made" in the Index volume. (G. E. Ho.)

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FIBRE PLANTS. Plants that have long slender threadlike thick-walled cells or groups of cells growing through the leaves, stems or fruits are fibre-yielding plants. More than 2,000 species of such plants have been catalogued in various parts of the world. Of this number, less than 50 are of commercial importance.

Abacá (manila or manila hemp), sisal (sisal hemp) and similar plants yielding leaf fibres are native to the tropics, while flax, cotton, hemp and other fibre-yielding plants grow better in the temperate zone. Although the United States uses large quantities of vegetable fibres, with the exception of cotton and some palm fibres, none are grown in commercial quantities within its borders. India and Pakistan supply jute and like fibres from which hessians (coarse textiles) and twine are made. Mexico, Cuba and Africa produce henequen and sisal used in the manufacture of rope and twine. Abacá, from which the better grades of cordage are made, comes mostly from the Philippines. Flax and hemp are produced in Russia and other European countries.

Most plant fibres are readily grouped according to their structure, to their origin in the plant, or according to their use. A simple classification that includes all vegetable fibres follows: (1) seed and fruit hair fibres, sometimes called as surface fibres; (2) structural or leaf fibres frequently referred to as hard fibres; (3) bast or soft fibres, often referred to as stem fibres; (4) miscellaneous fibres, including root and stem fibres; and (5) pulp fibres from tree trunks, bamboo and similar sources used in the manufacture of paper. (*See* also FIBRE.)

Uses.—The principal uses made of vegetable fibres in industry may be grouped under seven major headings which can in turn be subdivided to include all products made of fibres. The major uses are: (1) textiles; (2) cordage; (3) brush; (4) filling and padding; (5) paper; (6) plaited and felted fibres; and (7) raw materials for the chemical industry, particularly cellulose.

Many fibre-yielding plants produce other products that may be of equal or greater value than the fibre. Cottonseed yielding linters (fibres and fuzz not removed in ginning and used for batting, etc.), oil and meal; flaxseed yielding linseed oil and meal; the coconut yielding oil; and the yuccas (of the lily family) and lechuguilla (of the same family as the century plants, agave [*q.v.*]) yielding saponin (*see* SAPONINS AND SAPOGENINS), from which drugs and other products are made, are examples of the importance of by-products in the fibre industry.

Seed and Fruit Hair Fibres.—Seed and fruit hair fibres grow as short single-celled seed hairs in cotton, as pod fibres in kapok and as husk or hull fibres in the coconut. Cotton is by far the most important vegetable fibre grown, as to quantity and uses made of the fibre. The improvement in quality and yield of fibre resulting from breeding and selection, the progress in completely mechanizing production and the improvement in spinning and weaving and the manufacturing of cotton-made products, all contribute to its universal use.

Kapok, pachote, samohu and several similar fibres grow in seed pods on trees. The properties of these fibres make them useful as filler, as insulation and in life preservers and cushions on boats. Coir, the fibre from the coconut, is used in door mats, coarse twine, rope and brushes.

Leaf Fibres.—Structural or leaf fibres are hard and stiff in texture and extend lengthwise through the pulpy tissue of long leaves or leaf stems of monocotyledonous or endogenous plants. They impart rigidity and stability to the plant and help protect it from injury by wind and weather. Most of these plants are native to the western hemisphere. With the exception of phormium (New Zealand flax, or flax lily), native to New Zealand, and the istles (various agaves) native to northern Mexico, the leaf fibres are all grown in tropical or subtropical climates. Plants like henequen and lechuguilla thrive in the arid climate and rocky soils of Yucatán and northern Mexico, while abacá grows best in a fertile, well-drained soil having an ample supply of moisture.

Sisal is native to Yucatán but grows better in Africa and other areas where more fertile soils and more moisture are available. Leaf fibres come from perennial plants that produce fibre over a period of 5 to 20 years or more, depending on soil, climate and harvesting procedures. The leaves of the agaves are harvested for fibre as they mature. When mature, the entire abacá stalk is harvested.

Most of the leaf fibres are extracted by mechanical methods involving macerating and scraping. Machines ranging from a crude dull knife and a block of wood with which 10 to 15 lb. of fibre can be scraped daily, to large mechanically powered decorticators capable of producing up to 3,000 lb. of dry fibre per hour, are in use.

Many leaf fibres, as the istles in Mexico and caroa in Brazil, are harvested from the wild state and are processed by hand scraping. Others, as sisal and henequen (*see* SISAL FIBRE), and abacá are grown under cultivation on large plantations where decorticating, which is the process of extracting the fibre from the leaves, is highly mechanized. All other operations use large amounts of hand labour. The raspador type decorticator as used on most plantations consists of two large rotating drums equipped with dull knives operating against curved surfaces and disposed adjacent to offset gripping devices which carry the plant material through the machine.

Cantala, sisal, pita floja (a wild pineapple) and others are occasionally retted, or soaked, for local use, but the fibre is inferior in strength and colour.

Bast or Stem Fibres.—Bast fibres are secured from dicotyledonous or exogenous plants grown mostly as annuals planted from seed each year. In order to produce long slender stalks free from leaves and branches, the plants must be grown in a dense stand. The fibres are soft and flexible in character and extend through the inner bark of the stalk or stem of the plant. The stalks average one-half inch in diameter and are from 5 to 15 ft. tall. The best quality of the bast fibre is produced by water retting or by chemically treating the fibre. The retting process for jute and similar fibres is accomplished by submerging bundles of stalks in the back waters of rivers or in ponds or artificial pools where bacteria consume the nonfibrous material, leaving a slimy substance that is readily washed from the remaining fibre ribbon or strand. The time of retting varies from 5 to 20 days or more, depending on the age of the stalk and the temperature and kind of water.

Retting is usually considered complete when the bark and fibre slip easily from the woody part of the stalk. The fibre is cleaned and washed by workers who wade waist deep into the water. Drying is done in the open air.

Flax fibre contains more cellulose and is finer and stronger than jute. It brings a higher price on the market. More care is used in the handling and in the retting procedure. Under-retted fibre does not clean well and if over-retted it loses strength and luster thus lowering its value. In the United States and Canada

and in some European countries the retting is done in large tanks under controlled conditions. The washing is done by draining off the retting media and flushing several times with fresh water. The retted stalks are spread out on the grass or are stood up in shocks and completely dried before breaking, scutching, or separating, and hackling, or combing. The flax industry has been mechanized to a large degree but many operations are still done by hand in European countries.

The name hemp has been applied to many fibres that are in no way related to true hemp (*Cannabis sativa*). True hemp is one of the strongest vegetable fibres, comparing well with flax, ramie and others. Before the advent of abacá it was used for most of the marine rope and for other high-grade cordage. The better grades of fibre are produced by water retting. A large part of the crop is cut and spread on the stubble where it remains until retting is completed by dews, rains and snows.

Hemp production has been mechanized in the United States; but much hand labour and many of the old hand-operated brakers and scutchers are still in use in the countries where most of the fibre is grown.

Ramie (China grass) is one of the few bast fibre plants grown as a perennial. It is of the Urticaceae or nettle family, but is free of stinging hairs typical of most nettles. Plantings are established from root pieces planted in rows. The young plants soon spread out over the entire area and grow in a crowded condition much like other bast fibres. Once established, a plantation should produce fibre for ten years or more before replanting is necessary. Ramie is native to China but grows well in many other countries where soil and climate are favourable. The better grades of ramie fibre are produced by decorticating or ribboning the stalk and treating the resulting crude product chemically to purify the fibre. When degummed, ramie filasse (fibre prepared for manufacture) is white in colour with a soft luster that is much like silk in appearance. It contains a high percentage of cellulose which accounts for many of its unique properties.

Miscellaneous Fibres.—Miscellaneous fibres include the stiff roots of some grasses and stem fibres as Spanish moss. The principal root fibre is known as *zacatón* in Mexico where most of it is produced. It is also known as broomroot, rice root, etc. The root fibres are coarse, crinkled and stiff when properly treated. They are used mostly in brushes. Cheaper palm fibres are replacing this fibre and its demand is decreasing. Spanish moss is an air plant of the pineapple family. It has been produced in Louisiana, Mississippi, Florida and other states along the Atlantic seaboard. At one time it ranked next to horsehair as an upholstery material, and for mattress and cushion filler. Foam rubber and other rubberized products have largely replaced it.

For additional information the reader is referred to the articles on specific plants, as ABACÁ FIBRE; COIR; HEMP; etc. For uses *see* BRUSH; CELLULOSE; PAPER MANUFACTURE; ROPE; TEXTILES; etc.

For production *see* articles on countries and states.

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FIBRIN, the essential part of the blood clot, is an insoluble protein substance that connects the edges of a wound and prevents passage of the blood corpuscles. It results from a chemical process in the plasma that causes dissolved fibrinogen to separate out. *See* BLOOD.

FICHTE, IMMANUEL HERMANN (originally HARTMANN) **VON** (1796–1879), German philosopher, son of Johann Gottlieb Fichte (*q.v.*), was born at Jena on July 18, 1796. Having held educational posts at Saarbrücken and Düsseldorf, he became professor of philosophy at Bonn in 1836 and at Tübingen in 1842. He died at Stuttgart on Aug. 8, 1879.

Fichte's most important writings are: *System der Ethik* (1850–53), *Anthropologie* (1856), *Psychologie* (1864–73), *Die theistische Weltansicht und ihre Berechtigung* (1873). His general views on philosophy are marked by an eclecticism, a predominantly historical treatment of problems and a conciliatory tone. He edited the works and correspondence of his father.

See R. Mehlich, *I. H. Fichtes Seelenlehre und ihre Beziehung zur Gegenwart* (1935); J. Ebert, *Sein und Sollen bei Immanuel Hermann Fichte* (1938).

FICHTE, JOHANN GOTTLIEB (1762–1814), German philosopher and patriot, who was recognized, together with Friedrich Schelling and Hegel, as one of the three immediate claimants to the Kantian succession, was born at Rammenau in Upper Lusatia on May 19, 1762, the son of a ribbon weaver. Educated at the Pforta school (1774–80) and at the universities of Jena (1780) and of Leipzig (1781–84), he started work as a tutor. In this capacity he went to Zürich in 1788 and to Warsaw in 1791, but left after two weeks' probation. Meanwhile, at Leipzig in 1790, he had composed his "Aphorismen über Religion und Deismus" (1st ed. in the *Sämmtliche Werke*, i; see *Bibliography* below), reminiscent of Spinoza's determinism. The major influence on his thought at this time, however, was that of Kant, whose doctrine of the inherent moral worth of man harmonized with his character; and he resolved to devote himself to perfecting a true philosophy, the principles of which should be practical maxims. Having already begun an abridgment (never completed) of the *Critique of Judgment*, he went from Warsaw to see Kant himself at Königsberg. The first interview was disappointing, but when Fichte submitted his *Versuch einer Kritik aller Offenbarung* ("Essay Toward a Critique of All Revelation") to Kant, the latter was favourably impressed by it and helped to find a publisher (1792). Fichte's name and preface were accidentally omitted from the first edition and the work was ascribed by its earliest readers to Kant himself; when Kant corrected the mistake while commending the essay, Fichte's reputation was made.

From the *Critique of Pure Reason* it was clear that for Kant speculative theology must be purely negative, while the *Critique of Practical Reason* as clearly indicated the view that the moral law is the absolute content or substance of any religion. A critical investigation of the conditions under which religious belief was possible was still wanting; and this it was that Fichte sought to supply in the *Versuch*. His exposition of the conditions under which revealed religion is possible turns upon the absolute requirements of the moral law. Religion itself is the belief in this moral law as divine, and such belief is a practical postulate, necessary in order to add force to the law. The revelation of this divine character of morality is possible only to a being in whom the lower impulses have been, or are, successful in overcoming reverence for the law. In such a case it is conceivable that a revelation might be given in order to add strength to the moral law. Religion ultimately then rests upon the practical reason and satisfies the needs of man, insofar as he stands under the moral law. In this conclusion we see the prominence assigned by Fichte to the practical element and the tendency to make the moral requirements of the ego the ground for all judgment on reality. Having reached this point he had to press forward and leave the Kantian position.

In 1793 Fichte married Johanna Maria Rahn, whom he had met during his stay in Zürich. In the same year he published anonymously two remarkable political works, *Zurückforderung der Denkfreiheit von den Fürsten Europens* and *Beitrag zur Berichtigung der Urteile des Publikums über die französische Revolution*. Of these the latter, which is much the more important, was intended to explain the true nature of the French Revolution, to demonstrate how inextricably the right of liberty is interwoven with the very existence of man as an intelligent agent and to point out the inherent progressiveness of state arrangements and the consequent necessity of reform or amendment.

As in the *Versuch*, the rational nature of man and the conditions necessary for its realization are made the standard for political philosophy.

When K. L. Reinhold vacated the chair of philosophy at Jena

(1793), Fichte was called to succeed him. To the ensuing period belongs his most important philosophical work (*see* below). In this period he published *Einige Vorlesungen über die Bestimmung des Gelehrten* (1794; Eng. trans., *The Vocation of the Scholar*, 1847), being lectures on the importance of the highest intellectual culture and on the duties that it imposed, delivered not merely to his own pupils but to all students of the university; the introductory *Über den Begriff der Wissenschaftslehre* and the theoretical *Grundlage der gesamten Wissenschaftslehre* (both also 1794), supplemented by *Grundriss des Eigentümlichen der Wissenschaftslehre* (1795); the practical *Grundlage des Naturrechts* (1796; Eng. trans., *The Science of Rights*, 1869 and 1889); *Erste Einleitung . . . , Zweite Einleitung in die Wissenschaftslehre* and *Versuch einer neuen Darstellung der Wissenschaftslehre* (all three 1797); and *System der Sittenlehre nach den Principien der Wissenschaftslehre* (1798; Eng. trans., *The Science of Ethics as Based on the Science of Knowledge*, 1897). To the theme of his *Wissenschaftslehre* ("doctrine of knowledge" or "science") he was to recur continually throughout his life.

In 1795, however, Fichte had become one of the editors of the *Philosophisches Journal;* and in 1798 his friend F. K. Forberg sent him an essay on the development of the idea of religion. Before printing this, Fichte, to prevent misunderstanding, composed a short preface, "On the Grounds of Our Belief in a Divine Government of the Universe," in which God is defined as the moral order of the universe, the eternal law of right which is the foundation of all our being. The cry of atheism was raised, and the electoral government of Saxony, followed by all the German states except Prussia, suppressed the *Journal* and demanded Fichte's expulsion from Jena. After publishing two defenses (*Appellation an das Publikum über die . . . ihm beigemessenen atheistischen Äusserungen* and *Der Herausgeber des philosophischen Journals gerichtliche Verantwortung gegen die Anklage des Atheismus*, both 1799), Fichte threatened to resign in case of reprimand. Much to his discomfort, his threat was taken as an offer to resign and was duly accepted.

Except for the summer of 1805 (which he spent at Erlangen, delivering the lectures published in 1806 as *Über das Wesen des Gelehrten*, a longer version of his Jena lectures of 1794), Fichte resided in Berlin from 1799 to 1806. Among his friends were the leaders of German romanticism, A. W. and F. Schlegel and F. Schleiermacher. His works of this period include *Die Bestimmung des Menschen* (1800; Eng. trans., *The Vocation of Man*, 1848); *Der geschlossene Handelsstaat* (also 1800), an intensely socialistic treatise in favour of tariff protection; *Sonnenklarer Bericht an das grössere Publikum über die neueste Philosophie* (1801; French trans., *L'Essence de la théorie de la science*, 1916); two new versions of the *Wissenschaftslehre* (composed in 1801 and in 1804; published posthumously), marking a great change in the character of the doctrine; *Grundzüge des gegenwärtigen Zeitalters* (1806; lectures delivered 1804–05; Eng. trans., *Characteristics of the Present Age*, 1849), analyzing "the Enlightenment" and defining its place in the historical evolution of the general human consciousness, but also indicating its defects and looking forward to belief in the divine order of the universe as the highest aspect of the life of reason; and *Die Anweisung zum seligen Leben, oder Religionslehre* (1806; Eng. trans., *The Way Towards the Blessed Life*, 1849). In this last-named work the union between the finite self-consciousness and the infinite ego or God is handled in a deeply religious fashion reminiscent of the Gospel of St. John. The knowledge and love of God is declared to be the end of life. God is the All; the world of independent objects is the result of reflection or self-consciousness, by which the infinite unity is broken up. God is thus over and above the distinction of subject and object; our knowledge is but a reflex or picture of the infinite essence.

The French victories over the Prussians in 1806 drove Fichte from Berlin to Königsberg (where he lectured for a time), then to Copenhagen, whence he returned to Berlin in Aug. 1807. From this time his published writings are practical in character; not till after the appearance of the *Nachgelassene* and of the *Sämmtliche Werke* was the shape of his final speculations known. We may here note the order of these posthumously published writings as important for tracing the development of Fichte's thought. From 1806 we have the remarkable *Bericht über die Wissenschaftslehre* (*Sämmtl. Werke*, viii), with its sharp critique of Schelling, and from 1810 the *Thatsachen des Bewusstseyns* (published 1817), of which another treatment is given in lectures of 1813 (*Nach. Werke*, i). Of the *Wissenschaftslehre* we have, in 1812–13, four separate treatments contained in the *Nachgelassene Werke*. Perhaps the most interesting are the lectures of 1812 on transcendental logic (*Nach. Werke*, i). From 1812 we have notes of two courses on practical philosophy, *Rechtslehre* (*Nach. Werke*, ii) and *Sittenlehre* (*Nach. Werke*, iii). A finished work in the same department is the *Staatslehre* (published 1820), which gives the Fichtean utopia organized on principles of pure reason; in many cases what it proposes amounts to despotism.

From 1807, however, Fichte was mainly occupied with public affairs. In 1807 he drew up a plan for the proposed new university of Berlin. In 1807–08 he delivered at Berlin his noble addresses to the German nation (*Reden an die deutsche Nation*), full of practical views on the only true foundation for national recovery and glory. From 1810 to 1812 he was rector of the new Berlin university. During the great effort of Germany for national independence in 1813, he lectured on the idea of a true war (*Über den Begriff eines wahrhaften Kriegs*, forming part of the *Staatslehre*).

At the beginning of 1814, Fichte caught a virulent hospital fever from his wife, who had volunteered for work as a hospital nurse. He died on Jan. 27, 1814.

Philosophy.—The philosophy of Fichte falls chronologically into the periods of Jena and of Berlin, which are also different in their fundamental philosophic conceptions. The former period is marked by its ethical emphasis, the latter by the emergence of a mystical and theological metaphysic of being. Fichte was prompted to change his original position because he came to appreciate that religious faith surpasses moral reason. He was also influenced by the general trend which the development of thought took. It cannot be denied that his own turn coincided with, and resembled, the direction in which romanticism and the speculation of Schleiermacher, Schelling and Hegel moved.

But the system of 1794 was the historically most original and also the most characteristic work that Fichte produced. It was incited by Kant's critical philosophy and especially by the *Critique of Practical Reason*. From the outset it was less critical, precisely because it was more systematical, aiming at a self-sufficient, well-rounded doctrine in which epistemology and ethics were intimately united. Fichte's ambition was to demonstrate that practical (moral) reason is really (as Kant had only intimated) the root of reason in its entirety, the absolute ground of all knowledge as well as of humanity altogether. To prove this, he started from a supreme principle which was supposed to be independent and sovereign so that all other knowledge was deduced from it. Fichte did not assert that this supreme principle was self-evident, but rather that it had to be postulated by pure thought. He followed thereby Kant's doctrine that pure practical reason postulates the existence of God, but he tried to transform Kant's rational faith into a speculative knowledge, on which he based both his theory of science and his ethics.

The supreme principle is therefore at the same time a theoretical thesis and a practical act, and it is the practical act that prevails and dominates the meaning of the whole system. The supreme act concerns the origin of the ego itself. Insofar as the ego is the ego of a moral agent it does not originate from any source outside itself, since in that case it would not be responsible for its actions. It can be responsible only if its actions are rooted in the supreme act by which it "posits" itself. Fichte used this new term in order to indicate that the supreme act unites thinking and doing in originating both the highest speculative thesis and the highest ethical reality.

In one of the introductions to his *Wissenschaftslehre* we find an illuminating sentence: "What philosophy a man embraces depends upon the kind of man he is." This does not mean that philosophy is an outcome of a man's individual nature or that he may choose his philosophy according to his temper or mood, as the

existentialists of the 20th century would allow. On the contrary, it means that there is only one true philosophy, namely that which is in agreement with moral reason. A man by choosing his philosophy makes his character manifest. If he is what he ought to be, he has no choice but to obey the moral law. This is the same in thinking as in doing. The moral law governs the will as well as the thinking mind and therefore dictates the true philosophy. It is not merely a matter of science, but it is also and even primarily a matter of conscience when a man decides about the supreme principle of his philosophy. Only by obeying the moral law and the dictate of moral reason can he reach the truth in speculation and become truly free.

Whereas in all other things reality and thought are separable, a man as a moral being can be real only if he brings forth himself; he is not an ego if he does not act as such; and he cannot act as an ego if he is not aware of such action. Ego and self-consciousness are bound together, and only by virtue of this intrinsic bond is he a self. The philosopher has to be moral reason incarnate. Consequently he has to make the absolute ego the Archimedean point from which his system departs and on which it relies. The term "absolute ego" is however not free from a certain ambiguity.

Historians differ in their interpretations of this term. The absolute ego, Fichte says, posits itself. What is this absolute ego? Is it that of an empirical and finite man, inasmuch as he is a moral agent and only thereby an ego? Or is it absolute because it is no longer finite but infinite and therefore the ego not of man but of God? It is difficult to give a precise answer. But the supreme principle certainly points to an ideal ego; *i.e.*, to an ego which is in no way determined by any finite conditions but which determines itself and only thereby posits itself as a self. Yet this ideal self is not merely an ideal or an idea in the mind of finite man. On the contrary, it is even more truly real than any merely finite self; it is more truly a self, precisely because it is not finite and not restricted in its freedom. One might say that Fichte's "absolute ego" resembles the idea of God in Archbishop Anselm's ontological proof; if it were merely an idea, it would not be as absolute as it is supposed to be.

The absolute ego is absolute, Fichte says, in form as well as in content. It is absolute in positing itself by itself and it is absolute in positing itself as an ego. There is no higher reason that could be adduced to prove that it posits itself as an ego; if such a reason could be given, the absolute ego would no longer be absolute and an ego. Out of the same unconditional sovereignty the absolute ego posits over against itself its own opposite. This second act is absolute only as to its form (negation), but not with respect to its content, since there is no content that could be negated except the absolute ego itself. Since the act of self-negating is as independent as the act of self-positing, we cannot ask why the absolute ego brings forth its own opposite and thereby somehow restricts itself and even contradicts itself. Only later when the system unfolds do we learn why a supreme antithesis had to be put as a second supreme principle. The reason is again purely moral; the absolute ego restricts itself in order to originate that sphere in which morality can work; for morality cannot work and the will cannot operate without a certain resistance. Although morality depends upon the absolute freedom of the will, still this freedom itself has a moral significance and dignity only if it overcomes temptation and remains victorious in its struggle with desire and impulse.

Here again Fichte is the disciple of Kant transforming his teacher's doctrine in the direction of ethical speculation. "The world is nothing but the material of our duties"; these words illuminate Fichte's deepest intentions and reveal the very soul of his system. The absolute ego creates its own counterpart to make possible the finite moral person and the finite moral life of man. It is the religious mystery of creation that Fichte in his bold antithesis tries to expound philosophically. The moral will of the human being is both absolute and conditioned, infinite and finite and only thereby the will of an ever-striving, ever-fighting, ever-longing human person. Fichte sought the ultimate foundation of this contradiction inherent in our own existence and in the world in which we have to live and to act. And from this supreme antithesis Fichte develops in the course of his system the peculiarity of world and self in an utterly abstract dialectical procedure.

The dynamic of the system is set in motion by the contradiction of the two highest principles. They have to be reconciled to each other. The solution of this task is directed by the superiority of the thesis in which the absolute ego posits itself. Even the act of self-negation is still an act of the absolute ego and, as such, within the domain of its creative activity, which is indestructible and in the end victorious. How can the absolute ego defeat its opponent? The answer is given by means of the first synthesis in the system, which combines both thesis and antithesis on the ground of the thesis. The absolute ego posits itself according to this synthesis as both determined by its negative counterpart (called the nonego) and determining it; in the first case the world of sense perception and ultimately of scientific knowledge arises; in the second case the practical world of persons and of their purposes emerges. In each case new contradictions obstruct a final solution and new solutions have to be sought.

In the process of this dialectical deduction Fichte demonstrates that the world of sense is necessarily a world in space and time, ordered by causality and subject to general laws; and that the practical world is necessarily built on impulse and desire, inclination and longing, yet ultimately under the legislation of pure practical reason. Man can overcome the obstacles of his nature only by approximating to the goal of a community regulated by the moral conscience of its members. This goal, however, is infinitely remote. The finite ego can never restore within itself the original absolute ego. In this respect no final solution of the supreme contradiction can be attained.

A grandiose ethical intuition underlies the *Wissenschaftslehre* of the Jena period. But it is also evident that the system suffers from an incurable ill; though it claims to be perfect and self-sufficient, it never arrives at its own end. The beginning could be justified only if the end were attainable, but the tension between the contrasting poles of the infinite and the finite ego, between the ideal and the real self, is never completely solved. Ethical speculation defeats itself. The ambiguity of the absolute ego proves fatal to the system. Fichte himself was aware of this defect. This was the reason why he changed again and again the foundations of his *Wissenschaftslehre* and, especially, why he transformed it into a religious metaphysic in which the ethical speculation was not completely given up but was subordinated to a philosophic theology. These later drafts, however, he did not publish, probably because he felt that his day in the development of German idealism had passed.

The popular writings which Fichte did publish disclose in what direction his mind moved. Already in the *Bestimmung des Menschen* he had defined the absolute ego as the infinite moral will of the universe, God, in whom are all the individual egos, from whom they have sprung. More precise utterances are given in the *Thatsachen des Bewusstseyns* and in the later lectures. In them God is the absolute Life, the absolute One, who becomes conscious of himself by self-division and translation into the individual egos. The individual ego is only possible as opposed to a nonego, to a world of the senses; thus God, the infinite will, manifests himself in the individual and the individual has over against him the nonego or thing. "The individuals do not make part of the being of the one life, but are a pure form of its absolute freedom." "The individual is not conscious of himself, but the Life is conscious of itself in individual form and as an individual." In order that the Life may act, though it is not necessary that it should act, individualization is necessary. "Knowledge is not mere knowledge of itself, but of being, and of the one being that truly is, namely God. . . . This one possible object of knowledge is never known in its purity, but ever broken into the various forms of knowledge which are and can be shown to be necessary. The demonstration of the necessity of these forms is philosophy or *Wissenschaftslehre*" (*Thatsachen des Bewusstseyns*). The idea and the method of the *Wissenschaftslehre* prepare the way for Hegelian dialectic; while Schopenhauer's philosophy is very largely contained in the later writings of Fichte. *See* also HEGEL, GEORG WILHELM FRIEDRICH, and SCHOPENHAUER, ARTHUR.

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(R. Kr.)

FICHTELGEBIRGE is a rectangular plateau in northeast Bavaria, Ger., from which radiate three highlands: the Frankenwald (*q.v.*), leading to the Thüringer Wald in the northwest; the Elster Gebirge to the northeast, which join the Ore mountains; and the Oberpfälzerwald to the southeast. The Saale, Eger (Ohre), Weisser Main and Naab rivers have their source there. The plateau is about 18½ mi. wide, and undulating with an average height of 1,640–2,300 ft. Its highest points, Schneeberg (3,448 ft.) and Ochsen-Kopf (3,360 ft.), form a horseshoe-shaped periphery. Bare gneiss and granite rocks, spruce forest (Fichtenwald, from which the plateau takes its name) and bog characterize the higher lands. The interior (drained eastward by the Eger) is under arable and meadowland; much of the forest was cleared in the middle ages. Its relatively high density of population is due to a local cotton textile industry, timber working and rock quarrying. Railways cross the area from Nürnberg to Bohemia and from Leipzig to Munich via Hof. Selb (pop. [1961] 19,239) is the chief town. Alexandersbad (a pleasant watering place), Wunsiedel, and the granite labyrinth of Luisenburg are places of interest. (R. E. Dt.)

FICINO, MARSILIO (1433–1499), Italian philosopher and scholar, one of the leaders of Renaissance Platonism, was born on Oct. 19, 1433, at Figline near Florence. His father, a physician, was acquainted with Cosimo de' Medici and with St. Antoninus (archbishop of Florence from 1446 to 1459). After the customary training in Latin language and literature, Ficino studied Aristotelian philosophy and medicine, probably at Florence, but his early interests included also the thought of Epicurus, of Plato and the Neoplatonists, of Augustine and of Thomas Aquinas. After having studied the sources available in Latin, he acquired a thorough knowledge of Greek and devoted the greater part of his life to the translation and interpretation of Plato and of his ancient followers, as well as to the formulation and diffusion of his own Christianized and modernized version of Platonic philosophy. Encouraged and supported by Cosimo de' Medici and his successors, Ficino began his formal activity as a translator and teacher and as the head of the so-called Platonic Academy of Florence in 1462. His numerous translations from Greek into Latin include, besides some Neoplatonic and early Christian writings, the so-called Hermetic corpus (1463; printed in 1471) and, above all, the complete works of Plato and of Plotinus. Whereas several Platonic writings had been translated before, this was the first complete translation of Plato into any western language (begun in 1463, completed *c.* 1470, printed in 1484) and hence a major event in the intellectual history of Europe. In the case of Plotinus, it was the first translation of significance (1484–86; printed 1492). Both versions are excellent and were in general use until the 18th century.

Among Ficino's commentaries, those on Plato's *Symposium* (1469; printed 1484, translated into Italian by Ficino) and on Plotinus (printed 1492) were especially important and influential. Ficino's original works include the *Theologia Platonica* (1482), his chief philosophical work; *Epistolae* (1495), his collected letters, among which many of his shorter philosophical treatises are inserted; and works on medicine and astrology (*De vita libri tres*, 1489) and on theology (*Liber de Christiana religione*, 1474). Ficino's letters and prefaces show that he was engaged in more or less informal teaching, holding courses, orations and discussions, and that his personal and scholarly connections gradually extended from Florence to the rest of Italy and of Europe. Ficino was ordained as a priest in 1473, received several ecclesiastic benefices and became a canon of Florence cathedral. Having been closely identified with the Medici and particularly with Lorenzo, who was his pupil, Ficino retired after the expulsion of the Medici in 1494 and died on Oct. 1, 1499.

Whereas Ficino's role as a scholar, that is, as a translator and commentator of ancient Platonism, has always been recognized, his place as a philosopher in his own right is more difficult to assess. In an age which took pride in a revival of everything ancient, Ficino assumed the task of reviving ancient Platonism. In doing so, he felt free to add medieval and modern ideas to the authentic heritage. Citing the testimony of St. Augustine, he believed that there was a basic agreement between Christian religion and Platonic philosophy and that each of them had its own venerable tradition which remained fundamentally stable in spite of surface variations. In conceiving the universe as a hierarchy of substances that descends from God to matter, he was strongly influenced by Neoplatonic and medieval views. Yet in assigning to the human soul a privileged, central place in this hierarchy and in stressing that the soul through its universal, infinite aspirations and thoughts links the highest with the lowest beings and acts as a bond and knot of the universe, Ficino reveals his originality and his affinity with the thought of Renaissance humanism which had given special emphasis to man and his dignity. His notion of the world as an animated being held together by a dynamic unity was to dominate much speculation on nature during the 16th century and afterward. In accordance with the Neoplatonists and with the medieval mystics, he conceives the task of human existence as an inner ascent of the soul through higher and higher degrees of knowledge and of love, a process which culminates in the immediate contemplation and enjoyment of God. Since this ultimate end cannot be attained during our present life, Ficino postulates the immortality of the soul and assigns to the proofs for this immortality a prominent place in the *Theologia Platonica*. Elaborating on classical and Christian notions, he explains the human relations of love and of friendship in their highest form through a common share in God and in the contemplative life; and in his commentary on Plato's *Symposium* he laid the ground for the theory of spiritual or "Platonic" love that was to become dominant in the poetry and literature of the 16th century. His notion that religion is natural to all men and that every form of religion has a measure of truth whereas Christianity is the most perfect of all seems to have inspired Lord Herbert of Cherbury and later deists. In many other ways, the direct and explicit influence of Ficino's ideas can be traced through the 16th century, whereas his anonymous influence, disguised under the name of Plato or Plotinus, persisted to the end of the 18th.

The *Marsilii Ficini opera* were published (2 vol. 1576), and a *Supplementum Ficinianum*, ed. by P. O. Kristeller, (2 vol. 1937).

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FICK, AUGUST (1833–1916), German philologist, a pioneer in Indo-European etymological research, was born on May 5, 1833, at Petershagen, Westphalia, and was educated at the university of Göttingen, where he became a professor in 1876. His second professorship, at the university of Breslau (1888–91), was relinquished for ill-health, but his research continued. His most enduring contributions fall under two headings. (1) He was the first to undertake a comprehensive study of the common vocabulary of the Indo-European languages. The first edition, *Wörter-*

buch der indogermanischen Grundsprache in ihrem Bestande vor der Völkertrennung (1868), reconstructed a "parent" language of remote prehistoric times. In subsequent editions the title was more reserved, *Vergleichendes Wörterbuch der indogermanischen Sprachen;* while giving more emphasis to comparison of the recorded ancient languages, Fick did not discard reconstruction of the prehistoric source. (2) In *Die griechischen Personennamen nach ihrer Bildung erklärt* (1874; 2nd ed. with F. Bechtel, 1894), Fick showed how the formation of many proper names in Greek corresponded exactly to the manner of forming names in most other Indo-European languages (except Latin). This demonstration favoured the conception of the original Indo-European community as a stable aristocracy whose descendants became rulers of the Greek, Hindu, Iranian, Celtic, Germanic and other great nations of antiquity. Fick's method contained some features which were already outdated in his lifetime. Yet his lucid presentation and his orderly grasp of an immense repertory of facts made his writings useful for more than a generation, and much of his research has been incorporated rather than superseded by recent scholars. He died on March 24, 1916, at Hildesheim, Germany. (S. Ln.)

FICTION: *see* Novel; Romance; Short Story; *see* also separate articles on various national literatures.

FICTIONS are statements or concepts that are known to be false or pretense but are treated by general agreement as if they were true because such treatment serves some felt need. They are constantly met in daily life, as in the case of Santa Claus, or the conventional expressions of congratulation and thanks when a party has been an obvious failure, or in the practice called "daylight saving." Science could not develop or exist without fictions; thus the law of gravitation and the whole theory of ballistics were worked out in terms of the movement of objects in an imagined or fictional world free of friction. Legal fictions, which were among the earliest to attract attention, were vital in ancient law and are still of considerable importance.

The fictions of daily life seldom result, as daylight saving did, from organized planning. More commonly they are almost accidental growths whose purpose is to ease the impact of some hard fact, to flatter vanity, or extend courtesy, etc. Thus we keep the titles of governors, senators or judges no longer in office. Thus, also, when foreign aid by way of plain gift was unpleasant to face on either side, the gifts were called "lend-lease." The touch of deception of those who did not see through the fiction raises one of the lasting problems connected with fictions, problems both of operation and of fair dealing, for not all people are alike in understanding how much of the "let's pretend" is mere pretense.

The fictions of science are very different. In the first place, they are addressed only to people who have no business to be misled. Secondly, they aim not at all to make harsh things easier to accept but only to make this terribly complex world easier to handle. Thus certain theorists (a little artificially) insist that every classification ("tree," "trees," "apple," "breakfast") is a fiction, because so many different individual things are treated by such classifications as if they were all the same. And when we read about "the market" or think about that "economic man" whose supposed behaviour makes the market operate, it is important to remember that each of these concepts is no less imaginary than useful; their purpose is to aid us to understand what occurs in industry and business. Every scientific concept and every scientific "law" is a fiction of this kind: if it is "valid," that means that it is close enough to what happens so that the simplified statement is effective in helping people deal with what really goes on.

Legal fictions share the nature of daily-life fictions in that they make many needed changes easier by keeping them quiet and mannerly; and they share the nature of scientific fictions in that they are often called on, quite consciously, to get important work done which would otherwise be awkward and cumbersome to do. The most striking case again pertains to time: when a legislature has no power to sit beyond a certain midnight, and there are five hours more of work still to do, it is easier to turn back the official clock from time to time than it is to change the law or the constitution.

This illustration makes the point that it is commonly impossible to say in regard to any particular legal fiction whether it came about almost by inadvertence (imagine a first turning of the clock back for two minutes only) or whether it was a deliberate invention (as "lend-lease"). In early law men were as unwilling to change current practices as Americans are today to change the federal constitution. The resentment which defeated the effort to shift Thanksgiving to the third Thursday of November, or the importance of keeping 13 horizontal stripes in the national flag, can serve as reminders of such reluctance. It is against this kind of background that legal fictions grow. If ancestors needed service and worship, and all thinking centred on male heirship but no heir was born, then a desirable male could, as in Rome, by a fiction of adoption "become" the needed son. If all men are enemies but us, then to keep a good stranger from being an enemy we must make him one of us. ("Blood brotherhood" is one example of such a fictional "making"; adoption is another.) When in England there was more court business than could be comfortably handled by the appropriate court (and when increasing business paid any court which entertained it), then the court of king's bench, which was a criminal court, could pretend that the defendant in a simple civil suit had been arrested and was in custody, so that it must deal with any lawsuit which involved him. Or, if there was an established and convenient remedy for damages against a person who found a thing and would not turn it over to the owner, why could men not pretend that any man who would not turn back an owner's goods had begun by "finding" them—such as occurred in the nondeniable allegation of "finding" in the common-law action of trover?

Modern legal fictions are not often so bald as the above. We have long had legislation available as a means to accomplish needed change; moreover, courts, especially under the prodding of scholars, tend to rephrase more accurately such ideas as "conclusive presumption" or "implied condition." Nevertheless, the old procedure by way of "as if" is still in use, and it still has value when it does not mislead. Thus when one person has wrongfully taken funds from another and invests them wisely, a court can treat him as a "constructive" trustee of the funds—as if he were a trustee—and make him account. And while a state constitution (to prevent "grab" laws) may require that every statute be general, the courts politely recognize the need for special regulation of metropolitan government by upholding the constitutionality of a statute which applies, *e.g.*, to "all cities of more than 5,000,000 inhabitants." Almost any legal fiction can indeed be stated in terms of fact: thus the fiction that a corporation is for many purposes a person separate from its members is equivalent to saying that for those same purposes the law deals with the group as a unit, disregarding for the moment the individual members as such. But the fictional phrasing is often a very convenient shorthand. The danger, as in the use of such figures of speech as the metaphor, is that the shorthand may on occasion be taken as serious truth. Legal fictions therefore always need watching, that each may be held down tightly to its purpose; thus, when need arises, the court will "pierce the corporate veil" to prevent fraud. But within those limits fictions still lend to law a touch of grace and poetry which has lasting value.

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FICUS, a very large genus of the mulberry family (Moraceae; *q.v.*), comprising trees, shrubs and woody root-climbing vines, with milky sap, minute flowers and seeds inside an ovoid, a globose or pyriform receptacle (or fig) that has a small opening at the apex. Well-known examples are the cultivated fig (*q.v.*), the banyan (*q.v.*), the bo tree (*q.v.*) and the ornamental rubber plant (*F. elastica*). (J. M. Bl.)

FIDELITY AND SURETY BONDS. A fidelity bond usually provides protection against loss from dishonest acts of persons covered by the bond. A surety bond usually provides that the party furnishing the surety will make good any default by the

person covered by the bond (the obligor or principal) in performance of an obligation.

According to the narrow view, which prevails in most U.S. jurisdictions, the surety is allied with the principal and has a primary obligation to pay the principal's debt. This is distinguished from guaranty, whereby the guarantor's obligation is conditioned upon nonpayment by the principal, and hence is a secondary obligation. Unless the duty is primary, under the narrow view, the relationship is one of guaranty. According to the broad or British view, followed in a minority of U.S. courts, guaranty is included within the suretyship meaning. In such case, the surety's obligation may be either primary or secondary. The surety, upon making payment, usually has a right to be reimbursed.

United States.—The principal types of fidelity bonds in the United States are individual, schedule, position and blanket bonds. An individual bond protects against loss up to a stated amount resulting from dishonest or fraudulent acts of the named individual employee. There are two types of schedule bonds: a name schedule bond covers the employees named in the bond, each for a specified amount; a position schedule bond is similar but specifies the amount of coverage for each position rather than for each person, and an employee is covered so long as he occupies the position stated. A blanket fidelity bond covers all employees; names, schedules or positions are not specified. Rates for fidelity bonds depend partly upon the classification of the insured, such as importer, exporter, manufacturer, distributor, wholesaler or retailer. Public officials and employees are under fidelity protection through bonds written especially for such purpose in meeting statutory requirements. Their dishonest acts are covered, and guarantees of faithful performance of duties are given.

The principal types of surety bonds are contract bonds, judicial proceedings court bonds, fiduciary court bonds and miscellaneous bonds.

A contract bond guarantees that the surety will make good the obligation of principal or obligor should he default on the contract in relation, for example, to the construction, maintenance or repair of a building. The principal or obligor may default in performance, may be unable to meet time limitations for completion of a project or may default in payment of labour or material costs. Special types of contract bonds include bid or proposal bonds, performance bonds, payment of labour and materials bonds, and maintenance bonds. A bid or proposal bond guarantees that the bidder will enter into the contract and provide a performance bond, should his bid be accepted within a specified time period. Labour and materials bonds guarantee payment for labour and materials used in completion of the project. Maintenance bonds guarantee against defective workmanship and materials.

A court bond guarantees the preservation of the opposing litigant's rights and assures the solvency of the principal and his willingness to fulfill his obligations to such party. These bonds, which include appeal and attachment bonds, cover many forms of actions in civil, criminal and admiralty proceedings. The filing of court bonds and their coverage are governed by statute.

A court fiduciary bond, usually required by law, guarantees a court fiduciary will faithfully perform his duties as guardian, receiver, trustee, administrator or executor of property.

Miscellaneous bonds may be required by governmental bodies, individuals, corporations or other legal entities. They include auctioneers' bonds, convict lease bonds for the lease and hiring of state convicts, and depository and indemnity bonds.

Various other types of bonds are written by surety companies. Forgery bonds indemnify the insured against loss for having paid money, given value, extended credit or delivered property upon the faith of instruments or documents on which the signature has been forged, the amount raised or other alterations made. Checks, drafts, promissory notes or trade acceptances and securities may be covered. (V. G.)

Great Britain.—In general, principles are the same in Great Britain and the United States, but there are differences of detail. English practice considers a surety to be the same as a guarantor, but the term surety is usually restricted to a person who binds himself by a bond. This liability may be heavy for an individual, and the security given by a corporation, such as an insurance company, is obviously greater. In Britain such business is transacted under the name of fidelity guarantee and is divided into four classes —commercial guarantees, local government guarantees, government bonds and court bonds. Contract bonds, usually referred to as contract guarantees, are also issued.

Commercial guarantees in Great Britain are issued on similar lines to those of the United States; *i.e.*, an individual policy guaranteeing a named employee for a limited specified sum, a collective policy specifying a number of employees and the floating or blanket policy for a sum covering all employees but not specifying a definite sum against any particular employee. Blanket policies are not regarded with the highest favour by insurance companies because of the underwriting difficulties they present.

Local government guarantees are wider in scope than their usual commercial counterparts. As in commerce, there are individual, collective and floating policies, but the guarantee extends to cover not only the honesty of the official but also the correct discharge of his duties.

Government bonds are those required by departments of state, the wording of the bond being laid down by the department itself. Thus the board of trade requires bankruptcy bonds to cover the liabilities of trustees or special managers in bankruptcy, officials appointed under the Bankruptcy acts 1914 and 1926 to safeguard the interests of creditors. Where a debtor enters into a deed of arrangement, the trustee appointed by the creditors must properly dispose of assets and fulfill the duties required of him under the deed of arrangement. The trustee must give a bond to the senior registrar in bankruptcy or the appropriate registrar of the county court. Bonds are also given by liquidators of companies. Merchants and shippers give bonds to H.M. Customs and Excise to secure revenue which may be lost through improper use of merchandise subject to duty. Treasury bonds give security by officials such as county court registrars, who may have government money entrusted to them.

Court bonds may perhaps be regarded as a form of government bond; they are given by administrators or executors of a deceased's estate or by receivers appointed by the chancery division of the supreme court of judicature to safeguard the rights of debenture holders of a company.

Almost all bonds are subject to stamp duty which varies according to the type of bond and the security given. Administration and customs bonds have been exempted from stamp duty.

Contract guarantees are given not only by builders but also by those engaged in public work, such as construction of sewers or streets. Cover is required to meet claims for nonperformance or nonobservance on the part of a contractor of the provisions contained in his contract. The cover can be very wide. Not only is indemnity required for failure to complete a contract by a named date but also where the completed work has proved unsatisfactory during a prescribed maintenance period following completion date. (GA. S.)

FIDES, a Roman goddess, deified "good faith." Her cult was traditionally founded by Numa. She was closely connected with Jupiter, and her temple at Rome, dating from 254 B.C., was located on the Capitol near his. Sacrifices were made to her with covered hands symbolic of secret inviolable trust. On coins her symbol is often a pair of clasped hands. (R. B. LD.)

FIDUCIARY, a person who occupies a position of such power with regard to the property of another, due to extreme intimacy and confidence imposed, that the law imposes on him the duty to act solely in the interest of the person whom he represents. Examples of fiduciaries are agents, executors and administrators, trustees, guardians and officers of corporations. They are contrasted with persons in a business relationship, where the parties may deal at arm's length and each may seek purely personal benefits. *See* TRUST. (G. G. Bo.)

FIDUCIARY ACCOUNTING is the branch of accounting pertaining to the records and reports rendered by a fiduciary—one who is in a position of unusual trust and confidence. Because of the requirement for good faith, fiduciary accounting is largely prescribed by courts and emphasizes that the fundamental equation

for double entry is assets (properties) equal responsibilities. Whether acting under court jurisdiction or private trust instruments, the fiduciary will charge himself with asset values assumed and with increases in asset values; he will credit himself for decreases in value, values turned over to beneficiaries and for approved expenses. Fiduciary accounting includes accounting for decedents' estates, for trust arrangements and for firms in financial difficulty. With the separation of corporate ownership and control there is some inclination to treat managers as fiduciaries and general corporate accounting as fiduciary accounting. Both are governed by the objectives of general accounting.

(C. T. D.)

FIDUCIARY ISSUE, that portion of a note issue, whether that of a government or of a bank, which is not protected by a specific backing of metal or coin or assets capable of being converted into coin or bullion on demand. Thus, where no metallic reserve or other assets capable of automatic conversion into metal is kept, the whole issue is of a fiduciary character. The term does not imply that there are no assets of any kind maintained against the note, but only that such assets as are kept are of a nonmetallic character—commercial bills of exchange, government securities or floating debt due by government. In the modern world where many central banks keep part of their "metallic reserves" not in their own vaults but in the shape of deposits with other central banks or in the shape of short-dated bills payable in other gold-using countries, it is no longer possible to draw a sharp line of distinction between the fiduciary and the nonfiduciary portion of the total circulation, and what is regarded as "gold cover" has in such cases to be defined carefully by the legislation governing the issue. Strictly, the fiduciary circulation consists of all that part of the total issue which is not directly covered by gold coin or bullion in vault or such metal "earmarked" (*i.e.*, held specifically segregated) on account of the issue in some other institution.

It does not follow that the mere maintenance of a cash reserve adds to the safety of a note issue. To do so the whole of the note issue must be convertible; *i.e.*, the reserve against the notes must be used in case holders desire them to be redeemed. Unless the note is effectively convertible, an increase in the total note issue accompanied by an increase in the total reserve will not necessarily prevent "over issue," *i.e.*, a total of notes so large that its value falls in terms of the standard of value.

The fiduciary amount may be fixed absolutely in amount: *i.e.*, the issuer may be prohibited from issuing more than a certain volume of uncovered notes. Or the note issue may be based upon the principle of a fixed absolute amount, the proportion of covered to uncovered notes being left to the discretion of the issuing authority. Or the note issue may be based upon the idea of a proportionate reserve without any absolute limit to the total, a minimum proportion of cash indirectly fixing the amount of the fiduciary issue. The system of proportional reserves and of a fixed fiduciary amount may be partly combined by providing that if the total issue exceeds the sum of the fully covered notes and the fixed fiduciary amount (the so-called tax-free contingent) the excess shall be taxable. The reserve proportion is allowed to vary (thus varying the fiduciary portion), subject to provisions by which the tendency to over-issue is checked by a scale of taxation rising as the reserve proportion falls. *See* Gold Reserves.

(T. E. G.; X.)

FIEF, a constituent factor of the link between a lord and his vassal in feudalism, being the benefice held by the vassal in consideration of his service. Fiefs were usually lands, sometimes official positions, occasionally sums of money. *See* Feudalism: *Feodo-Vassalitic Institutions.*

FIELD, CYRUS WEST (1819–1892), U.S. businessman and promoter of the first transatlantic telegraphic cable, was born in Stockbridge, Mass., Nov. 30, 1819. At the age of 15 he went to New York city and worked as an errand boy in a dry goods store. He was employed briefly as an assistant by his brother Matthew, a paper manufacturer. In 1841 he organized the firm of Cyrus W. Field and Co. of New York city, wholesale paper dealers. He was one of the founders (1854) of the New York, Newfoundland and London Telegraph Co., formed to lay a transatlantic cable, and helped to organize a similar company, the Atlantic Telegraph Co., in Great Britain (1856). Unsuccessful attempts to lay a cable were made in Aug. 1857 and in June 1858. A complete cable was laid between July 7 and Aug. 5, 1858, and operated successfully for three weeks, but the insulation failed. In July 1866 a successful cable was finally laid. For this achievement Field received many honours at home and abroad.

In 1877 he bought a controlling interest in the New York Elevated Railroad company, of which he served as president (1877–80). He developed the Wabash railroad with Jay Gould, and later owned a New York newspaper, the *Mail and Express.* He suffered heavy financial losses in later years. Field died July 12, 1892, in New York city. He was buried at Stockbridge, Mass.

See Isabella Field Judson, *Cyrus W. Field, His Life and Work* (1896); Charles Bright, *The Story of the Atlantic Cable* (1903). (J. R. Lt.)

FIELD, DAVID DUDLEY (1805–1894), father of U.S. legal reform, was born in Haddam, Conn., on Feb. 13, 1805. He studied at Williams college, Williamstown, Mass., but did not graduate. Thereafter he studied law in Albany and New York city, being admitted to the bar in 1828. He entered vigorously upon the practice of law, and became an acknowledged expert in both common-law and equity pleading. Subsequently he began a campaign to bring about a codification of common-law procedure in New York, a movement that ultimately spread over the United States and abroad. The movement began in 1837 with a letter to Gulian G. Verplanck, a member of the New York state legislature, in which Field urged the reform of the judicial system. When a constitutional convention was called, to meet in 1846, Field, a master of propaganda, reorganized the arguments of 1837, which now appeared in a series of articles in the *New York Evening Post,* being later reprinted in pamphlet form as *The Reorganization of the Judiciary;* it was instrumental in persuading the convention to report in favour of a codification of the law. The legislature in 1847 appointed a commission on pleading and practice for both procedural and substantive law of which Field became a member. After several preliminary reports to the legislature, a code of civil procedure was reported and enacted in 1848. A code of criminal procedure was completed, but not adopted until later. Within a quarter of a century after 1848, the New York code of procedure, in some form, was adopted in 24 states, two territories, the district courts and in the federal courts. The Civil Code of Procedure was adopted in England and Ireland in 1873, and later by several British overseas possessions, including India. Although Field became chairman of a state commission for the reduction of the whole body of state law into a systematic code, the resulting codification was only partially adopted in New York; these codes were more extensively adopted in other states, such as California, where Field's brother, Stephen (*q.v.*), was a distinguished judge. He died in New York city on April 13, 1894. (A. Ry.)

FIELD, EUGENE (1850–1895), U.S. poet and journalist, known as the "poet of childhood," was born in St. Louis, Mo., Sept. 2, 1850 (or Sept. 3; Field himself confused the date). After his mother died when he was six, Field was sent to relatives in Amherst, Mass. He entered Williams college, Williamstown, Mass., soon transferring to Knox college, Galesburg, Ill., and then to the University of Missouri, but took no degree. At the university he was less a student than a prankster, a role he was to play all his life. For the local newspaper he wrote humorous verse which marked the beginning of his career in journalism.

After his marriage in 1873 Field did editorial work on the *St. Louis Journal,* the *St. Joseph Gazette,* the *Kansas City Times* and the *Denver Tribune.* From his *Tribune* column, "Odds and Ends," he gathered comic paragraphs to make his first small volume, *The Tribune Primer* (1882), journalistic joking in the tradition of Artemus Ward, Bill Nye and Josh Billings. These squibs served as apprentice work for his major literary achievement, his "Sharps and Flats" column in the *Chicago Morning News* (renamed the *Record* in 1890). This column (1883–95) did much to establish the daily personal column as a newspaper feature. In it Field satirized the cultural pretensions of the newly rich Chicago meat barons. Some of these paragraphs were later collected and entitled *Culture's Garland* (1887). In the column also appeared

some delicate stories and verses. The best of his verse was collected in *A Little Book of Western Verse* (1889), drawn in part from his column—poems in Pike county dialect, after the manner of Bret Harte and John Hay, verses for children in an affected Old English dialect, translations of Horace and the much-loved "Little Boy Blue" and the "Dutch Lullaby" ("Wynken, Blynken, and Nod"). His last work included *Echoes From the Sabine Farm* (1892), rhymed translations of Horace by Field and his brother Roswell (1851–1919), and *The Love Affairs of a Bibliomaniac* (1896), an amusing discussion of book collecting. His collected works in ten volumes were published the year after his death, and two more volumes were added in 1901.

Eugene Field was a gay, high-spirited person, whose ebullience and wit, often taking the form of elaborate practical joking, charmed his friends. Although some felt that indulging his fondness for the whimsical and eccentric led him to squander his very real literary talent, all were attracted by his rare and lovable nature, which his friends Slason Thompson and Charles Dennis sought to perpetuate in their volumes of personal reminiscences. A later age, however, has had to judge the man by his writing alone. Together with the characters in his fanciful lullabies, Field is memorialized in a bronze monument in Lincoln park, Chicago.

Bibliography.—Charles H. Dennis, *Eugene Field's Creative Years* (1924); Slason Thompson, *Life of Eugene Field* (1927); Robert A. Day, "The Birth and Death of a Satirist: Eugene Field and Chicago's Growing Pains," *American Literature*, xxii (Jan. 1951); and the introductions to the several volumes of Field's collected works. (L. T. D.)

FIELD, JOHN (1782–1837), Irish pianist and composer, was born in Dublin, July 26, 1782, the son of a violinist and the grandson of an organist. He first studied music at home with his father and grandfather, who were severe if not harsh teachers, and afterward in London with M. Clementi, under whose tuition, given in return for Field's services as a pianoforte demonstrator and salesman, the boy made rapid progress. In 1802 Clementi took Field to Paris and later to Germany and Russia. Field quickly secured recognition as a pianist and composer and in 1803 settled in Russia, becoming for a time a popular and fashionable teacher. He played extensively throughout Europe during the next 30 years, and had great success with his E flat pianoforte concerto at a Philharmonic society concert in London in 1832. Accounts of his playing, written by professional colleagues, leave no doubt of his individuality and mastery. In later years, however, his health was poor, and he died in Moscow on Jan. 23, 1837.

Field was a remarkable player and composer. Born 30 years before Chopin, he was one of the earliest of the purely pianoforte virtuosi, and his style and technique strikingly anticipated those of Chopin. This romantic and individual musician was at his best in shorter pieces, where his charming and expressive melodies and his imaginative harmonies, often effectively chromatic, are not exposed to the strain of long development. Field wrote seven pianoforte concertos and four sonatas, in which high quality is often apparent but not consistently maintained. In the famous nocturnes, more concise and intimate than his larger works, Field's music is distinguished in style and varied in mood.

(Th. A.)

FIELD, MARSHALL (1834–1906), pioneer U.S. department store owner and philanthropist, was born on a farm near Conway, Mass., Aug. 18, 1834. At 16 he became an errand boy in a dry goods store at Pittsfield, Mass., and developed rapidly into an adept salesman. In 1856 he went to work for Cooley, Wadsworth and company, a leading mercantile house in Chicago, and within five years became a partner in the firm. In 1860 he and another partner, Levi Z. Leiter (1834–1904), joined the merchandising firm of Potter Palmer (1826–1902), and eight years later Field and Leiter rented from Palmer an ornate building on State street, and set themselves up as Field, Leiter and company. The firm name, which gained world renown, became Marshall Field and company in 1881 after Field bought out Leiter for $2,500,000.

Field cultivated not only the trade but the good will of his customers, his innovations ranging from liberal credit and return-of-goods policies to the one-price system and the first department store restaurant for the convenience of women shoppers. A notable business peak for that era was reached in 1895, with an annual gross income, including revenues from extensive wholesale and manufacturing operations, of $40,000,000. When Field died Jan. 16, 1906, he left a fortune of $125,000,000. Among his benefactions were large gifts to The University of Chicago, the Field museum (later the Chicago Museum of Natural History) and the Chicago Manual Training school. This philanthropic tradition, especially in the area of child welfare and education, was carried on by his grandson, Marshall Field III (1893–1956), who was also the founder of the *Chicago Sun* (later the *Chicago Sun-Times*), and his great-grandson, Marshall Field, Jr., president of Field Enterprises, Inc., and publisher of the *Chicago Daily News* and the *Chicago Sun-Times*.

See Lloyd Wendt and Herman Kogan, *Give the Lady What She Wants!* (1952). (Hx. K.)

FIELD, NATHAN (1587–1619?), one of the principal actors of the Elizabethan stage and author of two comedies. He was the son of John Field, a leader of the Presbyterian movement in England, and was baptized at St. Giles, Cripplegate, London, on Oct. 17, 1587. Field attended St. Paul's school and was impressed for the Children of the Queen's Chapel *c.* 1600, in which year he acted in *Cynthia's Revels* at the Blackfriars theatre and may have read Horace and Martial in Latin with Ben Jonson. He played in the *Poetaster* in 1601, and contributed commendatory verses to Jonson's *Volpone* (1607) and John Fletcher's *The Faithful Shepherdess* (1608–09). Between 1609 and 1611 he wrote the comedies, *A Woman Is a Weathercock* (acted Dec. 1609?, printed 1612) and *Amends for Ladies* (acted by 1611, printed 1618). Field stayed with the original Children of the Revels company throughout its various changes of name and composition, until the second Children of the Queen's Revels reunited with Philip Henslowe's Lady Elizabeth's Men (March 1613), becoming the leading actor until he joined the King's Men (1616–17), with whom it has been suggested he took Shakespeare's place. In 1616 Field came to the defense of the stage, which had been bitterly attacked by his father, by publishing *Field the Player's Letter to Mr. Sutton, Preacher at St. Mary Overs*. He led a wild life, was often in debt, from which Henslowe rescued him, and was involved in a scandal which led to his leaving the theatre in 1619, the year in which he probably died (?June–August). Administration of his estate was granted on Aug. 2, 1620.

Field's comedies are competently written, in good dramatic blank verse. He collaborated with Beaumont and Fletcher, and with Philip Massinger in *The Fatal Dowry* (printed 1632). He was accounted a very good actor, of the calibre of Richard Burbage (*q.v.*), and appears among the list of actors in the First Folio of Shakespeare's plays (1623). He took the title roles of George Chapman's *Bussy d'Ambois* and Jonson's *Epicoene*, and possibly played Humphrey in Beaumont and Fletcher's *The Knight of the Burning Pestle* (printed 1613).

Bibliography.—Plays ed. by J. P. Collier (1829), W. C. Hazlitt (1875), A. W. Verity (1888) and William Peery (1950); R. F. Brinkley, *Nathan Field, the Actor-Playwright* (1928); W. Peery, "Nathan Field's Dates," *Modern Language Review*, vol. xli (1946). (B. L. J.)

FIELD, STEPHEN JOHNSON (1816–1899), U.S. jurist and supreme court justice from 1863 to 1897, was born at Haddam, Conn., on Nov. 4, 1816, the son of a Congregational minister. Like his brother, David Dudley Field (*q.v.*), he attended Williams college, where he graduated as valedictorian in 1837. He was admitted to the bar in 1841, and practised with his brother in New York until 1848. In 1849 he went to California and settled in Marysville. His eventful career is recounted in his *Personal Reminiscences of Early Days in California*, privately printed in 1878. As a legislator, he carried to enactment the civil and criminal practice acts of 1851. The former provided "the most liberal exemptions from forced sale of the personal property of the debtor," and gave effect in law to the customs and regulations established by miners. Field sat on the California supreme court from 1857 until his appointment, on March 10, 1863, to a newly created tenth seat on the U.S. supreme court. There he served—perhaps too long—until Dec. 1897, surpassing even Chief Justice John Marshall's record.

A war Democrat, Field tended to read small the powers resulting

from rebellion. He spoke for the court in holding invalid state and congressional test oaths; he struggled, unsuccessfully in the end, to invalidate the Legal Tender acts of 1862 and 1863. In the Slaughter House cases, in 1873, he wrote a memorable dissent arguing that economic *laissez faire* was a part of the "privileges and immunities" secured by the 14th amendment. Dissenting in *Munn* v. *Illinois* and companion cases, in 1877, he contended that the regulation of rates of railroads and grain elevators was beyond the powers of government. The spirit of these dissents came to prevail in the early decades of the 20th century. In 1895 he entered wholeheartedly into overturning the income tax law, warning against "a war of the poor against the rich." Field had a syllogistic mind, and went confidently wherever first principles seemed to lead.

In 1880 and 1884 Field aspired to the Democratic nomination for the presidency, and in the latter year concluded, "had I received the cordial support, instead of opposition of (California) my candidacy, according to the judgment of my friends, would have stood great chances of success." He died in Washington, D.C., on April 9, 1899.

See Carl B. Swisher, *Stephen J. Field* (1930). (C. Fn.)

FIELD ARTILLERY: *see* Artillery.

FIELD EMISSION is a physical effect consisting of the emission of electrically charged particles from a conductor under the action of a strong electric field. Particularly field emission of electrons from cold metals into a vacuum is an elementary effect comparable with thermionic, photoelectric or secondary emission. The effect is also called field electron emission, cold emission or autoelectronic emission.

The field emitter is the most effective of all cathodes for releasing electrons from the structure of a metal. Investigations conducted with it have made significant contributions to basic science, and provided early evidence in support of the wave mechanical theory. Technical application of field cathodes is still very difficult.

Field emission of either electrons or positive ions is applied in the field emission microscope. It was this most powerful of microscopes, in which helium ions from a cold emitter point produce an image, that made the atoms of a metal surface visible for the first time (E. W. Müller, 1956).

Historical Development.—Field electron emission from cold metals requires a field strength of order of magnitude 30,000,000 v. per centimetre. Because electrical breakdown in gases occurs at much lower field, the effect can be observed only in highly evacuated tubes. To produce such a high field with a reasonably low voltage, usually in the kilovolt range, the emitting electrode must have a small radius of curvature, as provided by a fine wire, a sharp edge or a needle point. It was in tubes containing such electrodes that field emission was first observed by R. W. Wood (1897). In the early 1920s J. E. Lilienfeld attempted to use field emission cathodes in high-voltage rectifiers and X-ray tubes, but high-vacuum techniques as well as theoretical understanding were not yet sufficiently advanced. Application of the then new quantum mechanics to the electron theory of metals in the late 1920s brought forward the theory of R. H. Fowler and L. Nordheim, describing field emission as "tunneling" of electrons through the metal's surface potential barrier. Experimental advances were made possible with the introduction of the field emission microscope and a cathode point polished to atomic smoothness by E. W. Müller in 1937. Subsequently, the field emission microscope was widely used for the investigation of field emission itself and for the study of adsorption phenomena and other problems of surface chemistry. A modified version led to the discovery of field ion emission. When the field emission microscope was operated with helium ions and the emitter cooled to the temperature of liquid hydrogen, the resolution of the best electron microscopes was surpassed by far and it became possible to see the atoms constituting a metal surface. The adaptation of radar microsecond pulse techniques to field emission studies by W. P. Dyke and co-workers (1953) had great technical significance. Very high-current densities became accessible, and the emitter could also be operated at elevated temperatures (temperature-and-field, or T-F, emission) to secure better stability and lifetime for technical applications.

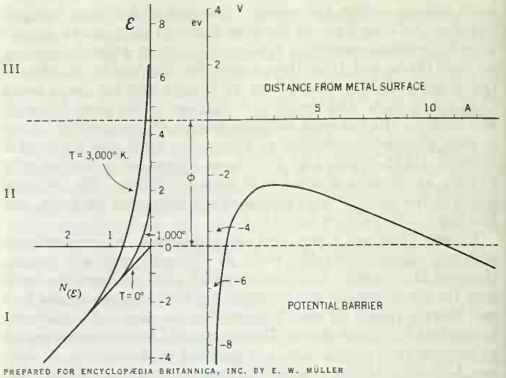


FIG. 1.—FIELD ELECTRON EMISSION OCCURS BY PENETRATION OF ELECTRONS NEAR FERMI LEVEL THROUGH POTENTIAL BARRIER AT METAL SURFACE. EXAMPLE SHOWN IS FOR A FIELD OF 40,000,000 V. PER CENTIMETRE, AND A WORK FUNCTION OF $\phi = 4.5$ EV

Theory of Field Emission.—Classical electron theory failed to explain the experimental facts of field emission. In their quantum mechanical theory Fowler and Nordheim use the following assumptions: The conduction electrons in a metal form a gas of free particles obeying Fermi-Dirac statistics. The metal surface is assumed to be an ideal plane, causing a classical image force acting on an electron outside the metal. The basic concept of wave mechanics is that conduction electrons arriving at the inside of the metal surface are not totally reflected but can rather penetrate or tunnel through the potential barrier, which is sufficiently thinned by the applied field (fig. 1). The number of electrons emitted per unit area from each energy level ε (measured here from the Fermi level) is then the product of the number of incident electrons, called the supply function, $N(\varepsilon)$, and the transmission coefficient, $D(\varepsilon)$, at this level. The total current density is the integral of this product taken over all energies ε and multiplied by the electron charge. Using Fermi-Dirac statistics one obtains for the supply function

$$N(\epsilon) = \frac{4\pi mkT}{h^3} \log\left(1 + e^{-\frac{\epsilon}{kT}}\right) \qquad (1)$$

where m = mass of electron, k = Boltzmann constant, T = absolute temperature, and h = Planck's constant. The transmission coefficient is found from a solution of the Schrödinger equation written for the assumed potential, which gives in the *WKB* approximation

$$D(\epsilon) = e^{-\frac{8\pi\sqrt{2m(\phi-\epsilon)^3}}{3heF} v(y)} \qquad (2)$$

where ϕ = thermionic work function, F = field strength, and $v(y)$ is an elliptic function of the variable

$$y = \frac{\sqrt{e^3F}}{\phi - \epsilon}$$

which describes the image force effect and for which some data are given in the table.

TABLE

y	v(y)
0	1.000
0.2	0.937
0.4	0.789
0.6	0.577
0.8	0.312
1	0.000

The total current density as obtained by an approximated integration for the case of negligible temperature is then

$$i = \frac{e^3F^2}{8\pi h\phi} e^{-\frac{8\pi\sqrt{2m}\phi^{3/2}}{3heF} v\left(\frac{\sqrt{e^3F}}{\phi}\right)} \qquad (3)$$

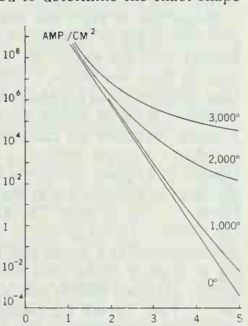
and with ϕ measured in e-volts (electron volts) and F in volts/cm., one obtains

$$i = \frac{1.54\times10^{-6}F^2}{\phi} e^{-\frac{6.83\times10^7\phi^{3/2}}{F} v\left(\frac{3.79\times10^{-4}F^{1/2}}{\phi}\right)} \text{ amp./cm.}^2 \qquad (4)$$

(A more detailed discussion of the possibilities of integrating the product of eq. [1] and [2] for finite temperatures is given in the *Bibliography:* Good and Müller.) Computed current densities for a typical tungsten emitter ($\phi = 4.5$ ev) are shown in fig. 2. Emitter temperature is not of great influence below 1,000° K. Here, the majority of the electrons comes from the conduction band below the Fermi level, shown as region I in fig. 1. At higher temperatures and at high fields most of the emitted electrons are thermally excited and tunnel through the barrier in region II. This kind of emission has been called temperature-and-field emission or T-F emission. At high temperatures and also at low fields barrier penetration is negligible compared to the number of electrons spilling over the hump in region III, which is thermionic emission.

Field emission of positive ions can be understood as the evaporation of ions over the potential barrier. The height of this barrier is the binding energy of the ion (without field) reduced through the image force by the Schottky effect. The emitted positive ions come either from an adsorption layer or from the atoms of the emitter itself, so that the supply is rather limited. A continuous-field ion emission can be obtained however, by supplying atoms or molecules from gas surrounding the emitter. At a field of more than 250,000,000 v. per centimetre in the case of hydrogen, and more than 400,000,000 v. per centimetre for helium, all incident gas molecules are ionized very close to the tip when one electron tunnels out of each molecule and enters the metal surface, while the ions are ejected by the field. This complex mechanism can be treated quantitatively (see *Bibliography:* Good and Müller).

Experimental Work in Field Emission.—Together with radioactive alpha decay, field emission provides the experimentally most easily accessible example of the quantum mechanical tunnel effect. A number of experiments have therefore been carried out to prove the validity of the Fowler-Nordheim theory and its consequences. Difficulties arise from the fact that only the applied voltage and the resulting current can be measured directly, while the theory provides the dependence of the current density upon field strength and work function. For a given atomically clean metal tip as a cathode, neither the field nor the work function is homogeneous over the entire emitting surface. Laborious experimental techniques have been applied to determine the exact shape of the emitter needle point by electron microscopy, to ensure cleanliness of the surface by ultra high-vacuum techniques and to find the work function of the various crystal planes of the tip metal. The dependence upon electrical field of eq. (4) has been confirmed within a possible error of 15% up to current densities of 6×10^6 amp./cm.^{2} At higher fields slight deviations in the direction of smaller currents have been observed, which may be due to space charge, the effect of atomic surface structure upon the image force or details of the electron band structure of the metal. Tungsten tips have been operated with microsecond pulses up to field strengths of 70×10^6 v./cm., where at current densities of about 10^8 amp./cm.^{2} a destructive vacuum arc is initiated by heat development in the tip (see *Bibliography:* Dyke and Dolan).

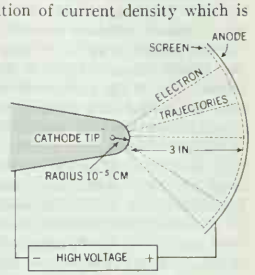


PREPARED FOR ENCYCLOPÆDIA BRITANNICA, INC. BY E. W. MÜLLER

FIG. 2.—COMPUTED CURRENT DENSITY OF FIELD EMISSION FROM TUNGSTEN ($\phi = 4.5$ EV) AT VARIOUS TEMPERATURES (°K.), PLOTTED AS A FUNCTION OF RECIPROCAL FIELD

Field Emission Microscopy.—The specimen is a needle-shaped field emitter, with an approximately hemispherical tip of radius 10^{-5} to 10^{-4} cm., arranged in a vacuum tube opposite to a fluorescent screen at anode potential (fig. 3). The emitted electrons move to the screen along nearly radial trajectories, there producing an enlarged pattern of the emission details of the tip surface. The magnification equals approximately the ratio of tip-screen distance to tip radius and can easily be 1,000,000 diameters. The resolution is limited by the inherent tangential velocity component of the field electrons, amounting to a few tenths of an electron volt, and by diffraction caused by the wave nature of the electrons, or, equivalent to it, the Heisenberg uncertainty principle. Under the usual condition the resolution is 20–30 Å.

The image depicts the distribution of current density which is determined by the local field strength due to tip geometry and local arrangement of surface atoms, and by the work function. The latter may again depend upon the atomic structure of the involved crystal planes, various kinds of disorder in the atomic arrangement, and the presence of adsorbed matter. The proper interpretation of the pattern in view of these features is the objective of field emission microscopy. Clean or presumably clean surfaces have been studied with a number of metals such as tungsten, tantalum, molybdenum, iridium, platinum, titanium, nickel, iron, silicon and copper, and some alloys such as stainless steel. Surface migration, details of crystal growth, phase transformation and motion of grain boundaries have been investigated.



PREPARED FOR ENCYCLOPÆDIA BRITANNICA, INC. BY E. W. MÜLLER

FIG. 3.—SCHEMATIC DIAGRAM OF FIELD EMISSION MICROSCOPE

The potential barrier at a metal surface may be considerably influenced by adsorption. The presence of a small fraction of a monomolecular layer or even of some individual molecules can be detected in the field emission microscope, making it a versatile tool for research in surface chemistry and catalysis. The behaviour of oxygen, hydrogen and other gases on the surface of various metals has been studied in a range from liquid helium temperatures (by immersing the entire microscope in liquid helium) to 2,000° K. Skilful interpretation of the patterns allows conclusions to be made about the electron exchange between adsorbate and substrate and the resulting binding forces. (For detailed results of the investigations of adsorption by field emission microscopy it is necessary to refer to the works listed in the *Bibliography.*)

If the tip of a field emission microscope is operated at sufficiently high positive voltages, surface atoms of an adsorption layer or from the tip metal itself are emitted as positive ions. The ion current, however, is usually too small to produce a visible pattern on the screen. Therefore the tip must be made negative again in order to inspect the changes in the electron emission pattern. Field desorption can be observed continuously when the microscope is operated with alternating current of independently adjustable half waves, the positive half wave causing field desorption, the negative one electron emission for viewing the surface. Quantitative study of field desorption provides a new way of investigating binding energies in surface chemistry. Field desorption is also a means of perfectly cleaning and smoothening the surface of the specimen in the microscope without the application of heat. For instance, at room temperature tungsten evaporates at a rate of one monolayer per second under the influence of an electrical field of 500,000,000 v. per centimetre.

Field Ion Microscope.—This modification of the field emission microscope was introduced by E. W. Müller (1951) in order to improve the resolving power. Compared with electron emission, in the case of field ion emission the tangential velocity components of the image forming particles can be greatly reduced by lowering the tip temperature, and diffraction effects are negligible because of the much shorter de Broglie wave length of the ions. By cooling the tip with liquid hydrogen to 21° K., filling the microscope with helium at about 1 micron pressure and operating the positive tip at a field strength of 400,000,000 v. per centimetre, a resolution of 2.7 Å. has been obtained (fig. 4, Müller, 1956). The field ion microscope is the first microscopic device to depict the individual atoms that constitute a surface. Although the extremely high field limits its application to the refractory metals, and some other metals with high melting points, it is a most promising

tool for some problems of metallurgy, such as the study of dislocations of fatigue under cycling stress or radiation damage.

Technical Applications.—From the report above it appears that field emission is mainly a subject of and a tool for basic research. The unique properties of field electron emission, such as instantaneous emission from a cold cathode, the extremely high-current density of up to 10^8 amp. per square centimetre, and the minute size of the point emitter have for a long time encouraged physicists and electrical engineers to design devices for practical use. As a result of all the experience of many researchers and particularly the successful work of Dyke and collaborators, technical application can be expected. A direct-current bias method has been found for stabilizing the electrical performance of the microsecond-pulsed T-F emission cathode during long periods of operation at useful power levels. Needle cathodes have been operated in parallel to yield a peak power of 3 megawatts, for instance, as a cathode in an X-ray flash tube. The minute dimensions of the electron source suggest further application in cathode ray tubes, X-ray microscopes and traveling-wave amplifiers.

BY COURTESY OF E. W. MÜLLER

FIG. 4.—PHOTOGRAPH OF ATOMS FORMING THE CRYSTAL LATTICE ON A METAL SURFACE. FIELD ION MICROSCOPE PICTURE SHOWS CENTRAL PART OF TUNGSTEN TIP OF RADIUS 1,000 Å.

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FIELDEN, JOHN (1784–1849), English radical reformer and a notable proponent of factory legislation, was born at Todmorden, Yorkshire, on Jan. 17, 1784, the son of a Quaker yeoman farmer turned millowner. On his father's death in 1811 he and his brothers inherited the cotton-spinning business at Todmorden which became one of the greatest manufacturing concerns in Great Britain. Unlike most millowners, Fielden was an early supporter of factory legislation to protect labour. He took up this course in 1816. Soon afterward he declared himself a radical and became closely connected with William Cobbett in the agitation against the paper money system and for parliamentary reform. Cobbett's son James Paul married Fielden's daughter. Both Fielden and Cobbett were returned as radical members of parliament for Oldham in the first general election after the passing of the reform bill of 1832. In the house of commons Fielden voted for every radical proposal. He was a vigorous opponent of the new poor law of 1834, and was the main Lancashire spokesman of the movement to limit the working day. In 1836, a year after Cobbett's death, he published *The Curse of the Factory System* in which he advocated legislative restriction on the working hours not only of children but of adults as well. Fielden was triumphantly returned for Oldham in 1835, 1837 and 1841. He joined Thomas Attwood in presenting the first Chartist petition to the house of commons in 1839, and he was a supporter of the second petition in 1842. His main energies, however, were devoted to the local and national struggle to resist the introduction of the 1834 poor law and to the fight for a ten hours bill. He sponsored the successful Ten Hours act of 1847, but was defeated at the general election of that year and spent his last two years in retirement from politics, dying at Skegness on May 29, 1849. (A. BRI.)

FIELDFARE (*Turdus pilaris*), one of the thrushes and a common winter visitor to the British Isles. In spring it nests in north European and Siberian birch forests, migrating to southern Europe, India and northern Africa in winter. It is gregarious in habit and somewhat resembles the mistle thrush (*T. viscivorus*) in appearance. The head and rump are gray, the back chestnut and the tail blackish; the upper surface of the wings is dark, the undersurface white. Its rusty throat and breast and its white belly are streaked with black.

The nest, placed high in a tree, is similar to that of the blackbird (*T. merula*), and the eggs are similar to blackbirds' eggs. The song consists of rapid feeble squeaks; the call note is harsh and loud. It feeds upon worms, slugs and insect larvae, adding, in hard weather, rose hips, haws and other berries. Some fieldfares occasionally stray as far as Greenland and the Foxe basin, arctic America. Structurally very like the fieldfare but differing in appearance and habits is the North American *Turdus migratorius*, the robin (*q.v.*).

FIELD GLASSES: *see* BINOCULAR INSTRUMENT.

FIELDING, HENRY (1707–1754), English novelist and playwright, with Samuel Richardson (*q.v.*) one of the two founders of the English novel, was born on April 22, 1707, probably at Sharpham park, near Glastonbury, Somerset. On his father's side he had aristocratic connections, being a kinsman of the earl of Denbigh and the second cousin of Lady Mary Wortley Montagu, while his mother's family belonged to the class of prosperous country gentlemen. The fact that he was essentially an aristocrat in outlook is the clue to a great deal in his life and writings. His mother died when he was ten and his father married an Italian widow, greatly to the disgust of his family. That his stepmother was a Roman Catholic may be one reason for the Protestant bias in all Fielding's books. One result of the disturbance in the household was that Henry was sent to Eton when he was 12. His schoolmates there included the elder Pitt, who was later one of the friends to whom he read passages from the manuscript of *Tom Jones*. He was a high-spirited and mischievous boy, but it is clear that he picked up a good education at Eton—an education essentially literary and classical in tone. He was reputed to be "uncommonly versed in the Greek authors, and an early master of the Latin classics," and at several points in his writings he insists on the importance of "Learning," without which "nothing pure, nothing correct, can Genius produce."

Meanwhile, in 1725, just after leaving Eton, he fell violently in love with a girl called Sarah Andrew and tried to abduct her one Sunday when she was on her way to church. Having been bound over to keep the peace, Fielding left the scene, but two years later he made use of his experience in his first play, *Love in Several Masques*, acted at Drury Lane in 1728. After this production Fielding continued his classical studies at Leiden university and sketched a dramatic version of Cervantes' masterpiece called *Don Quixote in England* (performed 1734). By the winter of 1729 he was back in England and in the next six months he had four plays produced. One of them, *The Author's Farce; and the Pleasures of the Town* (1730) consists of two parts, the first describing the misadventures of a young author about town and the second dealing with many of the chief absurdities of the day. *Tom Thumb* (1730; extended edition published as *The Tragedy of Tragedies; or . . . Tom Thumb the Great*, 1731) is a parody of the heroic play which can still be read with amusement. *The Miser* (1733) owes a great deal to Molière's *L'Avare*, yet it exhibits considerable originality and is characteristic of Fielding in its insistence on generosity of spirit. In 1734, at the age of 27, Fielding married Charlotte Craddock, later immortalized as Amelia in his novel of the same name; by that time he was a well-known dramatist, the author of about 16 plays, several of which had been highly successful. In 1737, however, his dramatic career was brought up short by Walpole's Licensing act, which prevented him from developing the type of satiric and topical comedy exemplified by *Pasquin: A Dramatic Satire on the Times* (1736) and *The Historical Register for the Year 1736* (1737). Bernard Shaw liked to claim that the act robbed England of its "greatest . . . dramatist, with the single exception of Shakespeare, produced . . . between the middle ages and the 19th century." (George Bernard Shaw, Preface to *Plays Unpleasant*, by permission of the Public Trustee and The Society of Authors.) What is certain is that when Field-

ing came to write novels he remembered a great deal that he had learned in the theatre.

In Nov. 1737 Fielding began to read for the bar at the Middle Temple. Meanwhile he continued to earn money by his pen, becoming editor of *The Champion* (1739–41), a pugnacious periodical which contains some admirable writing. The circumstance that led to his becoming a novelist was the publication of Samuel Richardson's *Pamela* in 1740. If *Pamela* had not been popular Fielding would probably have ignored it, but the success of a book which seemed to him objectionable both morally and as literature moved him to protest. It has never been conclusively proved that Fielding was the author of *An Apology for the Life of Mrs. Shamela Andrews* (1741), but there is virtually no doubt of it. It is an amusing little parody of Richardson's book, of no great literary merit; but it is of interest because *The History of the Adventures of Joseph Andrews, and of His Friend Mr. Abraham Adams* (1742) had the same origin. *Joseph Andrews* begins as a parody of *Pamela*, and although it soon becomes much more the book may still be regarded as something of a reply to Richardson, both from the point of view of literary art and from that of morality. Fielding regarded the author of *Pamela* as an uneducated fellow, and he evolved his theory of the "comic epic poem in prose" to rescue prose fiction from the reproach of being without tradition and without laws. The preface makes it clear how conscious Fielding was of developing a new "kind" and it is a mistake to regard the theory as a mere sop to the critics: he was an Augustan in his own approach to literature and he drew both confidence and inspiration from his ability to trace the genealogy of his new invention to respected classical models. Nor did the theory merely enable him to approach the new task of writing prose fiction in terms that were familiar: it also helped him to mobilize his experience as a writer of stage comedies. Aristotle had pointed out the affinity between serious epic and tragedy: Fielding's comic epic has a similar kinship with comedy.

Joseph Andrews also propounds an alternative morality to that of *Pamela*. All Fielding's most loathsome characters exhibit that "love to one's self" which is often made a reproach against Pamela's type of morality. Parson Adams is the incarnation of Fielding's own moral teaching. Comic as the parson is in appearance and in many of his actions, his teaching is hardly ever ridiculed; and the heart of it is its insistence on charity. His doctrine is simple and sincere: he is an emphatic believer in "good works," holding that an honest Turk or Muslim is a better man than a Christian whose belief does not influence his actions. He contrasts with the other clergymen in Fielding much as Chaucer's poor parson contrasts with the remainder of his ecclesiastical characters.

In 1743 Fielding published his *Miscellanies*, a three-volume collection of writings in prose and verse of which the most notable are two prose satires, *A Journey From This World to the Next* and *The Life of Mr. Jonathan Wild the Great*, the latter a mock-heroic biography of Wild (*q.v.*), the notorious thief and malefactor. Fielding was fascinated by the hypocrisy of this scoundrel, who often posed as a public benefactor, and in exposing his wickedness he produced the most sustained piece of irony in the language. His satire goes beyond Wild himself and becomes a severe study of the nature of what the world calls success or greatness: "The same parts, the same actions, often promote men to the head of superior societies, which raise them to the head of lower; and where is the essential difference, if the one ends on Tower-hill, and the other at Tyburn?" Most modern editions give the revised text of *Jonathan Wild*, which Fielding produced near the end of his life (1754). The text of 1743 has a good deal of bearing on the politics of the day: Wild himself stands for Robert Walpole, while the persistent use of the slang word "prigs" for thieves is due to its similarity to the word "Whigs." On revision the satire became less particular and more general.

In 1744 Fielding's wife, Charlotte, to whom he was devoted, died at Bath. The next few years were a time of sorrow, as well as a period of financial difficulty in which he was obliged to undertake hackwork for the publishers. In 1747 he married his first wife's maid, Mary Daniel, who bore him a son shortly afterward; and about the same time he must have begun work on *The History of Tom Jones, A Foundling*, which appeared in 1749. *Tom Jones* is *Joseph Andrews* "writ large." Like its predecessor, it is built around a romance plot. The hero, whose true identity remains unknown until the dénouement, loves the beautiful Sophia Western, and at the end of the book he wins her hand. Many obstacles have to be overcome before he achieves this, however, and in the course of the action the various sets of characters pursue each other from one part of the country to another, giving Fielding an opportunity of painting an incomparably vivid picture of England in the mid-18th century. Whereas Richardson's characters seldom leave the house, Fielding's are hardly ever indoors, except to eat or to sleep. In spite of the fact that so much of the action takes place on the open road, however, it is misleading to describe *Tom Jones* as a "picaresque" novel. Although he is highly inflammable where women are concerned, Tom has none of the other characteristics of the picaro, nor does the book as a whole exhibit the indifference to moral values which is typical of the picaresque novel (*q.v.*). On the contrary Fielding propounds the same liberal morality of "goodness of heart" in this book as in its predecessor.

From a formal point of view *Tom Jones* is equally reminiscent of *Joseph Andrews*. The introductory chapters at the beginning of each Book make it clear how carefully Fielding had considered the problem of planning a novel. No novelist for a century after him had so clear an idea of what a novel should be, so that it is the less surprising that *Tom Jones* is a masterpiece of literary engineering. Coleridge considered it one of "the three most perfect plots ever planned" (*Table Talk*, July 5, 1834) and it is significant that the other two were both plays. Nor is it only in its plotting that *Tom Jones* recalls Fielding's dramatic training. Other reminders of it are the way in which the characters fall into several distinct groups—romance characters (the hero and heroine), villainous characters (Blifil), Jonsonian "humours" (Thwackum and Square), "low" comic characters (Mrs. Slipslop) and the virtuous Squire Allworthy, who remains in the background and emerges to ensure the conventional "happy ending"; the deft alternations between humorous scenes and scenes of romance; occasional tricks straight from the theatre (at least three different characters hide behind the bed at various times); and above all the speed and ease of the dialogue. Before Mrs. Slipslop has been speaking for two minutes (for example), the whole of the untidy furniture of her mind is displayed for our inspection. A soliloquy as brilliant as that given to Mr. Allworthy's housekeeper when she hears the false news of his death and understands that she has been left the same legacy as her fellow servants achieves most of the things which later novelists have attempted to do by using the technique of the "stream of consciousness."

Just before the publication of *Tom Jones* Fielding's friends procured him the office of justice of the peace at the Bow Street court, and soon his jurisdiction extended over the whole of Middlesex. His predecessor had made a great deal of money in this position, but Fielding was a man of probity and he refused to earn the "dirtiest money upon earth" by adopting the unscrupulous practices of the "trading justice." As a consequence, he earned much less. He took his duties very seriously, as may be seen in his *Charge Delivered to the Grand Jury* (1749), in which he paints a dark picture of London morals and undertakes to be a vigilant upholder of the law. His *Enquiry Into the Causes of the Late Increase of Robbers* (1751) is of great interest and emphasizes the seriousness of his desire to reform the social conditions of London. He did a great deal to reorganize the rudimentary police force and helped to suppress nocturnal attacks and highway robberies. In this work his blind half brother, John (later Sir John) Fielding (*q.v.*), gave him invaluable assistance. Meanwhile he became more definitely interested in religion, while a pronounced change in his literary taste is evident in a remarkable letter to Samuel Richardson which was discovered and published in 1948. In 1748, while *Clarissa* was still appearing, Fielding wrote to Richardson congratulating him on his book, telling him that his heart had been "filled brim-full" by the pathos of the work, and begging him to give it a happy ending. This letter is a remarkable example of Fielding's honesty and generosity as a critic, and in spite of the

fact that *Clarissa* is a masterpiece, while *Pamela* is not, one is struck by the development in Fielding's attitude to life and literature since the early days of *Shamela*.

It was a much less lighthearted man than the author of *Shamela* and *Joseph Andrews* who wrote *Amelia* (1751). Although its structure owes something to epic, it is by no means a "comic epic" in the sense of its predecessors: if it is a comedy at all, it is a sentimental comedy. The central character, Amelia, acts as the perfect wife to an amiable but weak young man called Lieutenant Booth. His religious faith has been undermined by his reading of Bernard de Mandeville (*q.v.*). He is incapable of resisting temptation—the temptation of women, gambling or dueling—and therefore he plunges from one disaster to another, loyally supported by his wife, until he is rescued by a *deus ex machina*, the virtuous Dr. Harrison. The mottoes of the book—"Thrice and more blessed are they who live in unbroken marriage bonds" and "No greater good fortune falls to a man's lot than a good wife: no greater ill than a bad one" sum it up. Although it has a quiet charm it lacks the gaiety of Fielding's early work. It seems likely that Fielding began by making a list of the abuses of the time that he wished to expose, and then constructed the plot accordingly. *Amelia* is the first novel of any merit in English directed against specific abuses: the first novel of reform, of the kind more familiar in the Victorian age.

Fielding's main publications after *Amelia* were *The Covent-Garden Journal* (1752), a series of periodical essays which have a strong reforming tendency, the revised version of *The Life of Mr. Jonathan Wild the Great* (1754) and the *Journal of a Voyage to Lisbon* (1755) describing his last, fruitless search for health. He died in Lisbon on Oct. 8, 1754, at the age of 47.

Bibliography.—The most comprehensive edition of Fielding is *The Complete Works . . . Complete and Unabridged*, ed. by W. E. Henley, 16 vol. (1903). Of numerous other collected editions, mention may be made of *The Works . . . Complete in One Volume*, ed. by Thomas Roscoe (1840; small type and double columns); *The Works . . . With a Biographicol Essay by Leslie Stephen*, 10 vol. (1882) and *The Works*, ed. by G. H. Maynadier, 12 vol. (*c.* 1905). Most editions give all the novels, but only some (if any) of the plays and other writings. There is no modern edition of the plays, although several plays have been reprinted in various collections. Reprints of *Shamela* appeared in 1926, 1930, 1953 and 1956. The early text of *Jonathan Wild* is given in the "World's Classics" edition (1951). Modern biographers all oppose the emphasis placed by Arthur Murphy (in the *Life* prefixed to *The Works*, 4 vol., 1762) on Fielding's alleged dissoluteness as a young man. The standard work is W. L. Cross, *The History of Henry Fielding*, 3 vol. (1918). F. Homes Dudden, *Henry Fielding: His Life, Works and Times*, 2 vol. (1952), is reliable but highly derivative. A. Digeon's *Les Romans de Fielding* (1923; Eng. trans. *The Novels of Fielding*, 1925), is a good critical study. *See* also F. T. Blanchard, *Fielding the Novelist: a Study in Historical Criticism* (1927)—on Fielding's reputation; B. M. Jones, *Henry Fielding, Novelist and Magistrate* (1933); George Sherburn, "Fielding's *Amelia:* an Interpretation," *E. L. H: A Journal of English Literary History*, vol. iii (1936); W. R. Irwin, *The Making of Jonathan Wild* (1941); R. S. Crane, "The Concept of Plot and the Plot of *Tom Jones*," *Critics and Criticism: Ancient and Modern*, ed. by R. S. Crane, pp. 616–647 (1952).
(I. J.)

FIELDING, SIR JOHN (1721–1780), English police magistrate, was the younger half brother of Henry Fielding (*q.v.*) and his worthy successor in the arduous task of suppressing professional crime and of establishing reformed methods in London's administration of criminal justice. Born in London in the winter of 1721, John Fielding was blinded in an accident at the age of 19. Despite this he was appointed magistrate, at first as his brother's assistant, about 1750, and soon became locally famous as the "Blind Beak," being reputed to be able to recognize some 3,000 thieves by their voices. With his brother he was a founder of the Bow street runners, and he persuaded the government to contribute to the expenses of his small force of professional detectives. He also provided for the circulation among the police and the public of descriptions of offenders. A pioneer in the treatment of juvenile offenders, Fielding sought to analyze and remove the causes of crime and advocated a system of stipendiary magistrates which was adopted in 1792, after his death. His only authentic writings published are *A Plan for Preventing Robberies Within 20 Miles of London* (1775); *An Account of the Origins and Effects of a Police . . .* (1758); and *Extracts From Such of the Penal Laws as Relate to the Peace and Good Order of This Metropolis* (1768).

As a recognition of his services Fielding was knighted in 1761. He died in London on Sept. 4, 1780. There is an impressive portrait of him (now in the National Portrait gallery, London) by Nathaniel Hone, showing the massive head, lion locks and close-lidded eye sockets.

Bibliography.—R. Leslie-Melville, *Life and Work of Sir John Fielding* (1934); F. W. Grinnell, "Legal Careers and Influence of Henry and Sir John Fielding," *American Bar Association Journal*, vol. xxvi, no. 725 (1940); Gilbert Armitage, *The History of the Bow Street Runners, 1729–1829* (1932); Percy Fitzgerald, *Chronicles of Bow Street Police Office*, vol. i (1888); L. Radzinowicz, *A History of English Criminal Law*, 3 vol. (1948).
(G. H. J.)

FIELDING, WILLIAM STEVENS (1848–1929), Canadian statesman and journalist, who was dominion finance minister for 19 years, longer than anyone else in Canadian history, was born in Halifax, Nova Scotia, Nov. 24, 1848. From 1864 to 1884 he worked on the *Halifax Morning Chronicle*, the leading Liberal paper in Nova Scotia, and from 1884 to 1896 was provincial premier. An opponent of confederation, he represented the forces of maritime discontent, winning the provincial election of 1886 on a secessionist program and participating in the 1887 conference of provincial premiers that brought the provincial rights movement to a climax. In 1896 Fielding entered national politics as minister of finance in the government of Sir Wilfrid Laurier, a post he held until 1911. Fielding stood for economy, balanced budgets, a moderate protective tariff, federal subsidies to industry and bilateral trade agreements. He introduced a new tariff, granting a preference to British manufactures, and negotiated a series of commercial treaties. The most famous, the Canadian-U.S. agreement of 1911, providing for reciprocal free trade in natural products, was rejected by the Canadian electorate and brought down the Laurier administration. In World War I Fielding broke with Laurier on conscription, and at the national Liberal convention of 1919 he was narrowly defeated for the party leadership by William Lyon Mackenzie King, in whose government he served as finance minister from 1921 to 1925. Fielding died at Ottawa, Ont., on June 23, 1929.
(Fr. W. G.)

FIELD IONIZATION: *see* Field Emission.

FIELD MOUSE, loosely, any mouse occurring in fields rather than in forests or buildings; more strictly, the genus *Apodemus* in Eurasia, a long-tailed murid (member of the family Muridae) resembling the common house mouse.

See Mouse.
(K. R. Kn.)

FIELD OF CLOTH OF GOLD, often erroneously called Field of the Cloth of Gold, is the name given to the place between Guînes and Ardres, near Calais, where Henry VIII of England met Francis I of France in June 1520. The castles at both villages were in decay, and splendid temporary palaces and pavilions were erected for Henry at Guînes and for Francis at Ardres. Henry's palace covered nearly 12,000 sq.yd., and was sumptuously decorated; it contained a great hall, "longer and wider than the White Hall" (London), and a spacious chapel was attached. Outside, a gilt fountain spouted claret, hippocras (spiced wine) and water through separate runlets. The kings first met at the Val Doré, midway between the two camps, on June 7. The subsequent meetings and entertainments were conducted with much apparent cordiality, although "many persons present could not understand each other." There were jousts and mummers and on the last day, Sunday, June 24, sections of the Mass were sung alternately by French and English. Although its splendour made the meeting vastly impressive to contemporaries, its political result was negligible; Henry met the emperor Charles V, Francis' rival, at Gravelines on July 10, and each agreed to make no fresh alliance with Francis for two years.

See J. S. Brewer (ed.), *Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII* (1867).

FIELDS, JAMES THOMAS (1817–1881), U.S. publisher and author, was born in Portsmouth, N.H., Dec. 31, 1817, the son of a shipmaster who died when Fields was a child. At the age of 14 he went to Boston as clerk in a bookseller's shop. While working there he began to write for the local newspapers. In

1829 he became junior partner in the bookselling firm of Ticknor, Reed and Fields, which became Ticknor and Fields in 1854 and Fields, Osgood and Co. in 1868. He was the publisher of the foremost contemporary U.S. writers, with most of whom he was on terms of close personal friendship; Whittier, for instance, depicted him in *The Tent on the Beach*. He was also the U.S. publisher of some of the best-known British writers of his time.

In 1862–70, as the successor of James Russell Lowell, he edited the *Atlantic Monthly*. His writings include: *Poems* (1849), *Yesterdays With Authors* (1872) and *Hawthorne* (1876). He died in Boston on April 24, 1881. His second wife, Annie Adams Fields, whom he married in 1854, was the author of, among other works, *Under the Olive* (1880), a book of verses.

FIELDS, W. C. (CLAUDE WILLIAM DUKENFIELD) (1880–1946), U.S. comedian, was born in Philadelphia, Pa., on Jan. 29, 1880. He ran away from home at the age of 11 and at 14 began his professional career as a juggler. By 1901 he had achieved considerable recognition in U.S. vaudeville as a comic juggler and had made a successful European tour. He later made two world tours. He was featured in the *Ziegfeld Follies* from 1915 to 1921 and in George White's *Scandals* in 1922. Fields made the transition to comic acting in *Poppy*, a musical comedy produced in 1923, in which he created the character type, the grandiose fraud who flouts conventional virtues and sentiments, upon which his later reputation was built. Other trade-marks of Fields as a comedian were his raspy voice, nasal drawl and bulbous red nose. In 1925 he made his first motion picture and in 1931 he moved permanently to Hollywood.

He appeared in a series of films, among them *So's Your Old Man, The Bank Dick, My Little Chickadee* and *Never Give a Sucker an Even Break*, for the Mack Sennett, Paramount and Universal studios. He also was acclaimed for his "straight" portrayal of Mr. Micawber in *David Copperfield*. In the late 1930s he appeared regularly in a radio series. He died in Pasadena, Calif., on Dec. 25, 1946. (O. G. B.)

FIELDS are mathematical structures whose ingredients are a set or aggregate (*see* SET THEORY [THEORY OF AGGREGATES]) and compositions of addition and multiplication having the properties of these compositions in the system of rational numbers. The concept of a field, which is basic in abstract algebra, was first formulated as a necessary tool for making precise the statement that an algebraic equation can be solved by radicals (*see* EQUATIONS, THEORY OF). The solvability of algebraic or polynomial equations was a central problem in algebra from the time of the Renaissance to the early part of the 19th century. Its complete solution by E. Galois (*c.* 1830) enormously stimulated the subsequent development of algebra. In particular, it led to the formulation and intensive study of the concepts of groups (*q.v.*) and fields, which are of central interest in all of mathematics.

Fields were first encountered in considering subsets of the systems of real or of complex numbers (*see* NUMBER) which are closed under the rational compositions; that is, addition, multiplication, subtraction and division. One of the first examples was that (considered by C. F. Gauss) of the set of complex numbers of the form $a + b\sqrt{-1}$ where a and b are ordinary rational numbers. Later the axiomatization of geometry led to an axiomatization of the basic concepts of algebra. From this point of view a field F is defined as a set or aggregate in which two binary compositions $a + b$ and ab (or $a \times b$) are defined satisfying a number of axioms. These are as follows:

Closure.—For any a and b in F, $a + b$ and ab are in F.

Commutativity.—For any a and b in F, $a + b = b + a$ and $ab = ba$.

Associativity.—For any a, b and c in F, $(a + b) + c = a + (b + c)$ and $(ab)\ c = a\ (bc)$.

Distributivity.—For any a, b and c in F, $a(b + c) = ab + ac$.

Existence of identities.—There exists an element O in F such that $a + O = a$ for every a in F and an element $1 \neq O$ in F such that $a1 = a$ for every a in F.

Existence of inverses.—For any a in F there exists an element $-a$ in F such that $a + (-a) = 0$. For any $a \neq 0$ in F there exists an element a^{-1} such that $aa^{-1} = 1$.

These axioms state that F is a commutative group relative to addition and that the nonzero elements of F form a commutative group relative to multiplication. Important algebraic systems more general than fields are obtained by dropping some of the axioms in the list. Dropping commutativity of multiplication results in a system called a division ring. Dropping commutativity of multiplication, existence of identity and inverses for multiplication results in a ring which is the prototype of systems defined by such axioms as those listed above. Consequences of the axioms for a field are that 0 and 1 are unique; that the inverses are unique; that $-(-a) = a$, $(a^{-1})^{-1} = a$; that $a0 = 0$ for every a; that $a(-b) = -ab$ and $(-a)(-b) = ab$. Also, if a and b are given in F and $a \neq 0$, then the equation $ax = b$ has the unique solution $x = a^{-1}b$ in F.

Examples of rings and fields are: (1) The ring I of integers $0, \pm 1, \pm 2, \ldots$, with the usual addition and multiplication. This is not a field since if $a \neq \pm 1$ then there is no x in I such that $ax = 1$. (2) The field Q of rational numbers; addition and multiplication as usual. (3) The field R of real numbers; addition and multiplication as usual. (4) The field C of complex numbers; usual addition and multiplication. (5) The ring $F[x]$ of all the polynomials in an indeterminate (or symbol) x with coefficients in a field. Here addition and multiplication are the familiar compositions. The ring $F[x]$ is not a field. This example can be generalized to give the ring $F[x_1, x_2, \ldots, x_r]$ of polynomials in indeterminates $x_1, x_2, \ldots, x_r$. (6) The field $I/(p)$ of residue classes modulo p (p a positive prime) in the ring of integers (*see* NUMBERS, THEORY OF). The definition of $I/(p)$ is briefly as follows: let p be a fixed positive prime. If a is an integer, then the residue class $\bar{a}$ of a is the collection of all the integers x such that $x \equiv a \pmod{p}$; that is, $x - a$ is a multiple of p. For example, if $p = 3$ then there are three residue classes $\bar{0} = \{0, \pm 3, \pm 6, \pm 9, \ldots\}$, $\bar{1} = \{1, 1 \pm 3, 1 \pm 6, 1 \pm 9, \ldots\}$, $\bar{2} = \{2, 2 \pm 3, 2 \pm 6, 2 \pm 9, \ldots\}$. In the general case, if x is in $\bar{a}$ and y is in $\bar{b}$, then $x + y$ is in $\overline{a + b}$ and xy is in $\overline{ab}$. This leads to a definition of the sum of the classes $\bar{a}$ and $\bar{b}$ as the class $\overline{a + b}$, and of the product of $\bar{a}$ and $\bar{b}$ as the class $\overline{ab}$. The set $I/(p)$, consisting of the residue classes $\bar{0}, \bar{1}, \ldots$ modulo p, can be proved to be a field relative to these compositions of addition and multiplication. The field $I/(p)$ is finite; that is, it has only a finite number of elements. In fact, it has exactly p elements $\bar{0}, \bar{1}, \ldots, \overline{p-1}$.

Structure Theory of Fields.—There are simple algebraic equations (for example, $x^2 = -1$) which have no real solutions. This fact led to the problem of constructing a field C, the field of complex numbers, which contains the field R of real numbers and a root or solution of the equation $x^2 = -1$. In another example of this type let $F = I/(2)$ the field of residues modulo 2. The equation $x^2 + x + \bar{1} = 0$ has no solutions in F since $\bar{0}^2 + \bar{0} + \bar{1} = \bar{1}$ and $\bar{1}^2 + \bar{1} + \bar{1} = \bar{1}$. Again, an extension field is sought containing a root of the given equation.

To make this precise and general, first define a subfield F of a field E as a subset F of E which is closed under the addition and multiplication of E (that is, if a and b are in F then $a + b$ and ab are in F, which is itself a field relative to these compositions. For example, the subset of rational numbers is a subfield of the field of real numbers.

Now let F be a given field and let $f(x) = 0$ be a polynomial equation with coefficients in F. To construct a field E which contains F as a subfield and which is generated by F and a root Θ of the equation $f(x) = 0$ requires that E contain F and Θ, and that no proper (that is, smaller) subfield of E contain F and Θ. $E = F(\Theta)$ is written to indicate that E is generated by F and Θ, and more generally, if F is a subfield of E, and S is a subset of E then $F(S)$ will denote the smallest subfield of E containing F and S.

The Cauchy-Kronecker construction of a field $E = F(\Theta)$ for the equation $f(x) = 0$ is as follows: Without loss of generality, $f(x)$ may be assumed prime; that is, $f(x)$ cannot be factored as a product of two polynomials of positive degree belonging to the polynomial ring $F[x]$. Let $E = F[x]/(f(x))$, the ring of residue classes of polynomials modulo the polynomial $f(x)$. As for the ring $I/(p)$, let $\overline{a(x)}$ denote the residue class of all the polynomials of $F[x]$ which differ from $a(x)$ by a multiple of $f(x)$. It may be seen that the sum of any polynomial in $\overline{a(x)}$ and any polynomial

in $\overline{b(x)}$ is a polynomial in $\overline{a(x)+b(x)}$ and that the product is in $\overline{a(x)b(x)}$. As for $I/(p)$, the definitions $\overline{a(x)}+\overline{b(x)}=\overline{a(x)+b(x)}$ and $\overline{a(x)}\,\overline{b(x)}=\overline{a(x)b(x)}$ are made. The collection $E=F[x]/(f(x))$ of the residue classes $\overline{a(x)}$ with the addition and multiplication just defined is a field. Strictly speaking, E does not contain F. However, E contains a subfield $\bar{F}$ which is isomorphic to F. This means that there is a 1–1 mapping $u\to\bar{u}$ of F onto $\bar{F}$ such that $\overline{u+v}=\bar{u}+\bar{v}$, $\overline{uv}=\bar{u}\bar{v}$. In general, if F and $\bar{F}$ are any two fields then an isomorphism of F onto $\bar{F}$ is defined as a 1–1 mapping $u\to\bar{u}$ of F onto $\bar{F}$ which preserves addition and multiplication in the sense of the foregoing equations. In the case of F and $E=F[x]/(f(x))$ it can be verified that the subset $\bar{F}$ of elements $\bar{u}$, u in F, is a subfield of E isomorphic to F. $\bar{F}$ can be identified with F and then E can be considered as an extension of the field $F\,(=\bar{F})$. Then by taking $\Theta=\bar{x}$ it can be checked that $f(\Theta)=0$ and $E=F(\Theta)$ as required.

An extension of the type $E=F(\Theta)$ where $f(\Theta)=0$ for a polynomial $f(x)$ in $F[x]$ is called a simple algebraic extension of F. A second type, a simple transcendental extension, is obtained by starting again with the ring $F[x]$. The simple transcendental extension $F(x)$ is the quotient field of $F[x]$. This is the set of rational expressions $a(x)/b(x)$ (where $b(x)\neq 0$) with the usual rules for equality addition and multiplication. Thus, $a_1(x)/b_1(x)=a_2(x)/b_2(x)$ if and only if $a_1(x)b_2(x)=a_2(x)b_1(x)$, $a_1(x)/b_1(x)+a_2(x)/b_2(x)=(a_1(x)b_2(x)+a_2(b)b_1(x))/b_1(x)b_2(x)$ and $[a_1(x)/b_1(x)][a_2(x)/b_2(x)]=a_1(x)a_2(x)/b_1(x)b_2(x)$.

Every field can be obtained from the field of rationals Q or one of the fields $P=I/(p)$ by iteration of simple algebraic and simple transcendental extensions. It is noted first that the elements common to any collection of subfields of a field E form a subfield. In particular, the elements common to all subfields constitute a subfield E_0 which is contained in every subfield of E. This subfield is called the prime field of E. It may be seen that E_0 is isomorphic to one of the fields Q or $P=I/(p)$, p a prime. In this sense E can be considered as an extension field of Q or of one of the fields P. In the first case, E is said to be a field of characteristic zero; in the second, E is said to be of characteristic p. If E is of characteristic p, the sum $a+a+\ldots+a$ (p times) is zero for any a in E. Now if F is any subfield of a field E, then the subfield $F(\Theta)$ generated by F and an element Θ is isomorphic to either a simple algebraic or a simple transcendental extension of F. It follows that E can be obtained from any subfield, hence from its prime field (which is either Q or one of the fields P) by a succession of simple algebraic and simple transcendental extensions.

In studying a field E, interest is usually centred on properties of E relative to a given subfield F of E. One of the simplest questions concerning the pair E and F deals with whether E has finite dimensionality (or a finite basis) over F. An affirmative answer means that there exists a finite number of elements $e_1, e_2, \ldots, e_n$ in E such that every element e of E can be expressed as a linear combination $a_1e_1+a_2e_2+\ldots+a_me_m$ of the e_i with coefficients as a_i in F. If this can be done then the minimum number m for the generators e_i is independent of the choice of the e_i and is called the dimensionality of E over F. The symbol $[E:F]$ is used to denote this number. An elementary property of dimensionalities of fields is that if E is finite dimensional over F, and F is finite dimensional over the subfield G, then E is finite dimensional over G and $[E:G]=[E:F][F:G]$.

An element Θ of E is called algebraic over the subfield F if Θ is a root of a polynomial equation $f(x)=0$ with coefficients in F. In particular, if $E=C$, the field of complex numbers, and $F=Q$, the field of rationals, then the elements of C which are algebraic over Q are called algebraic numbers. If Θ is algebraic over F, then the polynomial $f(x)$ of least degree such that $f(\Theta)=0$ is prime in $F[x]$. If m is the degree of $f(x)$ then $[F(\Theta):F]=m$, and every element of $F(\Theta)$ can be written in one and only one way in the form $a_0+a_1\Theta+\ldots+a_{m-1}\Theta^{m-1}$ with the a_i in F.

The subset A, consisting of elements of E which are algebraic over F, forms a subfield of E containing F. Moreover, every element of E which is algebraic over A is algebraic over F and so belongs to A. These results follow by using the notion of dimensionality and the product formula for dimensionalities noted earlier. Any field F can be imbedded in a field E which is algebraically closed in the sense that it has no proper algebraic extensions. It may be assumed also that E is algebraic over F in the sense that every element of E is algebraic over F. In this case E is determined up to isomorphism by F, and E is called the algebraic closure of F.

An element Θ of a field E which is not algebraic over the subfield F is called transcendental over F. This notion has an important generalization from a single element Θ to an arbitrary subset S of E. Thus, it is said that S is an algebraically independent set relative to the subfield F if the following holds: Given any finite subset $\{\Theta_1,\Theta_2,\ldots,\Theta_m\}$ of S then there exists no polynomial $f(x_1,x_2,\ldots,x_m)\neq 0$ in the polynomial ring $F[x_1,x_2,\ldots,x_m]$ such that $f(\Theta_1,\Theta_2,\ldots,\Theta_m)=0$. If this is the case then the subfield $F(\Theta_1,\Theta_2,\ldots,\Theta_m)$ generated by F and the Θ_i is isomorphic to the quotient field of the ring $F[x_1,x_2,\ldots,x_m]$. In any extension field E of F there exists a subset T of E which is algebraically independent over F and which has the property that every element of E is algebraic over the subfield $F(T)$ generated by F and T. The set T is called a transcendency basis of E over F. There exist many such bases for E over F; however, the cardinal number of T is uniquely determined and is called the degree of transcendency of E over F. This idea on the generation of E over F means that every field E can be obtained from a subfield F by making a succession of simple transcendental extensions followed by a succession of simple algebraic extensions.

Galois Theory.—In elementary algebra any quadratic equation $ax^2+bx+c=0$ can be solved by the formula $x=\dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$. This formula shows that the roots of any quadratic equation can be expressed by rational operations and square root extractions in terms of the coefficients a, b and c. Similar formulas for the solutions of cubic equations $x^3+ax^2+bx+c=0$ and quartic equations $x^4+ax^3+bx^2+cx+d=0$ were found (*c.* 1540) by N. Tartaglia and L. Ferrari. These also expressed the roots by rational operations and radicals in terms of the coefficients. A long quest followed for analogous solutions by radicals for quintic and higher degree algebraic equations. The analysis of J. L. Lagrange (*c.* 1770) of the earlier solutions of cubics and quartics strongly suggested that no similar result could be found for general equations of fifth degree or higher. This definitely was established independently by P. Ruffini and N. H. Abel (1824) in the theorem: The general equation of the fifth degree cannot be solved by radicals. The word general in this theorem is used to mean that the coefficients of the equation are taken to be algebraically independent elements over some initial field.

The conclusive work on the theory of solvability of algebraic equations by radicals was done by Galois, who obtained the theorem of Ruffini-Abel as a corollary to a general criterion for solvability of an equation by radicals. The theory of Galois, as formulated by later mathematicians, particularly R. Dedekind, is based on the concept of an automorphism of a field. If E is a field and F is a subfield, then an automorphism of E over F is an isomorphism of E onto itself which leaves fixed every element of F. For example, if C is the field of complex numbers and R is the subfield of real numbers, then the mapping for every $a+b\sqrt{-1}$ (where a and b are real) into $a-b\sqrt{-1}$ is an automorphism of C over R. Let G_F denote the set of automorphisms of E over F and denote the individual automorphisms by s, t, etc. The image of x under s is denoted as x^s, which should not be confused with a power of x. The defining conditions are that $(x+y)^s=x^s+y^s$, and $(xy)^s=x^sy^s$ for x and y in E, and $a^s=a$ for every a in F. In particular, the identity mapping $1: x\to x$ belongs to G_F. If s and t are any two automorphisms of E over F, then the product st is defined as the mapping which sends x into the image of x^s under the mapping t; that is, $x^{st}=(x^s)^t$. It can be verified that st is an automorphism of E over F, which yields the important fact that G_F is a group relative to the product st. This group, which is the funda-

mental concept of Galois's theory, is called the Galois group of E over F.

If $f(x) = 0$ is a polynomial equation with coefficients in the field F, then there exists an extension field E of F (called a splitting field of $f(x)$ over F) such that $E = F(\Theta_1, \Theta_2, \ldots, \Theta_n)$ and $f(x)$ can be factored in $E[x]$ as $f(x) = a(x - \Theta_1)(x - \Theta_2) \ldots (x - \Theta_n)$. The field E is finite dimensional over F and is determined up to an isomorphism by F and $f(x)$. The Galois group G_F of E over F is a finite group which depends only on F and $f(x)$, and is called the Galois group of the equation $f(x) = 0$ over F. If F is of characteristic zero and $f(x)$ is a prime polynomial in $F[x]$, then it can be shown that the roots $\Theta_1, \Theta_2, \ldots, \Theta_n$ of $f(x) = 0$ in E are distinct. This need not be the case for characteristic p, which leads to calling a polynomial separable if its prime factors have distinct roots in the splitting field for $f(x)$ over F. An extension E over F is called normal (or normal and separable) if it is a splitting field over F of a separable polynomial. The fundamental theorem of the Galois theory establishes a 1–1 correspondence between the set of subgroups of the Galois group G_F and the set of subfields of E containing F. This theorem is the key to Galois's criterion for solvability of an equation by radicals. However, its importance in algebra far transcends its application to the theory of equations.

Galois's correspondence is of the following type: If H is a subgroup of G_F, then E_H denotes the subset of E of elements a which are fixed under the elements of H; that is, $a^h = a$ for every h in H. It may be verified that E_H is a subfield of E containing F. On the other hand, if L is any subfield of E containing F, then the Galois group G_L of E over L is a subgroup of G_F. The fundamental theorem can now be stated as follows: Let E be normal over F; then the mappings $L \to G_L$ and $H \to E_H$ are inverses of each other; so that either of these establishes a 1–1 correspondence between the set of subfields of E containing F and the set of subgroups of the Galois group G_F of E over F. The subfield $L = E_H$ corresponding to the subgroup H of G_F is normal over F if and only if H is invariant in G_F. When this is the case then the Galois group of L over F is isomorphic to the factor group of G_F relative to H.

An algebraic equation $f(x) = 0$ with coefficients in F is said to be solvable by radicals over F if the splitting field E of $f(x)$ over F can be imbedded in a field W which has a root tower over F; that is, there exists a sequence of subfields $F_1 = F, F_2, \ldots, F_k = W$ such that each $F_i = F_{i-1}(\Theta_{i-1})$ where Θ_{i-1} is a root of a radical equation $x^{n_{i-1}} = a_{i-1}$ with a_{i-1} in F_{i-1}. Galois's criterion for solvability of an equation by radicals is that $f(x) = 0$ is solvable by radicals over F of characteristic zero if and only if the Galois group G_F of $f(x)$ over F is a solvable group (*see* GROUPS). Recall that this means that there exists a chain of subgroups $G_1 = G_F, G_2, \ldots, G_{r+1} = 1$ such that each G_i is invariant in G_{i-1} and the factor group G_{i-1}/G_i is commutative. The equation $x^n + ax^{n-1} + bx^{n-2} + \ldots = 0$ whose coefficients $a, b, c, \ldots$ are algebraically independent over a field F_0 is called the general equation of the nth degree over F_0. The Galois group of this equation over $F = F_0(a, b, c, \ldots)$ is isomorphic to the symmetric permutation group S_n on n objects. It is known that this group is not solvable if $n \geq 5$; hence, the theorem of Ruffini-Abel can be deduced as a corollary of Galois's criterion.

The Galois theory can be applied also to prove the impossibility of certain constructions with compass and straightedge. For example, it can be seen in this way that there exist angles which cannot be trisected by straightedge and compass, and that it is impossible by straightedge-compass construction to obtain the side of a cube whose volume is two times the volume of a given cube.

The Galois theory is an important element in the theory of finite fields since it can be shown that any such field is normal over its prime field. The latter is finite and hence must be one of the fields $I/(p)$. If E is a finite field with $E_0 = I/(p)$ as prime field then E is finite dimensional over E_0. If $[E:E_0] = r$ then the number of elements in E is p^r. Moreover, there exists a finite field whose cardinal number is any prime power, and any two such fields are isomorphic.

Analytic and Arithmetic Aspects.—The system R of real numbers is endowed with a structure which is richer than that of a field; for, besides the basic algebraic compositions of addition and multiplication there is also a relation of order among real numbers. Where a and b are real numbers, $a > b$ means that a is greater than b. The relation of order in R satisfies the following axioms:

1. *Transitivity*—If $a > b$ and $b > c$ then $a > c$.
2. *Trichotomy*—If a and b are any two elements of R, then one and only one of the following possibilities holds: $a > b$, $a = b$, $b > a$.
3. If $a > b$ and c is arbitrary then $a + c > b + c$.
4. If $a > b$ and $c > 0$ then $ac > bc$.

In general, an ordered field is defined as a field F together with an order relation $a > b$ which satisfies these axioms (in addition to those given earlier for fields in general). In any ordered field a relation of the form $a^2 + b^2 + \ldots + k^2 = 0$ among elements $a, b, \ldots, k$ of the field can hold only if $a = b = \ldots = k = 0$. Fields which have this algebraic property are said to be formally real. The theory of such fields has been developed by E. Artin and O. Schreier, and it has been applied by Artin to solve a problem on the decomposition of positive definite rational functions as sums of squares. This was one of the famous Hilbert problems posed by D. Hilbert at the Paris International Congress of Mathematicians (1900).

The field C of complex numbers cannot be ordered since C contains a number i such that $i^2 = -1$, which implies that $i^2 + 1^2 = 0$, contrary to the formal reality of ordered fields. Any complex number u can be written in one and only one way in the form $a + bi$ where a and b are real numbers. If $u = a + bi$, then the absolute value of u (written $|u|$) is defined as the non-negative real number $\sqrt{a^2 + b^2}$. The absolute value has the following properties:

1. $|u| \geq 0$ and $|u| = 0$ if and only if $u = 0$;
2. $|u + v| \leq |u| + |v|$;
3. $|uv| = |u||v|$.

If F is an arbitrary field, then a mapping which assigns to every element u of F a real number $|u|$ with these three properties is called a valuation of F. Another valuation of quite a different sort is the p-adic valuation of the field Q of rational numbers which is defined as follows: Let p be a fixed prime integer. If u is any rational number, then u can be written in the form $u = p^e(c/d)$ where e is an integer (positive, negative or zero), and c and d are prime to p. The number e is uniquely determined and is called the p-adic order of a: $\mathrm{ord}_p a$. When $|u|_p = p^{-\mathrm{ord}_p u}$ then it can be verified that $|u| = |u|_p$ has the properties noted above. A particular valuation for a field which is trivial is the one such that $|u| = 1$ if $u \neq 0$ and $|0| = 0$. If this is disregarded and a suitable notion of equivalence is introduced, it can be shown that the only valuations of Q are the p-adic valuations for all the primes p and the usual absolute value valuation $|u| = \sqrt{u^2}$.

A valuation of a field F permits the introduction of analytic notions of limits and of regular or Cauchy sequences in F similar to these notions in the fields R and C (*see* NUMBER SEQUENCES). It may happen that there exist regular sequences in F which do not have limits. This deficiency of the field F can be removed by constructing a completion $\bar{F}$ of F. The method for doing this is identical with G. Cantor's (1872) method for constructing the field of real numbers as the completion of the field Q of rational numbers. If $F = Q$ and $|u| = |u|_p$ the completion $\bar{Q}_p$ is called the field of p-adic numbers. These fields play an important role in advanced aspects of the arithmetic of the field Q.

Similar considerations apply also to algebraic number fields. These are fields of the form $Q(\Theta)$ where Θ is algebraic over the rational field. The valuations of this field are of fundamental importance in the higher arithmetic of the field.

The concept of a valuation can be generalized so that the values $|u|$ are taken in any ordered group rather than in the field of real numbers. Then it is necessary to replace condition 2 by 2′: $|a + b| \leq \max(|a|, |b|)$, the larger of $|a|$ and $|b|$. Such valuations are basic in algebraic geometry, particularly in the theory of algebraic functions of one variable.

Fields occur in the foundations of projective and affine geometry. In any projective or affine geometry in which Desargues' theorem holds, co-ordinates can be introduced which are elements of a division ring. This division ring is commutative and hence is a field

if and only if the theorem of Pappus holds. *See* GEOMETRY.

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FIELD TRIALS are competitions among individual sporting dogs, or gun dogs, as they are called in Great Britain, of the same general type under conditions that approximate or simulate those found in the hunting field. Competing dogs need not necessarily be of the same breed. For instance, in field trials for pointing breeds it is the usual custom for pointers, the several breeds of setters, Brittany spaniels, Weimaraners and others of the same general hunting characteristics to compete against each other. However, in many instances field trials are confined to members of one breed.

In the United States many of the field trials in the bird-dog (pointing dog) area are staged under the sanction of the American Kennel club, the official governing body of dog shows. The majority, however, are held under the sponsorship of the Amateur Field Trial Clubs of America. In Great Britain field trials are sponsored by the Kennel club. In both countries winners in various stakes staged by the member clubs are eligible for the regional and national amateur championship stakes fostered annually by the parent body. These trials are usually held in good game country of sufficient acreage to allow the running of prescribed contiguous courses. However, in congested sections, where large areas of natural hunting country are impractical, the dogs are run over a shortened course and then directed into a bird field, in which pen-raised birds are released or planted. Various stakes are held, including puppy (for dogs not over 18 months old), derby (not over 30 months) all-age, shooting dog and championship events. Novice and limited stakes are sometimes added to the program of events. Many of these events are confined to amateur handlers only.

Sporting Dogs.—Dogs in bird-dog trials are run in braces or pairs. Time of running is determined by lot. The time consumed by each brace is called a heat. All heats of the same stake are of the same duration. The time of these heats, previously announced by the sponsoring club, ranges from 20 minutes in puppy stakes to 30 minutes in derby stakes, 30 minutes to one hour in all-age stakes and from one to three hours in championship events. The dogs are judged on speed, range, hunting intelligence, handling response, game finding, game and gun manners, style and intensity. Two judges, sometimes three in the United States, pass on the merits of the contenders. At the discretion of the judges, extra series of heats may be run. Game birds involved in the U.S. are quail, pheasants, prairie chicken, grouse and woodcock; in Great Britain, grouse, partridges and pheasants.

In field trials for spaniels (springers and cockers), there is no limit on the time each contestant is run. Should he make a grevious error or breach of manners, he may be taken up immediately. Should he fail to find game through no fault of his own, he may be given more time. The dogs are run, two at a time, on parallel beats on prescribed courses. Each dog is given a number, determined by drawing. Even-numbered dogs are run on one beat, odd-numbered dogs on the other. In Great Britain only natural, wild game is sought but in the United States pen-raised pheasants may be planted at intervals on each beat. These are shot by official guns as they are flushed or sprung by the dogs. The properly mannered spaniel will promptly stop at the flush and remain steady at the shot, staying until he is ordered to retrieve or resume hunting. Two judges usually officiate and they may hold as many tests as they desire. The dogs are judged on pace, range, handling response, style, game finding, marking of fallen game, retrieving (promptness, tender- or hardmouthed), carry of game, steadiness to flush and shot, etc. In stakes carrying championship points competing dogs are usually tested on their ability to retrieve from water.

In field trials for retrievers each dog is called upon to demonstrate his individual ability in solving various retrieving problems from both land and water. Great emphasis is placed on the dog's tractability, his rock-steadiness under the gun and his immediate handling response. Ability to mark fallen game is another factor, and nose, pace and style are also considered. In the matter of control, field-trial retrievers are usually the best trained of all sporting dogs. In competition they are tested singly, although in at least one test in an all-age stake each dog must honour another's work by remaining steady as the other contender is sent for the retrieve. While all tests are intended to simulate problems ordinarily encountered in an average day's shooting, many are quite difficult. Blind retrieves, where the dog has no idea where the bird is placed, require that the handler direct his dog to the fall or its vicinity by hand and whistle signals. As many of these are lengthy problems, the dog must be under complete control and some spectacular work is witnessed.

Hounds.—Field trials for hounds constitute another category in this sport. The most numerous of all field competitions for sporting dogs are beagle trials. Beagles are run in braces, with no time limit on the heats. Usually a short run after a cottontail rabbit or hare, in which the two contenders can demonstrate their hunting ability, keenness of nose, ability to carry a trail and work out "checks" or "losses" without undue delay, constitutes a heat. The judges, usually two, score each dog and call back the heat winners into a second series. This continues until all have been eliminated except the four winning dogs. The first-place dog must have defeated the second-place dog, etc. This same system is used in field trials for basset hounds.

In foxhound trials a different method is employed. Each hound is given a number and this number is painted on both his sides as identification. The entire entry is cast loose at early morning in good fox-hunting country. The dogs are followed by a number of mounted judges, who score them on the basis of hunting and trailing, speed, driving and endurance. Dogs are eliminated for "babbling" (giving vent to mouth when not on trail), cutting (taking short cuts to overtake the leaders when outdistanced on the trail), loafing and other faults. The day's hunt is usually called off by the master of hounds at 11 A.M. Judges then tabulate the scores and the standings of the hounds are posted daily. Trials last from three days to a week. (*See* also DOG: *Classification of Breeds;* HUNTING.) (H. P. D.)

Sheep-dog trials are held all over the world and remarkable feats of control and sagacity are seen. Generally the test takes the form of herding a given number of sheep, driving them through a prearranged and intricate succession of obstacles, dividing them into two or more groups of given numbers and penning each group at the end of the course. Awards are made on the basis of time taken and on the style in which the work is done.

Police dogs are called upon to demonstrate their capacity to follow a scent and to distinguish it from other scents which are artificially laid to confuse them. They are then tested for their boldness and resource in cornering and tackling a possibly hostile man, and for the manner in which they obey orders to desist from attack or to pin their quarry to the ground.

Obedience Tests.—Obedience tests are designed primarily for house dogs and they are planned on the assumption that the dog is kept as a guard. To be a good guard a dog should be bold and yet under complete control. Tests are devised to establish both these qualities and in nearly every case it is the actual owner, rather than a professional handler, who takes part in the competition with the dog. The most popular breed in tests involving intelligence and obedience both as a police dog and as a guard dog is the Alsatian, or German shepherd dog. Others which are much used include the Doberman pinscher (another German breed) and the Labrador retriever. Some smaller breeds, such as Shetland sheep dogs, are sufficiently intelligent and tractable to do well in obedience tests. *See* also DOG: *The Working Breeds.* (W. S.)

FIENNES, CELIA (1662–1741), English gentlewoman, who traveled all over England at the end of the 17th century, and whose journals are a lively and invaluable source for social, economic and architectural historians. Born on June 7, 1662, at Newton Toney, Wiltshire, daughter of Nathaniel Fiennes (*q.v.*) and granddaughter of the prominent Puritan magnate Lord Saye and Sele, she held stern Whiggish and Nonconformist views. She traveled

partly to improve her health (she drank and bathed at every available watering place), partly to visit relations, but mainly from sheer curiosity. Her journals were written up in 1702 from notes made during her travels (*c.* 1684–1702), and they were the first comprehensive eyewitness account of the face of England written since Elizabethan times.

Celia Fiennes had the seeing eye. In her rambling, unpunctuated style she recreates her England. Her "Great Journey" in 1698 took her from East Anglia to Liverpool, from Carlisle to Newcastle, through the west Midlands to Cornwall. She pried into stately homes such as Chatsworth or Woburn abbey; investigated "curiosities" like the Peak caverns, Stonehenge and Wookey Hole; observed enclosures, quarries, mines (Northumberland coal, Cheshire salt, Derbyshire lead, Cornish tin) and industries, writing of "cotton-tickings" in Lancashire, glass blowing in Nottingham, Staffordshire teapots, Kent silk and paper and Exeter serge. She sampled local food and drink, from northern potted char and clapbread to Colchester oysters and a delectable West Country tart. She described, but despised, antiquities; Lichfield cathedral was "a stately structure, but old" and the Rows at Chester "a dissight to the grace of the streets." She preferred "the new London way of building" and England's growing material wealth. On her journeys this intrepid spinster braved appalling roads, floods, highwaymen, filthy inns and unmapped hinterlands. She died at Hackney on April 10, 1741.

See Christopher Morris (ed.), *The Journeys of Celia Fiennes* (1947). (C. Ms.)

FIENNES, NATHANIEL (*c.* 1608–1669), English parliamentarian, who played an active part in the Civil War, was born in Oxfordshire, the second son of William, 1st Viscount Saye and Sele. He was educated at Winchester and at New college, Oxford, where as founder's kin he was admitted a perpetual fellow in 1624. After some time spent on the continent of Europe, where he came in touch with Calvinist leaders, he went to Scotland in 1639 and established contact with the covenanters there and with the opposition in England. As member of parliament for Banbury in both the Short and Long parliaments, Fiennes took a leading part in the attacks upon the Church of England. He was one of the commissioners appointed to attend the king in Scotland in Aug. 1641 and was nominated one of the committee of safety in July 1642. During the Civil War Fiennes commanded a troop of horses under the earl of Essex at Edgehill (Oct. 1642) and was sent in Feb. 1643 to Bristol where he arrested the governor; Fiennes received a commission as governor on May 1, 1643. In July, however, he surrendered the city to Prince Rupert. For this he was tried at St. Albans in Dec. 1643 and was found guilty of having surrendered the place improperly, but he was pardoned and, soon afterward, completely exonerated.

He held various appointments under the Commonwealth. Fiennes took no part in the Restoration, and died at Newton Toney in Wiltshire on Dec. 16, 1669.

FIESCHI, GIUSEPPE MARIA (1790–1836), Corsican conspirator who made a notable attempt to assassinate Louis Philippe, king of the French, was born at Murato on Dec. 13, 1790. Becoming a soldier in his youth, he rose early to sergeant's rank and finally served in Joachim Murat's Neapolitan army. On the Restoration he returned to Corsica and was condemned to ten years' imprisonment for theft (1816). He worked in France as a weaver from 1826 to 1830. After the July revolution he went to Paris, assumed the name Gérard and obtained government employment. He also seems to have been employed by the police as a secret agent among the Bonapartists. Later, however, he made contact with the republicans of the Société des Droits de l'Homme. With two of these people, Pierre Morey and Pierre Pépin, he contrived an "infernal machine" of 25 guns which could fire simultaneously. This they discharged at Louis Philippe as he was passing Fieschi's lodging on the Boulevard du Temple on his way to a review of the troops (July 28, 1835) celebrating the anniversary of the July revolution. The king and his sons were unhurt but 18 people were killed and many more wounded. The conspirators were guillotined on Feb. 19, 1836.

Bibliography.—*Procès Fieschi devant la cour des pairs,* 3 vol. (1835–36); L. Blanc, *Histoire de dix ans,* vol. iv and v (1844); P. Thureau-Dangin, *Histoire de la monarchie de juillet,* vol. ii (1884). (Je. V.)

FIESCO (DE' FIESCHI), **GIOVANNI LUIGI** (*c.* 1523–1547), Genoese nobleman, count of Lavagna, whose conspiracy against the Doria family is the subject of much literature, was descended from one of the greatest families of Liguria, which gave two popes and 72 cardinals to the church and innumerable political and military leaders to Genoa. While Andrea Doria (*q.v.*) had taken the side of the Holy Roman emperor Charles V, the Fiesco family adhered to the French or "popular" party in Genoa; the feud, rooted in the opposite political traditions of the two families, can hardly be related to a supposed rivalry in love. When Giovanni Luigi Fiesco conspired against Doria he found friends in many quarters. Both Pier Luigi Farnese, duke of Parma, and Francis I of France encouraged him. Among his associates in Genoa were his brothers Girolamo and Ottobuono, Giovanni Verrina and R. Sacco. A number of armed men from the Fiesco fiefs were secretly brought to Genoa, and it was agreed that on Jan. 2, 1547, during the interregnum before the election of the new doge, the galleys in the port should be seized and the city gates held. The first part of the program was easily carried out, and Giannettino Doria, Andrea's heir, rushed down to the port and was killed, but Andrea escaped from the city in time. Giovanni Luigi, while crossing a plank from the quay to one of the galleys, fell into the water and was drowned.

The news spread consternation among the Fiesco faction, and Girolamo found few aherents. They came to terms with the senate and were granted a general amnesty. Doria returned to Genoa on Jan. 4 thirsting for revenge and, in spite of the amnesty, confiscated the Fiesco estates. Girolamo Fiesco and Verrina were captured, tried, tortured and executed. Ottobuono Fiesco, who had escaped, was captured eight years afterward and put to death by Doria's orders.

The conspiracy has been treated in many poems and dramas, the most famous being *Die Verschwörung des Fiesco* by Friedrich von Schiller. A narrative by Agostino Mascardi, *La Congiura del conte Giovanni Luigi de' Fieschi* (1629), inspired the young J. F. P. de Gondi, later Cardinal de Retz, to write *La Conjuration de Fiesque,* in fact a treatise on conspiracy.

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FIESOLE, GIOVANNI DA: *see* Angelico, Fra.

FIESOLE, MINO DA (1430–1484), Italian sculptor, was born at Poppi in the Casentino. Trained in Florence, supposedly in the studio of Desiderio da Settignano, he worked in this town and in Rome, where he was active in 1454, 1463 and from about 1473 to 1480. He died in Florence in 1484. In Florence Mino executed the monuments of Giovanni Salutati, bishop of Fiesole (d. 1466), in Fiesole cathedral, and of Bernardo Giugni (d. 1466) and Count Hugo of Andersburg in the Badia. The latter was begun in 1471 and completed after Mino's return from Rome in 1482. In 1473 he carved two reliefs for the pulpit by Antonio Rossellino in Prato cathedral, and in 1481 a tabernacle for S. Ambrogio, Florence. Mino's work in Rome has been confused with that of the sculptor Mino del Reame. In Rome he worked in association with Giovanni Dalmata on the tomb of Pope Paul II for St. Peter's (Grotte Vaticane), and executed, among many other works, the monuments of Niccolo Forteguerri (Sta. Cecilia in Trastevere), Pietro Riario (SS. Apostoli), Cristoforo della Rovere (Sta. Maria del Popolo) and Francesco Tornabuoni (Sta. Maria sopra Minerva). Much of Mino's work in Rome was undertaken in conjunction with Andrea Bregno and others.

Mino enjoyed popularity as a portrait sculptor. His earliest portrait bust, that of Niccolo Strozzi (Kaiser Friedrich museum, Berlin), was carved in Rome in 1454. Other notable portrait busts by Mino are those of Astorgio Manfredi (National Gallery of Art, Washington, D.C.), R. della Luna (Museo Nazionale, Florence) and D. Neroni (1464; Louvre, Paris). These well-characterized busts are among the earliest Renaissance portrait sculptures.

Though much admired in the 19th century, Mino's sculptures

came to occupy a place below those of Desiderio da Settignano and Antonio Rossellino. In his larger works the treatment of form is frigid and mannered, and he appears, perhaps as a result of long absence from Florence, to have lacked the ready invention and technical proficiency of his great contemporaries.

See W. R. Valentiner, "Mino da Fiesole," in *Studies of Italian Renaissance Sculpture* (1950). (J. W. P.-H.)

FIESOLE (ancient FAESULAE), a small town and episcopal see in the province of Florence (Firenze), Tuscany, Italy, 7 km. (4 mi.) N.E. of Florence city, stands 968 ft. above sea level dominating the valleys of the Arno and Mugnone. Pop. (1961) 13,277 (commune). The centre of the town is the Piazza Mino, to the west of which the church of S. Francesco (*c.* 1330) stands on a hill (the site of Etruscan, and later Roman, citadels) and the Franciscan friary has interesting cloisters. The Romanesque cathedral, north of the piazza, was begun in 1028 and has been restored. To the east the old Palazzo Pretorio (or Comunale) contains the coats of arms of the *podestà* ("mayors") from 1502 to 1808; the old church of Sta. Maria Primerana was almost completely rebuilt in the 16th and 17th centuries. The Roman theatre, discovered in 1809 and excavated from 1873, was built early in the 1st century B.C. Nearby are the Roman baths of the same period. The Etruscan museum contains exhibits from Etruscan to early Christian and medieval times. The Bandini museum nearby contains terra cottas by the Della Robbias. The chief industry of Fiesole is straw plaiting.

Faesulae was a chief city of the Etruscan confederacy. It probably dates from the 9th to 8th century B.C., but its first record is in 283 B.C. when with other Etruscan cities it was conquered by the Romans. In 80 B.C. Sulla occupied it and a splendid town sprang up, which was conquered by the barbarians in A.D. 405. It later declined and was superseded by Florence.

FIFE, an eastern county of Scotland, is bounded north by the Firth of Tay, east by the North sea, south by the Firth of Forth and west by the shires of Perth, Kinross and Clackmannan. The Isles of May, Inchkeith, Inchcolm and the Oxcar rocks belong to Fife. The land area is 504.5 sq.mi. and its coast line measures 108 mi.

Physical Features.—Very broadly the landforms of Fife consist of three main erosion surfaces planed across the dip of the strata: the various hills are part of a dissected plateau at about 1,200–1,500 ft. largely developed on volcanic rocks; the lowlands consist mainly of a surface at about 500 ft. covered in boulder clay, with fluvioglacial sands and gravels in places, especially the valleys, and a coastal fringe including light-soiled raised beaches lying up to 100 ft. above sea level. In the north is the easterly extension of the Ochil hills in southward dipping lavas of Old Red Sandstone age; there are small patches of moorland in the highest parts, amid improved farm land. Northward, flanking the Firth of Tay, is an arable lowland strip developed on Lower Old Red Sandstones. Lapping the upland on the south is the Upper Old Red Sandstone howe ("hollow") of Fife, where the river Eden twines through a pleasant arable lowland, the drift there including much fluvioglacial material. This lowland swings round eastward to merge with the wide raised beaches of heathery fixed sand dunes of Tentsmuir. South of the Eden is the steep intrusive dolerite escarpment of the Lomond hills, again with patches of moorland, extending eastward toward Fife Ness in a series of lower hills under enclosed fields. Southward again, the drift-covered lowland plateau and raised beaches are planed across a large east-west belt of sandstones with some limestones, and coal seams of Carboniferous Limestone age which dip round the Coal Measures in the syncline of the East Fife coal field (the basin extends under the Forth to the Midlothian coal field). East of the coal field lie the warm soils of the East Neuk of Fife, where glacial drift and raised beaches overlie rocks of the Calciferous sandstone series, while to the west a complex anticlinal structure separates it from the West Fife coal field which in turn comprises the fringes of the great Central field in Stirlingshire and Lanarkshire. The Cleish hills and their continuation toward Kircaldy, which fringe the coal field to the south, are mainly of dolerite. In all this southern part of Fife heavier drift soils coupled with urban demand for milk give rise to arable dairy farming with more grassland, in contrast to the arable cash cropping of the east and north.

The east has 25–30 in. mean annual rainfall and tends to be particularly dry and sunny, although often cool with coastal mists or "haars" in the spring and early summer (daily average sunshine in June is 6 hours, compared with 4½ hours in August, the wettest month). The west is a little wetter, some hilly areas approaching 40 in.

The natural, deciduous woodland was practically extinct by the mid-18th century and few estate woodlands have survived the two world wars; but there are Forestry commission plantations at Tentsmuir, Edensmuir, Pitmedden, Blairadam and Tulliallan. Roe deer and foxes are found in the more remote parts, while on the coast seals bask on the rocks and sandbanks. There is a bird sanctuary at Tentsmuir and another on the Isle of May, frequented by kittiwake and puffin. (A. T. A. L.)

History.—The peninsula between the Tay and Forth, and cut off from the rest of Scotland by the Ochil hills, was the ancient Pictavia, peopled by a northern branch of the Picts; it became a leading province of Scotland, its earls having such privileges as the crowning of the monarch. Doubtless it was because of the long continuance of an independent king that Fife itself came to be called distinctively the Kingdom. The Romans, probably only temporarily, occupied a few points, and left no impression on the civilization of the natives. Christian missionaries—especially Saints Serf, Kenneth, Rule (or Regulus), Adrian, Monan and Fillan—have left memorials in the numerous coastal caves between Dysart and St. Andrews and in crosses and sculptured stones, some doubtless of pre-Christian origin, at various places. The word Fife, according to W. F. Skene, seems to be identical with the Jutland *Fibh* (pronounced Fife) meaning "forest" and was probably first used by the Frisians to describe the country behind the coasts of the Forth and Tay, where their tribes are supposed to have settled at the close of the 4th century. The next immigration was Danish, which left lasting traces in many places (such as the frequent use of *law* for "hill"). In 1426 the first shire of Kinross was formed, consisting of Kinross and Orwell, and was enlarged to its present dimensions by the transference from Fife of the parishes of Portmoak, Cleish and Tulliebole. Although the county has lain outside the mainstream of Scottish history, Dunfermline, Falkland and St. Andrews were often the scene of pageantry and romantic episodes during the reigns of the earlier Stuarts. Of the 66 royal burghs in Scotland 14 are in the shire. Notwithstanding the marked preference of the Stuarts the Kingdom played the leading part in the dramas of the Reformation and the covenant, and by the 18th century the people had ceased to regard the old royal line with any but sentimental interest, and the Jacobite risings of 1715 and 1745 evoked only lukewarm support.

Many notable buildings are to be found in St. Andrews (*q.v.*); these include the cathedral, St. Rule's tower and church, the castle and the United college, principal centre of university life. Dunfermline abbey is distinguished as being the burial place of seven kings of Scotland, the last being Robert the Bruce. Culross (*q.v.*) contains many fine examples of Scottish domestic architecture dating from the town's prosperity during the 17th and 18th centuries, and Falkland palace, dating from the early 16th century, was one of the favourite retreats of the royal family of Scotland.

Population and Administration.—At the 1961 census the population of the county was 320,692 persons and both Gaelic and English were spoken by more than 600 persons. The denser areas of population are in and around the three principal coal fields of central and west Fife while in the mainly agricultural area of northeast Fife, the population is much sparser.

The towns with a population of 5,000 or more at the 1961 census are as follows: Kirkcaldy (52,390), Dunfermline (47,151), Buckhaven and Methil (21,102), Cowdenbeath (11,920), St. Andrews (9,882), Leven (8,872), Burntisland (6,038), Cupar (5,495) (*qq.v.*), Lochgelly (9,118).

Glenrothes is a New Town formed in 1948 with a proposed ultimate population of 32,000.

The county council meets in Cupar and there are six county districts. Kirkcaldy and Dunfermline, being large burghs, perform most of their own local government functions with the principal exceptions of education, valuation for rating and police administration.

For parliamentary purposes, Fife is divided into two county constituencies of East Fife and West Fife, and the burgh constituencies of Dunfermline Burghs (Dunfermline, Cowdenbeath, Inverkeithing and Lochgelly) and Kirkcaldy Burghs (Kirkcaldy, Buckhaven and Methil, Burntisland and Kinghorn).

Agriculture, Industries, Communications.—About 10% of the total area of the 250,000 ac. devoted to farming is rough grazing, including hill pastures. The principal crops are oats, hay, potatoes, barley, turnips, wheat and sugar beets. Cattle numbers are fairly evenly divided between beef cattle and dairy cattle. Sheep breeding and feeding are important. East Fife, which is favoured by its soil and a low rainfall (about 30 in.), is mostly devoted to arable farming with cattle and sheep feeding. West Fife, less favoured by climate and soil but having a large industrial population, is mostly concerned with milk production. The whole of the coastal belt from Kincardine-on-Forth to Newburgh on the Tay, and in the valleys formed by the rivers Motray, Eden, Leven and Ore is very fertile and produces early crops. Elsewhere the soil is naturally poor but has been much improved by liming and other treatment. The poorest soils are mostly under afforestation.

The manufacture of linen ranks with agriculture as the county's oldest industry and still exists in Dunfermline, Kirkcaldy and Falkland, but has died out at Freuchie, Cupar, Leven and Strathmiglo. The weaving of pure silk and artificial fibres has also been introduced. Kirkcaldy, Newburgh and Falkland are noted for the manufacture of linoleum, and paper is made at Guardbridge, Inverkeithing, Markinch, Leslie and Leven. There are engineering works and iron foundries at Kirkcaldy, Dunfermline, Glenrothes, Cupar, Cowdenbeath, and Leven; shipbuilding is carried on at Burntisland, boatbuilding at Anstruther and St. Monance and shipbreaking at Inverkeithing. There is malting of cereals and the distillery at Cameron Bridge produces whisky, which is blended at Markinch. Aluminum ore is refined at Burntisland. At Cupar is situated the only sugar beet factory in Scotland. Other industries include furniture and carpetmaking and the manufacture of shuttles, bobbins, plastics, scales and weighing machines, oilskins, blankets, hygienic bedding, golf clubs, bricks, flour, meal and ropes.

Fife possesses large reserves of coal which supply first-class house coals and a wide range of industrial fuels for general purposes. Based on these extensive coal resources are the Electricity Generating station of Kincardine-on-Forth and the Lurgi gas production plant at Westfield, near Kinglassie, both of which are among the biggest of their kind in Europe. Beds of limestone and sandstone lying near to coal seams are quarried, as also are exposures of basaltic whinstone of unusual hardness and durability.

The fishing industry is centred in Anstruther and the neighbouring communities of Crail, St. Monance and Pittenweem. Of these Crail specializes in inshore fishing and Pittenweem is the home of the white fishing fleet. The Tay, which marks the northern boundary of Fife, is the most important salmon river in Britain and the salmon netting industry gives employment to substantial numbers.

From the Forth bridge the main railway line follows the coast as far as Dysart and then turns northward to Ladybank, where it diverges to the northeast for Cupar and the Tay bridge. From Thornton junction a branch runs to Dunfermline and there begins also the coast line for Leven, Crail, and St. Andrews which touches the main line again at Leuchars junction. A good system of roads links all parts of the county and is reinforced by two ferries, one in the northeast connecting Newport-on-Tay with Dundee in Angus and the other in the southwest connecting North Queensferry with South Queensferry in West Lothian. A road bridge crosses the river Forth at Kincardine and another was begun in 1958 near the Forth bridge to link North and South Queensferry.

A number of the coastal towns such as St. Andrews, Elie, Crail and Leven are also popular seaside resorts.

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HORNIMAN MUSEUM

B FLAT FIFE; LONDON, ABOUT 1800

FIFE, a military flute (from the German *Pfeife*) first employed, with the side drum, by foot regiments in Switzerland in the 16th century and so adopted in Tudor England. It is cylindrically bored in one piece, is about 14 in. long and has six fingerholes and no keys, thus conforming with the Renaissance design of the flute (*q.v.*) and preserving it long after orchestral flutes became constructed otherwise. Its pitch is C or B flat, respectively one or two tones below that of the piccolo. In England, however, this true fife was replaced about 1850 by an equivalent conical flute with from one to six keys, and a "drum and fife" band, or "corps of drums," uses this in various sizes. Duty calls for the fife, now rarely used, are preserved in printed instruction books. (A. C. Ba.)

FIFTH AMENDMENT. The 5th amendment to the United States constitution comprises part of the Bill of Rights, the group of ten amendments protecting individual liberty which were adopted in 1791 shortly after the ratification of the constitution (*see* BILL OF RIGHTS, UNITED STATES). The most pervasive guarantee of the 5th amendment, that no person "shall be deprived of life, liberty or property without due process of law," echoes language employed in Magna Carta in 1215 to limit royal prerogative, but the due-process clause has been expanded to permit judicial review of the essential fairness of legislation. This extension of the due-process clause is buttressed by the 5th amendment's further prohibition against taking private property without just compensation.

The balance of the 5th amendment relates primarily to court procedure: no person shall be tried for certain serious crimes except after indictment by a grand jury; nor may any person be tried twice for the same offense (the "double jeopardy" [*q.v.*] clause); nor may one be compelled to be a witness against himself. This protection against self-incrimination received attention through its use by witnesses called before committees of the United States congress; but in the controversial 1956 Slochower decision involving the state's discharge of an employee for invoking the 5th amendment, the U.S. supreme court condemned "the practice of imputing a sinister meaning to the exercise of a person's constitutional right under the Fifth Amendment."

The 5th amendment's provisions are directly applicable only to action by the national government, but several of its basic guarantees are also applicable to the states through the due-process clause of the 14th amendment.

See also CIVIL LIBERTIES; CRIMINAL LAW: *Criminal Procedure;* DUE PROCESS.

See Z. Chafee, Jr., *How Human Rights Got Into the Constitution* (1952); E. N. Griswold, *The Fifth Amendment Today* (1955).

(J. O. Ho.)

FIFTH COLUMN, a term of modern origin denoting the existence within a potential or actual enemy state of a group of hidden and unsuspected activists who attempt to undermine the nation's solidarity by whatever means at their disposal. It is the near-synonymous equivalent of disloyalty, subversion and treason. The term generally is credited to Gen. Queipo de Llano, a partici-

pant in the Spanish civil war (1936–39) on the rebel side. When four rebel army columns were moving on Madrid, the general referred to his militant supporters within the capital as his "fifth column," intent on undermining the resistance of the Loyalist government from within. The term thus connotes a modern parallel to the ruse of the Trojan horse.

Next to espionage and sabotage, the main technique of the fifth column is infiltration of sympathizers into the entire fabric of the nation under attack, and particularly into positions of policy decision and national defense. Fifth-column activities find a conspicuous field of operation in psychological and actual warfare between the rival ideological camps of totalitarianism and democratic constitutionalism. The techniques of infiltration and subversion, in preparation for subsequent military attack, were utilized with striking success by Adolf Hitler against neighbouring democratic nations, partly in literal imitation of the Trojan horse (hiding troops in the holds of vessels peacefully anchoring in the harbours of the land to be victimized), partly by availing himself of the support of local sympathizers, for whom Vidkun Quisling (*q.v.*), minister of defense of Norway, has provided a generic name.

The technique of the fifth column in all its disguises is also assumed to be standard practice of international Communism. In most cases, however, Communist practice differed from that of the Nazis, an openly operating Communist party taking the place of the clandestine fifth column. Occupancy by Communists of the ministries of the interior and of defense, in control of the police and the armed forces, respectively, together with the establishment of communist militia or action squads, proved the most effective methods of the fifth column, as illustrated by the fall of Czechoslovakia in 1948.

The defense of democratic states against totalitarian infiltration was handicapped by observance of the principle of freedom of political expression accorded to all; further, such states were accustomed to repress only overt criminal acts. However, realizing their danger, many European democracies passed legislation before World War II for the defense of the constitutional state, aiming primarily at preventing subversion from within and disloyalty of public officials and armed forces. The ideological "cold war" after the war resulted in the adoption of similar measures by most western states against Communist infiltration. In particular, in the United States a vast body of legislation was enacted and supplementary activity undertaken, including the loyalty review of the entire public service of the federal government and the states. In this context the term fifth column as such found access to a legal document, the Internal Security (McCarran) act of 1950 (64 Stat. 987), section 2. Whether the danger of fifth-column penetration was such as to warrant the infringement of traditional civil liberties that resulted from the precautionary policy was a matter of dispute. *See* also ESPIONAGE; SABOTAGE; TREASON.

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FIFTH MONARCHY MEN were an extreme Puritan sect which came into prominence in England during the Commonwealth and Protectorate. They were so called from their belief that the time of the fifth monarchy was at hand, that is, of the monarchy which should succeed the Assyrian, Persian, Greek and Roman and during which Christ should reign on earth with his saints for 1,000 years. After the fall of the Commonwealth they at first supported Oliver Cromwell; and the Nominated or Barebone's parliament of 1653, chosen from nominees of the Independent Churches, raised their hopes of bringing in speedily the rule of the saints. The establishment of the Protectorate, however, dashed these hopes and turned the sect against Cromwell. The violence of their agitation led to the arrest of their leaders—Maj. Gen. Thomas Harrison, Maj. Gen. Robert Overton, Christopher Feake, John Rogers and others—and an attempt at an armed rising, led by Thomas Venner in April 1657, was easily suppressed. Venner attempted another, and equally abortive, rising in Jan. 1661. He and a number of others were executed and the special doctrines of the sect died out. (R. B. WM.)

FIG, the popular name given to various plants of the genus *Ficus,* of the mulberry family (Moraceae), but especially applied to the common fig, *Ficus carica,* and its fruit. The species vary greatly in habit—some being low trailing shrubs, others gigantic trees, among the most striking forms of the tropical forests to which they are chiefly indigenous. They have alternate or sometimes opposite leaves and abound in a milky, usually acrid juice. This juice contains caoutchouc, the main constituent in rubber, in considerable quantity. The flowers are borne on the inner surface of a hollow receptacle or syconium that matures into a spherical or pear-shaped multiple fruit.

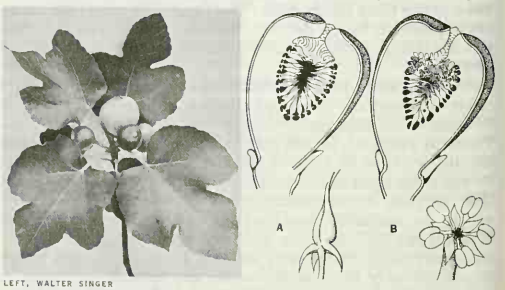
THE FIG OF COMMERCE

Ficus carica, which yields the well-known figs of commerce, is indigenous to an area extending from Asiatic Turkey to north India, but natural seedlings grow in most Mediterranean countries. It was undoubtedly one of the earliest fruit trees cultivated by primitive man, and spread in remote ages over all the districts around the Aegean and Levant. The Greeks are said to have received it from Caria (hence the specific name); Attic figs became celebrated throughout the east, and special laws were made to regulate their exportation. The fig was one of the principal articles of sustenance among the Greeks; the Spartans especially used it at their public tables. Pliny enumerates many varieties, and alludes to those from Ebusus (the modern Iviza) as most esteemed by Roman epicures; he describes those of home growth as furnishing a large portion of the food of the slaves, particularly those employed in agriculture, by whom great quantities were eaten in the fresh state at the periods of fig harvest. In Latin myths the plant plays an important part. Held sacred to Bacchus, it was employed in religious ceremonies; and the fig tree that overshadowed the twin founders of Rome in the wolf's cave, as an emblem of the future prosperity of the race, testified to the high value set upon the fruit by the nations of antiquity.

Plant Characteristics.—*Growth Form.—Ficus carica* is a bush or small tree—from a few feet to 30 or 40 ft. high—with broad, rough, deciduous leaves, deeply lobed or sometimes nearly entire.

The Fruit and Its Composition.—Several types of fig, based mainly on structure of flower and fruit, are grown (see *Basis of Classification,* below).

Fig fruits are borne singly or in pairs above the scars of fallen leaves or in axils of leaves of the present season. The flowers are of two kinds, female (carpellate) and male (staminate). Long-styled female flowers are characteristic of the fruits produced on most garden and orchard fig trees. Short-styled female flowers are found only in fruits of the caprifig tree and are adapted to the egg-laying habits of the fig wasp or *Blastophaga.* Male flowers, which produce pollen, are found in caprifigs, usually near the apex.



LEFT, WALTER SINGER

LEFT: BRANCH OF COMMON FIG TREE (FICUS CARICA); RIGHT: LONGITUDINAL SECTION THROUGH (A) COMMON FIG FRUIT SHOWING CARPELLATE FLOWERS, ONE ENLARGED; (B) THE WILD CAPRIFIG FRUIT SHOWING BOTH STAMINATE AND CARPELLATE FLOWERS, ONE STAMINATE FLOWER ENLARGED

Young receptacles of Smyrna-type figs drop from the tree because of lack of fecundation, which circumstance has led from ancient times to the practice of caprification or the placing of caprifigs containing mature *Blastophagas* in the cultivated trees. The insects as they issue from the caprifigs become dusted with pollen; they enter the Smyrna-type figs and crawl over the long-styled flowers in a vain attempt to find a suitable place to deposit their eggs. The flowers thus become pollinated and the resulting fecundation causes the fruit to set and eventually to mature. Hormone sprays will induce Smyrna-type figs to set and mature into seedless or even "seeded" edible fruit.

In Mediterranean countries, the fig is so widely used both fresh and dried that it is called "the poor man's food." Figs are known to possess in an unusual degree two important food qualities, a definite laxative effect and a high excess alkalinity of ash. The laxative effect is probably due to the bulk of seeds and fibre combined with some specific solvent present in the juice. The chief nutritive element in dried figs is sugar, the content of reducing sugar running as high as 64%. The vitamin content of figs depends somewhat upon the variety. For example, in California, fresh Mission figs contain about twice as much vitamin A precursor as Kadotas and considerably more than Calimyrnas. Vitamin B appears to be unfavourably affected by sulfuring preceding sun drying. In the fig districts of the old world both fresh and dried figs are commonly used for stock feed. Even the leaves are harvested when they are mature and stored or sold for fodder.

Varieties and Horticultural Types.—The varieties of figs grown in various parts of the world run into the hundreds. Their nomenclature is very much confused, since the same fig is often grown in neighbouring provinces under entirely different names. When introduced into other countries a new name is commonly coined. Thus Lob Injir of Smyrna became Calimyrna in California, and Dottato of Italy became Kadota. The Italian San Piero is known in England as Negro Largo, in France as Aubique Noire and in California as San Pedro Black, Brown Turkey or Black Spanish.

There are four general horticultural types of the fig. The most primitive is the caprifig, commonly regarded as the wild type from which edible figs have evolved. Trees of the caprifig characteristically produce three series of fruit buds each growing season; the first gives rise to the profichi or spring crop, the second to the mammoni or summer crop and the third to the mamme or winter crop. Most caprifigs are inedible, but all three crops harbour the larvae, pupae or temporarily the adults of the fig wasp.

The other three types of fig are Smyrna, White San Pedro and Common. Smyrna-type figs develop only when fertile seeds are present, and these seeds account for the generally excellent quality and nutty flavour of the fruit. Figs of the White San Pedro type combine the characteristics of both the Smyrna and the Common type on one tree. First-crop figs develop without flower pollination while second-crop figs in axils of leaves require it. Common figs such as the Dottato, Fraga and Brown Turkey do not require pollination of flowers of either crop, the seeds in the mature fruit usually being hollow. The flowers of such figs were once regarded as incapable of fecundation and were therefore designated as mule flowers; but this is incorrect; it has been proved that all common figs can produce fertile seeds if the flowers are pollinated.

Cultivation.—Fig trees are so readily propagated from woody cuttings that no other method of propagation is considered in a commercial way. Cuttings of dormant wood taken in February and planted in nursery rows should grow in one season to a height of 4 ft. and be ready to transplant at the end of the growing season. The trees thrive in a wide range of soil types and in most Mediterranean countries receive water only from the natural rainfall. Some varieties produce one crop only in summer or fall. Some bear two crops, the first maturing in June or July on wood of the previous growth, the second ripening in summer and fall in the axils of leaves of the same season. In cool climates such as England and central France most varieties mature only the first crop. Pot culture of figs in greenhouses has long been practised in England and some other countries.

Harvesting and Packing.—In most districts figs partially dry on the tree and drop naturally to the ground from which they are picked up and placed on trays in the sun. Turning and manipulating during the drying process improves the texture and quality of the product. The packing of dried figs in boxes, mats, baskets, cartons, bricks, etc., gives employment to thousands of men, women and children during the fall and winter seasons.

Basis of Classification.—Species of the genus *Ficus* are classified by botanists into groups depending upon the kind and distribution of flowers, which on the inside of the receptacle are either male, pseudohermaphrodite or female, with long- or short-styled pistils. Classification may also be made on the fruiting habit or method of producing receptacles. Some fig trees produce fruit singly or doubly in the axils of leaves. Some bear single fruits on the large branches or on the trunk; some bear clusters of fruit on woody knobs or leafless twigs while others have strings of figs on drooping branches. In a few species the figs are borne below ground on leafless runners, such figs being designated as geocarpic or earth figs. How these figs are pollinated underground or whether they are uprooted by animals is not apparent.

Commercial Plantings and Production.—In the old world, figs are grown commercially in the following countries: Italy, Turkey, Algeria, Greece, Portugal and Spain. In Spain the most important fig provinces are Málaga, where figs are grown in regular orchards as well as mixed plantings with other fruit trees; Huelva, the centre of the industry being at Lepe, where a fig variety of the same name is grown; Murcia, reported to have the largest number of trees and the greatest production of any of the provinces; Huesca, where the Fraga fig grown near Lérida has a good market reputation; and Majorca, the largest of the Balearic Islands. Spanish figs are mostly of the Common type, although the Turon fig grown in southern Granada is a variety of the Smyrna type. In Algeria figs are grown commercially in the mountainous coastal districts, principally in the vicinity of Tizi Ouzou and Bougie. The unirrigated orchards are on rolling hills or steep mountainsides and consist mostly of Smyrna-type varieties with Kabylian names.

The commercial production of figs in Italy is mostly south of Naples, the principal producing centres being Lecce in the south, Cosenza in the interior and Agropoli on the coast. Dottato is the principal commercial variety, but numerous other figs are widely planted for the production of fresh and dried fruit. The famous Smyrna figs of Turkey are produced mainly in the Meander valley, but the dried product is largely packed and marketed in Izmir. Sari Lop is the variety grown for drying while Bardajic is consumed in the fresh state. Both are of the Smyrna type. The commercial production of figs in Portugal is mostly confined to the province of Algarve, and Faro is the principal centre of growing and packing. In Greece figs of the Smyrna type comprise the bulk of the dried figs entering into commerce. Messenia is the variety most widely grown in the province of the same name, and Kalamata is the city where the fig-packing industry is centralized. Greek string figs are so called from the fact that the figs are flattened out, then strung on reeds about 1.5 lb. to each string before shipment to market.

Commercial fig culture in the United States is largely confined to California and Texas, although fig trees are very common in yards throughout the south and with winter protection thrive as far north as New York city. The varieties grown in California in order of importance are Calimyrna, Adriatic, Mission, Kadota and Brown Turkey. California fig orchards are practically all grown under irrigation.

The Texas fig industry is centred in the vicinity of Houston and is devoted mainly to the production of fresh figs for canning and preserving, mostly in glass containers. Because of summer rains and high humidity, figs are not dried commercially. Almost all the commercial plantings are of the Brunswick fig known in Texas as the Magnolia. The smaller Celeste is grown in small plantings from Texas to Florida and is used in Louisiana for preserving on a small commercial scale. *See* also FRUIT FARMING.

OTHER FIGS

Some fig trees, for example, *Ficus religiosa* and *F. benghalensis*, commonly start life from seeds deposited by birds, squirrels, mon-

keys or fruit-eating bats, high up on a palm or other native tree. The roots grow downward, attached to the trunk of the supporting plant, but are not parasitic. Such figs are known as epiphytes or more accurately as hemi-epiphytes, as they pass their early life on the trunks of trees but subsequently become connected with the ground by their own root system. The name "strangler" has become attached to fig trees which grow in this way, since their descending and encircling roots become at length largely or entirely confluent, forming a pseudo trunk hollow at the centre through which the dead or dying host plant passes. These fig trunks are roots and not stems, a fact which should be taken into account in studying their anatomy. Roots of fig trees often enter cracks and crevices, thus causing serious injury to buildings and walls on which they are growing. In a vivid description of an old ruin in Ceylon one writer states that a fig tree forms one of the most remarkable objects of the place, its roots streaming downward over the walls as if their wood had once been fluid, following every sinuosity of the building and terraces till they reach the earth.

The sycomore fig (*F. sycomorus*) is a tree of large size, with heart-shaped leaves. The deep shade cast by its spreading branches makes it a favourite tree in Egypt and Syria, where it is often planted along roads and near houses. The fruit is borne in clusters on specialized leafless shoots attached to the older branches. Sycomore figs become edible only if the apex is cut open to prevent the development of the insect that normally inhabits the fruit.

The Sacred fig, pipal or bo (*F. religiosa*), a large tree with heart-shaped, long-pointed leaves on slender stalks, is much grown in southern Asia. The leaves, bark and fruit are used in native medicine, and a gum resembling caoutchouc is obtained from the juice; but in India it is chiefly planted as a religious object, being regarded as sacred by both Brahmans and Buddhists. (*See* Bo Tree.)

Ficus elastica, the India rubber tree, with large, oblong-shaped glossy leaves and pink buds, furnished most of the caoutchouc obtained from the East Indies previous to the cultivation of Brazilian rubber trees (*Hevea*) in the orient. In nature it grows to a large size, and is remarkable for the snakelike roots that extend in contorted masses around the base of the trunk. The small fruit is unfit for food. It is often grown indoors, where it is trained as an attractive pot plant.

Ficus benghalensis, the banyan, of India, has heart-shaped leaves commonly used as elephant fodder. The branches send out numerous aerial roots that grow down to the soil and form props or additional trunks eventually developing the broadest crown of any plant. The fruits, fresh or dried, are eaten in various parts of India especially in times of food scarcity. (*See* Banyan.)

In southern Florida, two native species occur, the golden fig (*F. aurea*) and the short-leaved fig (*F. brevifolia*), both stranglers. Many species are native to Mexico and Central America. The common fig (*F. carica*) is sparingly naturalized in old fields and along roadsides from Virginia to Florida and Texas. Numerous species are grown as greenhouse ornamentals and as standard trees out of doors in Florida and California. No species of *Ficus* is native to the Hawaiian Islands, but several have been introduced and widely distributed for reforestation purposes. *F. macrophylla*, the Moreton Bay fig of Australia, is well suited to this project. Previous to 1921 fertile seeds of this fig had to be imported from its native home. During that year, however, the wasp essential to pollination of Moreton Bay figs was introduced into Hawaii and ripe figs containing fertile seeds were secured. This was the second case on record where the wasp of a wild fig tree had been established outside its natural habitat, the first being the colonization of the *Blastophaga* on caprifigs in California.

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(I. J. Cr.; X.)

FIGG, JAMES (*c.* 1695–1734), generally acknowledged the first champion of England at fighting with bare fists, was born at Thame, Oxfordshire, about 1695. For years he was the leading pugilist and master of the "noble art" of self-defense. He was also famous for his swordsmanship, and for cudgeling and wrestling. He was beaten only once, and then he is said to have been ill. Figg opened a boxing academy, Figg's amphitheatre, and, a magnificent and resolute figure, he was ready at all times to accept a challenge to fight.

Figg died on Dec. 7, 1734. *See* also Boxing: *The Bare-Knuckle Era*.

FIGNER, VERA NIKOLAEVNA (1852–1942), Russian revolutionary, a leading member of the Narodniki or Populists, was born on July 7 (new style), 1852, near Mamadysh, in the Kazan province in comfortable circumstances, the daughter of a country squire of Baltic-German origin. She received the conventional woman's education of the period, leaving boarding school in 1869. In Oct. 1870 she married the lawyer A. V. Filippov, who encouraged her to study. Intellectually ambitious and interested in progressive political thought, she went to Switzerland (1872–75), where she studied medicine at Zürich university. She also furthered her political education by reading and discussion with other Russian students and, eventually, was persuaded by her sister to abandon marriage and career in favour of revolutionary activities. This she did in 1873 by joining a Russian secret society whose aim was to undermine the authority of tsarism and to democratize the Russian regime.

On returning to Russia at the end of 1875 she worked in the countryside as a district nurse, using her opportunities to educate the people and to destroy their belief in the tsar as their protector. She belonged at first to the "propagandist" branch of the revolutionary movement as distinct from the terrorist branch and believed that propaganda would be enough to produce peasant risings in view of the unsatisfactory economic conditions. In this hope she and other moderates were disappointed. She also, however, did a considerable amount of organizing and conspiratorial party work and, in 1879, took part in the Voronezh conference of the Populists, which stressed the disagreement between the moderates and the terrorist radicals. Figner supported the moderates but, on returning to the revolutionary headquarters in St. Petersburg, threw in her lot with the radicals who formed the terrorist organization Narodnaya Volya ("The Will of the People"). She became a member of its executive committee and joined the enthusiasts who, in a flat in St. Petersburg, accumulated considerable quantities of dynamite and began to fabricate bombs—without, at first, appreciating that dynamite needs a fuze in order to explode. Thus she took an active part in the series of political murders that culminated in the assassination of the emperor Alexander II in 1881.

Figner then left the capital to organize further terrorist activities in the south. Arrested on Feb. 10, 1883, she was sentenced to death by a military tribunal in Sept. 1884 but the sentence was commuted to life imprisonment. She passed the next 20 years of her life in solitary confinement in one of the most dreaded of Russian prisons, the Schlüsselburg fortress. Her memoirs for that period, "When the Clock of Life Stopped" (*Kogda chasy zhizni ostanovilis*, 1921), describe how she preserved her sanity there. Sent on Sept. 29, 1904, into exile at Archangel, she was allowed to go abroad in 1906. There she took part in the activities of the Russian Socialist Revolutionary party, the descendant of the Populist movement, till her return to Russia in 1915, after which she devoted the rest of her life to literary and social work.

Endowed with strength of character and singleness of purpose, Vera Figner well deserved the comment of a Russian priest who, having visited her in the fortress and having listened to her profession of atheism, remarked, "Perhaps it is those who believe like you and not the others who will be saved." Her *Memoirs of a Revolutionist* were published in New York in 1927; her collected works, seven volumes, in Moscow in 1932. She died in Moscow on June 16, 1942.

(Ru. H.)

FIGUEIRA DA FOZ, a seaport and holiday resort of central Portugal in the Coimbra district, province of Beira Litoral,

is situated at the mouth of the Mondego river. Pop. (1960) 59,023 (mun.). It is an important fishing station and a centre of the coasting trade in grain, fruit, wine, olive oil, cork and coal; because of the bar at the river mouth large ships cannot enter. The city attracts many visitors by its excellent climate and its beach is considered to be the best in Portugal.

Figueira is connected by railway with Coimbra and Lisbon, and with the coal mines of Cape Mondego. Salt, cement and glass are produced. It received the title and privileges of a city in 1882.
(C. C. E C.)

FIGUERES, JOSÉ (1908?–), Costa Rican statesman whose program is considered to have been one of moderate socialism, with emphasis on welfare legislation and state ownership, was born in San Ramón, Costa Rica, the son of a Spanish physician. He was educated locally but traveled widely. Through his own efforts he turned barren acreage near Cartago into a thriving coffee and sisal plantation with hundreds of workers. In 1942 he was exiled for his political beliefs, returning home after two years. When the administration invalidated the 1948 election of Pres. Otilio Ulate Blanco, Figueres led a successful rebellion, became provisional president, then stepped aside in favour of Ulate in 1949.

In July 1953 Figueres was elected president by a vast majority and served until 1958, when he returned to his ranching and political writing. He is widely known for his opposition to Latin-American dictatorships and has often been a friendly critic of United States foreign policy. (T. L. K.)

FIGUEROA, FRANCISCO DE (1536–1617?), one of the earliest Spanish poets to use blank verse successfully, was born at Alcalá, to which—after the Italian sojourn customary at that period, marriage in 1575 and a diplomatic mission in Flanders in 1579—he eventually retired. Although Figueroa composed some verse in Italian, his Petrarchanism is essentially that of a belated disciple of Garcilaso de la Vega (*q.v.*), and alternates with a Horatian vein approximating him to Luis de León and the Salamancans.

The majority of his extant poems (which he had unavailingly ordered burned at his death) were posthumously edited by Luis Tribaldos de Toledo at Lisbon in 1626 (facsimile ed., 1903); others, discovered later, are included in the edition of his *Poesías* by A. González Palencia (1943). (F. S. R.)

FIGULUS, PUBLIUS NIGIDIUS (not later than 98–45 B.C.), Roman savant and writer, next to Varro the most learned Roman of the age. He was a friend of Cicero, to whom he gave his support at the time of the Catilinarian conspiracy (*see* CATILINE). He was praetor in 58, sided with Pompey in the Civil War, was afterward banished and died in exile. He sought to revive Pythagorean doctrines and combine them with Etruscan and oriental beliefs, notably a belief in astrology, and apparently gathered some adherents. Suetonius and Apuleius tell of Figulus' supernatural powers. Jerome calls him *Pythagoricus et magus.* The indifference of the Romans to such abstruse and mystical subjects caused his works to be soon forgotten. They included *De dis* ("Concerning the Gods"), in at least 19 books, the earliest comprehensive work on Roman religion, but soon superseded by Varro's *Res divinae; Commentarii grammatici,* in at least 29 books, a loose collection of notes concerned, among other matters, with synonyms, inflection, orthography, word formation, syntax and etymology; *De extis* ("Concerning Sacrificial Meats"); *Auguriurn privatum; De ventis* ("Concerning Winds"), in at least four books; *De animalibus,* in at least four books, used by Pliny the Elder; *De hominum natura,* in at least four books; *Sphaera graecanica et sphaera barbarica;* and a rhetorical treatise *De gestu* ("Concerning Gesture").

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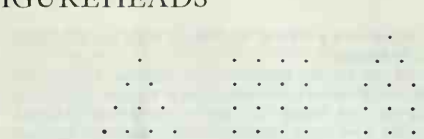
FIGURATE NUMBERS. The early Greek mathematicians found that if groups of dots were used to represent numbers, they could be arranged so as to form geometric figures, examples of which are as follows:



Of these, the first represents a triangular number; since there are 10 dots, 10 is a triangular number. It is also seen from the upper portions of the configuration that 3 and 6 are triangular numbers. The second figure is a square, and from it one sees that 4, 9 and 16 are square numbers. From the third it is seen that 12 is a pentagonal number; for if the perimeter is traced a five-sided figure results. The triangular numbers may be represented by $\frac{1}{2}n\ (n+1)$, where n is any positive integer. The square numbers are represented algebraically by n^2, and the pentagonal numbers by $n^2 + \frac{1}{2}n\ (n-1)$. The Greeks also considered oblong (heteromecic) numbers, the sides (or factors) of which differ by unity. Thus, 3×4, 4×5, . . . are oblong numbers. There were also prolate (promecic) numbers, the factors differing by two or more, as in the case of 2×5; but these were often included under oblong numbers. Besides various other types of plane numbers there are solid numbers. For example, 8 is a cubic number, and 5 is a pyramidal one. Numbers which are related to geometric figures in such ways are called figurate numbers or figured numbers. Plane figurate numbers are also called polygonal numbers, the solid figurate numbers being designated as polyhedral. The theory probably goes back to Pythagoras (*c.* 530 B.C.). Such numbers were studied and described by Nicomachus (*c.* A.D. 100), Theon of Smyrna (*c.* 125), Boëthius (*c.* 480–524) and many later writers.

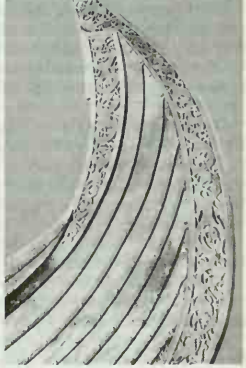
See NUMBERS, THEORY OF.

See Sir Thos. L. Heath, *History of Greek Mathematics,* vol. i, p. 76 (1921); D. E. Smith, *History of Mathematics,* vol. ii, p. 24 (1923–25).

FIGURED BASS: *see* THOROUGH BASS.

FIGUREHEADS, SHIPS', ornamental symbols or figures formerly placed on some prominent part of a ship, usually at the bow. A figurehead could be a religious symbol, an emblem indicating nationality, or a figure to symbolize the ship's name. Figureheads have been discontinued on most ships since World War I.

The custom of decorating a vessel apparently began in ancient Egypt or India, where an eye was painted on either side of the prow. The Chinese followed this custom with their river junks. The ancients are supposed to have believed that the eyes or *oculi* could help a vessel find its way safely over the water. The first prominent navigators and traders of the western world, the Phoenicians, probably spread this custom throughout the Mediterranean and handed it down to the Greeks and Romans.



BY COURTESY OF UNIVERSITETETS OLDSAKSAMLING, OSLO, NOR.

THE COILED-SNAKE FIGUREHEAD FROM THE OSEBERG SHIP, *c.* 800 A.D.

As early as 1000 B.C. the stem and sternpost were carved and painted to distinguish one ship from another, and at least one class of vessel used an identifying symbol: a falcon or a falcon's eye generally appeared on the bows of funeral barges of the Nile. Although the *oculi* were the most popular symbols used by early sailors, some figureheads were fashioned for the purpose of terrorizing less civilized tribes. The Egyptians probably originated the practice of using religious symbols; other Mediterranean peoples extended this practice by using carvings and paintings of their principal deity to identify the vessel with its city-state. The Carthaginians,

for example, often used a carving of Ammon while the Athenians used a statue of Athena.

The ships of the ancient Egyptians, Phoenicians, Greeks and early Romans were constructed with heavy vertical timbers at the bow and stern to which the side planking was attached. These stem- and stern-posts protruded well above the hull and their prominent and semierect position and form created a focal point of interest and a shape obviously suited for decoration. When the ram type of prow was developed as a weapon of warfare, the stem lost its prominence and the ram was decorated instead. One Athenian vessel of about 500 B.C. had the entire ram carved in the shape of a boar's head. After the ram type of prow lowered the prominent bow features of the ship, greater emphasis was placed on decorating the stern. This trend was carried to an extreme by the Romans at the height of their naval power when their ships were distinguished by a very high sternpost carved to sweep up and around in graceful curves which terminated in the gilded head of a swan or other figures. Even in the Roman merchantman of about 200 A.D., when the bowsprit first was used, the chief emphasis in decorating the vessel continued to be at the stern; but the trend was changing, for some paintings reappeared on the bow.

Along the more blustery northwest coast of Europe, good seamen such as the Vikings, Danes and Normans continued to build their ships with high bows and a projecting stem. The figurehead of the Oseberg ship of about 800 A.D. was a coiled snake with head upreared. In 1004 A.D. a Danish ship bore a dragon's head at the bow, and obtained the effect of a huge sea serpent by having the graceful sweep of the bulwarks terminate aft in a high-coiled tail. The ships of William the Conqueror are represented in the Bayeux tapestry as similar to those of his Norse ancestors, but the decorative symbols (except for the lion's head on the stern) reflect the spread of the Christian church.

In the 13th and 14th centuries a boarding platform was attached forward and projected out over the stem. With this type of construction the figurehead practically disappeared. Gradually the boarding platform was moved back until it formed the forecastle and the beakhead of the 16th century was added to become the natural place for a figurehead. Gradually the beakhead was reduced in size and moved back under the bowsprit until just the figurehead remained. During this period the fashions in figureheads varied from the popular carvings of the saints, to national emblems such as the lion and the unicorn, then to the simple scroll and the billethead, and finally to the carving representing the person for whom the vessel was named.

BY COURTESY OF THE MARINERS MUSEUM

LION FIGUREHEAD FROM THE BRITISH CLIPPER SHIP, "DERWENT," BUILT IN 1884

It is interesting to note that figureheads were carved from oak or elm in England, while pine was used almost exclusively in America. The cost of a figurehead in the United States about 1816 ranged from $700 for a 74-gun vessel, $600 for a 44-gun craft, $200 for a sloop, to $46 for the "head" on the revenue cutter "Eagle." The "Sovereign of the Seas," a galleon built in 1637, was the most highly decorated vessel in the history of shipbuilding. Her carving and gilding cost about £7,000, while the cost of the ship was about £41,000. Figureheads varied in size from 18 in. for small heads and busts to 8 or 9 ft. for full-length figures.

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(M. H. I.)

FIGURES OF SPEECH is a broad term for a large variety of uses of words, phrases, clauses and sentences to achieve desired effects in meaning, sound and style. Traditionally it is defined as deviation in the use of words from the literal sense or from simple and common practice, and includes figures of rhetoric, syntax, etymology and orthography.

METAPHOR, SIMILE AND KINDRED FIGURES

Figures of Resemblance.—The most basic of all figures is the metaphor (Gr. *metaphora*, from *meta*, "over," and *pherein*, "to carry"), which states an analogy, similarity or relation between two things. The difference between metaphor and synonym is that the metaphor does not mean that the two things are the same, only that they are similar in their relations to something else. For example, calling the first observed robin the "herald of spring" means that the robin is to the beginning of spring weather as the herald (announcer) is to his prince. A like set of relations is conveyed by the metaphorical use of the verb in "the ship plows the sea." Thus in a metaphor one thing is said to be another only as a fiction or useful analogy. A literal description is not figurative, *i.e.*, symbolical. "Blue" or "green" ocean is literal, but "sky-blue ocean," which compares the colour of the ocean to the colour of the sky, is metaphorical.

As Aristotle pointed out in his *Rhetoric*, the difference between a simile and a metaphor is slight, the simile being only a metaphor with an explanation: "Thus when Homer says of Achilles that 'he rushed on, a very lion,' it is a metaphor, for here, as valour is an attribute to both, he transfers to Achilles the metaphorical appellation of 'a lion.'" In general, the metaphor is more compact, forceful and suggestive. The simile requires a phrase beginning with "like," "as," "as if," etc., which makes it not only more prolix than a metaphor but also labels the thought as make-believe. Nevertheless, the simile can be effective in prose or poetry. The extended comparison is often called the "epic simile" from Homer's frequent use of it in his poems, as in the *Iliad*, Book VIII, 555–560 (reprinted from *The Iliad of Homer*, translated by Richmond Lattimore by permission of The University of Chicago Press. Copyright 1951 by The University of Chicago).

> As when in the sky the stars about the moon's shining
> are seen in all their glory, when the air has fallen to stillness,
> and all the high places of the hills are clear, and the shoulders out-jutting,
> and the deep ravines, as endless bright air spills from the heavens
> and all the stars are seen, to make glad the heart of the shepherd;
> such in their numbers blazed the watchfires the Trojans were burning
> between the waters of Xanthos and the ships, before Ilion.

Here the comparison, beginning with literal description, conveys spaciousness, multiplicity and implies cosmic significance. The "epic simile," in fact, often takes on the exaggeration of hyperbole to magnify the miraculous strength and courage of mythical heroes. The pseudo epic, James Macpherson's *Ossian*, is full of examples. "As autumn's dark storms pour from the echoing hills, so towards each other approached the heroes. As two dark streams from high rocks meet and mix, and roar on the plain: loud, rough, and dark in battle meet Lochlin and Innisfail."

Figures of Relationship.—The synecdoche (Gr. *synekdochē*, from *synekdechesthai*, "to receive jointly") is a variety of metaphor whereby a part stands for the whole, such as a "sail" for a ship, or ten "head" of cattle for that number of animals, or "motor" for automobile. The part must be characteristic, important and conspicuous. A ship is not referred to as a "rudder," or an automobile as a "taillight."

Closely akin to synecdoche is the metaphor called metonymy (Gr. *metōnymia*, from *meta*, "change," and *onoma* or *onyma*, "name"), by which a name closely associated with an object is used instead of the usual name of the object, as "crown" or "sceptre" for king; "White House" for president (or presidential staff) of the United States, sometimes even personified: "The White House announces . . ." Other variations of metonymy are cause for effect, or vice versa, such as "gray hair" for old age, or "shade" for trees, the latter very common in 18th-century "poetic diction," which overused both synecdoche and metonymy. The Anglo-Saxon kenning also used a part for the whole; in

Beowulf the ocean is called "swan's-bath," "whale-road," etc.

A kindred metaphor is the antonomasia (L. *anti*, "instead of," and *onoma*, "name"), in which the surname of an individual becomes a generic term for persons of similar activity, condition or characteristic; or for a noun associated with the proper name. For the latter, note "Venus" for love, "Bacchus" for wine, "Mars" for war, etc. Recent history has contributed "quisling" for traitor, "McCarthy" and "McCarthyism" for demagogue and demagoguery. If the use of a name becomes so widespread that its origin is commonly forgotten, it is then a part of the language and is not usually regarded as a figure of speech. Examples are "macadam," small broken stones for paving a road, a process developed by John L. McAdam, and "mackintosh," a waterproof coat invented by Charles Macintosh.

Play Upon Words.—Etymology is one source for the pun (It. *puntiglio*, "fine point" or "verbal quibble"), a humorous play upon two or more meanings for one sound (homophone or homonym). Thoreau, no less than Shakespeare, was a master of such quibbles. Three roads leading to a village, he said, make it "trivial." In Shakespeare's time "raskall" was a lean deer out of hunting season; when applied to a person, therefore, the word was an abusive metaphor (called by the Greeks *catachresis*), but only the abusive connotation remains in "rascal" today. What is most often called a pun, however, is actually paronomasia (Gr. *para*, "beside," and *onoma*, "name"), a play on similar but not identical sounds. O. W. Holmes illustrates it in pretending to condemn the pun in *Autocrat of the Breakfast Table:* "Homocide and verbicide—that is, violent treatment of a word with fatal results to its legitimate meaning, which is its life—are alike forbidden. Manslaughter, which is the meaning of the one, is the same as man's laughter, which is the end of the other." Prosonomasia involves a nickname created by a play on the sound of the person's name. An opponent of Erasmus called him "Errans Mus" (wandering mouse). Hostility breeds such coinages as "Dr. Fraud" for Dr. Sigmund Freud, founder of psychoanalysis.

Enlarged Metaphors.—When the pun is used seriously, it may become a symbol, as when Thoreau finds "concord" (harmony, peace) in the discordant cries of the wild goose and the owl. A symbol begins in a metaphor but acquires additional and more pervasive meaning each time it is used. If the meaning accumulates through a whole literary composition, the symbols merge into allegory. Myth is also an extension of metaphor, dramatizing symbolical fictions on the origin and purpose of man and nature.

The parable is allegory on a limited scale, being a story with both a literal and a figurative meaning, such as Christ's parable of the mustard seed; as is the fable, which instructs by making animals act like men. From proverbs such as "wise as serpents" or "harmless as the dove" are derived symbols of wisdom, peace, etc. The legend makes a symbol of heroic action, and uses the lives of great men as paradigms (L. *paradigma*, "example").

The Decay of Metaphor and the Cliché.—As noted above the common noun "mackintosh" illustrates one process of language formation in the decay of metaphor, and the cliché illustrates another. The former has ceased to be a figure of speech; the latter is still figurative, but lacks the impact of newly coined or unfamiliar metaphors. When Emily Dickinson described the flight of a hummingbird as

> A route of evanescence
> With a revolving wheel . . .

she created metaphor, fresh, accurate and thrilling in sense appeal. But if many people began referring to the flight of a hummingbird as "route of evanescence" or "revolving wheel" the phrases would cease to astonish and become clichés. Though pedagogues frequently condemn the use of clichés, their brevity, simplicity and conciseness keep them alive. "Jack-of-all-trades" is simpler and more vivid than "One who can turn his hand to any (or to many kinds of) work." Phrases such as "eat like a horse," "dead as a doornail," "sly as a fox"—implied also in "foxy"—are idiomatic figures. When the cliché is objectionable it is not because it is familiar but because it is used inappropriately, such as "allergic to" for all situations of dislike or incompatibility. The mixed cliché, like mixed metaphors of all kinds, is inept because it is confused and contradictory, often unintentionally ludicrous, *e.g.*, "The hand that rocked the cradle has kicked the bucket," for a solemn subject, the death of a mother.

The cliché is an obvious example of a basic linguistic process. Max Müller said in *Science of Language* that "under the microscope of the etymologist almost every word discloses traces of its first metaphorical conception." Emerson expressed the same idea in "The Poet": "Language is fossil poetry." Owen Barfield summarizes this doctrine (with which he does not entirely agree) in *Poetic Diction* when he writes: "every modern language, with its thousands of abstract terms and its nuances of meaning and associations, is *apparently* nothing, from beginning to end, but an unconscionable tissue of dead, or petrified, metaphors." (London, Faber & Faber Ltd., 1952). These decayed and petrified metaphors are the fossils of mythology ("jovial" from Jove); folklore ("lunatic," moon-struck, *i.e.*, made insane by exposure to moonlight); social custom ("jubilee," from Hebrew *jobil*, "ram's horn," used as a trumpet to announce a celebration); and every field (another metaphor) of human activity. Tabus and the desire to avoid unpleasant subjects also give rise to euphemisms, like "go west" for dying, *i.e.*, follow the setting sun.

FIGURES FOR EMPHASIS

Figures of Degree of Emphasis.—One of the most vigorous of all figures for emphasis is hyperbole, mentioned above under metaphor, which magnifies things beyond their natural bounds or attributes miraculous powers and qualities to persons. Emily Dickinson, to convince her lover of the steadfastness of her devotion, asks rhetorically and answers hyperbolically:

> Alter? When the hills do.
> Falter? When the sun
> Question if his glory
> Be the perfect one.

Humour.—American humour especially often employs hyperbole. Mark Twain: "Noise proves nothing. Often a hen who has merely laid an egg cackles as if she [had] laid an asteroid."

Emphasis can be secured by the reverse of hyperbole: by litotes (Gr. *litotēs* from *litos*, "plain, simple"), or understatement. Litotes asserts by the use of a negative: "He is not an ordinary man," meaning he is really a remarkable man. The understatement emphasizes by diminishing. Usually to be fully appreciated it must be taken in context. When Henry James has one of his characters say, "This is my little point," he means that he thinks his point is very important indeed.

The psychological origin of understatement may be either false modesty or a deeper sense of irony. Irony (Gr. *eirōneia*, from *eirōn*, "dissembler in speech") is one of the most emphatic of all figures and the most subtle and insinuating. It states the opposite of the intended or true meaning in such a way that the truth is underscored. In dramatic irony the speaker is unaware of the true import of his words, as when silly Dogberry in *Much Ado About Nothing* says as a joke, "Write me down an ass!" But serious irony can be profoundly pathetic or even tragic, as when Oedipus sets out to find the guilty person and ends by bringing himself to justice, arising from a sense of human frailty (especially prominent in Greek tragedy), or in protest against overwhelming odds, stupidity, arrogance, etc. Mark Antony in his oration at Caesar's funeral casts doubt on Brutus's motives by repeating "But Brutus is an honourable man." To his pretended consolers Job replies, "No doubt ye are the people, and wisdom shall die with you." Irony resembles, and often makes use of, paradox, antithesis, understatement, anticlimax.

Other Rhetorical Figures.—Of other figures that promote or express emphasis, one of the most obvious is the exclamation, expressing sudden or strong feeling. The exclamation may be a single word ("oh!", "alas!"), a phrase ("For shame!"—which is also a figure of syntax, ellipsis; *see* below), a sentence or whole passage: "What a piece of work is a man! how noble in reason! how infinite in faculties! . . ."

Another common figure is the interrogation or rhetorical question, *i.e.*, a question asked only for effect, the answer being obvious. The Greek Sophists were fond of this figure, and it has always

been a favourite with orators, lawyers and special pleaders. The apostrophe is also much used by orators, though found often, too, in older poetry, especially heroic. Here the speaker interrupts his discourse to address directly the thing or subject discussed—if a thing, this likewise involves personification, as when Milton begins *Lycidas* by begging the indulgence of literary fame ("laurel") and invoking the symbol of elegy ("myrtle"):

> Yet once more, O ye laurel, and once more,
> Ye myrtles brown, with ivy never sere, . . .

Figures of Syntax.—Although most figures of speech are some variety or combination of metaphor, the term figure of speech is also applied to variations from normal usage in syntax, word form, and spelling. Of these the most important are figures of syntax, which include omissions, repetitions and unnecessary addition of words. Ellipsis is the omission of words, phrases or clauses, as in the command, "Go home!" (subject understood but not expressed). Ellipsis is used for pithiness and economy. In asyndeton connectives are omitted for the same reasons: Julius Caesar's "I came, I saw, I conquered." The opposite is polysyndeton, in which connectives are repeated, like the famous "and's" of the Bible. The usual effect is, again, to increase emphasis: "Day after day the wind blew, and the snow melted, and the ground appeared, and thawed, and clucked like a hen . . ." (Sylvia Townsend Warner, *Summer Will Show,* New York, Viking Press, Inc., 1936, p. 25). These repetitions likewise affect the rhythm of the sentence or passage, as do anaphora, repetition of the beginning word or phrase; and anadiplosis, repetition of the last word or phrase.

Faulty or needless repetition is called pleonasm, tautology or redundancy. Primitive folk ballads sometimes employ ungrammatical repetition for metrical purposes: "Mary, she said," for "Mary said." Wasteful use of words is called circumlocution, verbosity, prolixity, and is an error of syntax and style rather than true figures of speech.

OTHER FIGURES

Etymological Figures.—Etymological figures include aphaeresis, omission or elision of a syllable (" 'neath" for "beneath"; " 'twas" for "it was"); syncope, elision of middle letter ("ne'er" for "never"); apocope, dropping or elision of a final letter or sound ("mo' " for "more"; "mos' " for "most"); prothesis, prefixing of a syllable—sometimes reverting to a more archaic form of the word—for emphasis or rhythm ("arunning" for "running"; "beloved" for "loved"); paragoge, adding a syllable at the end of a word ("deary" for "dear"; illiterate "drunken" for "drunk"); diaeresis, the separation of a diphthong into two vowels—or resisting elision of two vowels—indicated by two dots over the second vowel (coöperate, Thaïs); synaeresis, the opposite of diaeresis (Harvard students call their "Coöp. Store" the "Coop," rhyming with "dupe"); tmesis, inserting a word between compounds ("which thing soever" for "whichsoever thing").

Orthographic Figures.—Figures of orthography include mimesis, which is deliberate misspelling for comic effect or mimicry of dialect, as when Josh Billings claimed that "Hamericans speak Hinglish"; metathesis, displacing of a letter or syllable ("Fastolph" for "Falstaff"); and archaism, the resurrection of a word or expression no longer in common usage ("fain" for "glad"; "forsooth" for "in truth"). But none of these are especially important in modern literature. The linguistic study of figures of speech has been largely superseded by psychological and aesthetic analysis of imagery, which includes any use of words for sense appeal.

LITERARY STUDY OF FIGURES OF SPEECH

The Literature of Figures of Speech.—The Greeks and Romans of classical antiquity and both medieval and Renaissance scholars of Europe elaborately classified, defined and rationalized the use of figures of speech. Such a list is found in Quintilian's *Institutio oratoria* in the 1st century A.D. In the 16th century George Puttenham translated the classical names into English. Aristotle's observations in his *Rhetoric* (4th century B.C.) on the use of metaphors are still sound. To adorn, he says, borrow metaphors from things superior; to disparage, from things inferior. "It is proper to derive metaphors . . . from objects which are closely related to the thing itself but which are not immediately obvious." Metaphors should suggest things beautiful in sound, in association, or have a strong sense appeal. Note the epithet (another classical figure much used by Homer) in "rosy-fingered dawn." Observe the difference in literal "purple," "red" or even figurative "purple-fingered" or "red-fingered."

The unintentional degrading of a subject by using metaphors of low or repulsive associations has been definitively treated by Alexander Pope in "The Art of Sinking in Poetry." This can be illustrated by a passage in Shakespeare's *Henry V* when the King boasts (IV, iii):

> And those that leave their valiant bones in France,
> Dying like men, though buried in your dunghills,
> They shall be fam'd; for there the sun shall greet them,
> And draw their honours reeking up to heaven,
> Leaving their earthly parts to choke your clime,
> The smell whereof shall breed a plague in France.

Hugh Blair, an 18th-century Scottish rhetorician, calls this "a gross transgression . . . having mentioned a dunghill, [Shakespeare] presently raises a metaphor from the steam of it; and on a subject, too, that naturally led to much nobler ideas."

The Function of Figures of Speech.—Figures of speech have often been regarded as mere decoration, or even as deceptive or insincere. Because in classical Greece they were cultivated and taught by the Sophists, Plato distrusted the trickery of professional rhetoricians, though he himself was a master of figurative language; and Aristotle, as has been seen, rationalized the use of metaphor. If intelligently employed, all the figures of speech promote clarity and vigour of thought and expression. Far from being useless decoration, figures may be an essential part of the thought—or *the* thought, as when Isaiah says "All flesh is grass." In the case of onomatopoeia, the word imitates the sound made by the subject, and all good figures are a kind of intellectual onomatopoeia. *See* also ALLITERATION; ONOMATOPOEIA.

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FIJI (Fijian VITI), a British colony in the southwest Pacific, consists of an archipelago surrounding the Koro sea, the centre of which lies in latitude 18° S. and on the meridian of 180°. Pop. (1956) 345,737. Area 7,055, sq.mi.

There are more than 300 islands, varying greatly in size. The larger islands are of volcanic origin, mountainous and surrounded by coral reefs; the smaller ones are mostly of the low coral reef type. Suva, the capital, is on the southeast coast of Viti Levu, or "great Fiji" (4,114 sq.mi.). This island is mountainous in the

interior, rising to the highest point in the colony at Mt. Tomaniivi (4,341 ft.). About 40 mi. N.E. is Vanua Levu, or "great land," the second largest island (2,393 sq.mi.), rising to 3,139 ft. in Ndikeva or Mt. Thurston; its chief town is Lambasa on the north coast. Taveuni (168 sq.mi.) lies near the southeast point of Vanua Levu; its highest point is Uluinggalau (4,072 ft.). Kandavu (158 sq.mi.), about 50 mi. S. of Viti Levu, is the landfall for ships and aircraft approaching Suva from the south. Ovalau (40 sq.mi.) off the east coast of Viti Levu, is rich in historical associations surrounding Levuka, the early capital of the colony. Ngau (54 sq.mi.) and Koro (40 sq.mi.) lie in the Koro sea. To the east and south of this sea the Lau group forms a curved chain of small islands of which the principal is Vanuambalavu (21 sq.mi.). The Yasawa group (52 sq.mi.) is a chain of about 16 islands north of Viti Levu. Makongai (5 sq.mi.), between Viti Levu and Koro, is known for the Fiji leprosy hospital, which serves a large area of the south Pacific. About 400 mi. N. of Suva is the isolated dependency of Rotuma (18 sq.mi.).

Climate.—The climate, for the tropics, is temperate, the thermometer seldom falling below 60° F. or rising above 90°. The prevailing winds are easterly. At Suva, which has the climatic conditions of the windward coasts, the average annual rainfall is 120 in. distributed throughout the year. On the leeward coasts annual averages are 70–90 in., but most of this falls in the hot season (Dec. to March) when there are northerly winds. At least some part of the colony is affected by a hurricane almost every year.

Vegetation and Animal Life.—Nearly half the total area is forested, the larger and loftier islands being clothed in dense forest on the windward side, while the leeward slopes are grassland dotted with pandanus (screw pine) and ferns. Mangroves fringe the coasts in many places and coconut palms are abundant on the lower ground. Sandalwood and the Fijian kauri pine (*Agathis vitiensis*) are now scarce among the forest trees, which include acacias, *Afzeliae, Calophyllum inophyllum*, the breadfruit tree, the Tahitian chestnut *Inocarpus edulis* and the paper mulberry *Broussonetia papyrifera*, whose bark was formerly much used for making cloth (*masi*). Plantains are widespread and the island of Rotuma is noted for its small delicious bananas. Mammals include bats, dogs and pigs introduced in early times and rats. Bird life is not remarkable, pigeons and parrots being among the species best represented.

People.—The Fijians are of mixed Melanesian and Polynesian stock. Polynesian influence is most noticeable in the eastern islands where contact with Tongans and to a lesser extent with Samoans is evident in a lighter skin colour and straight rather than frizzy hair. The highlanders of Viti Levu look like other Melanesians; they maintain that they are the aboriginal people of Fiji, in contrast with the large majority of Fijians, who trace their origin to an arrival by sea from the west. Fijian dialects belong to the Malayo-Polynesian group of languages, but the dialect of Mbau (a small island off the east coast of Viti Levu) is understood, spoken and written throughout the archipelago except in Rotuma.

Most Fijians live a communal life in villages on land they themselves own. With the gradual spread of industrial activities in the first half of the 20th century, many Fijians took up work in one of the several centres of population, where their traditional way of life was appreciably affected. Their houses in the villages are built with a timber framework and thatched walls and roof, but increasing use is made of corrugated iron for roofs even in the remotest villages and many Fijians build houses of timber and corrugated iron on a European plan. The family house is usually about 25 or 30 ft. long by 18 or 25 ft. wide. Kitchens are built separately nearby. By the 1960s Fijians no longer built tall, steep-roofed houses nor huge double-hulled sailing canoes and the making of pottery from clay and sand had been abandoned. Mats are plaited from the leaves of a screw pine cultivated for the purpose and are used mostly for floor covering or as bedding. Clothing is entirely of imported cloths, though an air of distinction is gained by the wearing of the *sulu* or kilt, which for men is often tailored; elaborate ceremonial dress is worn only on special occasions. Both

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FIJIANS PREPARING THE KAVA DRINK, A TRADITIONAL BEVERAGE SERVED AT CEREMONIES COMMEMORATING A SPECIAL OCCASION SUCH AS MARRIAGE, BIRTH OR DEATH

sexes commonly oil their skins with scented coconut oil.

Certain ceremonies embodying a modicum of traditional ritual are still carried out in all parts of Fiji. Formal presentation of a sperm whale's tooth (*tambua*) may take place on occasions ranging from birth and death to the making of a request; the person accepting the tooth must be prepared to grant any favour asked. The root of the kava plant (*Piper methysticum*) may be presented with the *tambua* on important occasions, or may replace it for minor ones. Ceremonial presentation of large quantities of gifts or food between related social groups survived into the 1960s but less frequently than in past times.

An important aspect of Fijian social organization is the inseparable connection between the social unit to which a person belongs and the land that all the members of the unit, chiefs and people alike, own in common. This common ownership by related groups of peoples of their family lands and of their customary fishing rights over the shore reefs remains the basis of some Fijian economic activities, just as the principles of Fijian social organization have been used, with modifications, as the foundation for the system of native administration.

Religion.—The 1956 census recorded 138,147, mostly Fijians, as Methodists and 137,232 (all except 26 Indians) as Hindus. The total number of Christians was 178,161 (Roman Catholics 27,542; Anglicans 5,130). Indian Muslims totaled 16,932 and Sikhs 1,803.

History.—The Dutch navigator Abel Tasman discovered Vanua Levu, Taveuni and some smaller islands in the northeast of the archipelago in 1643; Capt. James Cook discovered Vatoa in the extreme south of the Lau group in 1774. Lieut. William Bligh in 1789 discovered and recorded (but did not land on) Viti Levu, Ngau, Koro and the Yasawa group when he passed through the archipelago in one of the ship's boats following the mutiny of the "Bounty." In 1791 Capt. Edward Edwards in the "Pandora," when searching for the mutineers, discovered Rotuma (named by him Grenville Island); Bligh on his return voyage in the following year discovered Kandavu and some of the Lau group. Vanuambalavu and others of the Lau Islands were discovered in 1797 by Capt. James Wilson of the British missionary ship "Duff." Minor discoveries were made in 1820 by F. G. von Bellingshausen and in 1827 by J. S. C. Dumont d'Urville in the Lau group. This group was named the Exploring Islands by the U.S. expedition that made the first thorough survey in 1840.

The sandalwood trade attracted United States ships and East Indiamen early in the 19th century. Firearms salvaged from

wrecks were used in native wars and were largely the monopoly of the chiefs of Mbau, who employed muskets against clubs and spears to obtain dominance. Traders and missionaries came to settle, the first missionaries (Wesleyans) arriving from Tonga in 1835, but the continuing native wars reached a climax in the 1850s when Cakobau, the most influential chief, was driven back to Mbau. In 1854 he became a Christian and the champion of the missionaries. The issue became one between the old ways and the new; it was decided in 1855 when the king of Tonga with 2,000 warriors came to the aid of Cakobau and was completely successful. Cakobau then became paramount chief of western Fiji and in 1857 a British consul was appointed at Levuka. Shortly afterward the U.S. government demanded of Cakobau the payment of an indemnity fixed three years previously for alleged injuries to the American consul. Cakobau, additionally embarrassed by the machinations of the Tongans who already controlled the Lau group, sought relief by offering to cede his territories to Great Britain, promising a large grant of land if the U.S. claims were paid. The offer was rejected and in 1863 the British consul was withdrawn. After the near ruin of the islands by a government of settlers who set themselves up to administer under Cakobau, a deed of unconditional cession was completed on Oct. 10, 1874, and Fiji was proclaimed a British crown colony. In the following year a measles epidemic carried off about one-third of the population. The governor of Fiji was created high commissioner of the western Pacific to assist in checking abuses in the treatment of island labourers who had already been recruited for Fijian cotton plantations in the 1860s; the two offices remained unified until 1952. Rotuma was annexed in 1881.

In the 1880s the large-scale cultivation of sugar cane by modern methods using labourers imported from India brought the return of prosperity. A plan for federation with New Zealand was rejected in 1900 and in the first half of the 20th century the production of sugar increased rapidly.

Population.—The population at the census of 1956 was 345,737, comprising 169,403 Indians, 148,134 Fijians, 7,810 part-Europeans, 6,402 Europeans, 5,320 other Pacific races, 4,422 Rotumans, 4,155 Chinese and 91 others. All sections were increasing rapidly. In 1874 the population, composed almost entirely of Fijians, numbered about 200,000. Epidemics reduced the number of Fijians, the low point, 83,000, coming in 1919; thereafter steady increases were recorded. By 1911 there were 40,000 Indians; by 1945 the Indians outnumbered the Fijian population and by 1956 they exceeded it by nearly 15%. Indentured Indian immigration was stopped in 1916; the main reasons for the more rapid increase in the Indian population are the higher fertility rate, the lower mortality and the fact that Indian women at an earlier age bear children. The steady increase of the Fijian population, however, showed that the race was recovering from the impact of an alien civilization and was readjusting itself to new conditions. The industrious Indians gradually improved their economic status; from poorly paid indentured labourers they mostly became leaseholders. There is practically no intermarriage between them and the Fijians.

The chief towns are Suva, Lautoka on the northwest coast of Viti Levu and in the north of the same island the gold-mining centre of Vatukoula.

Government and Land Tenure.—The governor presides over an executive council that consists of the colonial secretary, the attorney general and the financial secretary as ex officio members and five appointed members. There is also a legislative council presided over by the governor or by a speaker when the governor is not present. The legislative council consists of 16 official members and 15 unofficial members, the latter group being composed of 5 Europeans, 5 Indians and 5 Fijians. Both European and Indian representation consists of three elected and two nominated members; the Fijian members are elected by the council of chiefs.

There is also a separate Fijian administration which constitutes a local government system with jurisdiction over all Fijians in the colony. The 1960 report of the official economic commission recommended the gradual dissolution of the Fijian administration as tending to isolate Fijians and to discourage economic enterprise among them. Since cession of the islands to Great Britain the administration has permitted almost no alienation of Fijian land and in 1960, 84% of the land was still held by Fijians. Nevertheless, pre-cession land sales removed much of the best land from Fijian control and leases (mainly to Indians) account for a further 120,000 ac., leaving some Fijian communities extremely short of fertile land. A plan to proclaim Fijian reserves and to redistribute land was being carried out in the early 1960s.

The colony is divided into provinces which are grouped for purposes of administration into four divisions (*see* Table). In Rotuma the government district officer is the chief executive authority.

Administrative Divisions and Provinces

Division	Province	Area (sq.mi.)	Population (1956 census)
Central	Rewa*	105.06	47,758
	Tailevu	368.91	27,528
	Naitasiri	643.39	27,347
	Namosi	219.95	2,361
	Serua	320.61	6,513
	Kandavu	184.55	7,450
Western	Mba	1,016.86	94,004
	Nandronga-Navosa	920.79	27,443
	Ra	517.75	16,698
Northern	Mathuata	773.62	29,808
	Thakaundrove	1,087.19	23,339
	Mbua	552.41	7,622
Eastern	Lau	188.21	13,500
	Lomaiviti	158.57	11,244
	Rotuma	17.58	3,122

*Including Suva.

Welfare and Education.—Medical services are for the most part provided by the government. Health is generally good; tuberculosis is the most serious disease and malaria does not occur. There is a government housing scheme for workers in Suva. No provision is made for unemployment relief, social insurance or pensions, but indoor and outdoor relief is provided for the infirm, aged and destitute.

By the early 1960s there were more than 500 primary schools with about 75,000 pupils and about 30 postprimary and secondary schools with more than 5,000 pupils. The enrollment of girls was not far short of that of boys. Apart from the government and a number of missions, village school committees, Indian organizations and two commercial concerns also maintain schools. In general the government trains and supplies most teachers and administers the educational system; voluntary bodies provide buildings for nongovernment schools. There are three technical training centres and at Suva the Central Medical school (1888) provides courses in medicine and dentistry. Some students are maintained in higher educational institutions in New Zealand, Australia and India. The Fiji museum at Suva contains fine historical and ethnological collections.

Agriculture.—The economy of Fiji is primarily dependent on agriculture. Of the land under cultivation, estimated at 379,000 ac., about one-third is devoted to sugar cane which provides more than half of Fiji's export income. Indians, most of whom are tenant farmers, cultivate about 160,000 ac., on 120,000 of which is grown 95% of the sugar cane; Fijians grow a small but increasing proportion. Coconuts occupy about the same area as sugar cane and provide about 15% of the colony's income; production is shared about equally between European-owned plantations and Fijian planters. Bananas, which are grown almost exclusively by Fijians for sale in New Zealand, are the only other export crop of significance but the crop fluctuates widely from year to year. Fijians grow most of their own staple food requirements: ndalo (taro), yams and cassava. Rice and pulse (about 30,000 ac.) are cultivated by Indians but considerable quantities are imported.

Mining and Industry.—Gold mining is of importance at Vatukoula, but production in the 1950s declined as the richer lodes were worked out. Production of fine gold dropped from 103,394 oz. in 1950 to about 70,000 oz. by 1960. The most important industry is the milling of sugar. Other enterprises include an oil fuel installation at Vunda point on the west coast of Viti Levu, the processing of copra, cigarette factories and a brewery. Ex-

pansion of industry is limited by lack of a cheap source of power. In 1960 the report of a commission of inquiry into economic development proposed schemes estimated to cost about £F14,000,000 over a ten-year period, accompanied by administrative and social reforms intended to facilitate the exploitation of resources.

Trade.—Of total imports valued at about £F17,000,000 annually in the early 1960s, one-quarter came from the United Kingdom and one-half from other commonwealth countries. The main imports are foodstuffs, textiles, machinery, petroleum fuels, vehicles and tobacco. Sugar constitutes about one-half of the total exports by value and coconut products about one-seventh, gold being the next most valuable export. Annual exports by the 1960s totaled about £F15,000,000 in value.

Finance.—Fijian currency is linked to that of the United Kingdom. About 70% of the total revenue of £F6,775,403 is obtained from customs and excise duties, licences, income tax and other direct taxation. The main items of expenditure are public works, education and medical services. The Fijian Development fund, established in 1951, collects up to £F10 per ton from the sale of copra produced by Fijians. The money accumulated is expended on schemes for their benefit.

Communications.—There are about 800 mi. of all-weather roads, also 360 mi. of narrow-gauge railway operated by the sugar refining company on part of which free passenger services are run twice weekly. The main ports are Suva and Lautoka but overseas shipping also calls at Levuka, Savusavu and Rotuma to load copra. Motor vessels and numerous small craft maintain inter-island passenger and cargo services. The Rewa river is navigable by small vessels for about 70 mi. from its mouth near Suva. Nandi (or Nadi), 135 mi. W.N.W. of Suva by road, is an international airport used by transpacific airlines. A local airline maintains connections between Suva and Nandi, Lambasa, Taveuni, Savusavu and Levuka.

See also PACIFIC ISLANDS.

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FIKRET, TEVFIK (1867–1915), Turkish poet, who, continuing the work of Abdulhak Hamid (*q.v.*), succeeded in freeing Turkish poetry from the rules of Persian literary composition and established the forms and themes of western poetry. Born in Istanbul of a central Anatolian family, the son of a government official, he was educated at the Galatasaray *lycée* where he later became principal. Tradition bound in his early years, he soon came under the influence of French literature and in 1896 became the editor of the avant-garde periodical *Servetifünum* that gave its name to the literary school of the 1890s. Early sentimental poems about the humble and poor and simple descriptive pieces gave place to a series of powerful poems included in the *Rübabi Shikeste* and the *Haluk' un Defteri* in which the poet gave expression to his hatred of tyranny and fanaticism, his love of liberty and his faith in mankind's advancement. (F. I.)

FILALI (HASSANI, ALAWID OR ALAOUITE), the name of the ruling dynasty in Morocco. Of sherifian descent, the Filali came originally from the Tafilelt, an oasis of Saharan Morocco. The first king of the dynasty, Maulay Rashid, captured Fès in 1666. *See* MOROCCO: *History*.

FILANGIERI, CARLO (1784–1867), PRINCIPE DI SATRIANO, Neapolitan soldier and statesman, was the son of the jurist Gaetano Filangieri. At the age of 15 he decided on a military career and, having obtained an introduction to Napoleon Bonaparte, then first consul, was admitted to the military academy at Paris. Commissioned in an infantry regiment in 1803, he took part in the campaign of 1805 under L. N. Davout, first in the Low Countries and later at Ulm, Mariazell and Austerlitz. He returned to Naples as captain on André Masséna's staff to fight the Bourbons and the Austrians in 1806 and subsequently went to Spain, where he followed Joseph Bonaparte in his retreat from Madrid. Because of a fatal duel in 1810, he was sent back to Naples; there he served as general under Joachim Murat and fought against the Anglo-Sicilian forces in Calabria and at Messina. On the fall of Napoleon he took part in Murat's campaign against Austria and was severely wounded at the battle of the Panaro (1815). Under Ferdinand I of the Two Sicilies he retained his rank and command, but found the army utterly disorganized and rife with Carbonarism. In the disturbances of 1820 he adhered to the Constitutionalist party and fought under Gen. G. Pepe against the Austrians. On the re-establishment of autocracy he was dismissed from the service and retired to Calabria, where in 1819 he had inherited the princely title and estates of Satriano.

In 1831 Filangieri was recalled by Ferdinand II and entrusted with various military reforms. On the outbreak of the troubles of 1848 he advised the king to grant the constitution. When the Sicilians formally seceded from the kingdom he was given the command of an armed force to reduce the island to obedience. In September he began the bombardment of Messina, which he captured (Sept. 7) after very severe fighting. Advancing southward, he besieged and took Catania, where his troops committed many atrocities; by May 1849 he had conquered the whole island, though not without much bloodshed. He remained as governor until 1855, but then retired into private life because his plans for reform were frustrated.

When Francis II succeeded Ferdinand in 1859, Filangieri was appointed premier and minister of war. He promoted good relations with France, then fighting on Piedmont's side against the Austrians in Lombardy, and tried to persuade Francis to ally himself with Piedmont and to grant a constitution, in the hope of saving the dynasty. These proposals being rejected, Filangieri resigned. In June 1860 Francis at last promised a constitution, but it was too late, for Garibaldi was in Sicily and Naples was seething with rebellion. On the advice of Liborio Romano, the new prefect of police, Filangieri was ordered to leave Naples. He went to Marseilles with his wife and subsequently to Florence, where at the instance of Gen. A. Ferrero La Marmora he undertook to write an account of the Italian army. Though he adhered to the new Italian government he refused to accept any dignity at its hands, and died at his villa of San Giorgio a Cremano, near Naples, on Nov. 2, 1867. *See* also NAPLES, KINGDOM OF.

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FILANGIERI, GAETANO (1752–1788), Italian lawyer, author of an influential work on legislation in which he advocated economic, legal and religious reforms, was born at Naples on Aug. 18, 1752. His father planned a military career for him, but he soon abandoned it for the study of law. At the bar his knowledge and eloquence early secured his success, while his defense of a royal decree reforming abuses in the administration of justice gained him the favour of the king, Charles, afterward Charles III of Spain, and led to several honourable appointments at court.

The first two books of his great work, *La Scienza della legislazione*, appeared in 1780. The first book contained an exposition of the rules on which legislation in general ought to proceed, while the second was devoted to economic questions. These two books showed him to be an ardent reformer and vehement in denouncing the abuses of his time. He insisted on unlimited free trade and the abolition of the medieval institutions which impeded production and national well-being. Their success was great and immediate not only in Italy but throughout Europe at large. In 1783 he married, resigned his appointments at court and, retiring to Cava, devoted himself steadily to the completion of his work. In the same year appeared the third book, devoted entirely to the principles of criminal jurisprudence. The suggestion which he made in it as to the need for reform in the Roman Catholic Church brought upon him the censure of the ecclesiastical authorities, and it was condemned by the Congregation of the Index in 1784. In 1785 he published three additional volumes, making the fourth

book of the projected work and dealing with education and morals.

In 1787 he was appointed a member of the supreme treasury council by Ferdinand IV but his health, impaired by close study and overwork in his new office, compelled his withdrawal to the country at Vico Equense. He died on July 21, 1788, having just completed the first part of the fifth book of his *Scienza*. He left an outline of the remainder of the work which was to have been completed in six books.

The best edition of the *Scienza* is that by Villari, 3 vol. (1864–76); the book was translated into most of the European languages, Eng. trans. by R. Clayton, *The Science of Legislation* (1806).

FILARETE (Antonio di Pietro Averlino or Averulino) (*c.* 1400–1469), Italian sculptor and architect, who from 1433 until 1445 was employed in Rome on the bronze door of St. Peter's, is thought to have been born in Florence and trained under Lorenzo Ghiberti. In 1448 he fled from Rome back to Florence, entering in 1451 the service of Francesco Sforza, duke of Milan. In Milan he was active principally as an architect, and designed the Ospedale Maggiore (1457–65), the first Renaissance building in Lombardy. Between 1460 and 1464 Filarete wrote his *Trattato d'architettura*. Inspired by Leone Battista Alberti's *De re aedificatoria*, this describes a model city called Sforzinda, and was dedicated to Piero de' Medici, for whom Filarete made a bronze reduction of the equestrian statue of Marcus Aurelius, now in the Albertinum, Dresden (1465). According to Giorgio Vasari, he returned in 1465 to Rome, where he died.

The two wings of the famous door at St. Peter's are divided into unequal rectangular areas, with figures of God the Father and the Virgin Mary, St. Peter and St. Paul, and representations of the martyrdoms of these saints. Between them are historical scenes, and in the foliated borders are figures from classical mythology. By comparison with the bronze doors of Ghiberti and Donatello in Florence, Filarete's door is ill-planned and crudely executed, and its importance derives from its hieratic classicizing style. The first Renaissance monument of a specifically Roman type, it influenced the work of Isaia da Pisa and later Roman sculptors.

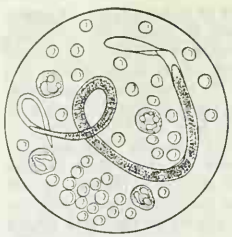
(J. W. P.-H.)

FILARIASIS, a diseased condition due to infestation of the body by slender, threadlike roundworms called filariae or filarias (*see* Roundworm). Filariae are parasitic in blood, tissues and body cavities of a great variety of animals, including man.

The principal human filariae are *Wuchereria bancrofti, W. malayi, Onchocerca volvulus* and *Loa loa*. The resulting infections are Bancroftian filariasis, Malayan filariasis, onchocerciasis and loaiasis, respectively. Filarial worms of lesser medical importance include *Acanthocheilonema perstans, A. streptocerca* and *Mansonella ozzardi*.

Many characteristics are shared by the four principal human filariae. Adult female worms living in body tissues give birth to large numbers of microscopic, motile embryos called microfilariae, which appear either constantly or periodically in blood or lymph vessels of the skin of an infected person. Unless ingested by suitable insect hosts (mosquitoes for *W. bancrofti* and *W. malayi*, black flies for *O. volvulus* and deer flies for *L. loa*), microfilariae cannot develop further and are destroyed by the human body. However, once in their particular insect host, microfilariae migrate quickly from the digestive tract to selected tissues where, after about two weeks, they complete a series of growth stages. Then, as infective larvae, they move to the mouth parts of the insect to await transfer to a new human host. As the insect takes another blood meal, the larval worms escape onto or into the person's skin and penetrate to subcutaneous tissues or lymph vessels. Little is known of the development of larvae in man, except that the worms mature in about a year.

Bancroftian Filariasis.—Adult *W. bancrofti* live in lymphatic vessels and lymphoid tissues, especially in the pelvic region. Microfilariae usually show nocturnal periodicity, swarming into cutaneous blood vessels at night and migrating to internal organs, especially the lungs, during the day. In inhabitants of certain South Pacific islands, however, microfilariae are present continuously in peripheral blood. Some authorities regard this nonperiodic form as a separate species, *W. pacifica*.



BY COURTESY OF DR. E. C. FAUST

SHEATHED EMBRYO (MICROFILARIA) OF WUCHERERIA BANCROFTI, THE CAUSATIVE ORGANISM OF BANCROFT'S FILARIASIS. AS SEEN IN THE BLOOD OF A PATIENT AT MIDNIGHT. ORIGINAL X 300

Bancroftian filariasis is widely but unevenly distributed in the tropics. It occurs along the coasts and watercourses of tropical Africa and of Asia from Arabia to China, along the northeastern coasts of Australia and South America, and on many tropical islands in the Pacific and Indian oceans and the Caribbean sea. The principal mosquito vectors are *Culex fatigans, C. pipiens* and *Aedes polynesiensis*. Several species of *Anopheles* are of local importance.

Many infected persons have no symptoms of disease. When symptoms do occur, they may appear as early as 3½ months after infection. Lymphangitis (inflammation of lymph vessels) and lymphadenitis (swelling of lymph nodes) near the worms are early symptoms. Acute attacks last a week or less, then subside, only to recur at irregular intervals of time. Between attacks the affected lymphatics remain swollen but not painful. These reactions probably result from sensitization of tissues to filariae. Severity of symptoms is intensified by secondary bacterial infections.

After repeated attacks, chronic disease causes blockage of lymph channels. The arms, legs, scrotum or breast may become permanently swollen, a condition known as elephantiasis. Deeper lymphatic channels of the body may rupture into the bladder, body cavity or tunica vaginalis (an internal covering of the testes).

Effects of medicinal treatment on filariasis are not consistent. Diethylcarbamazine, arsenicals and antimonial compounds are valuable in eliminating microfilariae and perhaps adult worms, but their effectiveness against filarial disease is unproved. Surgical treatment offers relief from chronic forms of the disease (elephantiasis, etc.), but these conditions tend to relapse.

Prevention of Bancroftian filariasis consists of antimosquito measures, protection from mosquito bite and use of antifilarial drugs (especially diethylcarbamazine) to reduce microfilarial infections in the human population.

Malayan Filariasis.—Infections with *W. malayi* generally resemble those with *W. bancrofti*. However, both adult worms and microfilariae of the two species can be differentiated. Other distinctive characteristics of *W. malayi* are its distribution and its mosquito vectors. *W. malayi* is found in river valleys of southeastern Asia from India to southern Korea and on adjacent islands. Several species of *Mansonia* mosquitoes are the principal vectors. Control of Malayan filariasis was complicated by discovery of microfilariae that appear to be *W. malayi* in Malayan monkeys.

Onchocerciasis.—Adult *O. vulvulus* are found either free or in tumours in subcutaneous tissues. Related species of *Onchocerca* occur in other animals. Onchocerciasis is prevalent in equatorial Africa and in coffee-growing areas of Mexico, Guatemala and Venezuela. Several species of black flies transmit *O. volvulus* (*see* Black Fly).

Early in the infection adult filariae wander freely in subcutaneous tissues but eventually they are trapped by growth of fibrous tumours around them. Microfilariae are found in nodules and the skin. Few appear in peripheral blood. In Africa, nodules are most abundant on the trunk, thighs and arms, but in Central America they occur most commonly on the head and shoulders. The nodules vary in size and firmness and may provoke intense itching but are otherwise painless. Wandering microfilariae may enter the eyes through small lymphatic vessels, become trapped and eventually cause blindness. Impaired vision is found in about 30% of infected persons in Guatemala and up to 85% in the Congo region.

Surgical removal of tumours is recommended, since this eliminates the source of microfilariae. Suramin sodium and diethylcarbamazine rapidly destroy microfilariae but also may precipitate

severe allergic reactions. Application of DDT as an emulsion to rivers in Africa effectively controlled black fly populations. In Guatemala, however, these flies breed in tiny mountain streams that are difficult to locate and control. (*See* also BLINDNESS.)

Loaiasis.—Adult *Loa loa* live freely in subcutaneous tissues. Microfilariae, usually with diurnal periodicity, are found in peripheral blood. Loaiasis is found in equatorial rain forests of Africa and several species of *Chrysops* (deer flies) act as vectors. *Loa* produces a chronic disease characterized by itching, irritation and fugitive swellings. The last-mentioned signs, known as Calabar swellings, are temporary inflammatory reactions appearing suddenly and disappearing in about three days. They probably result from sensitivity to the parasite or its products. In their wanderings adult worms may pass through the anterior chamber of the eye, hence the name "eye worm." They do not materially affect vision.

Diethylcarbamazine destroys microfilariae and, in recently acquired infections, adult worms as well. Long-established infections are more resistant to chemotherapy. Adult worms can be removed surgically when they move close to the surface of the skin.

Prevention of loaiasis includes use of antifilarial drugs to reduce human sources of infection and vector control measures. In some areas control is seriously complicated by loaiasis in monkeys.

See also PARASITOLOGY.

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FILBERT, the name applied to plants and nuts of the genus *Corylus* (*see* HAZEL). This genus includes at least 11 known species of deciduous, catkin-bearing shrubs and trees, which together nearly encircle the land portion of the globe in the north temperate zone. The American filbert, *C. americana,* and the beaked filbert, *C. cornuta,* attain heights of 10 to 15 ft.; the California filbert, *C. californica,* sometimes grows to 30 ft. The other species are the Chinese filbert, *C. chinensis;* the European filbert, *C. avellana;* the giant filbert, *C. maxima;* the Himalaya filbert, *C. ferox;* the Japanese filbert, *C. sieboldiana;* the Siberian filbert, *C. heterophylla;* the Tibetan filbert, *C. tibetica;* and the Turkish filbert, *C. colurna.* Hybrids between several of the species have occurred naturally or under cultivation.

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AMERICAN FILBERT (CORYLUS AMERICANA)

The European and giant filberts, together with some of their natural hybrids, furnish the commercial varieties under cultivation in Europe, Turkey and the United States. The plants range from shrubs to trees 25 ft. in height. In various parts of Asia, varietal selections for local use have been made from the Himalaya and Siberian species. The Chinese and Turkish filberts are free growing species, the former reaching heights of 120 ft. and the latter of 60 ft. or more. As known in western Europe and the United States, the nuts of both are rather small, thick-shelled and of mild flavour. Nevertheless both are important food producers in their respective habitats. Ornamental shrubby filberts include the Japanese with its red catkin flowers, the Winkler American variety with its red fall colour and the well-known purple foliaged variety of giant filbert. One variety has contorted limbs.

Culturally, the European filbert requires a cool to cold, but not rigorous climate, a definite period of winter chilling, a deep, medium rich soil, freedom from dense shade, an abundance of one-year wood for fruiting and pollen from other varieties. Wherever it grows it is likely to be vulnerable to winter injury; the staminate flowers may be killed for part or all of their length, or the branches may be frozen back. Flower injury, which is more common in most varieties, may occur during midwinter or while the pollen is being shed. It is most frequent when the flowers are open, when daily minimum temperatures suddenly drop from above freezing to several degrees below and when there are accompanying strong winds. Actually the damage is more largely due to desiccation by wind than to low temperatures and it may be prevented to a great extent by windbreaks.

Filbert roots penetrate deeply into the soil; where hardpans are less than 10 ft. below the surface the trees do not perform well after the first few years. All species tolerate considerable shade, but when this becomes too great, fruiting falls off sharply. By English systems of pruning the trees are appreciably dwarfed, as they are hard-pruned in late winter after the pollinating period is over and again in summer by merely nipping off certain new shoots. In Oregon and Washington valleys pruning is mostly limited to opening up the branches to permit the sun to reach all of the fruiting spurs, and to controlling the suckers which, in most varieties, tend to spring up thickly about the base of the tree. Also in the United States, all new plantings include trees of pollinizer varieties at regular intervals throughout the orchard. The usual ratio of pollinizers to the principal varieties is 1 to 5 or 8.

The American and beaked filberts have been used as pistillate parents in crossing with choice varieties of the European filbert to breed hardy varieties for use in the northern states and British Columbia. Breeding filberts by making backcrosses on the chance-hybrid Rush variety was begun in 1919 by J. F. Jones of Lancaster, Pa. Later breeding by J. U. Gellatly, Westbank, B.C., utilized the beaked filbert from the Peace river valley. The U.S. department of agriculture and the New York Experiment station introduced some hybrid varieties after 1950.

In England and the U.S. many varieties are grown. In England, Kentish Cob, the favourite, bears a large, attractive appearing nut which is oblong, wide and thick, and of excellent eating quality. Of the United States varieties, the first and a second in popularity are Barcelona and Du Chilly. The former bears a nut of irregularly rounded form but of large size. The tree is a stronger grower and a more fruitful bearer than Du Chilly though the nut is not its equal in flavour. Du Chilly resembles Kentish Cob so closely as to appear identical with it. Royal is a giant-fruited variety of Oregon origin. Germany has produced hardy varieties. Turkey, Italy and Spain are leading producers; the U.S. is a relatively small producer, mostly in Oregon and Washington.

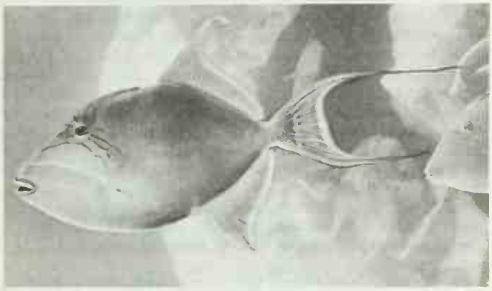
(J. C. McD.)

FILCHNER, WILHELM (1877–1957), German scientist and explorer who led the German antarctic expedition of 1911–12, was born at Munich on Sept. 13, 1877, and was educated at the Prussian military academy. A journey across the Pamirs in 1900 aroused his scientific curiosity and was followed by an expedition to Tibet in 1903–05. In 1911–12 he took a German expedition to Antarctica in the "Deutschland," having previously visited Spitsbergen (1910) to test equipment. In Antarctica Filchner discovered the southwestern continuation of Coats Land and made observations of ice drift in the Weddell sea. War frustrated plans for a second expedition. In 1926–28 he led a further expedition to Tibet, carrying out cartographic surveys and magnetic observations. In 1939–40 he made a magnetic survey of Nepal. The period of World War II he spent in India. He died in Zürich on May 7, 1957.

His published accounts of his travels include *Ein Ritt über den Pamir* (1903); *Das Rätsel des Matschu* (1907); *Zum sechsten Erdteil* (1922); *Om mani padme hum* (1929); *Bismillah* (1938); *Ein Forscherleben* (1950). (H. G. Kg.)

FILE. In modern usage this term denotes a steel tool used for abrading or smoothing, a device, *e.g.,* a folder, case or cabinet, in which papers are arranged in a systematic manner (*see* OFFICE MACHINES AND APPLIANCES); an orderly collection of papers; or a row of persons or objects arranged one behind the other. In military usage, a file is in contradistinction to a rank, the latter term denoting a row of soldiers aligned abreast.

FILEFISH AND TRIGGERFISH, names given to several closely related fishes of the family Balistidae, inhabiting all tropical and subtropical seas. The body is highly compressed side to side, and the scales are absent or modified into small scutes. The anterior dorsal spine, the largest, in triggerfishes, can be locked in an erect position by means of the smaller or rudimentary spine behind it. Many of the species are brilliantly and boldly marked with bright yellows, reds or blues. Some of the most attractive varieties have a bright background with fine lines of a contrasting colour over the body.



BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

QUEEN TRIGGERFISH (BALISTES VETULA)

The filefishes (*Monacanthus* and allied genera) have only the serrated anterior dorsal spine well developed, the following locking spine frequently being entirely embedded in the skin. The scales do not overlap and are often very minute. The triggerfishes (*Balistes* and allied genera) have three well-developed spines, of which the anterior spine is hollowed out behind, and receives the second spine when the former is raised and the latter depressed.

The small mouths of file- and triggerfishes bear few strong incisorlike pointed teeth, by which these fishes are able to break off pieces of corals on which they feed and to chisel holes into the shells of mollusks in order to extract the soft parts. Most of the species reach one foot in length, but a few attain considerably larger size. Although in many species toxins are occasionally present in the flesh and commonly in the viscera, these fishes are eaten in some parts of the world. The Hawaiian name "humuhumu-nukunuku-apua'a," known to many, is applied to two species of triggerfishes of the genus *Rhinecanthus*. (C. Hu.)

FILELFO, FRANCESCO (1398–1481), Italian humanist whose life and works illustrate the power acquired by men of letters in 15th-century Italy. He was born at Tolentino, July 25, 1398. In 1421 he went to Constantinople, returning to Italy in 1427, and from then until his death (July 31, 1481, at Florence) he moved from one city to another as a teacher of classical languages and literature. Exceptionally productive was the period spent in the service of the dukes of Milan, from about 1440 until 1471. His literary output, in Latin, Greek and Italian, was, like his culture, unusually extensive, including epic and lyric poetry, erudite classical works and treatises on philosophy. His most interesting achievement was his large collection of letters, an invaluable source of information on the period.

Filelfo's work is relatively unimportant as a contribution to philology or the history of poetry, but his life and writings together are of significance in the social history of his time since they show the influence letters had acquired. His services were eagerly sought by nearly all the Italian princes, who offered him the money and power for which he was ambitious in return for the subjection of his personality and principles. In Filelfo is epitomized the division of literature as a profession from moral considerations and personal feelings which was to constitute one of the main features of Italian history until the Risorgimento.

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FILIBUSTER, a name originally given to the buccaneers (*q.v.*). The term is probably derived from the Dutch *vry buiter*, "freebooter"; it was revived in the U.S. to designate those adventurers who, after the termination of the war between Mexico and the United States, organized expeditions within the United States to take part in West Indian and Central American revolutions. The modern use of the word in this sense denotes one who engages in private warfare against any state.

With the passage of time, the term has taken on another meaning applicable to legislative bodies and especially to the United States senate. It refers to the practice of using delaying tactics or engaging in prolonged discussion for the purpose of preventing a vote. It is consequently a device whereby a determined minority by delay and interminable debate seeks to prevent the majority from expressing its will in legislation. The intent is to wear out the majority so that from fatigue, or under the pressure of other business, it will give up and either lay aside the pending measure or alter it significantly to induce the minority to lay aside the filibuster. It is thus a stratagem to make the minority—rather than the majority—will prevail.

In the U.S. house of representatives a minor form of filibustering is sometimes carried through by frequent quorum calls. But the power of the rules committee to prescribe limits on debate normally assures the house of the ability to come to a vote. It is in the U.S. senate that the practice of filibustering has found its fullest development. Its effectiveness is greater near the end of a session when pressure to adjourn is great, the time is short and there tends to be a mass of other legislation to pass upon.

In most deliberative bodies attempts at filibustering can be prevented by the parliamentary action of moving the previous question. This motion, like those to adjourn and to lay on the table, is not debatable. If this motion carries, then the vote on the pending business must immediately take place. The United States senate had such a previous question rule from 1789 and 1806, and it was widely used in the British parliament in the 17th and 18th centuries. From 1789 to 1828 the presiding officer of the senate also had, in practice, the unappealable power to stop superfluous motions and tedious speeches, and evidence seems to indicate that this power was used by vice-presidents John Adams, Thomas Jefferson and Aaron Burr.

In 1825 John Randolph of Virginia was elected to the senate and proceeded to make irrelevant and tedious speeches which Vice-Pres. John C. Calhoun refused to rule out of order. In 1828, apparently in order to check such devices, the senate not only specifically provided that the presiding officer had such powers but also made his rulings appealable to the senate itself. Apparently the purpose was to strengthen rather than weaken senate discipline by adding the weight of the majority to questions of order. A rule of relevancy was also available to limit debate.

But in 1872, Vice-Pres. Schuyler Colfax ruled that "under the practice of the Senate the presiding officer could not restrain a Senator in remarks which the Senator considers pertinent to the pending issue." With this ruling, the heyday of the filibusters arrived.

During the so-called Progressive era, from 1907 to 1917, the filibuster was used a number of times on ideological grounds, notably by Sen. Robert M. La Follette, Sr. and others against the Aldrich-Vreeland Banking bill of 1908, the Canadian Reciprocity bill of 1911, the Ship Purchase bill of 1915 and finally Pres. Woodrow Wilson's Armed Merchant Ship bill of March 1917.

Rule XXII.—This last filibuster by the so-called "willful 11" during the closing days of the 64th congress, as relations with Germany reached a crisis, led to the adoption of cloture provisions in the opening days of the 65th congress. Under pressure from Sen. Thomas J. Walsh of Montana, rule xxii was amended so that a petition of 16 senators to close debate on "any pending measure" should, after two days' delay, be brought before the senate for a vote and could be passed by the affirmative votes of two-thirds of those present and voting. If this motion carried, then each senator was entitled to speak for not more than one hour on all motions, and dilatory motions or amendments were to be ruled out of order.

In the entire history of this version of rule xxii (1917–49), the closing of debate was successfully invoked on the treaty of Versailles in 1919, the World court in 1926 and on two other occasions. Though frequently tried, it was never affirmatively voted for the so-called civil rights bills of the 1930s and 1940s; *e.g.*, federal bills against lynching and use of the poll tax as a prerequisite to voting and bills for fair employment practices.

In 1949, a determined effort was made to modify rule xxii so that cloture would not be so difficult. But the move backfired when a coalition of the conservative southern wing of the Democratic party and the middle western and western wing of the Republican party, under the guise of broadening the rule to cover "motions or other matters" as well as "measures," made it more, rather than less, difficult to limit debate. This was done by requiring for passage of a cloture motion an affirmative vote of two-thirds of the members "duly chosen and sworn." A second change, although little noticed at the time, was even more important, namely, that there could be no limitation of debate on a motion to bring up a change in the rules. This new rule xxii, added to the historic underrepresentation of the populous states in the senate, was designed to give the senators of a small fraction of the people—from just 17 states—an unchangeable veto power over legislation.

Rules for the Senate.—A group of senators, however, believed that there was a crack in the filibuster defenses and that under the express constitutional provision that "each House may determine the Rules of its Proceedings" (art. i, sec. 5), it was possible for the senate, like the house, to change its rules at the beginning of a new congress without being inhibited by rule xxii itself. The opponents of this theory argued that the senate, as a "continuing body," carried over its rules from congress to congress and was, therefore, bound by rule xxii from the very beginning of a new congress.

A motion was therefore made by the proponents of a change at the beginning of the 83rd congress on Jan. 3, 1953, to proceed to the consideration of rules for the senate. After a brief debate, the Republican leader Sen. Robert A. Taft moved to table this motion, and this was done by a vote of 70 to 21. In Jan. 1957, this effort was renewed and again tabled. But this time there were 38 votes (and 3 others absent) against tabling the motion. During the discussion an opinion generally favourable to the motion was handed down by Vice-Pres. Richard M. Nixon.

Immediately following this vote, two main resolutions were presented for changing rule xxii. The majority and minority leaders, senators Lyndon Johnson and William Knowland, sponsored one which merely called for the re-establishment of the 1917 rule calling for cloture by a two-thirds vote of those present and voting, but also provided that senate rules should continue from one congress to the next and could only be changed in accordance with their own terms.

Sen. Paul H. Douglas of Illinois with 13 other senators presented an alternative resolution providing that after two days' notice on motion of 16 senators debate could be limited by two-thirds of those "present and voting," and after 15 days by an affirmative vote of a majority of those "duly chosen and sworn." The sponsors of this resolution pointed out that they wanted to provide for full and free debate, but that after a due period of discussion a majority was entitled to obtain a vote. These resolutions were not voted on in 1958 and similar ones were defeated in Jan. 1959. In the latter case, however, a resolution was adopted calling for the passage of a cloture petition upon an affirmative vote of two-thirds of the members present and voting. Another resolution allowed two-thirds of the senators present and voting to close debate on a motion to change the rules. Under the 1959 rule cloture was successfully invoked in Aug. 1962 to limit debate on the Communications Satellite act.

The longest filibuster in the history of the senate began on Feb. 29, 1960, and lasted for 125 hours and 31 minutes.

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FILICAIA, VINCENZO DA (1642–1707), Italian poet once highly esteemed for a wealth of sonorous verse on political and religious themes, was born at Florence, Dec. 30, 1642. He was educated by the Jesuits and studied law at Pisa university. He then returned to Florence where he devoted himself to literary studies. He secured the patronage of Christina of Sweden, entered the Arcadia (*see* ITALIAN LITERATURE), and was later appointed governor of Volterra (1696) and Pisa (1700) by Cosimo III, grand duke of Tuscany. Filicaia won fame with six spirited *canzoni* (1684) on the relief of Vienna from the Turkish siege by John Sobieski and the Poles. His sonnets lamenting the fate of Italy (*e.g.*, "Dovè, Italia, il tuo braccio?") were also admired until well into the 19th century; and for Lord Macaulay he was a major poet. Yet to modern taste—except for a few religious lyrics, such as the lines "Alla beata Vergine"—Filicaia's verses seem bombastic and pretentious. He died at Florence, Sept. 24, 1707. His *Poesie Toscane* was published in 1707 and *Poesie e lettere* in 1864.

(D. M. We.)

FILICINEAE, the botanical name for the ferns, a major group of vascular plants (phylum or division Tracheophyta). Some authorities consider the ferns a subclass (calling it Filicinidae) under the class Pteropsida; others give it class rank (Filicineae), promoting the Pteropsida to a subphylum. Ferns are characterized by the following features: large leaves, or fronds; spores rather than seeds; two free-living generations, the conspicuous and long-lived sporophyte (the popular "fern plant") and the barely noticeable and usually short-lived gametophyte. Under an older classification the ferns were grouped with the horsetails, club mosses and others as the Pteridophyta. *See* FERN; PLANTS AND PLANT SCIENCE: *Classification of Plants*.

FILIGREE, ornamental openwork made with twisted threads usually of gold or silver and widely used since antiquity for jewelry. The art consists in curling, twisting and plaiting fine, pliable threads of metal and uniting them at their points of contact with each other and with the groundwork by means of gold or silver solder and borax. The more delicate work is generally protected by a framework of heavier wire; brooches, crosses, earrings and other personal ornaments of modern filigree are generally surrounded and subdivided by bands of square or flat metal. For filigree in various countries in various periods *see* JEWELRY.

FILIPPI, FILIPPO DE (1869–1938), Italian scientist and explorer who led an important scientific expedition to the Karakoram range in central Asia, was born in Turin on April 6, 1869. He graduated in medicine at Turin university, and published a number of papers on physiological and biological chemistry. In 1897 De Filippi went to Alaska as scientific observer with the duke of the Abruzzi (*q.v.*) and climbed Mt. St. Elias. Although he did not accompany the expedition to the Ruwenzori in central Africa in 1906, he wrote the report. In 1909 he joined the duke's expedition to the western Himalaya and Karakoram mountains and in 1913–14 organized and led his own scientific expedition to the Karakoram under the auspices of the Indian government. De Filippi died at Florence on Sept. 23, 1938.

FILLAN (FAELAN), **SAINT,** the name of two saints of Irish origin; Fillan is the Scottish form of the name, Faelan the Irish. Very little is known about either of them.

A St. Faelan of Cluain Moescna (unidentified place name, somewhere in County Westmeath, Republic of Ireland) is entered in 8th-century calendars with a feast on Jan. 9. This was the date of several Fillan's fairs in medieval Scotland, showing the same patron. His crozier, still in existence (at the National museum, Edinburgh), was present at Bannockburn, with a relic of his arm, as one of the sacred battle ensigns of Scotland. His biography, as found in the medieval Breviary of Aberdeen, is unreliable.

The other St. Fillan, whose feast has been kept on June 20 from the 8th century onward, had churches dedicated to him at Kilwhelan (in the parish of Ballyroan, County Leix, Republic of Ireland) and in the district of Strathearn (in Perthshire, Scot.).

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FILLMORE, MILLARD (1800–1874), 13th president of the United States, came of a family of English stock which had early settled in New England. He was born on Jan. 7, 1800, in a log cabin built by his father and an uncle in a clearing made by them in the heart of the forest in the township of Locke, Cayuga county, in central New York. At 15 he was apprenticed to a wool carder and, except for intermittent brief attendances in a local one-room school, he had no formal education until he was 18 years of age. He then managed to secure six consecutive months of schooling and shortly after obtained his release as an indentured apprentice and started work in a law office. He was admitted to the bar in 1823 and, after a short time in Buffalo, practised law in and near the village of East Aurora until 1830 when he settled permanently in Buffalo.

Within 15 years he became one of the recognized political leaders of New York state; within 20 years he rose to the stature of a national figure and at the end of 30 years Fillmore became the president of the United States upon whom rested the burden of what proved to be one of the most fateful decisions in the history of the nation. In 1828 he was elected to the state assembly where he served three terms and secured the passage of a law abolishing imprisonment for debt. In 1833 he was elected to the U.S. congress as an anti-Jackson (antiadministration) man; he served 1837–43 as a Whig. During this period he had become one of the outstanding leaders of the northern wing of the Whig party and in his last term he was chairman of the all-powerful ways and means committee. In 1844 he was nominated as the Whig candidate for governor of New York. He was defeated by a narrow margin, but in 1847 was elected by a large plurality as the first comptroller of the state.

In 1848 the Whig national convention, which nominated Zachary Taylor for president, with the strong support of Henry Clay nominated Fillmore for vice-president. On the death of President Taylor (July 9, 1850) Fillmore became president.

Throughout the preceding decade agitation over the threatened extension of slavery into new territory had been steadily growing in intensity and reached its climax after the Mexican War when congress was confronted with the proposed admission of California to statehood. In his last speech, the dying Sen. John Calhoun sternly demanded recognition of the southern point of view favouring the extension of slavery into California and the southwest. His warning that the southern states might not remain in the union if these demands were denied, together with equally extreme demands by antislavery leaders, precipitated a crisis in the affairs of the Whig party as well as in the nation at large. To meet this, Senator Clay proposed a set of resolutions subsequently substantially embodied in legislative measures known as the Compromise of 1850.

President Taylor strongly opposed the adoption of these measures but Fillmore, becoming president upon his death, approved them. He reorganized the cabinet making Daniel Webster secretary of state, Thomas Corwin secretary of the treasury and John J. Crittenden attorney general. Fillmore had had nothing to do with the framing of the controversial measures and, while presiding over the senate, had scrupulously refrained from expressing any opinion. At heart, as he wrote to Webster, he detested slavery but viewed it as an evil which must be endured and given the protection of the constitution until it could be gotten rid of "without destroying the last hope of free government in the world." The alarm caused by the violent expressions of conflicting opinion, together with threats of secession, aroused his lifelong devotion to the cause of preserving the union. Joining with Webster, he exerted his influence openly in favour of Clay's proposals.

One of these measures was the Fugitive Slave law, introduced by Sen. James Mason of Virginia, making it the affirmative duty of the federal government to aid in the capture and return of slaves to their lawful owners. The attorney general advised that this statute was constitutional and, together with Webster, urged Fillmore to sign it, which he did. Fillmore publicly announced that if occasion required he would call upon the military to aid in the enforcement of the statute. In a real sense it was the enactment of this law, together with Fillmore's announcement, which disintegrated the Whig party. Throughout its history the party had been handicapped by the intrigue of powerful discordant factions, the most extreme of which had been the radical abolitionists in the north and the equally radical leaders in the south seeking the extension of slavery.

For a year or more after the adoption of the compromise, agitation died down somewhat but the attempts as well as the failures of the federal government to enforce the Fugitive Slave law soon made slavery the one dominant political issue. In 1852, Webster became a candidate for the presidency along with Fillmore and Gen. Winfield Scott, with the result that the vote of the northern Whigs was split. Scott was nominated and defeated; Clay and Webster both died. Fillmore retired as president on March 4, 1853. In the next presidential contest of 1856, while traveling abroad, he was nominated by the new American party which sought to capitalize upon maintaining nativism and was nicknamed the "Know Nothing" party. Overwhelmingly defeated, he never again sought public office but retired to Buffalo.

Several times in his career Fillmore had shown egregiously poor judgment: first, at its outset, in identifying himself with the political use of the anti-Masonic issue and later in accepting the nomination of the American party, both of these groups being saturated with intolerance and prejudice. When the Republican party emerged in 1856 he viewed it as an insignificant group of northern extremists; but when the war came, consistent with his lifelong devotion to the union, he loyally supported Lincoln until 1864 when, discouraged by the failure to achieve victory, he voted for George McClellan.

In a very real sense Fillmore's support and defense of the Fugitive Slave law proved to be his political death warrant. At heart a consistent opponent of the extension of slavery, it is reasonably clear that in supporting the Compromise of 1850 he was dominated solely by his conscientious desire to preserve the union. His policies and decisions delayed for a decade the outbreak of the Civil War.

Throughout his career he was a constant advocate of expanding the internal development of the country, seeking particularly to unite the east with the far west. Equally important, he was one of the first national leaders to appreciate the importance of extending U.S. influence in the Pacific. As president he sent Commodore Matthew C. Perry with a fleet to Japan in 1853, which resulted in the Japanese government altering its attitude and entering into trade and diplomatic relationships with the U.S.

Fillmore's successes in public life resulted from qualities of personal character. Although he was not a dramatic or spectacular figure and throughout his public career was handicapped by the jealousies and divisions in the Whig party, he consistently maintained an attitude of dignity, magnanimity, high-minded integrity and intense earnestness. In Buffalo he was a leader in founding the university, the general hospital, the Society of Natural Sciences, the Fine Arts academy, the Historical society and many other cultural institutions.

In domestic life he married (1826) the friend and counselor of his youth, Abigail Powers, by whom he had a daughter and a son. His first wife died in March 1853, and in 1858 he married Caroline C. McIntosh. Fillmore died at Buffalo on March 8, 1874. Most of his official papers were destroyed at the direction of his son.

See William E. Griffis, *Millard Fillmore* (1915); *Millard Fillmore Papers,* Buffalo Historical Society, vol. x, xi (1908); Robert J. Rayback, *Millard Fillmore* (1959). (J. L. O'B.)

FILMER, SIR ROBERT (*c.* 1588–1653), English absolutist writer and theorist of patriarchalism, was squire of East Sutton, near Maidstone, Kent. He was educated at Trinity college, Cambridge, and at Lincoln's Inn. Before he succeeded his father, he lived in the old porter's lodge of Westminster abbey. There he knew the historians William Camden and Sir Henry Spelman, the poet George Herbert, and possibly John Donne, and the royalist high-church canon of Westminster, Peter Heylyn. Filmer was knighted by Charles I and had a brother and a son at court. Dur-

ing the Civil War his house was sacked, and he went to prison as a royalist although he never fought for the king.

During the exclusion crisis of 1679–80 (*see* ENGLISH HISTORY), Filmer's political tracts (first published between 1648 and 1653) were reissued (1679)' and his major work, *Patriarcha,* was published for the first time (1680). John Locke, then writing on politics, passed judgment (in the famous *Two Treatises of Government,* published in 1690) on Filmer's political works: "There was never so much glib nonsense put together in well-sounding English." This was long the accepted opinion. There are, however, several reasons why modern historians, political theorists and sociologists are inclined to look on Filmer as a significant and interesting figure in his own right, quite apart from Locke's attention to him. He was the first English absolutist, for *Patriarcha* was written long before the Civil War and before Thomas Hobbes was published. Filmer, and the Kentish gentlemen who read him in manuscript, had rejected government by consent well before parliament proceeded to extremes against Charles I.

Filmer believed that the state was a family,.that the first king was a father and that submission to patriarchal authority was the key to political obligation. Making a strained interpretation of scripture, typical of his time but ridiculed by Locke, he pronounced that Adam was the first king and that Charles I ruled in England as Adam's eldest heir. Filmer represented that patriarchal social structure which characterized Europe until the Industrial Revolution and which, in one form, persisted longest in the southern United States. Many would now be disposed to call his account of social relations more realistic than Locke's mechanical individualism, and his scriptural fatuities no worse than the "political mythology" of Victorian liberalism. Filmer's reactionary politics did not prevent him from writing one of the early denials of witchcraft. But his historical importance must still rest on the fact that, as has now been shown, the whole of Locke's writing on politics was directed against him. In a special as well as a general sense, therefore, he can be looked on as the negative background to subsequent political thinking.

Filmer died at East Sutton on May 26, 1653, and is buried in the church there, surrounded by his descendants to the tenth generation, made baronets in his honour.

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FILMY FERN: *see* FERN.

FILTERABLE VIRUSES: *see* VIRUSES.

FILTERS, LIGHT. Light filters are used in optics (*q.v.*) and photography to change the light which passes through them by absorbing some part of it. If they absorb the same fraction of all wave lengths they are known as neutral density filters, and they change the intensity of the light, but not its colour. Most filters are coloured because they absorb some parts of the spectrum selectively, and their uses are determined by the nature of this absorption.

Filters are made in several forms: (1) liquid filters in which solutions of dyes or coloured salts are held in shallow glass troughs with parallel sides; (2) solid filters of coloured glass; (3) dyed films of gelatin, cellulose esters and other plastics—these are frequently cemented between flat plates of optical glass; (4) gaseous filters. Still another type, the Christensen filter, consists of a liquid in which is a suspension of small transparent particles having the same refractive index as the medium but different dispersion. The greatest variety of filters, of high reproducibility and precise transmission characteristics, are in the form of gelatin film. They are prepared by coating a previously determined thickness of gelatin containing the necessary dyes upon plate glass, and after drying, stripping the gelatin film off the glass.

The colour of a filter is determined by the light it absorbs. Thus a filter which absorbs blue from white light is yellow; a red filter absorbs blue and green; a green filter, blue and red; and a blue filter, green and red. The spectral absorption characteristics of a filter are best expressed by absorption or transmission curves (*see* fig. 1 and 2). They are measured on an instrument known as a spectrophotometer, which combines the properties of a spectroscope and a photometer.

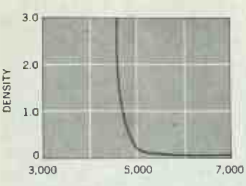

FIG. 1.—ABSORPTION CURVE OF YELLOW K2 FILTER

Filters are classified into several types according to their uses: (1) selective filters which absorb much of the spectrum and transmit a narrow spectral region; (2) subtractive filters which transmit most of the spectrum and absorb only a narrow spectral region (for every selective filter there can clearly be theoretically a subtractive filter of complementary colour); (3) compensating filters, which transmit in greater or less intensity most of the spectrum, and which have gradual absorption characteristics.

Application of Light Filters.—Filters used in optics or photography may be classified according to their use as:

1. *Compensating or correction filters.* These are used to alter the response of a film to a particular light source so that the photograph appears more nearly in the relative tone values as perceived by the eye. For black and white photography they are yellow or pale green in colour, while for colour photography they may be pale blue, yellow, magenta or cyan. When colour film intended for use with daylight is used with tungsten filament lamps, a special blue filter must be placed in front of the lens to obtain true colour reproduction; conversely, when film designed for use under artificial light is used in daylight, an orange filter is necessary. Photometric filters are designed to change the effective quality of a light source and are used for visual photometry and photography.

2. *Contrast filters.* These are used to modify the brightness of a particular colour visually or in a photograph. If the colour is to appear lighter in a black and white photograph than in the original it is photographed through a filter of its own colour; if it is to appear darker, a filter of complementary colour is used.

3. *Selective or separation filters* are used for making two- or three-colour separation negatives for colour photography, and for projection in the additive colour processes (*see* fig. 2, and PHOTOGRAPHY: *Colour Photography*).

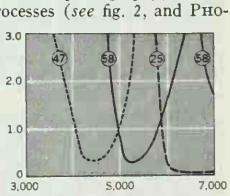

FIG. 2.—ABSORPTION CURVES FOR BLUE (47), GREEN (58), AND RED (25) FILTERS FOR THREE-COLOUR PHOTOGRAPHY

4. *Haze filters* are used to reduce or eliminate the effects of atmospheric haze in photography. They absorb ultraviolet and violet light, which are preferentially scattered by haze, and they are generally yellow. As greater haze penetration is desired, the filters shift to deeper yellow or red. Orange filters are used to increase visibility of distant objects through telescopes, binoculars, etc.

5. *Monochromatic filters* have sharp transmission bands, and are used to isolate particular lines from the spectra of gaseous-discharge lamps such as the mercury arc.

6. *Ultraviolet and infrared filters* are concerned with the invisible spectrum. Ultraviolet filters are generally made of glass, and usually have a narrow transmission band about the mercury line at 3,650 Å, and are opaque to visual light. Infrared filters are made to absorb most or all of the visual spectrum and to transmit the near-infrared freely.

7. *Safelights* embody special filters designed to illuminate photographic darkrooms when used in conjunction with tungsten filament lamps. They are made for use with films, plates and papers of different spectral sensitivities so that they may be handled in the safelight without being fogged in a reasonable time of exposure.

8. *Polarizing filters* polarize light very efficiently in the visual spectrum, and are used for producing polarized light effects, and reducing glare and reflections in photography.

9. *Neutral density filters* are gray in colour, and are made to absorb all visual wave lengths sensibly to the same extent. In photography they are used for reducing light intensity without changing its quality.

Filters which are made of dyes may be unstable, although the majority of the most commonly used filters are made of quite stable dyes. The manufacturer's specifications should be consulted. Gelatin filters cemented in glass or solid glass filters, to be of the best quality, should have flat surfaces which are parallel. They are usually available in two degrees of quality: those which are useful in general photography with short focus lenses, and those for use with long focus lenses or in making separation negatives in photomechanical reproduction. In the case of the latter, a very high degree of optical quality is required.

See also Optics. (W. Ck.; X.)

FILTRATION. This article discusses the filtration of liquids and gases; *i.e.,* the process in which solid particles in a liquid or gaseous fluid are removed by the use of a filter medium that permits the fluid to pass through but retains the solid particles. Either the clarified fluid or the solid particles removed from the fluid may be the desired product. In some processes used in the production of chemicals both the fluid filtrate and the solid filter cake are recovered.

Other media, such as electricity, light and sound, also can be filtered. For information about filtration of these materials *see* Capacitor: *Kinds and Uses of Capacitors;* Filters, Light; Sound: *Analysis of Sound Propagation: Selective Acoustic Transmission: Filtration.*

The art of filtration was known to primitive man, who obtained clear water from a muddy river by scooping a hole in the sand on a river bank to a depth below the river water level. Clear water filtered by the sand would trickle into the hole. The same process on a larger scale and with refinements has been used for more than 100 years to clarify water for cities.

The basic requirements for filtration are: (1) a filter medium; (2) a fluid with suspended solids; (3) a driving force such as a pressure difference to cause fluid to flow; and (4) a mechanical device called the filter that holds the filter medium, contains the fluid and permits the application of force. The filter may have special provisions for removal of the filter cake or other solid particles, for washing the cake and possibly for drying the cake. The various methods used for treating and removing the cake, for removing the clarified filtrate and for creating the driving force on the fluid have been combined in various ways to produce a great variety of filter equipment.

Filter Media.—Filter media may be divided into two general classes: (1) the thin barrier, exemplified by a filter cloth, filter screen or the common laboratory filter paper; (2) the thick or en masse barrier, such as a sand bed, coke bed, porous ceramics, porous metal and the precoat of filter aid often used in the industrial filtration of fluids that contain gelatinous precipitates.

A thin filter medium offers a single barrier in which the openings are smaller than the particles to be removed from the fluid. A single, thin filter medium usually is satisfactory if the layers of solid particles that accumulate on the medium produce a porous cake that is permeable to the fluid. If the filter cake is gelatinous or the particles are soft and compressible, rather than firm, the filter cake may "blind"; *i.e.,* the pores in the cake may close and stop filtration. If this happens a filter aid or a thick filter medium such as the sand bed may be used.

Contrary to the situation with the thin medium, the pores in a thick filter medium such as a sand bed may be appreciably larger than the particles to be removed. The particles may travel for some distance along the tortuous path of the fluid through the medium but sooner or later will be entrapped in the finer interstices between the particles that constitute the filter bed. In this way the soft particles removed are distributed over a volume of filter medium that is sufficient to prevent blinding and stoppage of filtration. After solids accumulate the beds may be backwashed with clear fluid to clean the bed.

Filtering Force.—The fluid to be filtered will pass through the filter medium only if some driving force is applied. This force may be caused by gravity, centrifugation, application of pressure on the fluid above the filter or application of vacuum below the filter or by a combination of such forces. Gravitational force alone may be used in large sand-bed filters and in simple laboratory filtrations. Centrifuges containing a bowl with a porous filter medium may be considered as filters in which gravitational force is replaced by centrifugal force many times greater than gravity. If a laboratory filtration is difficult a partial vacuum is usually applied to the container below the filter medium to increase the rate of filtration. Most industrial filtrations involve the use of pressure or vacuum, depending upon the type of filter used, to increase the rate of filtration and also to decrease the size of the equipment required.

Filter Types.—Filters may be classed according to the nature of the driving force that causes filtration (*i.e.,* gravity filters, pressure filters and vacuum filters). They also are described according to mechanical characteristics (*i.e.,* plate-and-frame filters, leaf filters, rotary-drum filters, top-feed filters, disk-type filters, sand-bed filters and precoat filters). Filters may operate on either a batch or continuous basis.

The gravity filter is the oldest and simplest type. Gravity sand-bed filters installed in city water plants filter more gallons of fluid than any other type of filter. Such filters involve the use of tanks that usually are constructed of concrete. At the bottom of the tank is a grating or false bottom; above this is coarse gravel or crushed rock of graded size; at the very top are layers of quartz sand of uniform size. (*See* also Water Supply and Purification: *Purification and Treatment.*) In industrial filtrations crushed coke of graded size is used in lead-lined boxes to filter sulfuric acid, crushed limestone of graded size is used for alkaline liquors and charcoal beds are used to purify organic liquids by both filtration and adsorption.

Pressure or vacuum filters usually are used in industry in preference to gravity filters. The driving force that can be supplied by pressure or vacuum is much greater than gravity, thus permitting higher filtration rates. Sand-bed filters are operated under pressure in closed vessels to give high-capacity service. Pressure filters are used in daily life by many people; *e.g.,* the housewife who operates a vacuum cleaner with a dust bag or paper filter and the motorist whose automobile engine has an oil filter cartridge. Many industrial operations involve the filtration of slurries that contain high concentrations of suspended solids. Pressure or vacuum filters with a thin filter medium such as a filter cloth or woven metal screen are preferred for such service because filter beds fill exceedingly rapidly when used with slurries that have a high solids content.

The most common type of pressure filter with a filter cloth is known as the filter press. This is a batch-operated filter that is used when the filter capacities involved do not warrant investment in more expensive continuous pressure or vacuum filters. The plate-and-frame filter press requires the least floor space per unit of filtering area and usually involves the lowest capital cost per unit of area. However, since it is batch operated and must be loaded and unloaded manually the labour costs are high, particularly in the larger sizes. There are many different types of filter presses. In one design, recessed plates about one-inch thick are assembled on a supporting frame with filter cloths between the frames. The assembly is made tight by a screw press at the end of the frame. Slurry is piped under pressure to each cloth and supporting plate through ports usually located in the corners of the plates. The clear liquid is removed through the recessed channels and additional ports in the plates. After a filter cake has been deposited on the cloth it may be washed by pumping water through the filter. Then the plates are separated and the filter cake is removed manually.

Leaf filters are also used for pressure filtration on a batch basis. The leaves consist of a centre section of coarse metal mesh that supports the filter medium and permits the filtrate to escape. This centre section is covered on either side with the filter medium, which usually is a woven wire screen of appropriate mesh size. The leaves may be circular or rectangular and are assembled on a frame with ports for removal of the filtrate. The assembly is usually enclosed in a pressure vessel that also contains the slurry. After sufficient filter cake is deposited on the leaves, the pressure is removed, the vessel opened and the leaf assembly with filter cake taken out. The cake is removed by water spray or by applying air pressure to the filtrate line. The leaf filter, as compared

with the filter press, costs less to operate because of the advantageous provisions for efficient washing and cake discharge without removing the leaves.

Vacuum operation is used for most laboratory filtrations and for most continuous filtrations used in industry. The rubber-hose connections and glass equipment of the laboratory are much easier and safer to use under partial vacuum than under pressure. Laboratory filters include, among others, the standard conical glass funnel lined with folded or fluted filter paper, the porcelain Büchner funnel with a perforated flat bottom to support the paper and the Gooch crucible with a perforated bottom that is covered with a thin bed of asbestos fibres to provide a filter medium. (*See* also CHEMICAL APPARATUS.)

The rotary-drum vacuum filter is used extensively in industry for the continuous filtration of large quantities of slurries containing a high content of suspended solids. The filter consists of a cylindrical drum with internal divisions, ports and valves for application of the vacuum and removal of the filtrate. The drum is covered with the filter medium, usually a woven wire screen or cloth, and is partially submerged in a trough of slurry. The partial vacuum inside the drum causes the filtrate to flow into the drum and out the ports, depositing a filter cake on the surface of the drum. As the drum rotates, the cake may be sprayed with wash water and then removed by scrapers. In another design for continuous vacuum filters, an assembly of leaves similar to those in the batch-leaf pressure filter is used instead of the drum. The leaves provide greater filter area but have less filtrate-handling capacity. In another design of the rotary-drum vacuum filter, the drum is surrounded with a hood supplied with hot air that dries the filter cake. In this design the slurry usually is fed to the top of the drum and is scraped off the bottom into a hopper.

Special Techniques.—Filtration involves such a variety of fluids and solids that special techniques are required in many cases. If the filter cake is extremely compressible, gelatinous or slimy and tends to blind the filter, a filter aid of porous, easily filtered solids such as diatomaceous earth (*q.v.*) or bone black may be added to the slurry to improve filtration. In another technique used with very slimy precipitate, a layer or precoat of filter aid, usually one to two inches thick, is deposited first on the drum of a rotary vacuum filter. Successive layers of the precoat and slimy solids are then cut from the precoat bed as the filter rotates to provide a new nonblinded surface to the slurry continuously.

Highly corrosive slurries used in some chemical industries and in the processing of nuclear reactor fuels are difficult to handle. Special filter media such as porous ceramics and porous stainless steels have been used to handle these materials both in the laboratory and in industry.

Air and other gases are usually filtered continuously by causing the gas to pass through a thick filter medium by application of pressure or vacuum. In household air filters pressure is used and the medium in the filter units may be several inches of glass fibres impregnated with oil to retain the removed dust particles. These filter units are replaced when they become plugged with dust. (*See* also HEATING AND VENTILATION: *Air Sanitation.*)

Very efficient filters are required and have been developed for the filtration of air containing radioactive solids. In one design many layers of thin paper in close contact are used with the air flow parallel to the surface of the paper. The channels between the sheets are so small that particles of very small size are retained. Filters based on this design also have been used in the tips of cigarettes. (L. E. B.)

FINALE, a musical term signifying either the concluding movement of a symphony, concerto or sonata, or the ensemble that concludes the act of an opera. The finales in works in sonata form by Mozart and Haydn derive their light-hearted character from an affinity with the spirited concluding dance of the earlier suite (*q.v.*). The finales in the symphonies of the romantic composers were designed as apotheoses or to convey a philosophical message. Operatic finales usually form a dramatic climax to the succession of arias and recitatives as in Mozart's *Figaro;* or they may emphasize a moral issue as in the final fugue of Verdi's *Falstaff.*

FINANCE (ARTICLES ON). The traditional view of money as a static embodiment of wealth has undergone drastic changes in the 20th century. Finance has become a form of economic engineering in which money in circulation is comparable to kinetic energy and unemployed capital to potential energy. The major divisions of this field are outlined in the brief article FINANCE, below, and each area of specialization described in it is treated in detail in a series of articles.

MONEY surveys the origin and development of mediums of exchange and their function in the economic structure; the causes and consequences of fluctuations in the value of money; and the relation between monetary policies and business activity. This article, like many others in the field of finance, outlines the historical background of modern concepts so that theories may be seen in the light of the body of economic experience from which they developed.

Specific monetary systems, including their history and the principles on which they are based, are described in BIMETALLISM; CURRENCY; and GOLD STANDARD.

The relationship between price levels and the supply of money is treated in terms of general economic implications in INFLATION AND DEFLATION, and on a mathematical basis in QUANTITY THEORY OF MONEY. Archaic systems are discussed in CURRENCY, PRIMITIVE and MONEY, MEDIEVAL. Individual currencies are described in a series of articles, *e.g.,* DOLLAR; POUND STERLING; FRANC; MARK; KRONE; PESO; etc.

BANKING summarizes the history of banks since antiquity, the general principles governing banking practice and specific methods used in various regions. Among the articles on various types of banking institutions are CENTRAL BANK; FEDERAL RESERVE SYSTEM; INVESTMENT BANKING; MERCHANT BANKERS; SAVINGS AND LOAN ASSOCIATION; SAVINGS BANK; and TRUST COMPANY. Individual national banks are treated in BANK OF ENGLAND; BANCA D'ITALIA; and BANQUE DE FRANCE. Discussions of national banks are included also in BANKING and in articles on specific countries.

MONEY MARKET describes policies and procedures connected with business loans. Articles on individual features of the money market include CHECK; CLEARINGHOUSE; COMMERCIAL PAPER; and SAVINGS AND LOAN ASSOCIATION. Loans through other than banking channels are discussed in MONEYLENDING and PAWNBROKING.

Investment is discussed in terms of economic theory in CAPITAL AND INTEREST and WEALTH AND INCOME. Investment mediums and procedures are described in INVESTMENTS: INDIVIDUAL. Among the articles dealing with investment via the stock market are ARBITRAGE; BEARER SECURITIES; BOND (IN FINANCE); FUTURES; STOCK; STOCKBROKER; and STOCK EXCHANGE. Related topics are treated in CAPITAL STRUCTURE and FINANCIAL STATEMENT.

Among the articles on international finance are CAPITAL, EXPORT OF and INTERNATIONAL PAYMENTS. Articles on international banking institutions include BANK FOR INTERNATIONAL SETTLEMENTS; BANK FOR RECONSTRUCTION AND DEVELOPMENT, INTERNATIONAL; and EXPORT-IMPORT BANK OF WASHINGTON. Additional articles on topics related to this field are listed in INTERNATIONAL RELATIONS (ARTICLES ON).

Among the articles dealing with public finance are BUDGET, GOVERNMENTAL; DEBT, PUBLIC; EXCHEQUER; and NATIONAL INCOME ACCOUNTING.

Taxation is surveyed in the article under that title and in such articles as ESTATE AND INHERITANCE TAXES; EXCESS-PROFITS TAX; EXCISE TAX; INCOME TAX; LAND TAX; LUXURY TAX; and TAXATION, LOCAL. Historic forms of taxation are described in GABELLE and WINDOW TAX.

Biographical articles summarize the careers of those who were influential in the molding of financial theory and practice, *e.g.,* KEYNES, JOHN MAYNARD KEYNES; LAW, JOHN; MORGAN (fam.); NECKER, JACQUES.

Selected lists on many topics closely related to finance will be found in ECONOMICS (ARTICLES ON).

The above lists are not complete; they have been compiled

merely as illustrations of the arrangement of subject matter. For specific references to articles dealing with any topic, the Index should be consulted.

Encyclopædia Britannica's articles on finance, like those in the field of general economics, have been prepared for the general reader as well as the advanced student. Of those cited above, only QUANTITY THEORY OF MONEY is essentially technical. The following articles are suggested as a minimal reading list for an introduction to the general principles of finance: BANKING; FINANCE; INFLATION AND DEFLATION; INVESTMENTS: INDIVIDUAL; MONEY; and STOCK EXCHANGE.

FINANCE. Finance has been defined as "the art of providing the means of payment." This, however, is not so complete a description as this picturesque phrase implies for finance may also refer to the sum total of resources available for any active or even passive purpose, such as mere hoarding, to any body ranging from a state to the individuals within it. For the purpose of this article, however, the emphasis will be on the process of assuring or providing resources whether by way of cash or credit, to meet debts incurred by individuals, corporations or governments. The modern approach which lays stress on planning, as well as the traditional view which considers finance as a problem of acquisition and administration of funds, will also be dealt with.

There are at least three general categories of finance that have developed specialized institutions, distinctive rules and mores, and sufficiently different goals and standards to merit separate treatment. Public finance is the acquisition and allocation of funds by governmental units. Business finance is the planning, acquisition and administration of funds employed in producing goods and services. Personal finance is the budgeting, investing and borrowing activity of individuals and families.

Public finance is mainly concerned with problems of levying taxes, borrowing funds and debt management by the central government, whether federal as in the United States or unitary as in Great Britain, or by state, provincial or local authorities. Public finance is based on the unique power to force contributions. A government's resources are limited only by the economic potential of the area and people governed.

Both in Great Britain and the United States the central government obtains a high proportion of its revenue from income tax and its ability to tax is restricted only by self-imposed rules which may be varied from year to year. In both countries, local municipal authorities have limited taxing and borrowing powers; but whereas in Great Britain revenue for local authorities arises primarily from some form of property valuation, in the United States, revenue from sales and excise taxes is also available.

If tax revenues plus secondary income from government enterprises, such as postal service or public utilities, are not equal to expenditures, the deficiency is met by borrowing. Control over a fractional reserve banking system simplifies borrowing by central governments but it transfers the problem from one of selling debt instruments to the control of inflation. Excessive use of deficit financing by a central government may result in the substantial devaluation or destruction of a country's monetary unit.

The level and significance of public finance has increased sharply since the 1930s. As a result, taxation, public expenditures and the size and distribution of the public debt have a much greater impact upon the national economy than in previous years. The fairness of the tax burden, the ease of collection and the economic repercussions of change in government revenues and expenditures have assumed great importance in the national economy.

Business finance includes the financial relationship between one business firm and another, between business firms and the general public and between business firms and government. Finance decisions in business include the equilibrium between the borrowed funds and equity capital employed, the choice of debt instruments to be used and the allocation of resources among competing claims. The management of working capital, the extension of credit to customers, the distribution of earnings to its owners and expenditure on new capital assets all interact.

In order to facilitate the production of goods and services a wide variety of general purpose and specialized institutions have developed to channel savings into productive use and to make credit readily available to producers, distributors and consumers. Both in Great Britain and the United States commercial banks provide substantial financial credits to business. In both countries investment trust companies, savings banks and other financial intermediaries aid and encourage the accumulation of small savings which are directed into the capital market where they are available to both commerce and government. In the United States, commercial paper dealers buy promissory notes of sound firms discounting them with banks and corporations throughout the country, but in the London money market the discount houses deal largely in government paper; commercial bills find their way directly to the great commercial banks.

The capital markets for corporate and governmental securities are more concentrated in Great Britain, while in the United States the same functions are provided by a series of organized exchanges and an active over-the-counter market. The process of selling new securities is similar in both countries.

Personal finance deals primarily with family budgets, the investment of personal savings and the use of consumer credit. Personal savings in the United States are, to a large extent, invested indirectly using financial intermediaries which in turn invest in stocks, bonds, notes and real property. The major financial intermediaries are life insurance companies, commercial banks, mutual savings banks, savings and loan associations, credit unions, pension funds and investment companies. Only a small portion of the annual savings of individuals in the U.S. is invested directly in corporate securities or in bonds issued by governmental units although most such securities outstanding are owned by individuals.

One of the outstanding characteristics of the United States is the variety, volume and availability of credit for individuals. Savings and loan associations, commercial banks and life insurance companies accept installment mortgages on residential property, thus permitting individuals to buy homes with small down payments and reasonable monthly installments. Sales finance companies, commercial banks and credit unions make direct loans and also buy conditional sales contracts from the retailers of large consumer durable goods thus permitting the retailer to extend generous credit terms to his customers. Charge accounts, credit cards and revolving credit accounts are readily available and if the consumer needs to consolidate his obligations, or borrow cash to meet an emergency, small cash loans can be obtained at commercial banks, credit unions or consumer finance companies operating under special state small loan laws.

The position in Great Britain is not entirely dissimilar from that prevailing in the U.S. British life assurance companies play an important part in the direction of small savings as do the commercial banks, the trustee savings banks, the post office savings banks and the unit trust movement which received an impetus in growth and drive in the early 1960s. Credit unions are unknown in England. There are variations in the machinery available for credit facilities, whether by way of mortgage for residential property or credit for consumer goods. As regards the former, life assurance companies will grant mortgages together with life assurance cover by way of endowment assurance policies for a term of years varying with a company's practice; commercial banks will grant facilities for house purchase subject to an equitable charge and a period of repayment limited to about ten years. Local authorities will also give mortgage facilities for house purchase under one or another of the Small Dwellings Acquisition acts, 1899 to 1923, subject to certain conditions; these financial powers were extended by the Housing (Financial Provisions) act of 1958. Most house purchases are effected through the powerful building societies with branches throughout the country. With regard to consumer credit, whether in relation to durables or otherwise, facilities are available through the commercial banks and finance houses or the credit machinery of the retail organizations.

Credit cards are little used although they have been introduced.

General Observations.—Before the 20th century, wealth was substantially subject to direct and personal management of the owners. More and more, however, ownership and control have been divorced, a process particularly marked in the industrialized

economies of the west. The ownership of real property that once represented a unified package of risk, income and control has been replaced by a variety of financial contracts that separate and distribute varying degrees of risk, income and control.

Control is passing increasingly to professional managers with limited or secondary holdings of ownership interests. The development along lines of professional management has, perhaps inevitably, brought with it a concept of financial planning of which the essential characteristics are the means and desirability of acquiring resources, the allocation of such resources in accordance with priorities based on predetermined aims, and earnings, all of which are coupled with constant and careful supervision. The process of acquiring funds is therefore associated with a complex system of creating debts and credits through an organization of powerful banks, stock exchanges and other financial institutions. Basically, and in the broadest sense, finance could be regarded as the machinery for directing funds from savers to users through the mechanism of the modern money market.

See also references under "Finance" in the Index volume.

(J. R. Lt.; Ga. S.)

FINANCIAL STATEMENT. Broadly defined, a financial statement is any report of the financial condition or of the financial results of the operations of a business, a government or other organization. The term is most often used in a more limited sense in trade and financial circles to refer to the balance sheet, statement of income and statement of retained earnings of a business. The balance sheet shows, as of a certain date, the amount and kinds of assets (properties), liabilities (debts) and the owners' investment (excess of assets over liabilities). The balance sheet indicates the liquidity of the concern and its probable solvency. Liquidity is measured by the readiness with which assets may be converted into cash. Solvency is measured by the firm's ability to meet its debts when due.

Comparative balance sheets showing the financial condition of a business for two or more years reveal financial tendencies, changes in response to varying business conditions, and policies on such matters as debt repayment and expansion of the ownership investment by retained earnings.

The statement of income or earnings statement summarizes those transactions which have brought gain or loss to the owners during a period of time, usually a year, between two successive balance sheets. Accountants ordinarily divide this statement into a statement of income (or profit-and-loss statement) and a statement of retained earnings (or earned surplus). The latter includes items that are not strictly profit or loss, such as dividends, arbitrary reductions in the valuation of fixed property or sometimes items that relate to the earnings of an earlier period, such as the revision of the tax liability of an earlier year. Some accountants regard it as improper to place these latter adjustments of prior years' gains or losses in this surplus section lest the unskilful reader overlook them in studying the earnings over a period of years; they prefer to show such adjustments in the regular income statement suitably segregated.

Earnings statements are useful in portraying the elements of profitability when details are given on sales or gross revenues, cost of goods sold, and certain expenses such as depreciation, maintenance, taxes, interest and rents. Good form calls for the separation of income and expenses derived from the main operations, such as the trading activities of a merchant, from similar data related to other activities, such as interest and dividends from investments or other nonoperating income. Extraordinary and nonrecurring gains and losses together with any related income taxes should be separately stated. Where the total earnings are summed up in the single figure of "earnings per share of stock," many prefer a figure that excludes extraordinary items. They want a representative or normal measure of earnings. Good practice requires the reporting of figures that both include and exclude such items. Whether a particular unusual item is likely to recur in the future may depend upon whether a short- or long-run point of view is taken.

The earnings statement is ostensibly a mere record of the past. But, as in other fields, the reader projects this historical experience in judging the probable future. Debates over proper form often hinge upon the debaters' ideas as to the probable way in which the reader is likely to think or react. Because statements are read for a variety of purposes, no single form can satisfy all persons. Adequate disclosure of material details enables informed and competent persons to derive the kinds of information that will serve their various needs. The past record of earnings has the greatest utility in gauging the future where the business offers goods or services that are bought frequently and habitually. Demand and earnings fluctuate most where technology changes, style alters frequently, raw materials vary greatly in cost, or durability or luxury character causes irregular buying. Mergers, the acquisition or sale of properties and the development of new products also make past earnings a poor measure of future performance.

Users of Statements.—The more important users of financial statements are (1) short-term creditors; (2) investors; (3) business management; and (4) government agencies. Commercial banks and trade creditors who extend short-term credit may rely heavily upon a personal estimate of the ability and character of the prospective debtor and his previous record of paying his bills rather than upon precise financial information. Experience has shown, however, that such credit can be extended more freely and with less risk, especially to small businesses, when statements are available. Attention of the short-term creditor centres on the balance sheet, especially on the current assets, consisting of cash and liquid investments, stocks of merchandise (inventories) and amounts owing by customers (accounts receivable) as they relate to short-term debts.

Investors in bonds or stocks tend to place primary emphasis upon the earnings statements and less upon the balance sheet, save as the latter suggests risk because of unliquidity and insolvency. When commercial banks extend term loans that are to be repaid systematically over a period of years, they have an interest in the statement of income because they depend for repayment more upon future earnings and less upon existing current assets. Ability to repay debt depends primarily upon "cash flow" from operations. This term includes retained earnings and depreciation expense. Retained earnings represent the excess of cash inflow from revenues less outflow from expenses and dividend distributions. Depreciation is added because, although an expense, it represents no cash outflow during the accounting period but a write down of assets previously acquired. Sometimes a statement of the sources and uses of funds is presented. Sources include "cash flow" from operations and amounts realized from the sale of assets and of the company's securities; uses or applications include the reduction of debt or other obligations, the purchase of fixed assets and additions to working capital.

A widening ownership of large business corporations makes fuller disclosure through financial statements a natural development. Such statements may have little utility for many individuals but are essential to investment advisers and financial institutions whose appraisals largely determine market opinion.

Business management finds detailed statements valuable. Comparison with the statements of other members of the industry is used to discover conformity to customary practice and to study relative operating achievement.

Standardized financial statements are the essential basis for many phases of governmental regulation and the taxation of business. When prices are regulated, especially as for public utilities, financial statements disclose the level of earnings and how they conform to the standard set by policy. Statements permit the study of a corporation's finances to determine the suitability of its securities for acquisition by regulated investment institutions, such as insurance companies and banks. Where securities are widely owned by individuals who are not in a position to enforce adequate statement information, the government may set up requirements for the disclosure of material financial information.

Differences Related to Function.—Figures compiled under rules for meeting one need may be inadequate to meet other needs. Merchandise inventories shown in a balance sheet at a very low-cost figure of the distant past will not tell a banker how valuable

they are currently for paying debts. Regulatory bodies when dealing with a financial institution like a bank may look with favour on an understatement of asset values that increases the margin of safety of that institution in a crisis. A stockholder, however, who wishes to value his shares for sale, would prefer fuller information on current values. Income tax regulations may specify certain maximum allowances for depreciation expense, but business management may find that rapid technological change justifies larger allowances. Or, management may elect the highest permissible depreciation rates for income tax purposes when less would appear adequate, lest possible tax savings for shareholders be lost. Considerable changes in the price level create many problems for all classes who use conventionally prepared statements. Radical accounting adjustments were suggested by German accountants in the price inflation after World War I and by some accountants and businessmen in the U.S. after World War II.

Accounting Terminology.—The conditions prerequisite to the interpretation of financial statements are an understanding (1) of the information required by the particular user; (2) of the terminology; and (3) of the rules or conventions employed by accountants in their preparation of financial statements. The needs of the various groups who use statements have been suggested. As for terminology, the two areas baffling for the ordinary reader but essential to the understanding of the balance sheet are the items that state the ownership interest and the "reserves."

The ownership interest of a proprietorship or partnership may be stated in amounts belonging to the one or several owners (thus, John Doe, Capital . . . $25,000) or merely as the net worth. The total amount is the excess of the assets over the debts of the concern. When added to the debts, the sum equals the assets by definition. Custom places the ownership interest on the side of the balance sheet headed liabilities or, more correctly, liabilities and owners' capital. The latter heading recognizes the legal difference between the creditors, who have claims to fixed sums of money as of certain dates, and the owners, who are the residual claimants to assets and income.

In a corporation's balance sheet, the interest of the owner-stockholders should be broken down as between paid-in investment and subsequent accretions from earnings left in the business. The former appear as so much capital stock, often at an arbitrary par or stated value, and any excess as excess paid in by stockholders, paid-in surplus or capital surplus. The other portion of the ownership equity may appear as earnings retained in the business, profit and loss, earned surplus or, as the Bank of England terms it, the rest. Recognition that this amount is merely a balance of value and represents the residual claim of the owners, which may be invested in nonliquid assets, should prevent a layman's not unusual misconception that surplus is a pot of money readily available for dividends or debt payment.

"Reserves" popularly means cash or liquid investments available to meet some specific purpose or a general emergency. The accountant may use the term quite differently. In the balance sheet it may be employed in three different ways: (1) as an allowance for loss in value of some asset (valuation "reserve"); (2) as an estimated liability; or (3) as an "appropriation" of the retained earnings or surplus.

Valuation Reserves.—Instead of merely showing such an asset as plant and machinery at its net book value, it is customary to show its original cost with a separately stated amount of allowances for depreciation or, more confusingly, a reserve for depreciation. Similarly, allowances for losses on customers' debts to the business may show as a deduction either for allowances for bad debt losses or a reserve for bad debts. The growing practice is to use the term "allowance" rather than "reserve" to make clear that these amounts are estimates of loss of value and not cash or funds. In Great Britain, however, the practice is still to use the term "reserve" or, alternatively, "provision."

Liability Reserves.—Occasionally a liability, especially where the amount is uncertain, appears as a "reserve." Thus, income tax liability may be called reserve for income taxes, although better practice is to label the item "estimated liability for" or "accrued" income taxes.

Appropriated Surplus.—Some accountants who wish to show that retained earnings are not available for dividend distributions, transfer a portion of such surplus to a "surplus reserve," such as reserve for contingencies, sinking fund reserve or merely general reserves. Others prefer to show this point by merely stating these amounts as appropriated surplus: for contingencies, for bond retirements or for plant expansion. Still others regard both forms as likely to mislead by implying that all of the remainder of the retained earnings account is available for dividend payments. Actual availability can be determined only by examining (1) the remainder of the balance sheet to see whether cash or other liquid funds exist in excess of what is required to satisfy creditors; (2) reported plans for the future that will use up existing cash; and (3) earnings prospects that will provide cash to pay dividends.

Originally, these "reserves" were sometimes grouped in the balance sheet between the liabilities and the ownership equity. As time passed, they were more commonly placed with the asset, liability or ownership accounts to which they were more closely related. An even later tendency was to abandon the term "reserve" for more accurately descriptive account titles.

Accounting Rules.—The significance and limitations of financial statements arise in part from the rules or principles of accounting which determine their construction. These rules grew from customs found most generally useful in trade and finance. One basic principle is that assets should reflect cost rather than current market value in order to avoid showing unrealized profits from appreciation. This rule is modified by allowances for value losses where some systematic basis for estimate exists, as in the case of depreciation of machines and buildings, bad debt losses and the depletion of oil wells and mines. This cost rule is commonly suspended when current assets have a market value below cost at the date of the balance sheet. The current assets are those assets that turn into cash in the course of ordinary operation within a year (longer in a few industries) and typically include cash, marketable securities, customers' indebtedness and inventories. Marketable securities and inventories are commonly valued at whichever is the lower, cost or market, partly as a matter of conservatism, which is itself almost an accounting principle. This practice is also a matter of recognizing a value loss that reduces current debt-paying power. The measurement of this ability is a central object of statement analysis. Fixed assets, such as plant or long-term security investments not likely to be sold to meet debt, are commonly shown at cost and ignore market value fluctuations on the assumption that such fluctuations are not important to the "going concern." Appraisal and revaluation of the fixed assets are not common practice.

Many special accounting rules arise from trade customs, governmental regulations and tax laws. They often apply only to the statements of special kinds of businesses, such as manufacturing, merchandising, railroads, public utilities, commercial banks, life, fire and casualty insurance, and holding companies. Because practice varies greatly, the reader is referred to standard textbooks to discover the typical forms and terminology in these various fields.

FINANCIAL STATEMENT ANALYSIS

Balance sheets and earnings statements may be analyzed comparatively or internally. In comparative analysis, changes in successive balance sheets or earnings statements, yearly, quarterly or monthly, are studied for tendencies and trends. These changes may reflect long-term growth or decline of the particular business or the industry of which it is a part, or they may represent cyclical, seasonal or special fortuitous factors. Correct understanding of the nature of the influences at work is as important as the facts of change.

Internal analysis examines the relationships or ratios between various items in the statements. The simplest devices are the percentage balance sheet, which compares each of the assets and liabilities as a per cent of total assets, and the percentage income statement, where the various operating income and expense items are shown as percentages of the gross revenues or sales. Ratios are studied to discover probable liquidity or solvency and profita-

bility or efficiency. Two common liquidity tests are the current and the quick ratios. The former is the ratio of current assets to current liabilities; the latter is the ratio of cash and equivalent plus customers' debts (receivables) to the current liabilities. Comparisons of annual sales volume to the customers' debts and to inventories give an idea as to their liquidity and also how efficiently the capital invested in those forms is being used to produce profits. Comparisons of indebtedness to the owners' investment indicates something of the risk of insolvency that is being assumed. Comparisons of the cost of goods sold and the various expenses to revenues may be studied from year to year and between companies in the industry to ascertain relative efficiency and profitability. The amount of earnings relative to the investment of creditors and owners provides another measure of profitability, which, however, requires greater care in interpretation because of changing prices and the failure of the balance sheet to reflect current property values.

Although financial statements are most important to those immediately concerned with the financial fortunes of the particular business, they are read and used by others. They are used for economic analysis; for studies of business conditions; for shaping political and legislative policies; for governmental regulation; and for background information for settling labour disputes. Misinterpretation is easy here as it is in all forms of statistical abstraction. Price level changes are an especially disturbing factor. In spite of such limitations, financial statements perform a useful economic service by making possible a more intelligent assumption of business risks; directing capital into more economic channels; and improving the quality of business management and of competition. They also serve a wider social purpose in providing one more kind of information useful in evaluating political and social policies. *See* also ACCOUNTING; BOOKKEEPING.

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FINCH, a name, sometimes in combination, as bullfinch, chaffinch, etc., for birds of the largest avian family Fringillidae. Generally speaking finches are small songbirds with short, stout, conical bills for crushing seeds, and are characteristic of Europe, Asia and North America, where most of the numerous species live. *See* also BRAMBLING; BUNTING; BULLFINCH; CANARY; CHAFFINCH; CROSSBILL; GOLDFINCH; GREENFINCH; GROSBEAK; HAWFINCH; LINNET; REDPOLL; SISKIN; SPARROW; and references under "Finch" in the Index.

FINCHLEY, a municipal borough (1933) and parliamentary constituency of Middlesex, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Hendon, Barnet, East Barnet and Friern Barnet to form the new London borough of Barnet (*see* LONDON). Finchley municipal borough is 12 mi. N.N.W. of Charing Cross. Pop. (1961) 69,311. Area 5.4 sq.mi. At the time of Domesday Book, Finchley was part of the manor of Fulham which belonged to the bishop of London. The agricultural land produced much hay. Finchley common, traversed by the Great North road, became notorious for highwaymen, Jack Sheppard being captured near there in 1724. Gen. George Monck camped on the common on his march on London in 1660. A military force to resist Prince Charles Edward, then at Derby, encamped there (1745) and inspired William Hogarth's painting "The March of the Guards Towards Scotland . . ." also known as the "March to Finchley." The common or glebe land now occupies 46 ac. St. Mary's parish church, largely 15th century, was first restored in 1872–73.

Finchley owns about 450 ac. of open spaces and playing fields. It is largely residential and part of Hampstead Garden suburb occupies its southern part.

FINCK, FRANZ NIKOLAUS (1867–1910), German philologist, whose major studies were in types of language structure, was born on June 26, 1867, in Krefeld. He concentrated more on Armenian than any other single language, publishing a grammar in 1902 and some works on Armenian literature and manuscripts in 1903 and 1907. He also published studies of the German and Armenian Gypsy languages (1903, 1907), of the noun accent in Baltic languages and Slavonic languages (1895), of the Irish dialect of the Aran Islands (1899), of the Bantu languages (1908) and of the Polynesian languages (1909).

Finck's work in structural typology, which was in the tradition of W. von Humboldt and H. Steinthal, first appeared in a study of German in 1899, then in *Die Klassifikation der Sprachen* in 1901 and in *Die Haupttypen des Sprachbaus* in 1910. When he died, on May 4, 1910, in Berlin, he was professor of the Oriental seminar at Berlin university. He is perhaps best remembered for *Die Sprachstämme des Erdkreises* (1909). (E. P. H.)

FINDLAY, a city of northwestern Ohio, U.S., the seat of Hancock county, lies in a rich agricultural area, and is the trading centre for the surrounding community. Industries include the manufacture of ditching machines, beet sugar, tires and rubber goods and radio and television equipment. The Blanchard river, which flows through Findlay, is the scene of "Down by the Old Mill Stream" written by Tell Taylor, who lived there. The original settlement developed out of Fort Findlay, built during the War of 1812 by Col. James Findlay, for whom it was named. The town was laid out in 1821, incorporated as a village in 1838 and chartered as a city in 1887. It is the seat of Findlay college (Church of God), chartered in 1882. For comparative population figures *see* table in OHIO: *Population*. (L. M. C.)

FINE, a pecuniary penalty imposed by a court of law upon a person convicted of a criminal offense. Fines constitute in whole or in part the punishment for many common-law and statutory offenses in both the United States and Great Britain. Unless the amount of a fine is specified by statute, it may be fixed by the court in the exercise of its discretion. The U.S. constitution and many state constitutions prohibit the imposition of excessive fines.

Several methods are employed in attempting to recover unpaid fines. Under the common law and by statute in many states, an execution may be levied against the defendant's property. In many jurisdictions, statutes also enable the court to order a defendant to work out his fine by manual labour. Moreover, in most states a defendant may be imprisoned until the fine is paid or otherwise settled in accordance with law, and in England it is frequently the practice for a defendant to be ordered to pay a fine or to go to prison for a given period in default. He may be imprisoned indefinitely in some jurisdictions, but statutes commonly limit the amount of time he may be compelled to serve. Usually, in the U.S., imprisonment for such a fixed period does not cancel the fine itself; however, some statutes provide that the fine is discharged by imprisonment for a fixed period, and others allow a credit on the fine for each day served in prison.

The term is also applied to payments formerly made to the lord of a manor on the alienation of land by a tenant, and to a fictitious legal action, abolished in England in 1833, dealing with the conveyance of land. *See* also CRIMINAL LAW.

(C. R. SE.; W. T. WS.)

FINE ARTS. In classical Greece the association of the arts, and more especially sculpture, with the temples of the gods and the great athletic festivals, gave them dignity and sanctity, though work as exquisite as any of these official commissions was produced in such arts as white-figured vase paintings and engraved gems. In the Roman empire the glorification of the emperor and the individual was added to the functions of art, and when such mass industries as Arretine ware and industrial bronze casting were developed a certain distinction of status between the artist and the craftsman was achieved. In the more simply organized life of the middle ages, however, great painters were employed by their patrons to paint fine religious pictures and to stain cloths for tournaments, indifferently, and no distinction of status was made between artist and craftsman in the medieval guilds. Even in the 16th century Holbein the younger was content to design jewels for Henry VIII and Raphael tapestries for the pope.

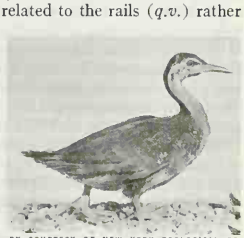
The conception of the fine arts as creation on a loftier level seems everywhere to have accompanied the establishment of academies of painting and sculpture. The earliest such institution was the Académie Royale de Peinture et de Sculpture founded at

Paris by Louis XIV in 1648. It hardly made the scission complete, for all through his reign royal buildings, and those imitated from them, were so richly decorated with painting and sculpture that his academicians were as much occupied with decoration as with the creation of easel pictures and free-standing sculpture.

In the 18th century a change of taste in western Europe made the division between the fine and the decorative arts more stringent. François Boucher takes an intermediate place; many of his pictures are independent of their setting, but an almost equal number are (or were) part of a larger decorative scheme, either as tapestries or as pictures built into paneling. A *dessus de porte* is not an easel picture and has not the same claim in academic eyes to an independent existence in the realm of creation. Gradually, however, the fashion changed, and by the middle of the century it was easy to put the carvers and plasterers who decorated rooms and the artists who painted creative pictures that might chance to adorn their walls into different categories. At this time verbal usage closely confirmed the association of the idea of the fine arts with academic foundations. The phrase "fine art" was, according to the *Oxford English Dictionary,* first used in 1767; the Royal Academy was founded in 1768. In France M. J. de Chénier used "les Beaux Arts" in his *Charles IX* in 1789; the Académie des Beaux-Arts was refounded under that title in 1795.

The distinction between the fine arts and all other arts continued through the 19th century, the great age of academies. It was encouraged by the rise of the middle classes, who were more apt to move house than the territorial magnates, and consequently preferred mobile pictures to elaborate and immovable decorative ensembles, and liked to give an enhanced status to their possessions. Two wars have, however, begun to modify the idea, for men of taste may no longer have room to display pictures in their homes. It is significant that by the middle of the 20th century Jean Lurçat was designing tapestries and Pablo Picasso pottery. Nonetheless the public—if not the artist—is still prepared to consider as "fine," art that fulfills no other purpose than the artist's desire for creation. *See* also references under "Fine Arts" in the Index volume. (J. Ev.)

FINFOOT or sun grebe, names for three species of medium-sized cootlike birds, brown above and whitish below, with lobed feet. They constitute the family Heliornithidae of the order Gruiformes and are more closely related to the rails (*q.v.*) rather than to the grebes (*q.v.*). The finfoot, a secretive bird, is a poor flyer and spends most of its time in shady, quiet rivers, half submerged near overhanging banks. None are more than two feet long; the olive-coloured American finfoot (*Heliornis fulica*), only half that size, with red bill and black-banded yellow toes, ranges from Veracruz to northeastern Argentina.



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

AMERICAN FINFOOT (HELIORNIS FULICA)

The African finfoot (*Podica senegalensis*) occurs from Senegal to the Congo and from Ethiopia to the Cape. The Asiatic finfoot (*Heliopais personata*) is found in Burma, Assam, Malaya and Sumatra. (G. F. Ss.; X.)

FINGAL'S CAVE, the most famous of a series of sea caves in the basalt lavas of the exposed southwestern shore of Staffa (*q.v.*) in the Inner Hebrides, Scot., is 227 ft. long and about 42 ft. wide. The walls are lined by hexagonal pillars formed by cooling in a deep lava flow of olivine basalt of Tertiary age (identical with that of the Giant's Causeway; *q.v.*). The arch reaches 66 ft. above mean sea level, above which is a cliff of 30 ft. The solid floor is covered by water never less than 25 ft. deep. The cave first became widely known through Sir Joseph Banks's visit in 1772, described in T. Pennant's *Tour in Scotland* (vol. 2). It inspired Mendelssohn's overture *The Hebrides* (or *Fingal's Cave*). (A. T. A. L.)

FINGERING, a term used to describe the methods for the use of fingers in playing keyboard, stringed and wind instruments. Research has shown that early systems of fingerings on the chamber organ, the clavichord and the harpsichord which originated in England influenced the systems of François Couperin, J. S. Bach and C. P. E. Bach, which have been generally taken to be the foundation of keyboard technique. These systems were based on the relative strength of the five fingers. The choice of fingers was also governed by considerations of sonority, touch and phrasing associated with one keyboard instrument or another. Later systems of pianoforte fingering were an expansion of these principles.

Fingering on stringed instruments is based on the principle of stopping the strings at varying lengths and on the movable positions of the hand along the finger board. In wood-wind instruments systems of fingering depend on the stretch between the fingers in regard to the uncovering of holes which, cut into the wall of the instrument, vary the length of the vibrating column of air.

See E. Halfpenny, "Fingering," in *Grove's Dictionary of Music and Musicians,* vol. 3 (1954).

FINGER NUMERALS, the representation of numbers by positions of the fingers, a method used by early peoples in the absence of inexpensive material upon which to write. The use of such symbols survived into modern times, particularly in international trade in the orient. In the system inherited from the Greeks and Romans small numbers were usually represented on the left hand, the right hand being used for hundreds. When Juvenal wrote (*Satire X*), "Happy is he indeed who has postponed the hour of his death so long and finally numbers his years upon his right hand," he referred to one who lives to be more than 100 years old. The finger numerals are related to the finger computations in use in the middle ages, referred to in various early printed books and still familiar in certain parts of the world. The operation of multiplication was the one in which they played the most important part, computation being carried as far as 10×10. For example, to multiply 8 by 6, turn down $8 - 5$ fingers on one hand and $6 - 5$ on the other. There are then 3 turned down and 2 standing on one hand and 1 turned down and 4 standing on the other. Add the fingers down $(3 + 1 = 4)$ and multiply those standing $(2 \times 4 = 8)$, and the result is 4 tens + 8 units, or 48; the operation follows the formula, $ab = [(a - 5) + (b - 5)] \times 10 + (10 - a)\ (10 - b)$. Numerous variants of the plan were in use, some having been brought to Europe from the Arab schools. *See* also NUMERALS. (D. E. S.)

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FINGERPRINT, the impression made by the ridges on the end joints of the fingers and thumbs. Scientific study has proved that fingerprints afford an infallible means of personal identification; not only is the ridge arrangement on every finger of every human being unique, but the arrangement does not alter with growth. Fingerprints serve to reveal an individual's true identity despite personal denial, assumed names or changes in personal appearance resulting from age, disease or accident. Because of its simplicity and economy, the practice of utilizing fingerprints as a means of identification, referred to as dactyloscopy, has become established as an indispensable aid to modern law enforcement.

While any ridged area of the hand or foot is useful as a means of identification, impressions of the fingers and thumbs offer two advantages over those of other areas. Finger impressions can be taken with a minimum of time and effort, and the ridges in such impressions form patterns (distinctive outlines or shapes) which can be readily sorted into groups for ease in filing. While the ridges on the skin of the lower finger joints are also unique, the ridges run more or less transversely and specific patterns do not result. As regards toe prints, the shortness and varying shapes of the toe and the varying conditions of the skin on the toes make legible and complete recording of toe impressions an almost impossible task. Palm prints, and footprints too, are rarely considered useful for systematic filing purposes, though they may constitute invaluable clues at the scene of a crime and are often made for specific comparison purposes.

Each ridge of the epidermis (outer skin) is dotted with sweat pores for its entire length and is anchored to the dermis (inner skin) by a double row of peglike protuberances or papillae. Identifiable prints can be obtained from the dermal papillae after the epidermis has been destroyed or sloughed off. Injuries such as superficial burns, abrasions, cuts and blisters, which affect only the epidermis, do not alter the ridge structure, and the original pattern is duplicated in the new skin. An injury which destroys the dermal papillae, however, will permanently obliterate the ridges. The ridges are not all continuous but end, fork and rejoin in numerous places throughout the pattern.

History and Development of Fingerprinting.—A number of obscure references to "finger-marks" have been found in early literature. Although these, coupled with finger or thumb impressions appearing on old documents and seals, have led some writers to ascribe to antiquity a practical knowledge of fingerprints as a means of identification, the claim remains debatable.

Descriptions of the finger ridges by early anatomists, among them Nehemiah Grew (1684), Marcello Malpighi (1686) and J. E. Purkinje (1823), showed an awareness of the intricate make-up of a fingerprint. They did not, however, yield any hint that these observers could foresee the use to which finger impressions would be put.

Interest in modern fingerprint identification dates from 1880. In the latter part of that year, a British scientific journal entitled *Nature* published letters written by two Englishmen, Henry Faulds and William James Herschel, on the subject of fingerprints. Faulds, who submitted his letter first, was associated at the time with a Tokyo hospital. He became interested in the subject through observing fingerprints baked into the surface of pottery and improvised a method of taking finger impressions with printer's ink. That method, in all essentials, is used today. Faulds also anticipated the identification of criminals by their fingerprints. Herschel, who was in the Indian civil service in Bengal, India, subsequently wrote that he had known about and used fingerprints in connection with his official duties for several years prior to the appearance of Faulds's observations. Both of these men, working independently and in widely separated locations, described the uniqueness and permanence of fingerprints—facts which the English scientist Sir Francis Galton was to verify through lengthy systematic observations.

Galton's researches indicated that identical fingerprints were not inherited. Though he suggested an elementary system of fingerprint classification based on grouping the patterns into arches, loops and whorls, it was not sufficiently detailed to permit the filing of large groups of prints. Galton's work, however, served as the technical basis for the fingerprint classification systems developed later by Sir Edward R. Henry, afterward chief commissioner of the London metropolitan police, and by Juan Vucetich of Argentina. Before either system is described, a discussion of the proper method of recording finger impressions may be helpful.

Fingerprints are universally recorded by spreading a thin, uniform film of black printer's ink over a smooth piece of glass or polished metal. The fingers are placed on the film of ink and then pressed immediately on a suitable record sheet or card. The entire pattern of slightly elevated ridges in detailed arrangement is faithfully reproduced by the ink, which dries quickly on the contrasting white card. Impressions of the end joints only are used for classification, but they must be complete and must be recorded in a specified, unvarying sequence.

Every properly taken record card bears two sets of the individual's prints. The "rolled" impressions taken in ten numbered blocks are made by rolling each finger completely from edge to edge in its individual block, thus providing the maximum area for classification. The "plain" impressions appearing at the bottom of the record sheet serve to verify the correct sequence of the rolled prints and may also aid in classification if the rolled impressions are blurred.

The purpose of fingerprint classification is simply to provide a method of filing so that sets of fingerprints can be quickly and easily located. Fundamentally, the classification tells where to look in the file for a prior set of prints and where to file a new set so that it may be located. It is possible, through proper classification of fingerprint patterns, to locate, within a matter of minutes, records previously placed in a filing system comprised of millions of entries.

Fingerprint patterns are classified in a three-way process: (1) by general shapes or contours, (2) by noting the finger positions of the pattern types and (3) by relative "size," which is determined by counting the ridges in loops and by tracing the ridges in whorls. The information thus secured is incorporated in a concise formula known as an individual's "fingerprint classification."

The Henry System.—The Henry system of fingerprint classification, published in June 1900, was officially introduced at Scotland Yard in 1901, displacing the anthropometric Bertillon system for criminal identification record purposes. The system was adopted immediately by scores of law-enforcement agencies around the world and is the most widely used method of fingerprint classification. Its success is attributable to its relative simplicity and the fact that it adapts to almost unlimited extension as a file increases in size.

BY COURTESY OF FEDERAL BUREAU OF INVESTIGATION

ILLUSTRATIONS OF VARIOUS FINGERPRINT PATTERNS

Henry recognized five general pattern shapes or types: the arch, tented arch, radial loop, ulnar loop and whorl. These patterns are generally referred to as A, T, R, U and W.

The whorl-type pattern has several subdivisions which vary slightly in appearance. Whorls are usually circular or spiral in shape. Arches have a moundlike contour. Tented arches are characterized by a spike or steeplelike appearance in the centre. Loops have concentric hairpin or staple-shaped ridges and are described as "radial" and "ulnar" to denote their slopes in relation to the radius and ulna bones of the forearm. Ulnar loops slope toward the little finger side of the hand; radial loops toward the thumb.

Loops constitute approximately 65% of the total fingerprint patterns; whorls make up about 30%; and arches and tented arches together account for the other 5%. The most common pattern type of fingerprint is the ulnar loop. Due to frequency in occurrence, however, both whorl and loop patterns must be subclassified in order to facilitate searching. Subclassification is accomplished by locating certain fixed points called deltas and cores and counting or tracing the ridges lying between such points.

The initial step in the filing procedure under the Henry system is an easy one. Fingerprint records are sorted according to the combination of whorl patterns in the ten fingers. All sets of prints which have no whorl patterns are placed in one file group. Those sets possessing a whorl in the right-thumb position only are placed in another group. Those which have a whorl only in the right-index-finger position are placed in still another group. This process is continued until the final grouping encompasses those sets of prints having whorls in all ten fingers.

The sorting process is accelerated as follows. Certain numerical values are assigned to whorl patterns in the various fingers. These are added in a specified order. The result is a fractionlike number, consisting of a numerator and a denominator, called a primary classification. The possible combinations of whorls, considering both number and position, total 1,024. It follows that there are 1,024 primary classifications.

Primary classifications are not numbered consecutively from 1

to 1,024 but are arranged, instead, in series of 32 in accordance with an original filing plan. The first series runs from 1 to 32 over the denominator "1"; the second series runs from 1 to 32 over the denominator "2"; and the groupings continue in this manner. The first file group which has no whorls at all is written $\frac{1}{1}$ (read as "1 over 1"), and the final file group containing all whorls is written $\frac{32}{32}$ ("32 over 32").

Within each primary group, the fingerprint cards are broken down by a secondary classification consisting of the letter abbreviations for the patterns in the two index fingers. These are always indicated as capital letters (A, T, R and U). The "W" was not placed in the secondary classification by Henry since, within a given primary, it affords no file breakdown. Arches, tented arches and radial loops in the other eight positions occur relatively infrequently and are indicated in the secondary classification as small-letter groups. The three patterns in these positions are abbreviated as a, t and r. Small-letter pattern combinations require a minimum of subclassification.

These initial two parts of the classification system encompass well over 1,000,000 possible file groups. Some of these groups are extremely large; many, however, have few cards in them and many have none. The larger groups are broken down by extension of the classification, the size of the file determining the extent of subclassification needed. The largest single file group is comprised of ulnar loops in all ten fingers. The primary and secondary classifications in this group would be indicated as $\frac{1\ U}{1\ U}$; this group requires subdivision from the outset.

The Vucetich System.—Juan Vucetich of Argentina also devised an original system of fingerprint classification. An employee of the police of the province of Buenos Aires in 1888, Vucetich developed an interest in fingerprints through reading an article outlining the research done by Galton. Like Henry, Vucetich had an expert knowledge of Bertillon's system of body measurements and was convinced of its inherent and practical deficiencies. In 1904, the Vucetich system of classification was published in book form under the title, *Dactiloscopia Comparada* ("Comparative Fingerprinting"). Written in Spanish, this system of classification has achieved prominence in the Latin-American countries and in other Spanish-speaking areas.

Vucetich differentiates four basic patterns: the arch (*arco*); the internal loop, or loop sloping left (*presilla interna*); the external loop, or loop sloping right (*presilla externa*); and the whorl (*verticilo*). His primary classification formula consists of a combination of ten letters and numbers indicating the types of patterns and their positions in the ten fingers. In the two thumbs the four patterns are abbreviated as A (arch), I (internal loop), E (external loop) and V (*verticilo* or the English whorl). In the four fingers of the hands, however, these patterns are designated by the numbers 1, 2, 3 and 4, respectively. In the formula, the right-hand symbols, or "series," are written above the left-hand symbols, referred to as the "section." A set of fingerprints having arch patterns in all ten fingers would be written $\frac{A\ 1111}{A\ 1111}$. The corresponding Henry formula is $\frac{1\ aA3a}{1\ aA3a}$. The Vucetich formula $\frac{E\ 3333}{I\ 2222}$ represents the Henry all-ulnar-loop group which is written as $\frac{1\ U}{1\ U}$. In the Vucetich system, the right-thumb patterns are filed first, followed by the fingers of the right hand before any of the left-hand formula is used. The Vucetich formula represents a calculated 1,048,576 different combinations and is the approximate equivalent of Henry's primary and secondary classifications, including the small-letter combinations. Actually, Henry's primary and secondary represent a greater number of groupings due to his initial differentiation of a fifth pattern, the tented arch. As mentioned previously, many of the potential classifications do not exist and many are extremely infrequent. Also, several types of extensions may be added to divide the larger file groups.

Many additional systems of fingerprint classification have been devised. They are, however, known or used only on a national or local basis. All of these incorporate some principles of the Henry or Vucetich systems, or of both, along with individual technical modifications or "improvements." None of these has attained the widespread acceptance of the prototypes.

Latent Fingerprints.—Latent print work is a specialized branch of fingerprinting involving locating, preserving and identifying impressions left by a culprit in the course of committing a crime. The principal differences between inked fingerprints taken for record purposes and latent or "hidden" prints found at the scene of a crime are the substances of which they are comprised and the generally fragmentary or incomplete nature of latent prints. In the one case, the ridge structure is reproduced in ink on a record card; in the other, it is outlined on the object in sweat, oily matter or other substance present on the fingers. Since the majority of latent prints are almost colourless, they are ordinarily difficult to see and must be "developed" or made visible before they can be preserved or compared.

Although many powders and chemicals have been suggested or employed as developing agents, only a few have been consistently regarded as effective. Gray powders, for use on dark-coloured and mirrorlike surfaces, commonly contain mercury and chalk or aluminum and chalk. Black powder is most often composed of lampblack and a resinous material. Powders are applied with soft bristle brushes. Chemicals employed are iodine, silver nitrate and ninhydrin. Chemicals are superior to powders for developing latent impressions on paper, cardboard or paperlike surfaces.

Latent impressions are preserved as evidence either by photography or by lifting powdered prints on the adhesive surfaces of tape, either rubber or the transparent type.

Extremely fragmentary prints are often adequate to establish positive identification through direct comparison with known prints of suspects even though it would be impossible to identify them through any type of file search. A clear area one-quarter inch square is sometimes enough to permit positive identification. Evaluating, comparing and identifying fragmentary prints are the provinces of the true fingerprint expert.

Latent palm prints, as well as finger impressions, are regularly found at crime scenes. In a few cases footprints or toe prints have been identified. Identifications made with these types of impressions are just as positive and legally admissible as evidence as those based on fingerprints.

The ten-finger classification formula is essential in searching a large collection of fingerprint records. Inasmuch as crime scene prints, in the majority of instances, are isolated impressions of single fingers, it is not feasible to attempt to identify such prints in the main file of fingerprint records. Single-fingerprint filing systems, several of which have been developed, permit the searching of single fingerprints if a pattern area is present. Due, however, to the relatively small area available in single prints on which to base a workable system, single-fingerprint files are limited to the fingerprints of certain types of offenders. In this field, the system of Harry Battley, former chief inspector in charge of the Fingerprint bureau of New Scotland Yard, and a simplified five-finger system presently used by the FBI, are widely known. Many single-fingerprint systems require specially designed scanning glasses or reticules to measure or locate specific details in the impressions being classified.

The Identification Division of the FBI.—Although fingerprint identification owes its inception to English originality and initiative, it is in the United States that it has been developed to its greatest usefulness. Files were set up in the United States a few years after the beginning of the 20th century. Eventually, two of these, operated by the federal penitentiary at Leavenworth, Kan., and by the International Association of Chiefs of Police at Washington, D.C., were consolidated to form the nucleus of the present file maintained in the Identification division of the Federal Bureau of Investigation, U.S. department of justice, Washington, D.C. This identification organization, inaugurated on July 1, 1924, under the guidance of FBI director J. Edgar Hoover, has attained eminence from both the volume and diversity of its huge collection of

records. In the early 1960s the fingerprints of more than 75,000,000 persons were included in the division's files.

Criminal and civil records are filed separately, the vast majority being civil. These records include fingerprints of the armed forces, civilians employed by the federal government, persons fingerprinted in compliance with other federal or local requirements, and several million sets of prints voluntarily placed on file by individuals for use as emergency identification.

The basic Henry system is used by the FBI although some modifications in pattern definitions have been made in the interest of greater precision. It has been necessary to add numerous subclassifications or extensions in order to process and file effectively the great number of records received. Approximately 13,000 contributing agencies forward more than 21,000 fingerprint records to the FBI daily. Of the more than 1,200 fingerprint records of unknown dead persons submitted annually to the FBI, about 60% are identified through cards previously on file. Law-enforcement agencies of 77 foreign nations participate in an international exchange of fingerprints with the FBI.

Due to its extensive collection of civil prints, the FBI has assumed an increasingly important role in identification of the dead, particularly with regard to mass disasters. Available fingerprint records of probable victims, taken to the scene by experts who compare them with the prints of the dead, ensure rapid and positive identification of many bodies which are often mutilated or burned beyond recognition. Numerous bodies which have lain in the open, or been buried for many weeks or months, have been positively identified by fingerprints. As a means of personal identification, fingerprints remain unchallenged. *See* also INVESTIGATION, CRIMINAL: *Methods of Investigation.*

For annual statistics relating to fingerprints *see* "Federal Bureau of Investigation" in *Britannica Book of the Year,* American edition.

(J. E. H.)

FINIAL, in architecture, the decorative upper termination of a pinnacle, gable end, buttress, canopy or spire; especially in the Romanesque and Gothic styles. It usually consists of a vertical pointed central element surrounded by four outcurving leaves or scrolls. When the form it decorates has crockets (*q.v.*) the finial may be formed of four or more crockets surrounding the central uprights. Finials in the form of candelabrum shafts occur frequently in early Renaissance work. The term is also applied loosely to any small pinnacle, knob or other decorative feature terminating a verticle motive. *See* also SPIRE.

FINIGUERRA, MASO (i.e., *Tommaso*) (1426–1464), goldsmith, draftsman and engraver, was born in Florence in 1426, and died there in 1464. He is recorded as the first Italian master of the early Renaissance to specialize in engravings. But owing to lack of documentation, all conclusions as to his activity remain speculative. As a young man Maso is believed to have worked with Lorenzo Ghiberti; later he associated himself with Antonio Pollaiuolo. His own style seems grounded on theirs. None of his productions as a goldsmith is known, save perhaps the Thewalt cross of about 1464, decorated with niello plaques, in the Metropolitan museum, the design of which may be his.

Before 1450 he had been producing nielli. A niello is made by engraving a design on a flat surface of silver and filling the engraved lines with a black enamellike substance. Before applying this substance Maso frequently made casts in sulfur of the engraved silver, and some of these are still preserved, notably the British Museum's "Coronation of the Virgin" of about 1459–1464. He also made niello prints, which are impressions from the silver on paper; some of these also still exist. Sulfur casts and niello prints now give us our most complete picture of Maso as niellist.

From the niello print it was only a step to the copperplate print, and shortly after 1460 Maso seems to have been busy turning these out. Perhaps most famous of the engravings attributable to him is the series of the seven Planets. The art of copperplate engraving is, however, a German development, and Giorgio Vasari erred in hailing Finiguerra as its inventor. Even in Italy he seems not to have been the first. Pollaiuolo's "Battle of the Naked Men" of about 1460 may antedate any of Maso's works. But Finiguerra remained the great popularizer of the new medium.

As draftsman his name is sometimes connected with the Florentine Picture-Chronicle of about 1464 in the British Museum, a work containing more than a hundred lively drawings. He is also believed to have produced designs for the intarsia woodwork in the sacristy of the Cathedral of Florence.

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FINISTÈRE (Lat. FINIS TERRAE, "land's end"), the westernmost *département* of France, comprises the western portion of Brittany. Pop. (1962) 749,558. Area 2,714 sq.mi. It is a peninsular area, jutting out into the Atlantic ocean beyond the *départements* of Côtes-du-Nord and Morbihan which border it to the east, and is formed of ancient rocks, injected with granite. The outcrops of the hardest rocks, granite and quartzite, aligned roughly west-east in the direction of the ancient folding, form low ridges, but only small areas in the Montagnes d'Arrée and Montagnes Noires rise above 1,000 ft. The granite tracts in the north and south form the massive promontories of Léon and Cornouaille, with rocky coasts and islands, among them the island of Ushant (*q.v.*). The re-entrant between is divided by the Crozon peninsula into the harbour of Brest and the bay of Douarnenez. Numerous rivulets flow from the higher ground toward the north and south coasts, and have drowned lower valleys known as *abers.* The longest river, the Aulne, flows through the *département* from the east, traversing the lowland basin of Châteaulin, which corresponds to an outcrop of softer shales, and emptying into the head of Brest harbour.

Along the coast of Finistère is a discontinuous fringe of intensive market gardening, patchworks of tiny plots in which advantage is taken of the exceptional mildness of winter and the early spring to produce early vegetables. This coastal strip benefits also from the availability of fertilizer in the form of seaweed and beach shells, and from the facilities for shipping produce directly across the Channel. The naval base of Brest also provides a local market. Early potatoes are generally the most important product, but there are many local specialities, such as the strawberry cultivation in the neighbourhood of Plougastel-Daoulas and large quantities of onions, artichokes and broccoli, and tomatoes are also grown. Inland, the poor soils and damp, cloudy climate combine with poor communications to make Brittany an area of backward farming. Until modern times great tracts were gorse and heather moorland, but the *bocage* countryside, a patchwork of small, hedge-enclosed fields, has been extended and livestock farming especially has developed. Large quantities of butter are made, and horse breeding is still important. The coastal settlements have other important resources in the fishing and tourist industries, the latter having greatly developed in this century. Fishing is largely a seasonal activity, which families combine with working their small holdings. There is fishing for mackerel, turbot and ray along the north coast, but the warmer water off the south coast has the chief fishing ports, for tunny (especially Concarneau) and sardine (especially Douarnenez), and each port has its canneries. Fishing for lobster and other crustaceans is also important. Brest, although endowed with a magnificent sheltered and spacious harbour, lacks an economically developed hinterland to sustain much commercial activity, and is primarily a naval base. There are several granite and slate quarries, and survivals of local industries typical of the long self-contained economy.

Celtic place names prevail, the parish churches are dedicated to Celtic saints, and Breton is still widely spoken. Megalithic remains are widespread features of the landscape, while calvaries and ossuaries are common manifestations of the intensely Catholic folk culture, as are the local religious festivals (*pardons*) that are still carried on in some places. Quimper and St. Pol-de-Léon have noteworthy cathedrals. Although Brest is the largest town, Quimper is the capital of the *département,* which is divided into four *arrondissements* centred upon Brest, Châteaulin, Morlaix and Quimper. Quimper is also the seat of the bishopric, which is

co-extensive with the *département*. As it is for the rest of Brittany, Rennes, in Ille-et-Vilaine *département*, is the seat of the court of appeal and *académie*. (AR. E. S.)

FINITE DIFFERENCES: *see* CALCULUS OF DIFFERENCES.

FINK, MIKE (1770?–1823), U.S. frontiersman and legendary hero, was born at Ft. Pitt, Pa. As a youth he won fame as a marksman and Indian scout around the fort. Later, when keelboats were the chief vessels of commerce on the Ohio and Mississippi rivers, he became "the king of the keelboatmen," renowned as the best marksman, most energetic roisterer, and champion rough-and-tumble fighter in perhaps the toughest group in the west. In 1822 he joined the Ashley-Henry trapping expedition to the Rockies; the next year he died a violent death at Ft. Henry on the Yellowstone river. Stories about him told orally and published by writers of many sorts in greatly varied publications spread his fame widely between 1828 and the American Civil War, though thereafter it declined. In tall tales, sketches, short stories, romances, plays and even poems, he was a symbol of the boastfulness, the playfulness, the might and the violence of frontiersmen. The picturesque nature of his death had imaginative appeal, and greatly varied versions of his murder were published.

See Walter Blair and Franklin J. Meine (eds.), *Half Horse Half Alligator: the Growth of the Mike Fink Legend* (1956). (W. BL.)

FINLAND (Finnish, SUOMI, in full SUOMEN TASAVALTA), an independent republic in northern Europe. It was a part of Sweden from the 12th century crusades until 1809; from then until 1917 it was a Russian grand duchy. Finland declared its independence on Dec. 6, 1917, and was legally admitted by the treaty of Tartu (Dorpat) with the U.S.S.R. on Oct. 14, 1920. Part of the Scandinavian peninsula, it extends from 59° 30′ to 70° 5′ N. and from 19° 7′ to 31° 35′ E., borders Norway in the north (430 mi.), the Soviet Union on the east (792 mi.), Sweden (335 mi.) and the Gulf of Bothnia on the west, and the Gulf of Finland on the south. The surface area was reduced by about a tenth following the wars with the U.S.S.R. (1939–44). The ceded territories consisted of a large part of the southeastern territory of Karelia, parts of the northeastern parishes of Salla and Kuusamo, and the so-called Petsamo (Pechenga) corridor to the ice-free arctic coast. The northern part of the country comprises the county of Lappi which is part of Lapland (*q.v.*). About one third of Finland's total length is within the Arctic circle.

This article is arranged as follows:

I. Physical Geography
II. Geographical Regions
III. The People
IV. History
V. Administration and Social Conditions
VI. The Economy

I. PHYSICAL GEOGRAPHY

Finland has an area of 130,119 sq.mi. including Ahvenanmaa (*q.v.*) or the Åland Islands, of which 71.6% is forested, 9.4% is under lakes and 8% is cultivated. Physiographically, it forms a part of the Fennoscandian (Baltic) shield of Archean rocks and rises as a low peneplain from the Baltic sea. Average altitudes are from 200 to 400 ft. above sea level and the greatest heights are reached in the extreme northwest (*e.g.*, Haltiotunturi 4,344 ft.). Geologically, Finland is a country of granites, the much-eroded surface of which is littered with glacial debris. Eskers streak the lake plateau from southeast to northwest, but the most outstanding features are the terminal morainic ridges of Salpausselkä, up to 600 ft. high and in the extreme south. Postglacial marine and lacustrine deposits are widely distributed, their clays and silts forming the most fertile tracts. The northern third of Finland has extensive blankets of peat, the humus soil of which is increasingly reclaimed. The landscape may be termed "amphibious." Chief among the tens of thousands of lakes are Saimaa, Päijänne, Näsijärvi, Oulujärvi, Pielisjärvi and Inari (in Lapland). The principal river systems are the Kymi, Kokemäki, Oulu, Kemi and Tornio (which with its tributary the Muonio forms the Swedish boundary). Lake Saimaa drains by way of the Vuoksi river to Lake Ladoga; the Imatra rapids, now harnessed for power, are on the Finnish section of its course. In Salla and Kuusamo there are tracts of White sea drainage: in the north, the Paatsjoki (Pasvik) drains considerable areas to the Arctic ocean. The coast line is much fretted and fragmented. It is marked by isostatic uplift, which is as much as 3 ft. per century in the North Quarken.

Climate.—The climate is of a modified continental character, with cyclonic influences affecting the southwest and severe and prolonged winters to the north. All Finnish waters are subject to varying interference by winter ice. Summers are short, with the long "white nights" of high latitudes. The growing season varies from more than 170 days in the southwest to 110 days in north Lapland. Precipitation is about 24 in. in the south and a little less in the north. About a third falls as snow. Summer frosts are a serious risk.

Vegetation.—Most of Finland is dominated by conifers, with a narrow deciduous zone (much denuded of its original oaks) in the extreme south and a tundra zone in the northern uplands. Pine (*Pinus sylvestris*) and spruce (*Picea abies*) prevail, with a variety of birches. The pine occurs mostly on drier depositional soils: the spruce, on moister bogland soils. Hazel, aspen, maple, elm and lime are also found in the south: alder is widely distributed. The pine extends to the northern limits of Finland, often standing solitarily among the dwarf arctic birch (*Betula nana*) and pygmy willow (*Salix herbacea*). Forest surveys also classify woodlands according to the dominant undergrowth, *e.g.*, heather (*Calluna*), reindeer moss (*Cladonia rangiferina*), *Vaccinium*, *Myrtillus*. Lichens multiply northward. In autumn the woods are rich in edible fungae. More than 1,000 species of flowering plants are recorded. There are some natural meadows along the flood plains of the rivers. Sphagnum swamps are widespread in the north, yielding harvests of cloudberries and plagues of mosquitoes.

Animal Life.—Finland is relatively rich in wild life. Sea birds nest in great numbers on the coastal islands: waterfowl, on the interior lakes. Many birds migrate south in winter. Game birds are more common in the north. Native woodland animals—bear, wolf, glutton (wolverine) and lynx—have retreated to the northeast. Wild reindeer have almost disappeared and those found in the north are domesticated. Salmon, trout and the much esteemed *siika* (whitefish) are relatively abundant in the northern rivers. Baltic herring is the most common sea fish; while the crayfish is caught for a brief summer season. Among reptiles, the viper is found. A noticeable feature, attributed by some to climatic change, is the recent northward advance of fauna and flora.

II. GEOGRAPHICAL REGIONS

Finland's classical geographers—from H. G. Porthan (1739–1804) to Z. Topelius (1818–98) and to J. G. Granö (1882–1955)—have been much concerned with its regional distinctiveness (*see* J. G. Granö, *Die Geographischen Gebiete Finnlands*, Helsinki, 1931). The three principal regions—a coastal plain, an interior lake district and an interior tract of higher land which rises to the falls (*tunturit*) of Lapland—merge imperceptibly into each other. The coastal plain may be subdivided into (1) a narrower tract sloping from Salpausselkä to the Gulf of Finland; (2) the southwest plainlands of Turku-Pori *lääni* (county); (3) the broad coastal lowlands of Pohjanmaa (Österbotten, Ostrobothnia). The coastal region has the most extensive stretches of farm land, the most continuous settlement and the largest number of urban centres. Associated with it are the offshore islands which reach their greatest extent in the Turku (Åbo) archipelago. The lesser Vaasa archipelago looks across North Quarken to the Umeå skerries. The "lake district" with its inland archipelagoes is the heart of Finland. It has been less subject to outside influences than the coastal region and its population has greatly increased in recent decades. Industrial cities—older, such as Tampere (Tammerfors) and Jyväskylä, and younger, such as Lahti and Valkeakoski—mix with administrative centres such as Kuopio and Mikkeli (St. Michels). The region is transitional to what may be called "colonial" Finland, the northeastern third of the country where the landscape still takes precedence over cultivated land. These frontier lands of the counties of Lappi and Oulu, with Rovaniemi as the chief inland administrative centre, have never known more active colonization than in the mid-20th century. (W. R. ME.)

III. THE PEOPLE

Rich Stone Age finds show that from prehistoric times the Finnish peninsula has been the meeting place of cultural influences from Russia, Scandinavia and central Europe. Besides ancient Lapp and Nordic stocks, Finland has been inhabited by Finno-Ugrian peoples of which the Karelians and the Tavastians (Tavastlanders), can be distinguished among present day Finnish-speakers (*suomalaiset*). The Karelians probably entered from the south-east and the Tavastians across the Gulf of Finland. (Tacitus' *Fenni*, for so long associated with the Finns, are now thought to be Lapps.) The Karelians are generally darker and shorter and have shorter skulls than the Tavastians, many of whom are noticeable for their pronounced cheek bones.

Finnish and Swedish are both official languages although by 1960 the Swedish-speaking percentage in the rapidly expanding population had declined to 7.4 (partly because of emigrations to Sweden and the U.S.). Swedish-speaking areas are the southwest and south coasts and Ahvenanmaa; dialects form a fairly distinctive group called "East Swedish." There is a small Lappish-speaking population in the far north.

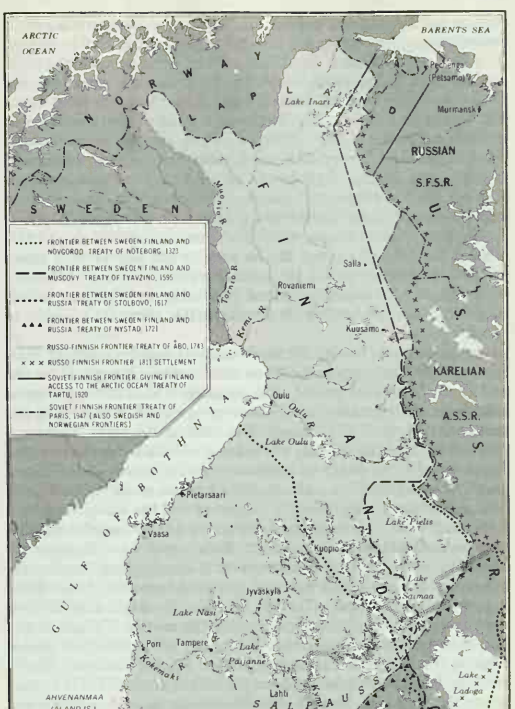
Christianity had its first footholds in the southwest as early as the 11th century but spread slowly. More than 95% of the population belong to the Evangelical Lutheran National Church (Evankelisluterilainen Kirkko) which is divided ecclesiastically into eight bishoprics (with Turku as the archiepiscopal see), 68 provostships and more than 560 parishes; the religious life is notable for piety and ecstatic revelation. The Greek Orthodox church of Finland claims 1.7% of the population. Finnish folk culture has many constituents unique in Europe, *e.g.*, in its lore, the role of the magician in its mythology, its music (the *kantälä*, Kantele or Finnish harp), forest-burning agriculture and steam-bath (sauna). In the mid-20th century there was much valuable Finnish inspiration in music (*e.g.*, Jean Sibelius), architecture, dress and work in glass besides work in the traditional medium of wood. (*See* also FINNISH LITERATURE; FINNO-UGRIC LANGUAGES; LAPLAND.) (R. P. B. P.)

Population.—The population, numbering about 421,500 in 1750 and 1,661,000 in 1851, had risen to 4,029,803 by 1950 and 4,446,222 by 1960. Considerable redistribution followed the loss of territory in 1944 (see *History* below) when about 425,000 refugees had to be resettled, and population structure was also affected by wartime casualties estimated at 78,000 killed. In 1960 live births were 18.5 per thousand, and the death rate was 9.0 per thousand. There was heavy emigration, especially from Ostrobothnia, earlier in the century. The common Scandinavian labour market encouraged regular movement, and a pronounced migration from countryside to towns was also evident. The principal centres of population (1960) are: Helsinki (Helsingfors), the capital, 452,777; Tampere (Tammerfors), 127,260; Turku (Åbo), 124,359; Lahti, 66,802; Oulu, 58,197; Pori, 54,103; Vaasa, 42,701; Kuopio, 44,911; and Jyväskylä, 39,636. (W. R. ME.)

Läänit (capitals in parentheses)	Area (sq.mi.)	Population (1960 census)	Density (per sq.mi.)
Ahvenanmaa or Åland Islands (Maarianhamina)	581	20,981	36.1
Häme or Tavastehus (Hämeenlinna)	7,499	580,765	77.4
Kesti-Suomi or Mellersta Finland (Jyväskylä)	7,077	245,014	34.6
Kuopio (Kuopio)	7,734	270,504	35.0
Kymi or Kymmene (Kotka)	4,961	337,772	68.1
Lappi (Rovaniemi)	38,274	205,113	53.6
Mikkeli or St. Michels (Mikkeli)	8,359	234,629	28.1
Oulu or Uleåborg (Oulu)	23,626	406,992	17.2
Pohjois-Karjala or Norra Karelen (Joensuu)	8,277	207,742	25.1
Turun-Porin (Turku-Pori) or Åbo-Björneborg (Turku)	8,886	660,269	74.3
Uudenmaan (Uusimaa) or Nyland (Helsinki)	4,000	832,936	208.2
Vaasa (Vaasa)	10,845	443,505	40.9
Total	130,119	4,446,222	34.2

IV. HISTORY

The ancestors of the present Finns began to migrate to Finland from the southern shore of the Gulf of Finland about A.D. 100.



FRONTIERS OF FINLAND FROM 1323 TO 1947

Finland was until then an almost uninhabited country: the nomadic Lapps who had hitherto been scattered over the greater part of Finland withdrew to the north, out of the way of the newcomers, and Finnish settlement spread across the south of Finland from west to east, reaching Karelia by *c.* A.D. 800. Meanwhile other peoples of Balto-Finnic (or Finno-Ugric) origin seem to have arrived in Karelia from the east. The population, even in the south of Finland, was still extremely sparse, and no Finnish state emerged. Three loose unities, however, seem to have crystallized: the Finns proper; the Tavastians; and the Karelians. These each had their own chiefs, and they waged war on each other.

Swedish Rule.—Christian missionaries were active in western Finland from the 11th century onward; Finland's first bishop, the Englishman Henry, who had formerly been bishop of Uppsala (Sweden), died a martyr's death *c.* 1155. The oldest primary document concerning Finland is a papal bull of 1171 or 1172, which refers to the Finns as looking to Sweden for protection against kindred tribes or Russians in the east. Early in the 13th century Bishop Thomas, another Englishman, converted the Tavastians, whose territory was annexed to Sweden by Birger Jarl in 1238 or 1249. In 1293 the Swedes undertook a crusade to Karelia, where the Novgorodians had already been propagating the Greek Orthodox faith. A war against Novgorod ended in the peace of Nöteborg (Orekhovets or Pähkinäsaari) in 1323, which divided Karelia between Sweden and Novgorod. Later settlements by pioneers from the western side of the demarcation line shifted the effective border further eastward.

Finland having thus become a part of the Swedish kingdom, Swedish inhabitants moved to its coasts (Ahvenanmaa had long been inhabited by Swedes). Some degree of Swedish cultural in-

fluence had already reached the Finns, and now Scandinavian institutions began to take root. Finland ranked equally with Sweden as a part of the realm: in 1362 the Finns were granted the right to take part in the elections of the Swedish kings, and this was the origin of the Swedish-Finnish diet. Under Swedish sovereignty the Finnish tribes gradually developed a sense of unity, which was encouraged by the bishops of Turku. Study in universities brought Finnish scholars into direct touch with the cultural centres of Europe, and Mikael Agricola (*c.* 1510–57), the creator of the Finnish literary language, brought the Lutheran faith from Germany. As part of medieval Sweden Finland had enjoyed, in effect, a semi-independent status, which had been underlined since 1581, when King John III raised the country to the dignity of a grand duchy. In the course of the administrative reforms (1611–32) of Gustavus II Adolphus, Finland became an integral part of the kingdom and the educated classes thereafter came increasingly to speak Swedish.

On its eastern frontier Finland was harassed by constant warfare, and the danger became more serious when Novgorod, at the end of the medieval period, was succeeded by a more powerful neighbour, the grand duchy of Moscow. In 1595, however, by the peace of Täyssinä (Tyavzino), the existing *de facto* boundary, right up to the Arctic ocean, was granted official recognition by the Russians. By the peace of Stolbovo (1617), Russia ceded Ingermanland and part of Karelia to the kingdom of Sweden-Finland. The population of the ceded territories was of the Greek Orthodox faith, and when the Swedish government began forceful conversion to Lutheranism many fled to Russia and were replaced by Lutheran Finns. After Stolbovo Sweden found new outlets for expansion in the south and west and developed into one of the leading powers of Europe. Though Finnish conscripts played their part in making Sweden a great power, the role of Finland in the kingdom steadily decreased in importance. In Charles XII's reign Sweden lost its position as a great power. During the Great Northern War Russians occupied Finland for eight years (1713–21), and under the treaty of Nystad (Uusikaupunki) in 1721 Sweden had to cede the southeastern part of Finland with Viipuri (Vyborg) as well as the Baltic provinces. The Finns lost their faith in Sweden's capacity to defend Finland and the years of hostile occupation had given them a permanent feeling of insecurity.

In the course of the next Russo-Swedish war (1741–43), the Russian empress Elizabeth declared to the Finnish people her intention of making Finland a separate state under Russian suzerainty, but she failed to follow up the idea and at the peace settlement of Turku (Åbo) in 1743 contented herself with annexing a piece of Finland. Meanwhile, however, her original idea had found favour with some Finns, not so much as a tempting possibility but as a last resort against merging with Russia. During the next bout of hostilities (1788–90), a number of Finnish officers involved themselves in the activities of G. M. Sprengtporten (1740–1819), a Finnish colonel who had fled to Russia and who wanted to detach Finland from Sweden; this movement won little support, however.

Autonomy Under Russian Rule.—In Feb. 1808 the Russian emperor Alexander I, under pressure from Napoleon, invaded Finland in an effort to force Sweden to abandon its pro-British policy. Thanks largely to the defeatism of the Finnish officers, the invaders made rapid progress in the initial stages, and Alexander announced the annexation of Finland to Russia. Finnish resistance stiffened, however, and the uncertainty of the international situation made it important for the Russians to win the sympathy of the Finns lest they should pine for their old association with Sweden. Alexander summoned the Finnish diet to convene at Porvoo (Borgå) in March 1809 and promised to allow Finland to retain its constitution and not to interfere with existing civil and religious rights. Thus Finland had already achieved autonomy before being formally ceded to Russia on Sept. 17, 1809, under the peace treaty of Fredrikshamn (Hamina). The autonomy of the grand duchy was manifested in the diet, in the constitution and laws inherited from the Swedish kingdom, in the government of Finland by a senate and in the fact that all matters concerning Finland were submitted direct to the emperor. The territories ceded to Russia by the peace treaties of 1721 and 1743 were restored to the grand duchy in 1811. Finland had, in addition to the senate, a governor general who was the personal representative of the emperor, and there was also a Finnish minister of state in St. Petersburg whose job it was to submit the most important items of Finnish business to the emperor in person. In 1812 the country's capital was transferred from Turku to Helsinki (Helsingfors). Finland's autonomous status favoured the growth of a strong sense of nationality.

Swedish continued to be the language both of administration and of education. Publication of the great national epic *Kalevala* compiled by Elias Lönnrot (*q.v.*) helped to foster a national spirit. Then the philosopher Johan Vilhelm Snellman (1806–81), later to become one of Finland's most eminent statesmen, led a demand from the 1840s onward for the adoption of Finnish as the mother tongue of the educated classes and insisted that Finnish should be allowed in government offices and schools. A number of educated people adopted Finnish as their first language, but the majority of this class continued to be Swedish-speaking. Thus two rival groups came into being, and in the 1860s and '70s these organized themselves into political parties.

During Alexander II's reign Finnish autonomy was strengthened. The old constitutional laws inherited from Sweden were supplemented in 1869 by a new constitutional law concerning the Finnish diet. The Finnish monetary system was dissociated by degrees (1860–77) from the Russian. In 1878 Finland obtained its own conscript army. There was also a gradual improvement in the status of Finnish: in 1858 the first Finnish secondary school was established and after 1863 the use of Finnish was permitted in government offices. The reforms of the period were partly a result of Snellman's realistic statesmanship and partly the outcome of the demands of the Liberals, whose main aim was to develop an autonomous and constitutional system of government.

Nationalism had already begun to raise its head in Russia before the end of Alexander II's reign, but his strong-minded successor Alexander III, who had a personal liking for Finland, was able to resist the demands of the Russian nationalists for the abolition of Finnish autonomy and the absorption of the Finns into the Russian nation. Russian jurists took the line that, though Alexander I in virtue of his supreme powers had granted Finland autonomous rights, any Russian emperor exercising the same supreme powers was entitled to take them back whenever he wished. Applying this principle, Nicholas II issued a manifesto on Feb. 15, 1899, according to which he was entitled, without the Finnish diet's consent, to enact laws enforceable in Finland if such laws affected Russian interests. Direct attempts at Russification were then made. The gradual imposition of Russian as the official language was ordered in 1900 and in 1901 it was decreed that Finns should serve in Russian units and that Finland's own army should be disbanded. Increasing executive power was conferred on the ultranationalist governor general, Gen. N. I. Bobrikov. Faced with this situation, two opposing factions crystallized out of Finland's political parties: the Constitutionalists (the Swedish party and the Young Finnish party), who demanded that nobody should observe the illegal enactments; and the Compliers (the Old Finnish party), who were ready to give way in everything that did not, in their opinion, affect Finland's vital interests. The Constitutionalists were dismissed from their offices and their leaders were exiled. Young men of Constitutionalist views refused to report for service when called up and at last the emperor had to give in: the Finnish army remained disbanded, but no Finns were drafted into the Russian army. A more extreme group known as the Activists were prepared to endorse even acts of violence, and Bobrikov was assassinated by them.

Further opposition came from the Labour party which had been founded in 1899 and had in 1903 adopted Marxist tenets, changing its name to Social Democratic party (Sosialidemokraattinen puolue). Unwilling to compromise with tsarist Russia, the party was developing along revolutionary lines. When the Constitutionalists, availing themselves of Russia's momentary weakness, combined with the Social Democrats to organize a national strike, the emperor restored the *status quo ante* 1899 (Nov. 4, 1905)—but

not for long. Another result of the strike was a complete reform of the parliamentary system (July 20, 1906). This had been the Social Democrats' most insistent demand. The old four-chamber diet was changed to a unicameral parliament elected by equal and universal suffrage. The Social Democrats became the largest party in parliament, obtaining 80 seats out of 200 in the very first elections (1907). Nevertheless, the importance of parliament remained very small, as it was constantly being dissolved by the emperor; thus the assault on Finnish autonomy soon began afresh. The Constitutionalists resigned from the government and the Compliers soon followed their example, since even in their opinion the extreme limit had been overstepped. In the end an illegal senate composed of Russians was formed. In 1910 the responsibility for all important legislation was transferred to the Russian duma.

The Achievement of Independence.—When autonomy could no longer be defended by legal means, active resistance revived. On the outbreak of World War I the Finnish Activists asked the Germans, as Russia's chief enemies, whether they would give military training to Finnish volunteers who intended to start an insurrection when opportunity arose. The Germans consented, and 2,000 men, from all ranks of society, made their way secretly to Germany to join the "Jägers." When the tsarist regime in Russia collapsed, the Russian provisional government appointed a parliamentary senate for Finland, with the Socialist Antti Oskari Tokoi as president, and restored Finland's autonomous rights (March 20, 1917). This was no longer enough: the Finns then desired to shake themselves free of Russia altogether.

On July 18, 1917, the Finnish parliament, on the initiative of the Social Democrats, adopted by 136 votes to 55 a proclamation arrogating to itself the emperor's powers in Finland; foreign policy and military matters, however, remained the responsibility of the authorities in Russia. The provisional government dissolved parliament and invalidated the proclamation: in this it had the support of the Finnish *bourgeoisie,* most of whom did not want a constitution that did not provide for any head of the state. The dissolution of parliament tended to strengthen the revolutionary wing of the Social Democrats, and the ferment was increased by the famine and severe unemployment that resulted from Finland's economic isolation in World War I. After the Communist Revolution in Russia the extreme left on Nov. 13, 1917, called a general strike and resorted to acts of violence. By the proclamation of Nov. 15, 1917, parliament again assumed the emperor's powers, this time without excluding foreign policy and national defense but only until such time as a constitution for Finland had been enacted. The actual power was vested in a government composed of all the bourgeois parties and headed by P. E. Svinhufvud. A formal declaration of independence was passed by parliament on Dec. 6.

Finland sought and was accorded recognition by the Soviet government (Jan. 4, 1918), whereupon several neutral and Entente countries as well as the Central powers followed suit. But there were 40,000 Russian troops in Finland, and these supported the Red guards, an armed organization that had been set up by the extreme left. In the absence of a Finnish army, the Activists had organized a Civic guard, partly to expel the Russians and partly to maintain internal order, and the government placed it under the command of Gen. Carl Gustaf Emil Mannerheim (*q.v.*). He was given the task of expelling the Russian forces from Finland and on Jan. 27, 1918, he began operations from the base he had selected in Ostrobothnia. Meanwhile the Social Democratic party, then controlled by the Red guard, seized southern Finland. The war of independence became a civil war, cruel on both sides. The battle front divided the country into two areas of roughly equal population, "White" and "Red." Troops were called up by the government under the 1878 act, which had been illegally repealed by Russia; the Finnish "Jägers" arrived from Germany; and early in April the Germans sent an expeditionary force of 12,000 under Rüdiger von der Goltz. Germany also gave Finland political support, for the treaty of Brest-Litovsk (*q.v.*) of March 3, 1918, laid down that Russian troops were to leave Finland. The war came to an end on May 16.

Two days after the conclusion of the war Svinhufvud was elected regent, and both the government and a majority of the parliament (from which almost all Social Democratic members were absent) were in favour of a monarchical form of government. Since it was hoped that Germany would guarantee Finland's independence, a German prince, Frederick Charles of Hesse, brother-in-law of the German emperor, was elected on Oct. 9 king of Finland. When Germany collapsed, the prince refused to accept the crown. Mannerheim, who had been keeping out of the limelight, then entered into relations with the western powers. Svinhufvud resigned, and on Dec. 12 Mannerheim was elected regent. Parliament was dissolved; new elections were held on March 1, 1919, and the depleted Social Democratic party obtained 80 seats. In the new parliament the supporters of a republic had a large majority. By the constitution of June 17, 1919, executive power was vested in a president elected for a six-year term by 300 electors nominated by the citizens.

At the Paris peace conference Finland was not treated as an ally of Germany. Peace between Finland and the U.S.S.R. was concluded at Tartu (Dorpat) on Oct. 14, 1920. In addition to the territory of the former grand duchy, the treaty granted Finland a corridor to the Arctic ocean at Petsamo. On Dec. 16, 1920, Finland became a member of the League of Nations. When Sweden, in accordance with the wish expressed by the local population, applied for the annexation of Ahvenanmaa, the League of Nations decided in June 1921 in favour of Finland but insisted on a considerable degree of autonomy for the islanders.

During the early years of the republic considerable changes took place in the party system. The Swedish People's party (Svenska folkpartiet), composed both of conservatives and liberals, remained unchanged. The conservative elements of the Compliers and of the Finnish-speaking Constitutionalists combined to form the National Coalition party (Kansallinen Kokoomus), while the liberals of these groups coalesced into the National Progressive party. The small Agrarian union (Maalaisliitto) grew into the largest of the bourgeois parties. V. A. Tanner reconstituted the Social Democratic party in 1918–19, committing it to parliamentary methods and leaving its intransigent left wing to join the Communist party, which had been founded in 1918. The Communist party was dissolved in 1923 as a result of its illegal activity but was reformed and subsequently took care to remain formally on the right side of the law. Although it was not very large (having secured 23 seats at the 1929 election), many Finns were alarmed at the idea of a Communist party operating openly in such close proximity to the U.S.S.R., and a demand arose for discriminatory laws against Communism. These laws were passed in 1930 against a background of intensified right-wing Lapua extremist agitation, which went on until 1932. In due course those right-wing extremists who favoured a nondemocratic form of government founded the Isänmaallinen Kansanliike (I.K.L.) or Patriotic People's movement, but this remained politically insignificant. Internal dissension was aggravated by the language quarrel, which had flared up again and was carried on with especial bitterness in Helsinki university circles. Meanwhile a lively program of social reform was carried out. The great land reform, under which tenant farmers had been turned into proprietors, had already been enacted in 1918.

Government changes were frequent, ministries being composed either of all the bourgeois parties together or only of some of them, in which case the government was usually a minority one. On one occasion the Social Democrats formed a government on their own (1926–27), and in 1937–39 they shared office with the centre parties. Because of the wide powers of the presidency, the personalities of the various presidents made themselves clearly felt. The first president of the republic was Kaarlo Juho Ståhlberg (Progressive party; 1919–25). His successors were: Lauri Kristian Relander (Agrarian union; 1925–31), Svinhufvud (National coalition; 1931–37) and Kyösti Kallio (Agrarian union; 1937–40).

In foreign policy Finland remained neutral. In 1935 the government announced that Finland would pursue a policy in line with that of the Scandinavian countries; since no question of military

co-operation between these countries ever arose, such a policy amounted in fact to neutrality. In 1938–39 Finland and Sweden jointly undertook the fortification of Ahvenanmaa, but abandoned the project as a result of Soviet opposition. Relations with the U.S.S.R. were never good, but a Finnish-Soviet nonaggression treaty was signed in Moscow on Jan. 12, 1932.

World War II.—By the German-Soviet agreements of Aug. 23 and Sept. 28, 1939, Finland was considered as belonging to the Soviet sphere of interest, and on Oct. 5, 1939, the Russians invited a Finnish delegation to Moscow for political discussions. The principal demands made by J. V. Stalin were the surrender of a small but strategically important area of the Karelian isthmus (against compensation in eastern Karelia) and the lease of the Hanko (Hangö) peninsula to the U.S.S.R. as a naval base. Backed unanimously by public opinion, the Finnish government and parliament refused to agree to the demands, apart from a minor frontier adjustment. On Nov. 30 Soviet armed forces attacked the country and two days later Moscow set up a puppet Finnish government consisting of Communists who had fled to Russia after 1918, headed by Otto Wilhelm Kuusinen, the secretary of the executive committee of the Comintern. In Finland an all-party government under Risto Ryti was set up, and Mannerheim, then 72, accepted the command of the armed forces although he knew that material preparations for defense had been sadly neglected. The Finns fought heroically and inflicted great losses on the enemy in the battles fought in the wastes of the eastern boundary. As a result of the Finns' stubborn resistance, the U.S.S.R. consented to negotiate a peace with Finland's legal government. But before peace was concluded the Russians had smashed the Finnish lines on the Karelian isthmus.

The League of Nations urged member nations to give Finland assistance. Great Britain and France each promised to send a force, but the Finnish government considered this aid inadequate; Sweden and Norway (though the former provided generous aid in the form of armaments) refused to allow transit right to Allied troops. Finland could not hope to hold out alone against superior forces and on March 12, 1940, signed a peace treaty in Moscow ceding to the U.S.S.R. the southeastern part of the country and leasing Hanko as a Soviet naval base. The inhabitants of the ceded area chose to settle in what was still Finnish territory. (*See* WORLD WAR II: *The Russo-Finnish Winter War.*)

After the conclusion of peace Soviet pressure continued to be exercised in various ways. An attempt to create a defensive alliance between Finland and Sweden was at once vetoed by the U.S.S.R., which also intervened in Finland's internal affairs and acquired military transit rights across southern Finland to Hanko. When the Germans conquered Norway, Finland was isolated from the western powers and felt itself to be entirely at the mercy of the U.S.S.R. V. M. Molotov, on his visit to Berlin in Nov. 1940, did in fact announce his intention of dealing with Finland as he had done with the Baltic states. The only country from which support could be hoped for was Germany, and when the Germans in their turn requested military transit rights, they were granted (Sept. 1940). By the time when Hitler launched his attack on Russia (June 22, 1941), German troops had poured into Finnish Lapland, and there was nothing that could then prevent Finland from becoming a theatre of war. When the German attack began, Finland announced its intention of remaining neutral; however, after the Russians had bombed a number of towns in southern Finland, parliament declared (on June 25) that a state of war existed between Finland and the U.S.S.R. Thus began the Russo-Finnish Continuation War. The command was again placed in the hands of Mannerheim, who succeeded in maintaining the independence of the Finnish forces *vis-à-vis* the German command, refusing, for example, to attack Leningrad or the Murmansk railway. Foreign affairs were handled by Ryti (who on Dec. 19, 1940, succeeded Kallio as president of the republic). By the end of Aug. 1941 all the territory lost in 1940 had been reconquered, but the Finnish offensive was kept up until the beginning of December, by which time the greater part of eastern Karelia had been secured. It was considered that this area might be valuable as a bargaining counter in peace negotiations. Just before the close of this offensive (Dec. 6) Great Britain declared war on Finland, but no actual hostilities between the two countries took place. The United States, however, never issued a declaration of war.

Feelers were put out for a peace with the U.S.S.R., but these were all unsuccessful, partly because the Finns were unwilling to accept the 1940 frontier, on which the Soviet government insisted, and partly because the Germans were still strong and it was feared that they would occupy the country, which would then become a Soviet-German battlefield. When detailed peace conditions were conveyed to the Finns in March 1944, two of them were considered impossible of fulfillment: the payment of a war indemnity of $600,000,000 and the expulsion of all German troops within a month. In June 1944 a major Russian offensive broke the Finnish lines on the Karelian isthmus and the Finns were obliged to withdraw also from eastern Karelia. For the sake of obtaining military aid Ryti, on his own responsibility, signed a treaty with Germany. As soon as the front was stabilized Ryti resigned the presidency and Mannerheim (marshal of Finland from June 4, 1942) was elected in his place (Aug. 4). The armistice with the U.S.S.R. was signed on Sept. 19. Once again Finland ceded the territory lost in 1940, plus Petsamo (Pechenga); instead of Hanko, the Porkkala peninsula, only 18 mi. from Helsinki, was leased to the U.S.S.R. The indemnity was reduced to $300,000,000. It took several months of fighting to expel the Germans (under Col. Gen. Lothar Rendulic) from Lapland.

The Republic Since 1945.—The peace treaty between Finland and the Allies was signed in Paris on Feb. 10, 1947; in the main it confirmed the stipulations of the armistice. Until the peace treaty came into force (Sept. 15, 1947) an Allied control commission, headed by the Russian A. A. Zhdanov, sat in Finland to supervise the execution of the armistice conditions. Since the payment of the war indemnity proved to be beyond Finland's capacity, the U.S.S.R. agreed to extend the period of payment from six to eight years and to reduce the total by $73,500,000. If the true market value of the reparation payments (completed in Sept. 1952) was taken as the basis of calculation, Finland actually paid the equivalent of $444,700,000; the discrepancy was due to the use of 1938 prices. Considerable internal difficulties were caused by the armistice clause compelling Finland to "collaborate with the Allied powers in the apprehension of persons accused of war crimes." Finland was forced to set up an emergency tribunal and, on the strength of a retroactive law, to sentence its wartime political leaders to imprisonment as "war criminals." The "Fascist" organizations whose disbandment was ordered included not only such bodies as the I.K.L. but also the Civic guards, which had continued to exist after 1918 and, although run on a voluntary basis, had formed an integral part of the armed forces.

One of the problems arising out of the cession of territory was the resettlement of the more than 400,000 Karelians. The refugees were paid compensation for the property that they had lost in Karelia, and new holdings were found for farmers, either of cultivated or of cultivable land, partly by means of compulsory expropriation.

In the parliamentary elections of March 1945 the Communists, campaigning as the Suomen Kansan Demokraattinen Liitto (S.K.D.L.; Finnish Democratic People's league), emerged with 51 seats. The political leadership fell to the aged statesman J. K. Paasikivi, first as prime minister (Nov. 1944) and then, from March 5, 1946, on the resignation of Mannerheim, as president of the republic. During the period 1944–48 several members of the S.K.D.L. held posts in the cabinet, including both the premiership (Mauno Pekkala) and the ministry of the interior (Yrjö Leino). The Communist state police detained many people in prison without trial or sentence. The Communists failed, however, to bring either the army or the regular police under their control and in May 1948 parliament found the courage to pass a vote of nonconfidence in the Communist minister of the interior. In the elections of July 1948 the S.K.D.L. lost 13 of its seats, and Karl August Fagerholm formed a minority government of Social Democrats, under which democratic liberties were restored. During Paasikivi's second term of office as president (1950–56) there followed a series of governments composed jointly of Agrarians

BY COURTESY OF (TOP LEFT, TOP RIGHT, CENTRE RIGHT) EMBASSY OF FINLAND; PHOTOGRAPHS (BOTTOM LEFT) WALT SANDERS FROM BLACK STAR; (BOTTOM RIGHT) FERNAND GIGON FROM BLACK STAR

SCENES IN FINLAND

Top left: A grove of young birch trees in the winter. Birch is used widely in the plywood and furniture industries of Finland

Top right: Aerial view of Turku, third largest city of Finland

Centre right: Punkaharju ridge, a continuous strip of land winding between lakes near Laukansaari

Bottom left: Statue of Alexander II of Russia, and the cathedral, Helsinki

Bottom right: Children feeding pigeons on the Esplanade, Helsinki

FINLAND

PHOTOGRAPHS: THREE LIONS

LIFE IN FINLAND

Top left: Lumber piled up for transport to a processing plant

Top right: Horse-drawn cart, still used in northern cities such as Sodankyla

Centre right: Laplander and child of the Lake Inari region. The cradle is covered with reindeer skin

Bottom left: Horse and sled used to drag cut timber from the woods

Bottom right: Water front houses, Porvoo. The tower of the cathedral is in the background, right

and Social Democrats, led mostly by Urho Kaleva Kekkonen, who had risen to the leadership of the Agrarian league.

In his conduct of foreign affairs Paasikivi made it his aim to build up a relationship of mutual confidence between Finland and the U.S.S.R. On April 6, 1948, a Soviet-Finnish treaty of mutual assistance was signed, under which Finland was bound to come to the defense of the U.S.S.R. if the latter were attacked through Finland—but even then on Finnish territory only. On Sept. 19, 1955, an agreement was signed in Moscow by which the U.S.S.R. gave up its military base at Porkkala in return for a 20-year prolongation of the treaty of mutual assistance. Later in 1955 Finland was admitted to the United Nations and joined the Nordic council.

On Feb. 15, 1956, Kekkonen was elected president by 151 votes against 149 for Fagerholm, who became prime minister. The heated labour disputes that had been a feature of economic life ever since the war culminated in a general strike which lasted three weeks (March 1956). Co-operation between the Social Democrats and the Agrarians broke down in the spring of 1957, and the Agrarians began a deliberate cultivation of the left-wing opposition group within the Social Democratic party. This group ultimately seceded and formed its own party. In Aug. 1958 Fagerholm formed a majority government composed of all the parties except the Communists and the left-wing Socialist group. When the Soviet government indicated clearly that this government was not to its liking, the Agrarians resigned from it in December and formed a single-party minority government in Jan. 1959.

On Oct. 30, 1961, a Soviet note to Finland invoked the 1948 mutual assistance pact with a demand for immediate defense talks. The talks were "postponed" after a meeting between Kekkonen and N. S. Khrushchev. The coalition of Social Democrats and bourgeois parties which had aimed to elect the attorney general Olavi Honka president of the republic broke up, and in Feb. 1962 Kekkonen was re-elected by a large majority. (E. K. I. J.)

V. ADMINISTRATION AND SOCIAL CONDITIONS

Government.—Finland adopted a republican constitution in 1919. Legislative power rests in the diet (*eduskunta*) of 200 members, elected by proportional representation for four years, and the president, elected for six years. All citizens over 21 are entitled to vote. Executive power is vested in the president and council of state (cabinet), which is appointed by him and responsible to the diet. At the 1958 election the three largest parties were the People's Democratic league (emerging as the S.K.D.L.), which represents the extreme left and includes Communists, the Social Democratic opposition and the Agrarian party, others being the National coalition (Conservatives), Swedish People's party and Finnish People's party (Liberals).

Finland is divided into 12 *läänit* (counties) (*see* Table). These are under the supervision of presidentially appointed governors and are subdivided into rural and urban districts; market towns and cities form independent municipalities.

The chancellor of justice is the supreme judicial authority and there is a supreme court (*Korkein oikeus*), which appoints the circuit judges, together with four courts of appeal.

Welfare and Education.—The ministry of social affairs (established 1917) supervises local social welfare boards and is also responsible for such matters as health and unemployment insurance, pensions, workers' protective legislation and employment exchanges. Compulsory accident insurance dates from 1895, insurance against occupational disease from 1926, and old age and disability insurance from 1939. Winter unemployment and underemployment are persistent problems. Housing is good, with apartments dominant in towns and wooden dwellings common in rural areas. Few countries have built more housing units per head since World War II.

Finland is a highly literate nation. School attendance is compulsory between the ages of 7 and 15 years. About 430 secondary schools prepare for the students' examination (*ylioppilastutkinto*) at 17–18 years and for technical and vocational training. Finland's first university was founded in Turku in 1640 and transferred to Helsinki in 1827. Turku has a Swedish-speaking (1919) and a Finnish-speaking (1922) university. Oulu university was opened in 1959. Jyväskylä has a pedagogical institute of university standing.

Defense.—By the treaty of Paris (1947) Finland may maintain an army of 34,400, an air force of 3,000 officers and men and 60 aircraft (bombers being forbidden) and a navy up to 10,000 tons with 4,500 officers and men. All male citizens between 19 and 60 are liable for military service. Finland has an "agreement of friendship, co-operation and mutual assistance" with the U.S.S.R. It is also a member of the Nordic council.

VI. THE ECONOMY

Agriculture, Forestry and Fisheries.—About two-fifths of the population earn their living from agriculture and forestry. Coniferous woodlands form an integral part of most farms and frame the agricultural horizon, although reclamation still continues. Of about 360,000 holdings more than half have less than 12 ac. of cultivated land: most are run on a mixed farming basis and almost all are owner-occupied. The leading crops are sown grasses and clovers, oats, barley, potatoes, wheat, rye, sugar beet and rape. There is increasing use of artificial fertilizers, partly imported. Animal husbandry is concentrated on dairy cattle (more than 1,100,000 milch cows), with Ayrshires most important after native breeds, and on pigs. The ensilage value of hay, oats and other crops has been greatly improved by the AIV method, named for Artturi Ilmari Virtanen (*q.v.*). Finland has a surplus of dairy products and a deficiency of grains. Sheep (about 400,000) have diminished in number, but poultry (4,000,000) and reindeer (160,000) have increased. Horses are still bred for export, though numbers in use (250,000) have declined with the increase in tractors. Mechanical techniques facilitate deep drainage (most farms still have open ditches), stone clearance, harvesting and animal management. The severe northern winters call for heavy investment in farm buildings.

About three-quarters of the country is under forest (mostly pine and spruce) but this shows marked variations in quality, with regeneration more speedy in the south. The annual output of timber is about 50,000,000 cu.yd. Advisory organizations such as "Tapio," foresters' schools and the university institute of forestry at Helsinki have made Finland a leader in softwood management. Accessibility is the key to exploitation and there is a steady extension of sleighways, forest roads, and lake and river floatage ways. Logging operations are confined to the summer months because of the prevalence of ice in the winter. Fragmentation of ownership has been increased by resettlement legislation whereby 30,000 new farms have been created, principally by dividing larger properties.

Coastal fisheries, with the aid of modern trawlers and canneries, make a small contribution to the economy, but the yield of and market for Baltic herring tend to decline.

Minerals and Power.—A diversity of minerals occurs in the Archaean bedrock, but output is modest. Outokumpu, in the east, has Finland's largest copper mine, producing about 600,000 tons of copper, zinc and iron sulphides annually. Limited amounts of iron, vanadium and titanium are produced at Otanmäki, near Kajaani, and there are new iron ore developments at Jussarö in Uusimaa and at Äkäslompolo in the western part of Finnish Lapland. There is also a little granite quarrying, while cement output has grown in Parainen in the southwest and Lappeenranta in the southeast.

Finland has neither coal nor oil. Much of its power comes from hydroelectric plants, relatively low heads of water making damming necessary, but these have to be supplemented by thermal power stations. The loss of Karelian hydroelectric resources has turned attention to the north, where Oulu river sites have been developed and the Kemi river system was harnessed in the 1960s.

Industry.—The dominant basis of industry is softwood. Historically, tar and pitch have given place to sawn goods, pulp, (mostly chemical) and paper. There are mills by the lakes (*e.g.*, at Varkaus, Mänttä, Vuoksenniska) and along rivers (Kuusankoski) and estuaries (Kotka, Oulu, Pori, Kemi), while integrated plants produce wallboard, plywood and veneer. Old-established metallurgy persists in such places as Taalintehdas (Dalsbruk) and Fiskari (Fiskars). The number of engineering and shipbuilding

establishments greatly increased after 1944 (*e.g.*, for electrical goods in Helsinki, locomotive and truck assembly in Tampere, shipbuilding in Turku), and Helsinki gained a new reputation for building icebreakers. Textiles are manufactured at Turku, Tampere, Vaasa, Forssa and Hyvinkää. The capital is said to have Europe's largest porcelain factory, while Riihimäki, Karhula and Iittala have international reputations for glass. Naantali has Finland's largest oil refinery, and Oulu manufactures phosphates. The processing of agricultural products, often in co-operatively owned factories, is widely distributed.

Trade.—During the period of reparations (1944–52), the U.S.S.R. claimed the leading role in Finland's trade, but by 1960 the United Kingdom had again become the main export market, others, after the U.S.S.R., being the German Federal Republic, the United States and France. The main suppliers of imports are the German Federal Republic, the U.S.S.R., the United Kingdom, Sweden, France and the United States. The principle of most-favoured nation was reapplied in the 1961 trade pact with the U.S.S.R. which provided for a 25% trade increase between the two countries.

The most valuable exports are wood and wood products, cardboard and paper, wood pulp, transport equipment, and machinery and apparatus. The chief imports are mineral fuel and oils, metals and metal goods, machinery and apparatus, transport equipment and textiles.

Finance.—About one-third of the government's total revenue is derived from income and property taxes, farm and forest land being taxed according to estimated fertility. Of current expenditure, about one-third goes to education and other social services. State business enterprises include an alcohol monopoly and softwood processing plants, while the state also owns substantial share capital in commercial organizations. The Bank of Finland (Suomen Pankki) has been a state bank from its inception in 1811 and has been guaranteed and supervised by the diet since 1868. Finland acquired its own monetary system in 1860, the unit of currency being the markka, which had an official par value of 320 markkaa = $1 until 1963 when it was revalued at 3.20 markkaa. Finland is a member of the International Monetary fund.

Transport.—There were in the early 1960s about 300,000 motor vehicles in Finland, but most of the 40,000 mi. of roads are unsurfaced because it has been considered more important to build additional roads. New bridges and ferries are rapidly improving communications; *e.g.*, in the Turku archipelago. There are more than 3,000 mi. of state-owned railways and these are still being extended. There is a break of gauge between Tornio and Haparanda, Swed., but continuity with the Soviet system at Vainikkala in the southeast. The Finnish line terminates at the Soviet border in Salla, but no traffic has passed through to the Murmansk sector. Diesel locomotives are slowly replacing coal- and wood-burning engines. Much of Finland's oversea traffic is carried by the Finnish merchant fleet, which exceeds 700,000 gross tons. Lake and island shipping routes are uneconomic except during the tourist season. The Soviet segment of the Saimaa canal (the link between Lake Saimaa and the Gulf of Finland, completed in 1856 and bisected by the 1944 frontier) was in Nov. 1960 leased to Finland for 50 years. Finnish airways provide connections with Stockholm, Copenhagen, Zürich, Paris, London, Moscow and other cities, besides maintaining a dense domestic network. The chief airport is Sentula (Helsinki). *See* also references under "Finland" in the Index volume.

(W. R. Me.)

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(W. R. Me.; E. K. I. J.; R. P. B. P.)

FINLAY, CARLOS JUAN (1833–1915), Cuban physician and epidemiologist, discoverer of the mosquito vector of yellow fever, was born in Puerto Príncipe (now Camagüey), Cuba, on Dec. 3, 1833, of an English father and a French mother. He took his degree in medicine at Jefferson Medical college, Philadelphia, Pa., in 1855, and after further study in Havana and Paris began the practice of medicine in Cuba, first at Matanzas and then in Havana. Forced to emigrate to Trinidad for political reasons, he returned to Cuba permanently in 1870 and began to interest himself in the great sanitary problems of his country.

In Aug. 1879 a North American commission arrived in Cuba to study the causes of yellow fever, and Finlay was designated by the Cuban government to co-operate with this commission. He conceived the idea that the transmission of yellow fever from the sick person to the well one required a vector, and at the International Sanitary conference in Washington (1881) he urged this point strongly. In Aug. 1881 Finlay read before the Academy of Sciences of Havana his historic work showing a mosquito, *Culex fasciatus* or *Stegomyia fasciata* (now known as *Aëdes aegypti*), to be the vector of the yellow-fever organism. His theory, though based on numerous experiments and observations, was not accepted by the scientific world for almost 20 years. It was confirmed by Walter Reed (*q.v.*) in his report before the International Sanitary conference at Havana in Feb. 1901. As a consequence of this notable discovery, there followed the work of W. C. Gorgas (*q.v.*) in Cuba and Panamá for the eradication of the mosquito vector, putting an end to the plague that for more than 200 years had scourged the Caribbean and Gulf coastal areas.

Apart from his work in the epidemiology of yellow fever, Finlay published numerous works on exophthalmic goitre, tuberculosis, filariasis, trichinosis, beriberi, leprosy, cholera and tetanus, as well as works on ophthalmology, which was his first branch of specialization in medicine. The Finlay Institute for Investigations in Tropical Medicine was created by the Cuban government in his honour. He died at Havana on Aug. 20, 1915. *See* also Yellow Fever.

(R. A. Pi.; X.)

FINLAY, GEORGE (1799–1875), British historian and philhellene, was born of Scottish parents near Faversham, Kent, on Dec. 21, 1799. He studied law in Glasgow, and about 1821 went to Göttingen. In 1823 he went to Greece, being interested in the struggle for Greek independence, and spent 14 months studying the country. At Cephalonia he met Byron, and for two months spent nearly every evening discussing Greek affairs with him at Missolonghi. After a short visit to Scotland in 1825, he returned to Greece, where he spent the rest of his life.

In 1827 Finlay took part in the unsuccessful operations of Lord Cochrane and Sir Richard Church for the relief of Athens (*see* Greek Independence, War of). When independence was secured in 1829 he bought an estate in Attica, and tried, without much success, to introduce better methods of agriculture in Greece. He then turned to the systematic study of Greek history with which he occupied himself until his death in Athens on Jan. 26, 1875.

The first part of his great work appeared in 1844, under the title of *Greece Under the Romans*, and was followed by *History of the Byzantine and Greek Empires From 716–1453*, two volumes (1854); *History of Greece Under the Ottoman and Venetian Domination* (1856) and *History of the Greek Revolution*, two volumes (1861). From 1864 to 1870 he was correspondent of the *Times* (London).

Bibliography.—H. F. Tozer's edition of his *History of Greece From Its Conquest by the Romans to the Present Time, 146 B.C.–A.D. 1864*, 7 vol. (1877), which includes the books mentioned above, contains also a fragmentary autobiography in vol. i. Finlay's *Greece Under the Romans* and *History of the Byzantine Empire From 716 to 1057* have been published in the Everyman Edition (1906).

FINLAY, ROBERT BANNATYNE FINLAY, 1st Viscount (1842–1929), British lawyer and statesman, remembered

for his work in the field of international justice, was born near Edinburgh, Scot., on July 11, 1842, and educated at Edinburgh university. He was called to the bar in 1867 and became a queen's counsel in 1882. He sat as Liberal member of parliament for Inverness Burgh from 1885 to 1892 and from 1895 to 1905. In 1895 he became solicitor general in Lord Salisbury's government as a Liberal Unionist and was knighted. He was attorney general from 1900 to 1905.

Elected member for Edinburgh and St. Andrews universities in 1910, Finlay became lord chancellor in Lloyd George's coalition government of 1916 and received a barony. He became a viscount on his retirement in 1919. He was appointed British member of the Permanent Court of Arbitration at The Hague in 1920 and a judge of the Permanent Court of International Justice in 1921. He resigned because of ill health in 1928 and died in London on March 19, 1929.

FINNER, the name used by whalers to denote the finback whales or rorquals (*see* also WHALE).

FINNEY, CHARLES GRANDISON (1792–1875), U.S. "new measure" evangelist, theologian and college president, was born in Warren, Conn., Aug. 29, 1792, and grew to manhood in Oneida county, N.Y. After teaching school for a few years he studied law privately and in 1818 entered the law office of Benjamin Wright, Adams, N.Y. His religious training had been meagre, but references to Mosaic institutions in his law studies impelled him to study the Bible. With his conversion in 1821 he was convinced that he had been given a "retainer from the Lord Jesus Christ to plead His cause," so he immediately dropped his law practice to become an evangelist, and was licensed by the Presbyterians. Adopting some of the features of frontier revivals —especially the "anxious seat"—and addressing congregations as he used to plead with a jury, he fomented wild revivals in the villages of upper New York. These methods, carried into the Congregational and Presbyterian churches of the larger towns and cities, were soon dubbed "new measures" and aroused intense opposition, particularly among men trained in the New England schools and at Princeton. Such opposition lessened as Finney's methods became more polished, while his revivals carried into the larger cities continued to be spectacularly successful.

In 1832 he began an almost continuous revival in New York as the settled minister of the Second Free Presbyterian church. Because he was at odds with Presbyterian theology and discipline, his supporters built the Broadway tabernacle for him in 1834. Two years later he withdrew from the presbytery, and the church became Congregational in polity. In 1835 he became professor of theology in the newly formed theological school at Oberlin, O., and for two years divided his time between that post and his New York tabernacle. In 1837 he severed his connection with the latter and became minister of the First Congregational church in Oberlin, which was closely related to Oberlin college. From 1851 to 1866, besides his other two posts, he was president of the college. He died Aug. 16, 1875.

The changing modes and surroundings of Finney's career as a revivalist typify the development of revivalism during the period of his greatest activity. Beginning in raw frontier villages among lower-class and poor people, he moved into the burgeoning urban centres of financial and social power, working among those of the rising middle class with its growing philanthropic interests. In making this change of locale, his revivals were metamorphosed from the largely unplanned fomenting of emotional outbursts leading to conversions, into rather carefully designed meetings in which he pleaded the cause of Christianity in sermons and lectures which resembled the lawyer's brief. When he settled as a minister and professor of theology his emphasis changed from concentration solely upon getting conversions to include concern for the perfection of the Christian life in the churches.

His theology was typical of all the revivalists, emphasizing common sense and man's initiative in conversion and ability to make himself a new heart by his own choice. As did other revivalists, he tended to make the test of the truth of the doctrine preached its effectiveness in getting results, namely converts. This emphasis, of course, played havoc with traditional standards of doctrine and polity in the churches, impoverishing the religious life by excessive emphasis on the conversion experience to the neglect of cultivation of the Christian life thereafter.

His life is best told in his *Memoirs* (1876), and his views expounded in his *Lectures on Revivals* (1835) and *Lectures on Systematic Theology* (1847). (S. E. MD.)

FINNISH LITERATURE. Finland was rich in folklore, and in epic poetry orally handed down (*see* KALEVALA), but its written literature began virtually with the work of Mikael Agricola (*c.* 1510–57), who published an ABC book (*c.* 1540–42) and, as bishop of Turku, religious and educational works. A translation of the New Testament was printed in 1548 and of some books of the Old Testament in 1551–52. A complete Finnish Bible was published at Stockholm in 1642.

Swedish rule was unfavourable to the development of Finnish literature, but the annexation of Finland by Russia (1809) led to a revival of national consciousness that in turn stimulated the development of a national literature. In 1835, through the efforts of Elias Lönnrot (*q.v.*), the first edition of the *Kalevala* was published; this greatly enriched the Finnish written language, which had been little used for literary composition. The pioneer work of Suomalaisen Kirjallisuuden Seura (the Society of Finnish Literature), founded in 1831, and of the patriotic philosopher and politician J. V. Snellman (1806–81) resulted in the evolution of a national literature. Of great importance was Snellman's reform of 1863, which put Finnish on an equal footing with Swedish as an official language.

Modern Finnish literature had its roots in the poetry, drama and fiction of Aleksis Kivi (*q.v.*), a genius with an original style who inspired others to write in Finnish. The play *Nummisuutarit* (1864) is one of his robust peasant comedies. His most famous work is the epic novel *Seitsemän veljestä* (1870; Eng. trans. *Seven Brothers*, 1929), in which Kivi gives full rein to his humour and rich fantasy. Realistic writing was developed by the woman novelist and playwright Minna Canth (*q.v.*). Cultural life received a vigorous impulse when Kaarlo Bergbom (1843–1906) founded the Finnish National theatre in 1872 and P. E. Cajander (1846–1913) translated Shakespeare's plays.

The central figure at the beginning of the 20th century was Juhani Aho (*q.v.*), a realist who toward the end of his life made large concessions to romanticism. His works include *Rautatie* (1884), *Papin tytär* (1885) and *Lastuja* (1891–1921), eight volumes of stories, memoirs, essays and sketches. Aho and Teuvo Pakkala (1862–1925) may be regarded, after Kivi, as the originators of the modern Finnish novel and short story. A much-discussed author was Johannes Linnankoski (pseudonym of Wihtori Peltonen; 1869–1913); his best-known novel was *Laulu tulipunaisesta kukasta* (1905; Eng. trans. *Song of the Blood-Red Flower*, 1920) and his best work stylistically was *Pakolaiset* (1908).

Joel Lehtonen (1881–1934), who began as a national romanticist, attained remarkable results in the field of epic writing (the novel *Putkinotko*, 1919), but later became an exponent of witty social criticism. Ilmari Kianto (1874–) skilfully portrayed peasant life (*Punainen viiva*, 1909; *Ryysyrannan Jooseppi*, 1924, etc.), and Arvid Järnefelt (1861–1932) became a disciple of Tolstoi. A milestone was the appearance in 1933, after a long silence, of *Alastalon salissa*, by the important writer Volter Kilpi (1874–1939); picturesque and rich in detail, it is a monument of a patriarchal country community.

Like most Finnish writers, the 1939 Nobel prize winner F. E. Sillanpää (*q.v.*) depicted country life, but none has caught its poetic undertones as well as he, especially in his lyrically beautiful novel *Ihmiset suviyössä* (1934). The "proletarian" writer Toivo Pekkanen (1902–57) began his career as a factory hand and became a member of the Finnish Academy; *Lapsuuteni* (1953) is a harrowing but uplifting account of his hard early years.

The historical novels of the versatile and prolific Mika Waltari (1908–) are well known abroad; in his later novels, beginning with *Feliks onnellinen* (1958; Eng. trans., *The Tongue of Fire*, 1959), he reverts to an early interest in religion. Pentti Haanpää (1905–55) was a master of the short story; his harsh humour and pithy style were well suited to his portrayal of the

ordinary soldier and of life in the backwoods. He, like many others, made full use of the kaleidoscopic nuances of the Finnish language and created many new words to give colour and precision to his writings.

Jorma Korpela (1910–), belonging to the tradition of Dostoevski, published an excellent novel in 1960, *Tunnustus*, the first since the taut and sensitive prose of his *Tohtori Finckelman* (1952). Väinö Linna (1920–), whose *Tuntematon sotilas* was such a success in 1954, continued his social trilogy *Täällä Pohjantähden alla*, the first part of which appeared in 1959. Other outstanding novelists were Veikko Huovinen (1927–), a satirist with a dry humour; Marko Tapio (1924–), who at first showed the influence of Sillanpää but later seemed to be seeking his way toward a style all his own; Paavo Rintala (1930–), a portrayer of the social scene, the recurrent theme in his novels being his deep concern for the fact that the best and most sensitive qualities in human nature are often crushed by the callousness of others; Veijo Meri (1928–), with a rather grotesque and grim humour which he uses to great effect; and Antti Hyry (1931–), an objective storyteller with a unique style characterized by short sentences and minute detail.

The leading woman writer during the first half of the 20th century was Maria Jotuni (1880–1943), whose short stories and plays had keen humour and insight into human nature; also prominent in cultural life were Maila Talvio (1871–1951) and Aino Kallas (1878–1956). Of the younger generation, Eeva Joenpelto (1921–) soon established herself as a novelist with a sure style; both she and Marja-Liisa Vartio (1924–) wrote revealingly about women.

The greatest poet in Finnish after Kivi was Eino Leino, whose best-known work is *Helkavirsiä* (vol. i, 1903; vol. ii, 1916), poems in ballad style showing a mastery of form and impulses from folklore. The most significant of the poets before Leino to express the nationalist Finnish movement was Kaarlo Kramsu (1855–95), and typically Finnish in feeling in the next generation was the lyrical Larin-Kyösti (1873–1948), a contemporary of the classicist and stylist Otto Manninen (1872–1950), who was also a translator of the Greek classics and of Molière, Goethe and Ibsen.

Two eminent poets, scholars and critics were V. A. Koskenniemi (1885–1962) and Lauri Viljanen (1900–). The development of modern Finnish poetry was influenced by Juhani Siljo (1888–1918), Aaro Hellaakoski (1893–1952), who is in many ways a prototype, Uuno Kailas (1901–33) and Kaarlo Sarkia (1902–45). Important also were P. Mustapää, whose real name is Martti Haavio (1899–), Yrjö Jylhä (1903–56) whose poems *Kiirastuli* describe the events of the Russo-Finnish war in the winter of 1939–40 with a searing beauty, Viljo Kajava (1909–) and Lauri Viita (1916–), who also wrote a notable novel, *Moreeni* (1950). The modernist generation was represented chiefly by Paavo Haavikko (1931–), a poet of international class and Pentti Holappa (1927–), both of whom have also published novels. The early deaths of two women poets, Saima Harmaja (1913–37) and Helvi Juvonen (1919–60), were a great loss to Finnish letters. The work of Aale Tynni (1913–), Eeva-Liisa Manner (1921–), Aila Meriluoto (1924–) and Kirsi Kunnas (1924–) merits attention; the last two also wrote charming verse and prose for children. Helvi Hämäläinen (1907–) is a noted writer of both poetry and prose.

Swedish-Finnish Literature.—Finland's most famous poet is Johan Ludvig Runeberg (*q.v.*), whose works, though written in Swedish, are truly Finnish in spirit. Zacharias Topelius (1818–98) also influenced Finnish literature in general. Among many fine poets of the next generation were Bertel Gripenberg (1878–1947), Arvid Mörne (1876–1946) and Emil Zilliacus (1878–1961) who also translated the Greek classics into Swedish. Edith Södergran (1892–1923) was a pioneer with a deep influence on later writers as well as on contemporaries; modernism's second great figure was Elmer Diktonius (1896–1961), followed by Gunnar Björling (1887–1960), Rabbe Enckell (1903–), Göran Stenius (1909–) and Ralf Parland (1914–). Walentin Chorell (1912–) was an outstanding playwright and novelist, and prominent among younger writers were Jörn Donner (1933–) and Bo Carpelan (1926–). A sensitive and productive writer was Solveig von Schoultz (1907–), the leading woman poet after Södergran.

One of the great humanists of Europe was Yrjö Hirn (1870–1952), essayist, aesthete and literary historian. Runar Schildt (1888–1925) was the most eminent writer of Swedish prose in Finland. His son Göran Schildt is well known abroad for his books on travel and the history of art.

Finns whose mother tongue is Swedish made up less than 10% of the total population in the 1960s. Sales for the works of Swedish-Finnish writers was therefore inevitably small in Finland but there was an immediate market in Sweden.

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FINNISH ORTHODOX CHURCH, one of the Orthodox Eastern Churches (*q.v.*), was detached from the church of Russia when Finland became an independent republic at the end of World War I. In the 12th century the Finns of Karelia were converted by Russian missionaries from Novgorod, when the rest of the country was christianized by the Swedes. After the Reformation, attempts were made by the Swedes to convert the Orthodox Finns to Lutheranism, with the result that many of them migrated to Russia. Orthodoxy prospered, however, in the 19th century, when Finland came under Russian rule. In 1919 the Finnish Orthodox Church was granted autonomy by the patriarch of Moscow, a status conferring independence except in relations with other churches and the appointment of its archbishop. In 1923 it transferred to the jurisdiction of the patriarch of Constantinople with autonomous status. After World War II its organization was disrupted by the cession to the U.S.S.R. of the Karelian isthmus, which necessitated the transfer of its members to otber parts of Finland. In 1957 the patriarch of Moscow (but not the patriarch of Constantinople) recognized it as autocephalous.

The Finnish Orthodox Church, whose members make up about 1.5% of the population in a predominantly Lutheran country, follows the western dates for Easter and the fixed feasts. Its liturgical languages are Finnish and Slavonic, and there are three monasteries. The archbishop resides at Kuopio, and there is also a bishop at Helsinki. (H. M. W.)

FINNMARK, a *fylke* (county) in the far north of Norway, borders Finland in the south and the U.S.S.R. in the southeast. The Arctic ocean is to the north and northeast. Pop. (1961 est.) 72,038. Area 18,782 sq.mi.

Long, broad fjords penetrate the land masses; in the west they are protected by islands. The weather is often stormy, especially in winter when the temperature averages 23° F. on the coast, and 10° inland. Summer temperatures are in the 50s. Steep cliffs rise 500–1,000 ft. from the sea to a barren plateau of sedimentary rocks. To the south a boggy Pre-Cambrian peneplain is exposed, with many small lakes and a few branched river systems draining to the fjords. Lapps keep their reindeer herds there during winter, and in spring move to the coast.

Fishing is the principal industry, pursued the whole year from settlements along the coast. In the lower valleys cattle farming is important. Near Kirkenes in Sør-Varanger, close to the Soviet border, iron ore is mined (yearly output 1,000,000 tons). An east-west motor road is blocked by snow in winter. A road from Hammerfest, a commercial centre of the county, goes southward to Finland. A regular Bergen-Kirkenes liner service calls at all principal coastal towns. (L. H. HG.)

FINNO-UGRIC LANGUAGES are a family of languages constituting much the larger of the two branches of a more comprehensive grouping, the Uralic languages. The Finno-Ugric languages are spoken by over 18,000,000 people distributed discontinuously over an area extending from Norway in the west to the environs of the Ob river in Siberia, and into the Carpathian basin. In this vast territory, the Finno-Ugric peoples constitute

enclaves, surrounded mostly by speakers of Germanic, Slavonic, or Turkic tongues. Formerly, their habitat was more restricted, essentially to a region between the Baltic and the Urals; it was under the pressure of their Indo-European and Turkic conquerors that they migrated, in successive waves, farther to the west and north in Europe and beyond the Urals into Asia.

The family is usually considered to comprise the following extant units.

The Ugric division. This is further subdivided into: (1) Hungarian (Magyar); and the two Ob-Ugric languages, (2) Vogul (Mansi), and (3) Ostyak (Khanty). Single Hungarian words are known from the 10th century and the first full text from the 13th, so that this is both the oldest recorded Finno-Ugric language as well as the one spoken by the largest population (about 13,000,000). Vogul, the language of some 5,000 peasants, hunters and reindeer breeders, is spoken along the western tributaries of the Ob and the Irtysh; and Ostyak is spoken by over 20,000 fishermen, hunters and reindeer nomads along the Ob and several of its tributaries.

The two Permian languages. They are the closely related (4) Zyrian (Komi) and (5) Votyak (Udmurt). Attested since the 14th century by religious texts and inscriptions written in a specially constructed alphabet, invented by St. Stephen of Perm (1335–1396), Zyrian—also known as Syryenian—is now spoken by more than 360,000 people over an enormous territory between the Vychegda, Mezen, Pechora and Kama rivers, near the Arctic ocean, as well as in the Murmansk region and on both sides of the Urals. Zyrian has two literary forms, one of them based on the southernmost dialect, Permyak. Votyak is spoken between the Vyatka and the Kama, and smaller groups are scattered beyond both of these rivers; there are over 500,000 speakers.

There are two groups of (6) Mordvins (Mordva), the Moksha and the Erzya, who speak different dialects and possess separate literary standards. Mordvin is spoken by a population of approximately 1,500,000, in numerous enclaves south of the Volga bend, along both sides of the river.

The (7) Cheremis (Mari) divide into three dialect groups spoken, by a population of somewhat under 500,000, along the right bank of the Volga (the so-called Mountain Cheremis, of Kozmodemyansk); in the prairie region beyond the left bank (Meadow Cheremis); and in the Bashkir Autonomous Soviet Socialist Republic (Ufa Cheremis).

The Finnic (or Balto-Finnic) division consists of eight more or less mutually intelligible dialects or languages: (8) Finnish (Suomi); (9) Karelian; (10) Olonets; (11) Vepse; (12) Lude; (13) Vote; (14) Estonian; and (15) Livonian. Finnish is the language of about 3,500,000 speakers in Finland (where it is the principal national tongue), and in adjacent regions of Scandinavia and the U.S.S.R. Written Finnish dates from the 16th century and has been, since the middle of the 19th, the vehicle of a comprehensive literature. Karelian is a term used to designate a dialect spoken in the Karelian Autonomous Soviet Socialist Republic; Olonets is the dialect spoken on both sides of the boundary north of Ladoga. Lude is spoken farther to the east and it, in turn, shades into Vepse, spoken in small settlements along the southwestern edge of Lake Onega. Vote is spoken by a dwindling population—perhaps 500 peasants—in Ingria. Estonian is used by about 1,250,000 speakers in the Estonian Soviet Socialist Republic and in scattered enclaves elsewhere in Russia. Its written form dates from the 16th century; modern literary Estonian is based upon the Tallin (northwest) dialect, but formerly the rather different Tartu (southeast) dialect was employed for this purpose. Livonian is almost extinct; it is spoken by perhaps 1,500 fishermen and peasants on the north promontory of Kurland.

The (16) Lapp languages, spoken by over 30,000 people, are usually divided into northern (sometimes, however, called central or western), southern and eastern groups. Northern Lapp is the language of the reindeer breeding Finnish Lapps, those of Norwegian Finnmark and Troms, and of Norrbotten, except that southern Lapp is spoken in the southernmost region of this Swedish province. Eastern Lapp is the language of the fishermen of Inari, and the Russian Lapps of Kolta and Kola.

The vocabulary of the Finno-Ugric languages contains an adequate common stock of terms to permit the reconstruction of the ancestor language, but also reflects a series of contacts with neighbouring peoples at different periods in their history. The Iranian loanwords seem to be the oldest. Finnish borrowed from Lithuanian in remote times, and later from Germanic languages and Russian. Cheremis, Votyak and the Ob-Ugric tongues are rich in Turkic loans. Hungarian has also borrowed, at different times, from several Turkic sources, as well as from Iranian, Slavonic, German, Latin and Romance.

The sound systems of the present day Finno-Ugric languages exhibit a variety of structures and practically no trait is common to them all. Vowel harmony, for instance, which is sometimes thought of as a characteristic of these tongues, is absent from Ostyak, Lapp and the Permian group. Consonant gradation—an intricate alternation between two classes of stem consonants—occurs in Lapp and the Finnic tongues, with only occasional traces in the sister languages. The grammar of Finno-Ugric languages typically operates by the addition of multifarious endings to different stem forms. The declension of some of these languages—for example, Hungarian and Finnish—includes a more or less elaborate case system. Lapp and the Ob-Ugric languages possess dual number as well as plural. The verb in the Ugric languages and Mordvin is marked by a distinction between subjective and objective conjugation, and the non-Ugric languages have a negative conjugation. A typical feature of Finno-Ugric syntax is illustrated by the contrast of these two Hungarian phrases: *a nagy ház* "the big house," and *a ház nagy* "the house is big": in the former phrase, the attribute precedes the head; in the latter, an equational sentence, the predicate comes after the subject.

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FINSBURY, a metropolitan borough (1899) of London, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Islington to form the new London borough of Islington (*see* LONDON).

Finsbury metropolitan borough is bounded by Islington, Shoreditch, the City of London, Holborn and St. Pancras. Pop. (1961) 32,887. Area 0.9 sq.mi. Because of the large number of offices, factories and warehouses in Finsbury it has been estimated that the daytime population is about 150,000.

One member is returned to parliament by the constituency of Shoreditch and Finsbury. The borough was created from the parishes of St. James and St. John, Clerkenwell; St. Luke, Middlesex; St. Sepulchre, Middlesex; the Charterhouse and the liberty of Glasshouse Yard.

The Angel, once a famous coaching inn, lies in Finsbury and not Islington as commonly supposed; from there, Goswell road, the residence of Charles Dickens' Mr. Pickwick, and St. John street radiate through the borough. Rosebery avenue runs from St. John street southwestward to Clerkenwell road, which with Old street crosses the borough from west to east. The old distinctions of Clerkenwell on the west and St. Luke's on the east are still frequently used. Local industries are many and include light engineering, manufacture of optical, surgical and scientific instruments, clothing factories, printing, bookbinding, stationery, tobacco-pipe manufacture, brewing and distilling. Watch- and clockmaking, once the largest industry in Finsbury, has almost disappeared, but the borough is still the centre of the repairing trade and for the supply of parts and tools. The establishment of the British Horological institute in Northampton square in 1858 showed the importance of Clerkenwell as the centre of the trade, and the Northampton Polytechnic carries on the tradition by holding special classes in horology and optical work. The large parcels depot and inland section of the general post office (built in 1934) are at Mount Pleasant, Rosebery avenue; close by are the Finsbury town hall (1895) and the head offices of the Metropolitan Water board (1920), with the former reservoirs of the New River Head.

It is probable that the name of the borough is derived from the family name of the Fiennes (also spelled Finnes or Fennes), who

were the owners of Finsbury manor, the manor house of which stood in Finsbury fields or Fynnysberefelde. Two ladies of this family gave some land north of the city gates for the use of the citizens of London. The nature of this ground, which was marshy and fenlike, led to the belief that this was the origin of the name Fensbury or Finsbury. The ground was drained in 1527 and for several centuries was used for sports and pastimes, especially for archery. Chalybeate springs were discovered in Clerkenwell in the 17th century, the most famous being Sadler's well. Islington spa and the London spa. These were quickly made into popular resorts by their enterprising owners, who added tea gardens and other entertainments to attract custom. The Fortune theatre and Red Bull theatre were erected at the end of the 16th century. After the fire of London many refugees came from the city into Moorfields, and it was from that time that the area really became residential. By 1901 its population had risen to 101,463.

The borough includes several buildings of historical interest. In the old parish of Clerkenwell (*q.v.*) is the gatehouse of the former priory of St. John of Jerusalem. West of Aldersgate street are the buildings of Charterhouse (*q.v.*), originally a Carthusian monastery, subsequently a hospital and school. Bunhill fields, City road, is the famous burial ground used by the dissenters from the middle of the 17th century until 1852; the graves of John Bunyan, Daniel Defoe, Isaac Watts and William Blake (*qq.v.*) are there. Facing Bunhill fields is Wesley's chapel and the house of John Wesley, which is now a museum. In Bunhill row John Milton died. South of Bunhill fields lies the Artillery ground of the Honourable Artillery company, so occupied since 1641, with barracks and an armoury house, started in 1734, completed in 1735.

Sadler's Wells theatre, Rosebery avenue, preserves the name of the fashionable medicinal spring discovered in the grounds of Sadler's Musick house in 1683. A new theatre was built on the site in 1765 and rebuilt in 1931, and it is now famous for ballet and opera. The Northampton Polytechnic, St. John street, was opened in 1898. Owen's school for boys was founded in 1613, and in 1886 a girls' school was opened. St. Luke's Hospital for Lunatics, Old street, erected in 1751, is now a Bank of England printing works.

The housing programs, after World War II, of Finsbury Borough council included Spa Green estate, Priory Green estate, Holford Square estate and the Stafford Cripps estate; the three blocks of the latter are 12 stories high. The borough is provided with only 15 ac. of open spaces, but it has a large memorial sports centre (38 ac.) at Barnet, Herts, opened by Prince Philip, duke of Edinburgh, in May 1955. This comprises football, cricket and hockey pitches, bowling green, tennis and netball courts, putting green, running track and children's playground. (M. McD.)

FINSEN, NIELS RYBERG (1860–1904), Danish physician, winner of the 1903 Nobel prize in medicine for advances in the treatment of skin diseases, was born Dec. 15, 1860, at Thorshavn, in the Faeroe Islands. His parents were Icelandic, and he went to school in Reykjavik. His interest in the contrasts in the light and darkness of the north led him to study the effects of light on living organisms. Graduated in medicine from the University of Copenhagen in 1890, Finsen conducted experiments on light and published (1893) a paper on treatment of smallpox with red light (excluding blue, violet and ultra-violet rays of ordinary light), thus preventing suppuration of pustules. Later he found actinic rays to be responsible for the bactericidal property of sunlight, and this enabled him to develop a method of treatment of lupus vulgaris by ultra-violet rays. In 1895 he published his general theory of the effect of light on living organisms. *The Treatment of Lupus Vulgaris by Concentrated Chemical Rays* was published in 1897. Finsen's Light institute was founded in Copenhagen in April 1896. From the age of 23 Finsen was practically an invalid, and during the last few years of his life he directed the work of the institute from his home. He died Sept. 24, 1904. (A. U. D.)

FINZI, GERALD (1901–1956), English composer known for his settings of Shakespeare and Thomas Hardy, was born in London, July 14, 1901. He studied under Sir Edward Bairstow (1918–22) and R. O. Morris (1925), and was professor of composition at the Royal Academy of Music, London (1930–33). In 1935 he published his first important work, *Introit*, for violin and small orchestra, followed by his nocturne for orchestra entitled *New Year Music*. With his *Dies Natalis* (1939) for soprano and strings on poems of Thomas Traherne, his style matured, and it was further defined in *Farewell to Arms* for tenor and small orchestra (1945). His three song cycles on poems of Hardy, *A Young Man's Exhortation* (1933), *Earth and Air and Rain* (1936) and *Before and After Summer* (1949), and his Shakespeare cycle, *Let Us Garlands Bring* (1942), show his sensitive musical prosody at its best. His later works include *Intimations of Immortality* for chorus and orchestra (1950) and a concerto for cello and orchestra (1955). He died at Oxford on Sept. 27, 1956.

FIORD: *see* FJORD.

FIORE, PASQUALE (1837–1914), Italian jurist and leading authority on international law, was born at Terlizzi, Puglia, on April 8, 1837. He studied at Urbino, Pisa and Turin and, after a period of teaching philosophy at a school at Cremona, during which he published *Elementi di diritto pubblico constituzionale e amministrativo* ("Elements of Public Constitutional and Administrative Law," 1862), he was appointed professor of constitutional and international law at Urbino in 1863. He then occupied similar chairs at Pisa, Turin and finally, from 1881, at Naples, where he died on Dec. 17, 1914.

Although a prolific writer on a wide range of legal topics, Fiore's international reputation rests on his writings on public and private international law, which were translated into many languages. Since they reflect the spirit and political conditions of his time, they have tended to become out of date, but he made a lasting contribution by realizing the need for dividing international law into new categories, in his *Traité de droit pénal international et de l'extradition* ("Treatise on International Criminal Law and the Law of Extradition," 1880), and by meeting the need for a more precise statement of the law in his *International Law Codified* (1890; Eng. trans., 1918).

Fiore's *Elementi di diritto internazionale privato* ("Elements of Private International Law," 1901) is one of the principal statements of the doctrines of the so-called Italian or neostatutist school which, inspired by P. S. Mancini, has exercised profound influence, especially in Latin and Latin-American countries. (J. U.)

FIORELLI, GIUSEPPE (1823–1896), Italian archaeologist noted for his excavations of Pompeii and his outstanding contributions to field and museum archaeology, was born in Naples on June 8, 1823. He worked on coins and in the excavations of Pompeii until 1848, when he was imprisoned for political reasons. After his release, he dug at Cumae. In 1860 he was appointed professor of archaeology at the University of Naples and resumed work at Pompeii as director of excavations, where he inaugurated the first methodical exploration of the town. There he also developed a system of observation, recording, preservation (including a museum on the site) and reporting, fundamental for modern archaeological method, and founded the first archaeological school in Italy. Named director of the National museum in Naples (1863), he began scholarly reorganization and publication of the museum's collections. From 1875 he was director general of antiquities and fine arts of Italy and initiated a journal for the prompt publication of excavation results. His numerous publications include *Giornale degli Scavi* (1861–65) and *Descrizione di Pompei* (1875). He died in Naples on Jan. 28, 1896. (L. T. Se.)

FIR, the Scandinavian name originally given to the Scots pine (*Pinus sylvestris*) but now primarily used to designate members of the genus *Abies*, of the pine family (Pinaceae). The firs are distinguished from other genera in the pine family by their sessile needles, which develop conspicuous circular leaf scars upon falling. Their cones, which are erect at maturity, are composed of many thin, rounded, closely overlapping scales, each bearing two broadly winged seeds, and enclosed by a bract carrying the ovules. The cones disintegrate soon after ripening, and leave the erect, naked central axis attached to the supporting branchlet.

The trees usually have a straight trunk and a tendency toward conical or pyramidal growth, throwing out each year a more or less regular whorl of branches from the foot of the leading shoot, while the buds of the lateral boughs extend horizontally.

JOHN H. GERARD

WHITE FIR (ABIES CONCOLOR)

There are about 40 species of the true firs (*Abies*), widely distributed in the northern hemisphere.

The silver fir (*A. alba*), a representative of the old world, is a lofty tree, sometimes 150 ft. high, with large spreading horizontal boughs curving upward toward their extremities. The flat leaves are two ranked, deep green above but with two broad white lines beneath; as the foliage in large trees has a tendency to curl upward, a silvery appearance is observed from below. The large, erect cones are cylindrical in shape, and have long bracts, the curved points of which project beyond the scales. When the tree is young the bark is of a silvery gray, but becomes roughened and darkened with age. The tree is abundant in most of the mountain ranges of southern and central Europe, but is not found in the northern parts of that continent. In Asia it occurs on the Caucasus and Urals, and in some parts of the Altaic chain. Extensive forests of this fir exist on the southern Alps, where the tree grows in elevations up to nearly 4,000 ft.; in the Rhine countries it forms a great part of the extensive forest of the Hochwald and occurs in the Black Forest and in the Vosges; it is plentiful likewise on the Pyrenees and Apennines. The wood is inferior, but, being soft and easily worked, is largely employed in the countries to which it is indigenous for all the purposes of carpentry. Deficient in resin, the wood is more perishable than that of the spruce, although it is said to stand well under water. The bark contains a large amount of a fine, highly resinous turpentine, which collects in blisters on the trunk during the heat of summer. After purification by straining, it is sold as "Strasbourg turpentine," much used in the preparation of some of the finer varnishes. Burgundy pitch is also prepared from it by a process similar to that used on the exudations of the Norway spruce. A fine oil of turpentine is distilled from the crude material; the residue forms a coarse rosin. Introduced into Great Britain at the beginning of the 17th century, the silver fir has become a common exotic, although, like the Norway spruce, it rarely comes up from seed scattered naturally. It is also planted as an ornamental tree in eastern North America.

Several other old world firs are successfully grown for ornamental purposes in Europe and North America. Among these are the Spanish fir (*A. pinsapo*); the Greek fir (*A. cephalonica*); the Algerian fir (*A. numidica*); the Cilician fir (*A. cilicica*) of Asia Minor; the Nordmann fir (*A. nordmanniana*) of the Caucasus; and the Momi fir (*A. firma*), the Nikko fir (*A. homolepis*) and the Veitch fir (*A. veitchii*) of Japan.

In North America there are ten native species of fir, found chiefly from the Rocky mountains westward and attaining their maximum development in the Sierra Nevada and Cascade ranges. Of the two firs occurring in the eastern states and Canada, the best known is the balsam fir (*A. balsamea*), which is found from Newfoundland to Virginia and northwestward to Labrador and the Yukon. It is a widely branching tree, 40 ft. to 60 ft. high, with fragrant resinous leaves; it is extensively used for pulpwood, sparingly for lumber, and yields the valuable oleoresin known as Canada balsam (*q.v.*). The smaller southern balsam fir or she-balsam (*A. fraseri*) is confined to the southern Appalachian mountains. Several firs of the western United States attain immense size. The white fir (*A. concolor*), sometimes 250 ft. high with a trunk diameter of 6 ft., ranges from Wyoming to the Sierra Nevada and southward to Mexico. The lowland white or grand fir (*A. grandis*), occasionally 300 ft. high, is a valley species found from Montana west to Vancouver Island and south near the coast to central California. The Pacific silver fir (*A. amabilis*), a beautiful tree native to the Cascade and Olympic ranges from Oregon to British Columbia, reaches a height of 250 ft. and a trunk diameter of 4 ft. to 6 ft. The red fir (*A. magnifica*), often 200 ft. high, is a handsome tree of the northern Sierra Nevada and the southern Cascade mountains. The noble fir (*A. nobilis*), usually 150 ft. to 200 ft. but sometimes 250 ft. high, with a trunk 6 ft. to 8 ft. in diameter, forms large forests in Washington, Oregon and northern California. The smaller Alpine fir (*A. lasiocarpa*), commonly 80 ft. to 100 ft. high, is found in the Rocky mountains from New Mexico to Alaska, and westward to Oregon, Washington and British Columbia. With the exception of the noble fir, the wood of most western firs is inferior to that of pine or spruce, but is used for lumber and pulpwood. When wood was used in aircraft fabrication, noble fir was occasionally substituted for the preferred spruce.

The name fir is often used in combination for several other species: *e.g.*, Douglas fir (*q.v.*); hemlock fir (*see* HEMLOCK); joint fir (*see* EPHEDRA). (E. S. HR.)

FIRBANK, (ARTHUR ANNESLEY) RONALD (1886–1926), English novelist who both in his use of dialogue and in his concise narrative technique was a literary innovator of some importance, was born in London on Jan. 17, 1886, of rich middle-class parents. A delicate child, his education was mainly private, though he spent a short period at Uppingham school and a little over two years at Trinity Hall, Cambridge. Thereafter, his life was spent largely in travel, for the sake of his health.

Firbank, as a novelist, was greatly indebted to the literature of the 1890s, but his outstanding quality is a peculiarly fantastic and perverse brand of humour which he made wholly his own. His novels are comedies of manners in which the wit is largely verbal, depending upon the shape and cadence of the sentence and upon Firbank's eccentric and highly personal vocabulary. His best and most characteristic novels are probably *Valmouth* (1919), *The Flower Beneath the Foot* (1923) and *Prancing Nigger* (first published in England as *Sorrow in Sunlight,* 1924). He died at Rome on May 21, 1926.

BIBLIOGRAPHY.—Collected works: *The Complete Ronald Firbank* (1961). *See* also Ifan Kyrle Fletcher *et al., Ronald Firbank: a Memoir* (1930); Jocelyn Brooke, *Ronald Firbank* (1951). (B. J. B.)

FIRDAUSI (FIRDUSI, FIRDOUSI) (*c.* 935–*c.* 1020), Persian poet, was the author of the celebrated *Shah-Nama* ("Book of Kings") in which the Persian national epic found its final and enduring form. His real name was Abul Qasim Mansur (or Hasan or Ahmad), Firdausi being a nom de plume. He was born *c.* 935 in a village on the outskirts of the ancient city of Tus (near the city of Meshed in northeast Iran). In the course of the centuries many legends have been woven around the poet's name but very little is known about the real facts of his life. Something can be gathered from the personal references scattered here and there

throughout his poem, but otherwise the only reliable source is the account given by Nizami-yi-'Arudi, a 12th-century poet who visited his tomb in 1116 or 1117 and collected the traditions that were current in his birthplace less than a century after his death. According to Nizami, Firdausi was a *dihkan* or landowner, deriving a comfortable income from his estates. He had only one child, a daughter, and it was to provide her with a dowry that he set his hand to the task which, in the event, was to occupy his attention for 35 years.

The *Shah-Nama* of Firdausi, a poem of nearly 60,000 verses, is based mainly on a prose work of the same name, compiled in the poet's early manhood in his native Tus. This prose *Shah-Nama* was for the most part the translation of a Pahlavi (Middle Persian) work, the *Khwatai-Namak*, a history of the kings of Persia from mythical times down to the reign of Khosrau II (590–628), but it also contained additional material bringing the story to the overthrow of the Sassanians by the Arabs in the middle of the 7th century. The first to undertake the versification of this chronicle of pre-Islamic and legendary Persia was Dakiki, a poet at the court of the Samanids, who came to a violent end after completing only 1,000 verses. These verses, which deal with the rise of the prophet Zoroaster, were afterward incorporated by Firdausi, with due acknowledgments, in his own poem.

The *Shah-Nama*, finally completed in 1010, was presented to the celebrated sultan Mahmud of Ghazni, who by that time had made himself master of Firdausi's homeland, Khurasan. Information on the relations between poet and patron is largely legendary. According to Nizami-yi-'Arudi, Firdausi came to Ghazni in person, and through the good offices of the minister Ahmad ibn Hasan Maimandi was able to secure the sultan's acceptance of the poem. Unfortunately Mahmud then consulted certain enemies of the minister as to the poet's reward. They suggested that Firdausi should be given 50,000 dirhems, and even this, they said, was too much, in view of his heretical Shi'ite tenets. Mahmud, a bigoted Sunnite, was influenced by their words and in the end Firdausi received only 20,000 dirhems. Bitterly disappointed, he went to the bath and, on coming out, bought a draft of *fuka'* (a kind of beer) and divided the whole of the money between the bath attendant and the seller of *fuka'*. Then, fearing the sultan's wrath, he fled first to Herat, where he remained in hiding for six months, and then, by way of his native Tus, to Mazanderan, where he found refuge at the court of the Sipahbad Shahriyar, whose family claimed descent from the last of the Sassanians. There Firdausi composed a satire of 100 verses on Sultan Mahmud, which he inserted in the preface of the *Shah-Nama* and read out to Shahriyar, at the same time offering to dedicate the poem to him, as a descendant of the ancient kings of Persia, instead of to Mahmud. Shahriyar, however, persuaded him to leave the dedication to Mahmud's name, bought the satire from him for 1,000 dirhems a verse and caused it to be expunged from the poem. Nizami adds that Firdausi also destroyed his rough copy of the satire and that in his day only six verses remained extant. This is of course inconsistent with the fact that the whole text, bearing every mark of authenticity, has survived to the present day.

It was long supposed that in his old age the poet had spent some time in western Persia or even in Baghdad, under the protection of the Buyids, but this assumption was based upon his presumed authorship of *Yusuf and Zulaikha*, an epic poem on the subject of Joseph and Potiphar's wife, which, it later became known, was composed more than 100 years after Firdausi's death. For an account of his last days it is necessary to fall back upon the narrative of Nizami-yi-'Arudi. Sultan Mahmud was returning from one of his campaigns in India when the minister Ahmad ibn Hasan Maimandi, by means of an apposite quotation from the *Shah-Nama*, reminded him of his shabby treatment of Firdausi. He determined to make amends and, upon returning to Ghazni, gave orders that 60,000 dinars' worth of indigo should be given to Firdausi and that it should be transported to Tus on the royal camels. The indigo reached Tus in safety; but as the camels were entering the town by one gate Firdausi's bier was being carried out through another. A fanatical preacher had denied the poet burial in the Muslim cemetery and his body was being taken to its final resting place in a garden that belonged to the poet outside the walls of the town. He was survived by his daughter, who proudly refused the sultan's gift; in the end the money was spent on repairing a resthouse on the boundaries of Tus. Nizami does not mention the date of Firdausi's death. The earliest date given by later authorities is 1020 and the latest 1026: it is certain that he lived to be more than 80.

The Persians regard Firdausi as the greatest of their poets. For nearly 1,000 years they have continued to read and to listen to recitations from the *Shah-Nama*, which, though written before the Norman conquest, is as intelligible to the average modern Persian as is the Authorized (King James) Version of the Bible to a modern Englishman. The language, based as the poem is on a Pahlavi original, is pure Persian with only the slightest admixture of Arabic. European scholars have criticized the monotonous metre, the constant repetitions and the stereotype similes of this enormous poem; to the Persian it is the history of his country's glorious past, preserved for all time in sonorous and majestic verse.

BIBLIOGRAPHY.—The chief editions of the *Shah-Nama* are those of T. Macan (1829), J. Mohl (1838–78) and J. A. Vullers (1877–84), the last incomplete. Beroukhim's edition (1934–35) is based on the earlier three. There are English translations by J. Atkinson (1832), A. G. and E. Warner (1905–25) and A. Rogers (1907), a French translation by J. Mohl facing the text of his edition, also published separately (1876–78); German translations by J. Görres (1820), A. von Schack (1851) and F. Rückert (1890–95); Italian translation by I. Pizzi (1886–88).

See also E. G. Browne, *A Literary History of Persia*, vol. i and ii (1902 and 1906); T. Nöldeke, *Das iranische Nationalepos*, 2nd ed. (1920); H. Massé, *Les Epopées persanes. Firdoussi et l'épopée nationale* (1935); Furughi's introduction to *Khulasa-yi-Shah-Nama*, ed. by Muhammad 'Ali Furughi and Habib Yaghma'i (1942); V. Minorsky, "The Older Preface to the Shah-nama" in *Studi orientalistici in onore di Giorgio Levi Dalla Vida* (1956). (J. A. Bl.)

FIRE has always been one of man's essential tools. It was the control of fire, together with the making of stone tools, that distinguished early man from his close primate relatives. The use of fire allowed man to leave the tropical habitat natural to primates and thus to develop in varied environments—possibly even aiding his own evolution. Furthermore, with fire early man began to exert a powerful influence on his natural environment by burning brush and trees. This practice came quite naturally to man since it was from vegetation set on fire by lightning that he probably learned of the usefulness of fire. It is with these aspects of fire—its early control and use and its role in the development of civilization—that the present article is concerned. The destructive aspects of fire and the means of combating it are discussed in the article FIRE PROTECTION. For the chemistry of fire, *see* COMBUSTION; FLAME.

Early Control of Fire.—Although we cannot reconstruct exactly the sequence of events by which flames were brought under control and then maintained so that they could be transported and used, it is possible to define many of the conditions which would have been necessary to learn to control fire. In the first place, it must be assumed that man first feared and therefore avoided fire, just as animals do. Many fires at different seasons and under varied conditions must have occurred before the right combination of events, such as the roasting of wild game or the isolation of a slow-burning log with which a camp could experiment, encouraged a group to overcome its fear. With the materials for experimentation at hand and with the usefulness of fire apparent, a group might have decided to preserve the fire with constant care.

However, man could only have acquired mastery of fire with frequent opportunity to renew it. In the first place, only after many fruitless attempts to keep fire could such a complex procedure be successful; in the meantime, while trial and error were taking place, new fire would need to be regularly available so that the experiment could be repeated. Furthermore, it is reasonable to assume that families and bands who moved away from the tropical forest sometimes lost their fire and went cold until fire could be obtained again from nature or from neighbours. The very wide distribution of ancient men into temperate zones, with great seasonal variations of temperature, indicates that these early men must have had sources for the renewal of fire.

Of the natural forces which ignite wood—spontaneous com-

bustion, the friction of two branches rubbing together, sparks from rolling stones, volcanic lava and lightning—only lightning occurs with sufficient regularity and with enough world-wide distribution to have allowed man to experiment sufficiently with fire to learn that it could be controlled. While hot lava escaping from active volcanoes, especially in Africa and Java, undoubtedly started a few fires each year, fires from lightning must have been frequent, as they still are, over most of the world. Indeed, it has been estimated that approximately 10,000 thunderstorms occur daily throughout the world, with roughly 100,000 lightning strokes per day to the ground. We might well say that lightning gave fire to man, rather than that it was a "gift of the gods" or was "stolen from the gods" by some culture hero, such as Maui of Polynesia or Prometheus of Greece, as has so often been believed in the past.

Peking man, christened *Sinanthropus pekinensis* when discovered in 1927, but renamed *Pithecanthropus pekinensis* in 1957 to indicate his similarity to Java man, was the most primitive and most ancient unquestionable user of fire. The excavation at Choukoutien, near Peking, brought to light 15 individual skulls and skull fragments from near-human beings who lived about 500,000 years ago. In the cave with hundreds of pieces of fossilized bones of human type were crudely chipped stone tools and large quantities of solidified wood, ash, charcoal, seeds, animal bones and other material distinct from the rocks of the limestone caves. There is no doubt that Peking man tended the fire in his cave home, and he must have carried it with him when he moved abroad.

As long as man depended on nature and chance for fire he must have taken great pains to maintain it, carefully transporting hot coals in the hollow of horns, or "slow matches" made from twisted bark in which a spark was buried or a slow-burning piece of punk. Even after man learned to produce fire himself by friction he probably transported it with great care, just as most present-day aborigines with only simple hand drills, fire saws or fire-plows with which to produce fire prefer to maintain a spark rather than to manufacture one. Some aborigines preserved fire for years; among others, such as the Aztec, there occurred periodic fire renewal ceremonies after all old fire had been extinguished.

Original Uses of Fire.—The first men to control fire gradually learned its many uses. Fire not only kept man warm and cooked his food; he also learned to use it in fire drives in hunting or warfare, to kill insects, to obtain berries and to clear forests of underbrush so that game could be better seen and hunted. Eventually he learned that the burning of brush produced better grasslands and therefore more game. Let us consider how this might have happened. Would early man traveling with fire carefully extinguish each campfire? More likely, would he not put on a big log and bank his fire to preserve it against the chance of his return, even though he carried a spark in a horn or carried a "slow match"? If an accident occurred and the portable spark were extinguished, it would be comforting to know that logs or roots had been left burning and that he might find a glowing spark on his way back. Such fires could frequently be the source of wildfire if a spark were blown by the wind onto surrounding vegetation. Thus man's fires were added to the blazes started by lightning; together they were a potent force for modifying the landscape. What first happened by accident took place later by design. Certainly, long before history man's fires were used to burn forest and field to improve the environment for human use. The record of the antiquity and widespread use of fire for this purpose is seen in the windy steppes of Russia, the Great Plains and pampas of the new world, and the Sudan and velds of Africa. Only fire, regularly employed for fire drives, for clearing old grass or brush, or for killing insects, etc., could have produced these pure stands of grass and maintained them.

With the achievement of agriculture in Neolithic times in the near east, about 7000 B.C., there came a new urgency to clear brush and trees. The first agriculturists made use of fire to clear fields and to produce ash to serve as fertilizer. This practice, called slash-and-burn, or milpa, cultivation, persists in many tropical areas and some temperate zones today.

Widespread burning by no means produced identical landscapes. Depending on climate, geology and local conditions the effect of burning varies. In the new world the large Maya cities of Yucatán appear to have been abandoned because of soil exhaustion caused by the reaction of the thin limestone soil to slash-and-burn agriculture. On the other hand, the deep porous soil on the slopes of the volcanoes of Costa Rica appear to have been cleared by burning and to have been planted for millennia without deterioration. Although burning removed the forests or prevented their growing on the Great Plains of the United States, creating grasslands instead, under different circumstances burning has produced nearly pure open stands of trees. The scattered acacia of the savannas of Africa, the valuable teak forests of India and Burma and the longleaf pine forests of the southern states of the United States are dependent for their reproduction and survival upon regular burning of grass and brush between the trees.

Manufacture of Fire.—The step from the control of fire to its manufacture is great and required hundreds of thousands of years. The number and variety of inventions of such manufacture are difficult to imagine. Not until Neolithic times is there evidence that man actually knew how to produce fire. Whether a chance spark from striking flint against pyrites or a spark made by friction while drilling a hole in wood gave man the idea for producing fire is not known, but flint and pyrites, as well as fire drills, have been recovered from Neolithic sites in Europe. Also, the Eskimo of Alaska and the Ona of Tierra del Fuego had flint and pyrites strike-a-lights.

Most widespread archaeologically and among present-day aborigines is the friction method of producing fire. The simple fire drill, a pointed stick of hard wood twirled between the palms and pressed into a hole on the edge of a stick of softer wood, is almost universal. The fire-plow and the fire saw are variations on the friction method common in Oceania, Australia and Indonesia. Mechanical fire drills were developed by the Eskimo, ancient Egyptians, Asian peoples and a few American natives. A fire piston which produced heat and fire by the compression of air in a small tube of bamboo was a complex device invented and used in southeastern Asia, Indonesia and the Philippines. About 1800 a metal fire piston was independently invented in Europe. In 1827 the English chemist John Walker invented the friction match containing phosphorous sulphate, essentially the same as we use today (*see* MATCH).

Only the Andamanese and a few Congo pygmies, of all historic people, have denied all knowledge of producing a spark.

Fire in Religion and Philosophy.—The sacred fires and fire drills of religious rituals and the numerous fire-gods of world mythology must be interpreted as additional evidence of both the antiquity and importance of fire in human history. In the ancient Vedic scriptures Agni (*q.v.*), or Fire, is the messenger between man and his gods and the personification of the sacrificial fire. Brahman households today are supposed to maintain a sacred fire for the worship of Agni, much as the ancient Romans kept a holy perpetual fire cared for by the vestal virgins (*see* VESTA) and the Greeks tended and transported the sacred fire of Hestia (*q.v.*) during migrations. The Zoroastrians of Iran placed fire at the centre of their religion and worshiped it as the most subtle and ethereal principle and the most powerful and sacred power, thought to have been presented to man directly from heaven and kindled by the Deity himself (*see* ZOROASTRIANISM). Among the Israelites Abraham might be viewed as a reformer who resisted the ancient worship of Moloch (*q.v.*), the god of fire, by child sacrifice. In Siberia both the primitive Koryak and Chuckchi and the more civilized Buryat honoured the fire-god by keeping all filth and impurities away from their fires and hearths. The need to protect fire from contamination was also a belief of the aborigines in Africa, in North and South America and elsewhere. The Aztec of Mexico and the Inca of Peru worshiped gods of fire with sacred flames, which the Inca ignited by concentrating the sun's rays with a concave metallic mirror.

The great Greek scientists and philosophers found fire just as significant as did the mystics of religion. Aristotle, for example, declared fire, along with water, earth and air, to be one of the four general and essential elements of life and of all things. Plato asserted that God used the four elements in the creation of the

world. Heraclitus attributed to fire the essential force for creation.

Fire and the Growth of Civilization.—Familiarity with fire, resulting from its easy production by flint and steel, phosphorus matches or electricity, has led modern man to take fire for granted. Yet, just as the initial control of fire was essential to the development of man from the Old Stone Age hunters of the tropical forests into the first village-dwelling farmers of the Neolithic, so fire has been essential at every stage of the growth of civilization during the succeeding 10,000 years. From the use of fire to cook food, to clear land and to furnish warmth and illumination in caves or hovels, fire has been applied to vessels of clay to make pottery, to pieces of coloured stone to get copper and tin, to combine these to make bronze (*c.* 3000 B.C.) and to obtain iron (*c.* 1000 B.C.). The modern history of technology and science might be characterized as a continual increase in the amount of energy available through fire and brought under human control. Most of the increased available energy has come from ever greater amounts and kinds of fires. The control of atomic energy is merely the most recent step in the use of fire for the benefit of mankind, a process that began about 500,000 years ago.

See also references under "Fire" in the Index volume.

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FIREARMS: *see* ARQUEBUS; CARBINE; MACHINE GUN; MUSKET; PISTOL AND REVOLVER; RIFLE; SMALL ARMS, MILITARY.

FIREBRAT, a whitish, wingless insect (*q.v.*; *Thermobia domestica*) of the order Thysanura (the bristletails), so-called because of its occurrence about fireplaces and bakehouses. It feeds on starchy material. *See* also SILVERFISH.

FIREBRICK. Another descriptive term for this product is refractory brick, which includes a variety of shapes made from nonmetallic minerals and intended for service at high temperatures. The largest consumers of firebrick are the metal and glass industries.

Raw materials for firebrick include fire clays, of which the essential mineral components are hydrated aluminum silicates; minerals of high aluminum oxide content, such as bauxite, diaspore and kyanite; sources of silica, including sand and quartzite (commonly known as ganister); the magnesia minerals, magnesite, dolomite, forsterite and olivine; chromite, a solid solution of chromic oxide with the oxides of aluminum, iron and magnesium; carbon in the form of graphite or coke; and vermiculite mica. Minor raw materials are zirconia, zircon, thoria, beryllia, titania and ceria and other minerals containing the rare-earth elements.

Manufacture.—Refractory shapes are formed by the following processes used in the manufacture of building brick: dry press, stiff mud and soft mud (*see* BRICK), as well as casting and hot pressing. The soft mud process of forming firebrick is a hand operation in which a slug of plastic clay is thrown into a steel-lined wooden mold. The casting process employs a suspension of finely ground raw material in water, which is poured into absorbent plaster molds to form the desired shapes. Hot pressing consists in subjecting the dry mix to moderate or high pressures in a heated die, causing bonding and densification to occur more readily than would be the case without pressure application. This method has been utilized in the preparation of specialized refractories for very high temperature service.

Some raw materials, including magnesite and dolomite, require firing in rotary kilns to bring about sintering and densification before the crushed and sized material can be fabricated into refractory shapes and refired. Electric furnace fusion of raw materials, followed by casting of the melt in special molds, is important. Fused alumina, mullite and zirconia brick have no porosity and great resistance to attack by molten glasses. Silicon carbide, a widely used refractory, is formed by reaction of petroleum coke with sand in electric or resistance furnaces. The resulting crystalline product is crushed and graded. After incorporation of a bonding material it is formed into the desired shapes which are then fired in a tunnel kiln.

Drying of firebrick shaped by conventional methods is commonly performed in continuous tunnel driers in which temperature and humidity are carefully controlled. In the burning of firebrick oil- or gas-fired tunnel kilns or periodic kilns are ordinarily used.

Properties.—Desirable properties of firebrick are: (1) refractoriness; (2) resistance to attack by such corrosive materials as glasses, metals, slags and salts; (3) high strength at ordinary temperatures and resistance to deformation under loading at high temperatures; (4) resistance to spalling (surface fracture of the brick resulting from stresses which are usually induced by uneven heating or cooling); (5) ability to withstand abrasion; and (6) thermal conductivity suitable for the conditions of use.

Firebrick may conveniently be grouped into three categories: (1) acid; (2) neutral; and (3) basic. The neutral classification is not widely used, however, since some refractories, such as those made from mixtures of chrome ore and magnesite, have both acid and basic characteristics. Silica brick is typical of acid firebrick and magnesite brick of the basic group.

Refractoriness of firebrick is often evaluated in terms of pyrometric cone equivalents. These provide an index number corresponding to a given temperature at which the material undergoes marked softening and deformation. Low-duty fire-clay bricks have cone values ranging from 19 to 26 (1,520° to 1,595° C.), and superduty fire-clay bricks have values of 33 to 34 (1,745° to 1,760° C.). High-alumina firebricks have cone values that increase from 34 to 42 (1,760° to 1,990° C.) as the aluminum oxide content is raised from 50% to 99%. For very high temperature service, graphite and other carbon refractories, as well as silicon carbide, are available. These have the disadvantage of poor resistance to oxidation, although this condition can be improved by incorporation of additives designed to form a protective glaze at operating temperatures.

In the majority of uses, firebrick must be able to resist corrosive chemical reactions, particularly those which result from contact with molten slag. It is a general rule that the refractory should be of chemical nature similar to the material with which it will come in contact; *e.g.*, a basic refractory should be used when it will come into contact with a basic slag, for example in basic open-hearth steelmaking. Silica brick might seem ideal for lining a glass tank in which a high-silica glass is to be melted, but this is not the case; such bricks are porous and would permit the melt to penetrate within the grains and destroy the bond, resulting in early failure. Therefore it is customary to use a very dense firebrick made from fire clay and ganister, or a fused cast refractory with zero porosity.

Uses.—The greatest use of firebrick is in the production of iron and steel. Vast quantities of refractories are used in blast furnaces, open hearths, Bessemers, electric furnaces and ladles.

Fire-clay brick has been most commonly employed in the lining of blast furnaces, but carbon refractories are also widely used. It is in the open hearth, however, that the greatest variety of lining materials is employed, including magnesite, chrome, silica, fire-clay and insulating brick. The front and back walls of the furnace as well as the roof are made of silica brick, and it is usual practice to introduce a layer of chrome brick between the silica and magnesite brick. Chrome firebrick is compatible with both silica and magnesite, whereas the two latter types of firebrick, if in immediate contact, would fail through chemical reaction at high temperatures.

Firebrick is vital to the production of glass. Glass furnaces or tanks, as they are called, are elaborate refractory structures in which high rates of melting can be maintained. Glass may be considered as a special and extremely corrosive type of slag. Several materials used in its manufacture, such as soda ash, sodium sulfate, lime and borax, react vigorously with many refractories

at high temperatures. For this reason highly siliceous, dense, fireclay bricks, known as flux blocks, are much used in the portion of the tank that is in contact with molten glass. Mullite firebricks, prepared from the mineral kyanite, have excellent durability, as do also fused alumina bricks, since these allow no penetration of the glass and are comparatively inert chemically.

Industrial Trends.—The history of the firebrick industry shows a continuous change from manufacture of a few types of all-purpose materials to a high degree of specialization. Initially, iron and glass manufacture provided the impetus for firebrick development. Near the close of the 19th century the great variety of lining materials used in the steel industry, including silica, magnesite and chrome firebrick, was introduced.

For most processes where firebricks are employed as a lining material, the production rate and efficiency are augmented by increases in operating temperatures. Thus, there has been a continued incentive for the firebrick manufacturer to improve the refractoriness and general quality of his products as well as to diversify them for many new applications.

Special types of refractories are required in the construction of power plants based on the utilization of nuclear energy; the materials must have outstanding chemical and physical stability at high temperatures. These specifications resulted in intensive study and use of various high-melting oxides, carbides, sulfides and nitrides that were not previously widely employed as refractories (*see* NUCLEAR ENGINEERING).

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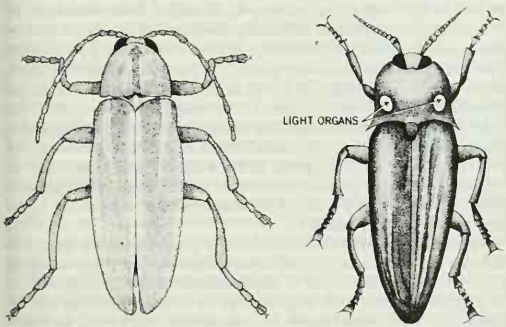
FIRE CONTROL: *see* ARTILLERY: *Tactics;* GUNNERY, NAVAL; RADAR; SIGHTS, GUN; TORPEDOES.

FIRECRACKER: *see* FIREWORKS.

FIREDAMP: *see* COAL AND COAL MINING: *Hazards of Mining;* METHANE.

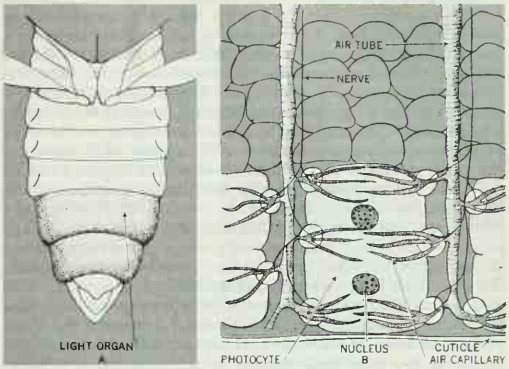
FIRE ENGINE: *see* FIRE PROTECTION.

FIREFLY, a popular name, with "lightning bug," for nocturnal luminous members of certain families of beetles, particularly the Lampyridae (fig. 1A) and Elateridae (fig. 1B). Lampyrids are soft-bodied; from 5 to 25 mm. long, depending on the species; bear their specialized light-organs on the underside of the abdomen; and include many hundred species widely distributed in non-arid tropical and temperate regions. Commonly both sexes are winged and luminous, though the female's "lantern" is typically smaller than the male's. In some species the female has reduced wings or none and is called a glowworm (*q.v.*). Most lampyrid fireflies produce short, rhythmic flashes in a species-characteristic pattern, which, in some cases, form part of a rather precise system of signals that brings the sexes together. Synchronous flashing of huge numbers of fireflies has been observed, particularly in southeast Asia, but the mechanism and significance of this behaviour are unknown.



(A) W. N. NESS IN "THE BIOLOGICAL BULLETIN," 1920; (B) W. H. SEAMAN IN "TRANSACTIONS OF THE AMERICAN MICROSCOPICAL SOCIETY," 1891

FIG. 1.—(A) AMERICAN LAMPYRID FIREFLY (PHOTURIS PENNSYLVANICA), × 2; (B) ELATERID FIREFLY (PYROPHORUS NOCTILUCUS), × 1½. DORSAL VIEWS



(A) W. N. NESS IN "THE BIOLOGICAL BULLETIN," 1920; (B) J. B. BUCK, "THE ANATOMY AND PHYSIOLOGY OF THE FIREFLY" IN "ANNALS OF THE NEW YORK ACADEMY OF SCIENCES," 1948, VOL. 49, ARTICLE 3

FIG. 2.—(A) VENTRAL VIEW OF ABDOMEN OF MALE LAMPYRID FIREFLY (PHOTURIS PENNSYLVANICA) SHOWING LIGHT ORGAN (ENLARGED); (B) DIAGRAMMATIC CROSS SECTION THROUGH LIGHT ORGAN OF LAMPYRID FIREFLY (GREATLY ENLARGED)

The elaterid fireflies are hard-bodied click beetles, usually from 20 to 35 mm. long. They comprise only a few genera, of which *Pyrophorus* is the most celebrated, and have an exclusively tropical and subtropical distribution. Both sexes have a pair of circular luminous organs on the dorsal prothorax (fig. 1B) and a single ventral organ in an anterior abdominal cleft. The thoracic organs emit long-sustained glows of green light while the insect is at rest; the abdominal organs give an orange glow when the insect is in flight.

Much experimental work has been done on the American lampyrid genera *Photinus* and *Photuris.* It has been found, for example, that peak flash intensity is $\frac{1}{10}$ candle (*see* CANDLE POWER) and that only light in the visible spectrum is emitted, *i.e.,* "cold" light. The alleged high efficiency of firefly light does not refer to the efficiency of metabolic conversion of food energy into light, but to the fact that the energy emission spectrum of the light corresponds approximately to the wave-length sensitivity curve of the human eye. Firefly light, produced within special cells (photocytes) richly supplied with respiratory air tubes (tracheae) (fig. 2), is under nervous control. As in many other luminous organisms the light is the result of a complex series of chemical reactions involving oxygen, the enzyme luciferase, the substrate luciferin, the energy source adenosine triphosphate and certain accessory substances. *See* also BIOLUMINESCENCE; BEETLE: *Natural History.*

See J. B. Buck, "The Anatomy and Physiology of the Firefly," *Annals N. Y. Acad. Sci.* 49:397–482 (1948); F. G. Vosburgh, "Torchbearers of the Twilight," *National Geographic Magazine* 99:696–704 (May 1951). (J. B. BU.)

FIRE INSURANCE. As now transacted all over the world, fire insurance evolved in England in the 17th century. Until then anyone suffering loss by fire was dependent on charity or the assistance of members of his guild to recoup his loss. The charitable principle was put into effect largely through church briefs or king's letters which entitled the sufferer to beg. Many proposals for a more systematic provision against fire losses failed to obtain support until after the Great Fire of London in 1666. In 1680 a fire office was formed to insure houses in London at a premium calculated at 2½% of the yearly rent for brick houses and 5% for frame houses. Forty years later fire insurance had become established not only for houses but for goods, merchandise, furniture and wares of every description, and during the next 100 years numerous fire offices were formed all over the country.

At the same time, fire-insurance companies were organized in other parts of the world. In the American colonies, with the growth of cities along the eastern seaboard, the danger from fire assumed greater and greater importance and promoted a demand for fire insurance. Since the London insurance companies were prohibited by their charter from writing fire insurance in America, individual underwriters or insurers undertook to assume the fire risk and indigenous companies also began to appear. The first American incorporated company, the Philadelphia Contributionship, a mutual company patterned after the Amicable Contributorship of London, was organized by Benjamin Franklin in 1752. The first joint-stock company, the Insurance Company of North America, was organized in 1792 to insure marine risks but was extended to include fire insurance during its first year of operation. Both companies are still in business.

In its developmental period, fire insurance in Great Britain was particularly free from restrictive legislation. Apart from a heavy stamp duty, which often cost the insured more than the premium, there was little interference by the legislature and not until 1909 were fire-insurance companies made subject to special legislation designed essentially to insure their solvency. A sound reputation for the fulfillment of contracts was early established by the British companies, due in no small measure to their co-operation in establishing adequate rates of premium, particularly in respect to hazardous risks. Some rate-level agreements of this kind existed as early as 1826 and led eventually to the formation of the Fire Offices' committee in 1868, the members of which, known as tariff companies, regulate their business in the light of their pooled experience. By penalizing hazardous features and allowing discounts when the property is suitably protected, the companies have done much toward the prevention of fire.

The fire-insurance companies also initiated fire brigades; the company-maintained brigades which operated in London at the beginning of the 19th century eventually formed the nucleus of the metropolitan fire brigade. When it was recognized that the protection of property and lives against fire was a public duty to be discharged by the government or local authorities, the fire-insurance companies became free to concentrate on the technical aspects of risk improvement.

GENERAL PRINCIPLES

Since a policy of fire insurance is the written evidence of a contract, the general law of contracts applies. But because of the unique character of the insurance transaction the principles which govern contracts in general have been greatly modified in their application to fire insurance. Because of the early origin of fire insurance, it was in connection with this branch of the business that much of the body of insurance law was developed. Most of the unique legal aspects of the fire-insurance contract spring from the fact that it is an aleatory as distinguished from a commutative contract. The latter involves a relatively even exchange of values. In making a fire-insurance contract, on the other hand, the insured knows that he is exchanging a small sum for the promise of a larger one payable, however, only upon the happening of certain events which may or may not occur.

Insurable Interest.—In lay terms, insurable interest means that the applicant for insurance on specified property stands to suffer financial loss from damage to or destruction of the property. In some jurisdictions and under some policy forms this interest must exist both at the inception of the policy and at the time of loss; in others it is sufficient only that it exist at the time of loss. The existence of insurable interest at the inception of the contract or at the time of loss removed the insurance transaction from the realm of gambling and is an essential requirement for the formation of a legally binding insurance contract. There are many types of insurable interest, including absolute ownership, either sole or joint; limited ownership (*e.g.*, tenants for life); secured creditors such as mortgagees and lienees; trustees; and bailees. These examples illustrate two points: (a) Insurable interest may rest in one person or in several persons concurrently. (b) Legal or equitable title is not essential, as rightful possession also gives rise to an insurable interest.

Indemnity.—A fire-insurance policy is a contract of indemnity against loss and not a contract intended to produce gain. The insurer undertakes to make good to an insured person, either by money payment or reinstatement, the loss he has suffered within the limits and conditions of the policy. The insurers are liable only for the material loss; they cannot be called upon to pay for sentimental value. A corollary of the principle of indemnity is the doctrine of subrogation, under which the insurer, after paying a loss, succeeds to the full legal rights which the insured may have to recover from a third party.

Good Faith.—To enable an insurer properly to appraise the risk entailed in any proposal and so to determine the appropriate rate to be charged, certain information is required of the applicant. Insurance contracts are contracts of the utmost good faith. It is not sufficient that an applicant for fire insurance answer truthfully such questions as may be asked of him by the insurer; the higher duty of full disclosure of all material facts applies. If the material representations made by the proposer are not true, or if he fails to disclose everything that ought to be made known to the underwriter as material for a proper assessment of the risk, then the contract may be rendered either voidable or void. In general, it is sufficient if the information given by the proposer is substantially correct but any material fact that appears on the policy as a warranty must be literally correct.

A Personal Contract.—A fire-insurance contract is known as a personal contract. The contract may not be transferred from one insured to another, even though the property changes hands, except with the written agreement of the insurer.

Co-insurance.—Basic fire-insurance rates contemplate an average relationship of insurance coverage to insurable value. But rates are reduced when certain restrictive clauses are made a part of the contract. These are variously designated, for example, as co-insurance, average, or reduced-rate contribution clauses. Under the terms of such clauses, a reduced rate is charged if the insured agrees to insure his property up to, say, 80% of its insurable value. If he insures his property for a lesser amount he recovers from the insurer, in case of a partial loss, only in the proportion which the insurance coverage in force bears to the amount of coverage required by the clause.

Consequential Loss.—The standard contract of fire insurance, as well as those applying to many of the allied hazards insured by fire companies, agrees to indemnify the insured for direct loss by fire and other hazards specifically enumerated in the policy. The concept of direct loss, as interpreted by the courts over the years, excludes such consequential losses as the loss of use of a damaged structure, loss of rents or profits, the value of a leasehold canceled because of fire damage, loss of net profits and fixed expenses, the earning of which is prevented by a suspension of business due to fire or other specified peril, and the like. Such losses may be covered by what is generally known as contracts of consequential-loss insurance, widely offered by fire-insurance companies. (*See* also *Great Britain*, below.)

Types of Insurers.—Fire-insurance companies fall into two classes: (1) proprietary institutions, organized on a capital-stock basis, including syndicates of underwriters; and (2) corporations or joint-stock companies organized as co-operative enterprises, including mutual corporations or associations, reciprocal or inter-insurance exchanges and a number of special types. Along with the dominant role which Lloyd's of London has played in the marine-insurance field, this organization has participated extensively in fire insurance on a world-wide basis for many years. Risks assumed at Lloyd's are actually underwritten by individuals operating through syndicates. This method of operation has attracted some imitators, called Lloyd's associations, but they have assumed little importance in either the fire or other insurance fields.

World-wide, the major share of the fire-insurance business is handled by proprietary capital-stock companies, whose capital and surplus provide a sort of safety fund to assure the meeting of obligations to the public. Mutual companies, which are owned and controlled by those they insure, have no comparable safety fund at their inception. In its place is substituted an obligation on the part of each member to submit to assessment in case premium in-

come is insufficient to meet its obligations. As time passes and the mutual company prospers, its surplus may grow and even surpass the capital and surplus fund of any given stock company. In some countries, notably the United States, nonassessable policies may be issued as soon as an adequate surplus has been accumulated.

Sales and Service.—Insurance companies maintain contact with the public for the negotiation of business either through independent agents who represent several companies; exclusive agents who represent only one company; salaried employees; or brokers who represent the public in contract negotiations. Claims are settled either directly by agents representing the particular company or by adjustment companies that specialize in this type of work.

Reinsurance.—Insurance companies usually experience a relatively constant rate of loss over a period of time because the risks they accept tend to be fairly uniform in size and of comparable quality within a given class. All risks submitted in the regular course of business do not, however, meet this requirement. Risks that are of appropriate quality may be accepted and the excess above the amount that the company elects to retain is reinsured with another company or companies. Amounts thus reinsured are said to be ceded to the reinsurer. If the reinsurer in turn reinsures a portion with a second reinsurer, the process is known as retrocession. Reinsurance may be facultative, requiring submission and acceptance or rejection by the reinsurer of each specific case, or by a prearranged agreement known as a treaty. Under an automatic treaty, acceptance of a risk by the direct writer or originating company automatically commits the reinsurer for an agreed amount or share. There are many companies specializing in the acceptance of reinsurance but direct-writing companies also engage in this type of business. It is significant, generally speaking, that reinsurance knows no national boundaries but is international and world-wide in scope. (P. Ss.; J. E. Hs.)

UNITED STATES

The insurance of property against loss by fire was one of the first forms of insurance to be provided in the United States by purely domestic companies. It was early recognized that the business of insurance so affected the public interest that special forms of regulation were required. Because of its prior origin, fire insurance was subject to regulation much earlier than other forms of insurance. In no case, with the possible exception of life insurance, has regulation been so detailed. While control is vested in the states, there is considerable uniformity in regulatory laws and practices. The chief supervisory official in each state is termed the superintendent or commissioner of insurance. He is charged with administration of the financial requirements imposed upon new companies desiring to enter the business or existing companies seeking admission to the state. He also receives and reviews the companies' annual statements required by law; makes periodic examinations; determines whether reserve, investment and other requirements are being met; and appoints conservators or liquidators when conditions require.

The making and promulgation of fire-insurance rates is an activity principally carried on in the United States by state rating and inspection bureaus supported by the companies doing business in the state. In behalf of their member companies, these bureaus file with the insurance commissioner of the state class rates by areas for dwellings and a few other types of structures. In addition, schedules for the determination of rates on commercial and industrial properties are filed. By application of the schedule, specific rates for such properties are developed by the inspection bureau. Factors taken into account in schedule rating include, in addition to a rating on the community in which the property is located, construction, occupancy and exposure to possible fire from adjoining properties. State bureaus usually operate in cooperation with regional bureaus which compile statistics and perform other functions related to the measurement of the fire hazard, as well as with the National Board of Fire Underwriters. The latter, in addition to technical and statistical functions, is concerned with the establishment of standards for and the rating of towns and cities to reflect the relative community fire hazard. Since World War II an increasing number of fire-insurance companies have resigned their bureau memberships and have independently promulgated rates and filed them with the insurance commissioners.

Standard fire-insurance policies issued in the United States consist of two parts: the agreement or contract, and the stipulations or conditions. The agreement or contract is sufficiently complete so that it could stand alone as a contract of insurance. It includes space for description of the property and for the attachment of various endorsements which may be used to modify or supplement the terms of the contract. The stipulations set out certain requirements imposed on the insured both before and after a loss has occurred, circumstances which void or suspend the contract, property and perils not covered, permission for certain types of modifications, etc. They are added to make the contract more definite and precise.

The risk assumed is "all direct loss by fire, lightning and removal from premises endangered by fire," of the property described in the contract, which property may be either real or personal. To be covered, loss by fire must be due to a "hostile" fire. The measure of damage is actual cash value, or replacement cost, new, less depreciation. No consequential losses, such as loss of use of the premises until rebuilt, are covered by the fire policy itself, but may be separately insured. Fraud or misrepresentation may void the policy and coverage is suspended if the hazard is increased by means within the knowledge or control of the insured. Intangibles such as money and securities are not covered, nor are bullion and manuscripts unless specifically described.

In order to place a standard contract in effect, there is usually added to it a form containing a standard description of the type of property concerned, as well as a number of standard modifications. The form designed for dwellings and their contents, for example, permits application of 10% of the building amount to apply as additional insurance to other buildings on the insured premises. A similar amount may be used, as additional insurance, to cover rental value, limited to one-twelfth of the amount per month. Ten per cent of the insurance on the contents may be used to cover personal property away from the premises. In forms applying to property other than dwellings, coinsurance or reduced-rate contribution clauses are sometimes used for the purpose of inducing the insured to purchase insurance more closely approaching the insurable value of his property than might otherwise be the case.

During the 1930s fire-insurance companies began to issue supplementary contracts in conjunction with fire-insurance policies, covering such hazards as windstorm, smoke, riot, aircraft and vehicles, for which such companies already were offering separate insurance. Within a period of 15 to 20 years such extensions of the fire-insurance policy had become standardized under the terms of a form called the extended-coverage endorsement. This endorsement does not increase the amount of insurance but merely extends the coverage to additional hazards. In the 1950s further extensions were introduced under multiple-line insurance powers granted by the state legislatures, permitting fire companies to insure hazards formerly the exclusive province of casualty companies. At the same time, casualty companies were permitted to insure hazards formerly reserved to fire companies and some uniformity was beginning to appear in the comprehensive policies issued by both types of companies. (*See* CASUALTY INSURANCE.) By the late 1950s it had become possible through a pooling of company resources to insure both liability and property damage resulting from radioactive fallout due to faulty operation of atomic reactors. (J. E. Hs.)

GREAT BRITAIN

Consequential Loss.—In Great Britain consequential-loss insurance, sometimes termed profits insurance, in the mid-20th century assumed considerable importance. It was designed to insure "loss of profits and standing charges consequent on a fire" and thus to place the policyholder, as far as possible, in the same financial position after a fire as he would have been in had the

fire not occurred. Consequential-loss insurance is looked upon as a natural corollary of fire insurance.

Common law has laid down that ordinary fire insurance protects the insured only in respect to material loss or damage. The loss occasioned by a serious fire does not end, however, with material damage. The interruption of business which results may involve the complete cessation of manufacture or trade over a long period and perhaps the loss of skilled employees. The acquisition or temporary leasing of alternative premises may become necessary. Against this, consequential-loss insurance provides indemnity for three types of loss: (1) it compensates for loss of net trading profit due to a reduction in output following a fire; (2) it defrays the cost of meeting certain fixed charges which, but for the fire, could have been met out of revenue; (3) it undertakes to meet any additional expenditure necessarily incurred after the fire for the purpose of minimizing or avoiding the reduction in output. Insurance may be effected for any combination of these indemnities. The productiveness of a business is measured by the amount of its turnover or output, and any diminution in turnover or output caused by a fire is therefore considered the proper and normal standard for measuring the loss sustained.

Comprehensive Policy.—This covers private dwellings and their contents and provides a wide range of protection—fire, explosion (unqualified), burglary, third-party and other special perils—at an inclusive premium rate. Both contents and building may be covered in one policy or the building and the contents may be covered by separate policies. A primary condition common to comprehensive cover for building and contents of private dwellings is that the property insured be covered for its full value, this being a condition precedent to the right of recovery under the contract.

Explosion.—The most commonly effected form of "special perils" cover written on fire account is that of explosion. Varying types of explosion insurance are offered but the considerable lack of uniformity of practice renders the insurance position somewhat complex. No special legal meaning has been applied to "explosion" nor can the term be said to have been satisfactorily defined for the purpose of insurance. It is, however, a recognized principle of mercantile contracts that any words used in them, unless they have a legal meaning which differs from their ordinary one, shall receive that ordinary meaning in the event of any controversy. In this context, the terms "fire" and "explosion" are to be construed in their ordinary and popular sense.

The standard fire policy used by most insurance companies excludes by a printed condition all destruction or damage by explosion—even if the explosion is proximately caused by fire—except as stated on the face of the policy. In the end, however, the fire policy covers fire damage resulting from explosion, whether the latter occurs on or off the insured premises. It also covers damage to the insured property by explosion (not occasioned by or happening through earthquake, subterranean fire, riot, civil commotion or "war risks") of boilers used for domestic purposes only. It also covers damage caused by the explosion of gas used for domestic purposes and for lighting or heating the building, such building not forming part of any gasworks.

The exclusion of liability for certain forms of explosion damage from the scope of an ordinary fire policy gives rise to demand for cover against concussion damage, the cover for which is usually made effective by means of an endorsement to the fire policy. Explosion damage caused by steam-heated vessels, cover for which is usually provided under an "engineering" policy, is excluded and thus overlapping is obviated.

Aircraft.—The usual form of wording used in endorsing a fire policy to cover danger from the air extends the policy to include "destruction or damage to the property insured (by fire or otherwise) caused by aircraft or articles dropped therefrom." The inclusion of fire damage in the extension seems unnecessary, since it is already covered by the policy, and when granted by means of a separate policy the cover is restricted to damage "other than by fire." The wording is clearly wide enough to embrace damage by vibration from low-flying aircraft and from sonic booms, and insurers have been faced with claims under both these headings.

Riot and Civil Commotion.—This term has a distinct and detailed legal definition. The wording used by the companies in conjunction with the standard fire policy provides the following cover: "Destruction or damage (by fire or otherwise, including explosion) of or to the property insured directly caused by riot, civil commotion, strikers, locked-out workers or persons taking part in labour disturbances or malicious persons acting on behalf of or in connection with any political organization."

Water Damage.—The term "water-damage insurance" is a generic one used to embrace cover against damage by storm, tempest, flood or the bursting or overflowing of water apparatus. The terms "storm," "tempest" and "flood" have no legal definition and for the purpose of insurance are interpreted according to their normal everyday meaning. The forms in which the cover is expressed are as numerous and varied as those of the perils themselves. (P. Ss.)

OTHER COUNTRIES

The United States and the United Kingdom together account for a large share of the fire-insurance business done throughout the world, operating either through overseas branches or subsidiary companies domiciled in other countries. An important unifying force, internationally, has been supplied for many years by the activities of the British tariff companies' Fire Offices' Committee (Foreign). International reinsurance transactions also have helped to promote uniform contracts and practices. Accordingly, the principles and practices outlined above tend to prevail wherever fire insurance is found. Where variations appear they are due largely to differences in civil or commercial codes or other applicable law.

See also ARSON; CASUALTY INSURANCE; FIRE PROTECTION.

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FIRE ISLAND, an elongated sandspit, 30 mi. long by ½ mi. at its widest, is located in Suffolk county, N.Y., U.S., lying off the central southern shore of Long Island between Great South bay and the Atlantic ocean. The island, known also as Great South Beach, is a popular summer resort.

A large number of shipwrecks led to the acquisition of the westerly tip of Fire Island as a lighthouse site by the U.S. in 1825 and to the construction of a lighthouse (1858), which still stands. In 1908 the Fire Island (now Robert Moses) state park was opened on the western end of the island. It is connected by a bridge opened in 1964 with Captree state park on Long Island. Ferry service is also available. The eastern end of Fire Island is a county park, linked to the mainland by a bridge constructed in 1958. Fire Island National Seashore, a 4,300-ac. park, was created in 1964. A point of interest on Fire Island is the "sunken forest," which lies in an east-west trough, below sea level. When the trees—sassafras, holly and tupelo—reach a height of about 35 ft., they cease to be protected by the trough and are sheared off by wind and blowing sand. (D. L. D.)

FIRENZUOLA, AGNOLO (1493–1543), Italian prose writer and dramatist much admired in his day for his stylistic purity, was born in Florence. After studying law, he became a Benedictine monk at Vallombrosa (1518) but in 1526 was dispensed from his vows by Clement VII who, however, allowed him to keep his substantial benefices. He died in Prato on or about June 27, 1543.

Firenzuola's work is that of an ingenious stylist who aimed at classical elegance in the vernacular. In his *Ragionamenti d'amore*, an unfinished collection of ten stories (1523–24), he follows Boccacio in structure, but his style is more sophisticated. More interesting is his autobiographical recasting of Apuleius' *Golden Ass* (completed 1525; first known edition, 1550) in which the 16th-century ideal of translating *alla moderna* ("in a contemporary recasting") is realized. The dialogue *I discorsi delle bellezze delle*

donne (1540) is an interesting document of 16th-century aesthetic ideals. His best work is *La Prima veste dei discorsi degli animali* (1493), a free recasting of a 15th-century Spanish translation of the Sanskrit *Panciatantra*, a collection of fables. Less important are the *Discacciamento delle nuove lettere aggiunte* (1524), written against the orthographical reforms proposed by Giovanni Trissino, and his two comedies, *I Lucidi* and *La Trinuzia* (both 1549).

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FIREPLACE FURNISHINGS are household equipment for holding or supporting the fuel in the hearth, for maintaining the fire, and for protecting the fireplace and its surroundings. In the course of time there developed a considerable variety of pieces.

Andirons, a pair of horizontal iron bars upon which wood is supported in an open fireplace, are the oldest of such furnishings; they were used widely from the late Iron Age until the 18th century. The andiron stands on short legs and usually has a vertical guard-bar at the front (to prevent logs from rolling off), giving a grotesque doglike appearance: hence the alternative name, firedog. It was ordinarily fitted with a guard at each end when intended for use in a central open hearth, a form that went out of general use in the late 14th century. The guard was often cast in the form of a statue or with elaborate decoration; ornamentation was also sometimes applied in other metals, including silver. Plain andirons, called cobirons, with ratcheted guards holding brackets for spits, were used in the kitchen.

"COUNTRY LIFE"

PAIR OF ANDIRONS OF STEEL AND BRASS DECORATED WITH THE ROYAL ARMS, THE MONOGRAMS OF HENRY VIII AND ANNE BOLEYN AND THE LATTER'S DEVICE; FROM KNOLE PARK. ENGLISH; 1533–36

The grate, an iron receptacle for holding a fire, is usually more or less in the form of a basket. Recorded as early as the 11th century, grates came into general use with the growth of the use of sea coal as domestic fuel in the 17th century. Many 18th-century grates are of elegant design with elaborate pierced decoration.

The fireback, a slab of cast iron, usually decorated, protected the back of the fireplace from the heat of the fire. The earliest surviving examples date from the 15th century and the latest, modern reproductions excepted, from the 18th century. It is usually held that the majority of English firebacks were produced in the ironworking areas of Surrey and Sussex, but there can be little doubt that they also were made elsewhere in the British Isles. On the continent of Europe firebacks were made in the Netherlands and in France. In the Germanic areas, where stoves were commoner than fireplaces, stoveplates very much resembling firebacks were used. Firebacks were cast in sand molds. The most primitive method of preparing the mold was to make an impression in a bed of sand with a board of the requisite size. Decoration, where required, was added by pressing small stamps into the recess left by the board. From the middle of the 16th century it became increasingly common for the design to be carved in relief on the board so that an unlimited number of identical molds could be made. The subjects used for decoration varied widely. Coats of arms were especially popular but emblems, historical, allegorical, mythical and biblical scenes and an occasional portrait also are found.

The curfew, a domed metal cover, open at the front and with a handle on top, was placed over the fire at night; by cutting off nearly all ventilation it reduced the rate of burning and so kept the fire alight until morning. Its use is first recorded in the 16th century, continuing until the 18th century.

The chimney board (or fire board), decorated *en suite* with the room, was used in the 18th century to block the fireplace when it was not in use.

The fender, a low guard set at the base of the hearth to prevent hot ashes and cinders from falling on the wooden floor, is used almost exclusively with the raised grate. The fender first appeared in the third quarter of the 17th century and has been used widely since the beginning of the 18th century. Early examples consist of a wide strip of brass or steel, often with rich pierced and engraved decoration, bent to an appropriate shape and set on its edge. Some fenders are mounted on feet; some carry kettle-trivets or supports for fire irons.

REPRODUCED BY GRACIOUS PERMISSION OF HER MAJESTY THE QUEEN

CAST-IRON FIREBACK REPRESENTING NEPTUNE; FROM THE KING'S DRESSING ROOM, HAMPTON COURT PALACE. DUTCH OR ENGLISH IN THE DUTCH STYLE; LATE 17TH CENTURY

Fire irons for wood fires comprise tongs, a fire or log fork and, sometimes, a brush; for coal the same with the addition of a shovel, and a poker instead of a fork. All these objects except the poker have been in use since the end of the 15th century at the latest. The poker, which was designed for breaking up the burning coal, seems only to have become common in the 18th century. Fire irons are often decorated *en suite* with the fender.

The coal scuttle, box or hod, a receptacle, generally of metal, for holding a supply of coal by the hearth, was apparently first used in the early 18th century.

Fire screens, to prevent sparks and hot coals from flying out of the fireplace, came into use in the 19th century and are usually made of fine wire mesh. Earlier screens, to give protection from the intense heat of the fire, were made in various ways and often were elaborately decorated. *See* also SCREEN.

See article "Chimney Furniture" in P. Macquoid and R. Edwards, *Dictionary of English Furniture* (1954); J. S. Lindsay, *Iron and Brass Implements of the English House* (1927). (C. BL.)

FIRE PROTECTION. Since the earliest days of mankind, fire has been both a friend and a foe. Modern civilization would have been impossible had man been unable to utilize fire, but while the advance of technology brought improved methods of fire protection, it also created many new fire risks. This article deals both with fire hazards and with methods and equipment used to combat them; in addition, there is a section on conflagrations and a list of notably disastrous fires from early to modern times.

The material is organized in the following sections:

I. Introduction
II. Fire Research
III. Fire Protection in Buildings
  1. Interior Finishes and Furnishings
  2. Fire Escape Facilities
  3. Structural Stability
IV. Fire Control and Extinction
  A. Extinguishing and Alarm Equipment
    1. Extinguishing Appliances
    2. Automatic Fire Alarm Systems
    3. Automatic Sprinkler Systems
    4. Special Automatic Extinguishing Systems
  B. Fire Engines
    1. Early Types
    2. Steam Fire Engines
    3. Motor Fire Engines
  C. Fireboats
  D. Ladder, Rescue and Allied Equipment
    1. Ladder Equipment
    2. Aerial Ladders
    3. "Snorkels"
    4. Rescue Equipment

E. Fire Departments (Brigades)
1. Great Britain
2. United States and Canada
3. Integrated Fire-Fighting Services
V. Conflagrations
1. Peacetime Conflagrations
2. Wartime Conflagrations
VI. Notable Fires of History

I. INTRODUCTION

In the United States by the 1960s, fire was taking an annual toll of more than 11,000 lives, and the direct financial loss, in building fires alone, was more than $1,500,000,000; in the United Kingdom the yearly toll was about 750 lives and the financial loss was £44,000,000. However, in many cases, indirect losses from fire may amount to more than the direct ones. For example, when an industrial property suffers a fire that interrupts production, employees are liable to be idled, with a resultant loss of income and buying power; suppliers of raw materials and services, as well as distributors of the finished product, sustain a loss of market; and these losses produce a chain reaction of further loss throughout the economy.

The immediate impact of economic loss by fire is usually cushioned, as far as the property owner is concerned, by insurance; but from the point of view of national wealth, every fire represents a permanent loss of capital resources. Furthermore, many businessmen have been dismayed to find that documents needed to validate insurance claims have been destroyed by fire. This situation usually results in a compromise settlement, frequently on a basis that involves financial loss. It may occur even in so-called fireproof buildings, for these can act as incinerators for materials and records stored in them unless separate protection has been provided for the building contents.

The occurrence of fire depends upon three basic factors, frequently referred to as the "fire triangle": the presence of fuel, of the heat required to ignite this fuel and of oxygen to support combustion. Therefore, fire protection for the most part involves the limitation or exclusion of fuels, and the exclusion of dangerous sources of heat or ignition.

The protection of life and property from fire involves three essential activities:

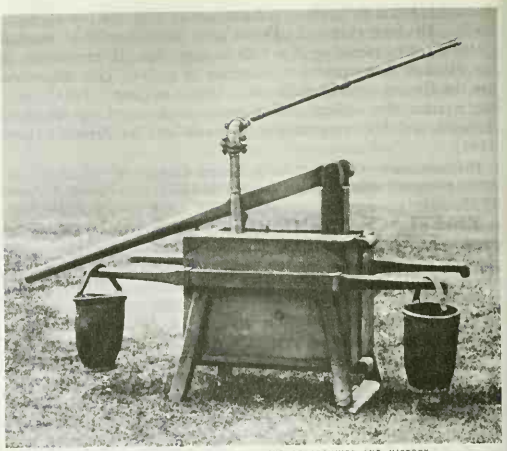
First, buildings must be designed so that they can be quickly and safely evacuated in case of fire. They must be subdivided into fire areas small enough to be controllable, and the amount of combustible fuels must be limited as far as possible. The design, arrangement and layout of the contents, equipment and utility systems must be such as to minimize the chance of a source of ignition coming in contact with combustible materials.

Second, the building and its contents must be utilized in a safe manner. This involves the general field of fire prevention and includes the education of the building occupants in safe practices. The majority of all fires are caused by human carelessness in allowing combustible fuels and a source of ignition to come together.

Third, since some fires will occur despite all precautions, facilities must be provided for fighting them. These include devices such as fire extinguishers and automatic sprinkler systems, and the maintenance of fire brigades or departments equipped to control and extinguish fires.

II. FIRE RESEARCH

The earliest efforts in fire research consisted mainly of developing tests to measure the fire resistance of various materials. In the United States the first formal work of this type began with the formation of Underwriters' Laboratories, Inc. in 1894. William Merrill, a young engineer, was employed by various fire insurance companies to inspect the huge electric light exhibit at the World's Columbian exposition held in Chicago in 1893. As a result of this work, Merrill became interested in the fire hazards associated with electrical equipment. He persuaded the insurance companies to sponsor a laboratory to test various electrical devices and establish an approval system to guide the companies in writing fire insurance. From this small beginning, Underwriters' Laboratories grew to be the largest safety testing organization in the world.



BY COURTESY OF NORTH CAROLINA STATE DEPARTMENT OF ARCHIVES AND HISTORY

FIG. 1.—NORTH CAROLINA'S FIRST "FIRE ENGINE," ABOUT 1765

In Great Britain, the first systematic inquiry into fire protection methods was stimulated by a particularly disastrous fire in Cripplegate, a district of London, in 1897. Edwin Sachs, an architect, interested a number of prominent persons in forming the British Fire Prevention committee to study methods of protecting lives and property. During the first seven years of its existence the committee conducted 79 fire resistance and fire equipment tests and issued numerous reports on the test results and on general fire prevention subjects. Sachs died in 1919 and the committee, lacking active leadership, became relatively inactive. In 1905, the Fire Offices' committee, formed in 1868 by English fire-insurance companies for underwriting purposes, opened a laboratory in Manchester to test various types of fire extinguishing apparatus. Later a furnace was erected for testing doors and shutters.

During the first three decades of the 20th century fire research efforts in all countries were concentrated mainly on the testing of potentially hazardous materials and equipment. In the United States, Factory Mutual laboratories was organized about 1900 by the Associated Factory Mutual Fire Insurance companies near Boston to perform research similar to that conducted by Underwriters' Laboratories. In 1910 congress appropriated a fund to enable the national bureau of standards to conduct comprehensive fire tests on building materials, and the bureau subsequently played an important role in this field. In Great Britain, the building research station of the department of scientific and industrial research operated three large fire-test furnaces at a testing station at Boreham Wood near London, owned by the Fire Offices' committee.

However, it was not until World War II and subsequent years that basic research on the development, propagation and suppression of fires began in earnest. In the United States both the research and development laboratories of the army corps of engineers and the naval research laboratory of the office of naval research were instrumental in the development of several new extinguishing agents as well as more effective utilization of water in fire fighting. Both Factory Mutual and Underwriters' laboratories engaged in extensive testing programs on various types of extinguishing agents, on the behaviour of materials, etc. The division of forest fire research of the department of agriculture has done extensive basic work, in conjunction with several universities, on the behaviour of free-burning mass fires and the feasibility of using model and full-scale fires for experimental purposes.

Fire research in the United States was given considerable impetus in 1956 when the Federal Civil Defense administration re-

quested that the National Academy of Sciences and National Research council establish a committee on fire research. The committee's purpose was to stimulate and advise on research directed toward the development of new knowledge and techniques in preventing or controlling both wartime and peacetime fires. A fire research correlation conference was sponsored in 1956 to provide an interchange of existing knowledge and to encourage further fundamental research in the spread and suppression of fires. Subsequently, additional conferences were held on methods of studying mass fires and on the use of fire models as study aids. The committee also undertook the publication of abstracts and reviews of significant scientific papers and reports.

Fire research in Canada has been a part of the work of the division of building research of the National Research council since 1950. Studies carried out by this organization included the development of fire model systems and the experimental burning of buildings. In 1958 construction of the St. Lawrence power project necessitated the flooding of a large area on the Canadian bank of the St. Lawrence river. Included in this area were a number of small towns that had to be relocated at new sites. As a result, the fire section of the division of building research was able to obtain several condemned buildings for experimental use. Burnout tests were conducted to study fire development from the standpoints of heat radiation, ventilation and survival of occupants. Other organizations engaged in various phases of fire research include Underwriters' Laboratories of Canada and the Canadian Standards association.

In Great Britain in 1935 the Riverdale committee, set up to advise the government on the fire service, recommended that research be undertaken on fire protection. The need for this was emphasized during World War II when fire became a powerful weapon. Postwar fire research in Great Britain began when the department of scientific and industrial research joined with the Fire Offices' committee in establishing the Joint Fire Research organization. The work undertaken by this organization included studies on the ignition, growth and suppression of fire and the use of model systems to study fire development.

Other European countries that have been active in the field of fire research include Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway and Sweden. The most prominent among these is the Swedish government testing institute in Stockholm, which has made extensive studies of flame spread on building materials and has developed several standard test procedures.

Fire research in Japan is unique in that, from its beginning, primary emphasis has been on the study of the development and propagation of mass fires, a natural result of the large number of conflagrations that Tokyo and many other Japanese cities have suffered since early times. The first systematic study appears to have been made by the physics department of the University of Tokyo following the Kanto earthquake fire of 1923, which leveled 12,000 ac. of the central district of Tokyo. The study indicated that fires had propagated from at least 80 independent sources. Further studies also were made on the relationship between weather conditions and the occurrence of mass fires; it was found that nearly all of Japan's serious fires had occurred during the winter, December through March, when winds were strongest and the mean air humidity was at a minimum.

In the 1930s further work was done by researchers from the University of Tokyo on the development of fires in wooden buildings, and in 1941 a committee was formed by the Tokyo Fire Fighting Research association to investigate the spreading of fires by wind. The Building Research institute of the ministry of construction was formed in 1946 and subsequently conducted experimental studies on the spread of fire within and between buildings. In 1948 the Fire Research institute was established as a laboratory of the National Fire Defense board. Its functions include not only fundamental research but also the testing and approval of all kinds of equipment and devices for fire protection. In 1950 the Fire Prevention society of Japan was formed, with a membership including all those interested in the various phases of fire research and fire protection.

III. FIRE PROTECTION IN BUILDINGS

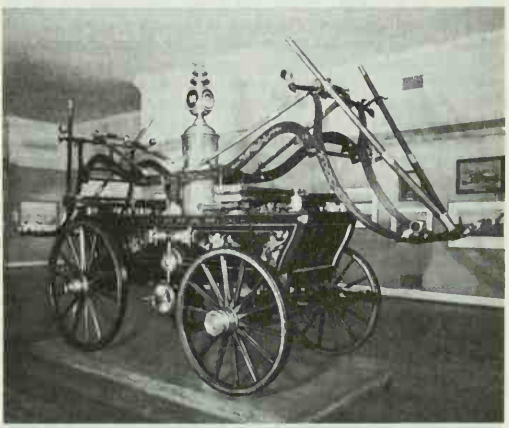
From the standpoint of fire protection, two basic considerations must be kept in mind in designing a building: the safety of the occupants and the retention of structural stability during a fire. A building made entirely of fire-resistive materials is not necessarily safe for occupancy. In turn, a building that is reasonably safe for human occupancy does not necessarily have to be fire resistive.

In the United States the design of fire-safe buildings was given continuous study, beginning in 1911, by the National Fire Protection association, which investigated major fires involving loss of life and published a series of standards for the proper design of exits, training of building occupants in exit procedures, etc. In 1927 there appeared the first edition of the *Building Exits Code,* embodying the principles of earlier standards, and this code was revised and expanded in subsequent editions.

The fire-protection problems involved in designing a building vary with the type of construction, over-all size, interior arrangement and the purpose the building is to serve. However, in general, it is essential to provide a sufficient number of protected exits so arranged as to offer at least two independent routes of safe escape from any part of the building. In addition, highly combustible interior trim and finishes must be avoided, especially in areas of assembly or in exit passages. Also, an alarm system or some other reliable means of signaling a fire should be provided, and the occupants should be trained in proper evacuation procedures.

1. Interior Finishes and Furnishings.—The problem of highly combustible interior finishes and furnishings has received much study. In the United States, Underwriters' Laboratories began an intensive investigation in 1943, following the disastrous Cocoanut Grove night club fire in Boston, Mass., Nov. 28, 1942, in which 492 persons perished. A fire hazard classification test was developed by the Laboratories, utilizing a tunnel furnace 25 ft. long, to classify interior finish materials such as fibreboard and wood paneling as to the rate at which flame spreads across their surfaces, the amount of fuel they contributed to a fire and the amount of smoke and other toxic vapours they produced. Identical furnaces later were placed in operation at the Southwest Research institute, San Antonio, Tex., Underwriters' Laboratories of Canada and at several other locations.

Fire-retardant coatings, consisting of intumescent paints with good heat-insulating qualities, have been developed for application over combustible surfaces and have shown excellent results in reducing surface combustibility. Another development, introduced as early as 1895 but not marketed on a commercial scale



BY COURTESY OF THE MUSEUM OF THE CITY OF NEW YORK

FIG. 2.—AN ENGINE OF THE 1850S, ONE OF THE LARGEST OF ITS DAY. IT WEIGHED ABOUT 4,500 LB. WHEN LOADED AND REQUIRED 16 MEN TO OPERATE THE PUMP

until many years later, is fire-retardant lumber, produced by impregnating wood with fire-retardant chemicals under high pressure. Manufacturers of these products can submit representative samples to Underwriters' Laboratories for tunnel-furnace tests and receive approval of their products if the combustibility is sufficiently reduced. Similar tests have been developed by the city of New York and the Forest Products laboratory, Madison, Wis.

The treatment of fabrics used for draperies and curtains to reduce their combustibility, while frequently referred to as fireproofing, actually only retards the development and spread of flame. Regulations in practically all countries require that fabrics used in theatres and other buildings where large numbers of people congregate must be either incombustible or treated to reduce combustibility. A problem common to all such treatments is that the impregnated chemicals are soluble in water; thus, each time the fabric is cleaned, the treatment must be renewed.

2. Fire Escape Facilities.—Improving the exit facilities of existing buildings can be a difficult and costly problem. Therefore, it is customary in most countries to allow the use of exterior fire escapes, the most common of which is the open iron stairway, with railed balconies, extending from roof to street. However, fire escapes of this type have serious limitations. In cold climates they must be kept clear of ice and snow, and unless installed against a blank wall, or one having wired-glass windows, smoke and flames from windows in the lower floors may render them impassable. Furthermore, many people are affected by height and are likely to be timid and descend at a much slower rate than they would on inside staircases. Because these fire escapes are not in daily use, their proper upkeep may be neglected. In spite of these limitations, however, many lives have been saved by this type of installation.

Because many fire escapes must overhang public walks or alleys, the lowest section often is hinged and counterweighted so that it will remain normally in a raised position; usually some form of locking device is provided to prevent prowlers on the street from pulling it down. Alternatively, the fire escape may end above ground level in a balcony to which ladders can be raised.

Another type of fire escape that may be applied to existing buildings consists of an iron balcony leading around a fire wall or fire exit partition. Persons escaping a fire in one section of a building leave by way of the balcony, usually through a window, passing around the fire wall and entering another building or another section of the same building, where they can use the regular means of egress.

A third type of fire escape that may be installed in existing buildings is the slide escape, that is, a chute built as a vertical spiral or as a straight incline and either open along its top or fully enclosed; access to the chute is through openings at each floor level. Chutes often are included in the design of new industrial buildings housing hazardous operations such as chemical or explosives plants. Their use is usually limited to schools, children's homes and hospitals. One advantage in the case of hospitals is that patients may be removed through the chute on mattresses.

The best fire escapes, however, are those that are planned as integral parts of a building, such as enclosed staircases within the building or adjacent fireproof stairway towers.

BY COURTESY OF THE MUSEUM OF THE CITY OF NEW YORK

FIG. 3.—CRANE NECK TYPE OF ENGINE, BUILT ABOUT 1863, WHICH WAS CAPABLE OF THROWING A STREAM OF WATER 150 FT. INTO THE AIR

BROWN BROTHERS

FIG. 4.—NEW YORK STEAMER DATING FROM 1905–1910

3. Structural Stability.—The behaviour of structural materials, insofar as their ability to resist damage from fire is concerned, has been studied for many years. The first systematic work appears to have been done about the beginning of the 20th century by the German Royal Technical Research laboratory and by the British Fire Prevention committee. Most of the early tests were conducted on hollow-tile floor arches and cast-iron columns, both with and without cement fill. In 1903 an international fire congress was held in London and a standard fire test was adopted. In the United States most of the earliest test work was conducted at Columbia university, Underwriters' Laboratories and the U.S. Structural Materials Testing laboratories. As a result of this work, a U.S. fire test standard was adopted in 1918 by both the National Fire Protection association and the American Society for Testing Materials. The basic feature of this standard is a time-temperature curve specifying a standard degree of fire severity to which all structural members under test must be subjected. The curve is characterized by a rapid increase in temperature up to 1550° F. for the first 30 min. and then a gradual leveling off at 2,300° F. after 8 hr. The wall, floor, column or other structural member subjected to this test is required not only to retain its structural strength but to resist the passage of heat to its unexposed side. The fire resistance of various structural members is then expressed as the number of hours they can withstand the standard fire exposure. There is also a British standard time-temperature curve that is similar to the U.S. standard.

IV. FIRE CONTROL AND EXTINCTION

Early discovery and prompt action are essential to the control and extinction of fires. Various types of automatic extinguishing devices are available but in many cases manual appliances are the only means at hand. A pail of water, the simplest and most primitive fire extinguisher, is effective if available during the first few minutes, although water should not be used on oil, grease or electrical fires. In the home, a large metal cover is excellent for confining flames if a pan of cooking fat takes fire on the kitchen stove. However, no matter what extinguishing means is used its effectiveness will depend upon the training and experience of the person using it.

A. Extinguishing and Alarm Equipment

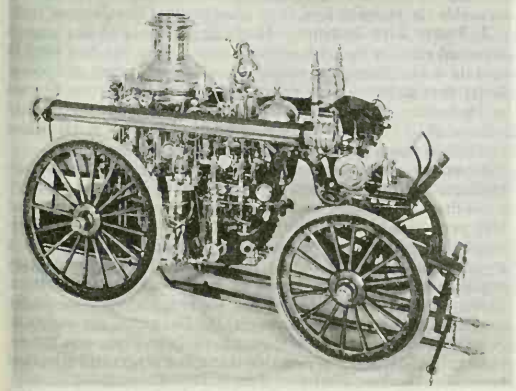
1. Extinguishing Appliances.—The term "first aid" is ap-

plied to fire extinguishers that contain a limited supply of extinguishing medium and that are readily portable. The success of this type of equipment depends upon its use in the early stage of a fire.

In the United States and Canada extinguishers are classed on the basis of their extinguishing potential and the types of fires on which they are effective. Underwriters' Laboratories uses a classification system embodying three basic types of fires. Class A fires are those occurring in ordinary combustible materials such as paper, wood, etc., for which the quenching or cooling effects of water or water solutions are most effective. Class B fires are those that involve inflammable liquids, greases, etc., for which a blanketing or smothering effect is essential. Class C fires are those that occur in "live" electrical equipment on which the use of an electrically nonconductive extinguishing agent is of first importance. The rating of extinguishing potential is based upon the maximum size fire that a given extinguisher can control. In the case of Class B fires an extinguisher is assigned a numerical rating that represents 40% of the size of a gasoline pan fire that can be extinguished by an average operator. A Class 8-B extinguisher, for instance, is one that can successfully extinguish an inflammable-liquid fire in a pan having a surface area of 20 sq.ft. The numerical ratings assigned to Class A extinguishers are based upon their ability to extinguish wood crib fires of various sizes; an extinguisher having a Class 4-A rating can be considered to have twice the extinguishing potential as one having a 2-A rating, etc. All extinguishers rated as Class C also have a Class B designation, and their numerical ratings thus describe their relative extinguishing potential.

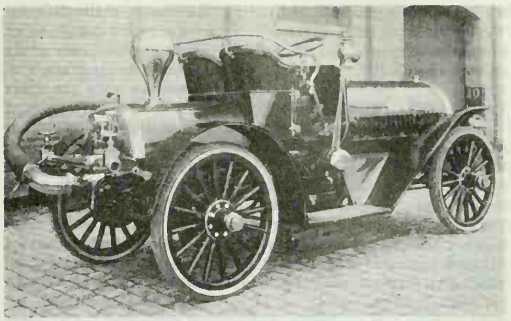
One of the most common types of Class A extinguishers is the so-called soda-acid type containing a chemical in water solution. Operation of the extinguisher causes a chemical reaction that provides the force to expel the water solution; it is the water that cools the burning material and extinguishes the fire. Other Class A extinguishers include the water pump-tank type in which the operator manually provides the expelling force and the water-pressurized type, which utilizes a cartridge of pressurized gas to expel the water. When water-solution extinguishers must be kept in areas subject to freezing temperatures, they must be filled with an antifreeze solution containing either calcium chloride or a special alkali-metal salt.

Class B extinguishers work on principles other than cooling. The foam type spreads a layer of tough foam over the burning material and extinguishes the fire by excluding oxygen. Other types that produce a similar smothering action are the carbon-dioxide extinguisher, the dry-chemical extinguisher and the vaporizing-liquid extinguisher. As these last three employ an agent that is not electrically conductive, they may also be used safely on Class C fires.



BY COURTESY OF THE MUSEUM OF THE CITY OF NEW YORK

FIG. 5.—STEAM FIRE ENGINE FIRST PUT INTO SERVICE ABOUT 1905. FROM ABOUT 1913 IT WAS DRAWN BY A GASOLINE-POWERED TRACTOR RATHER THAN BY HORSES. THIS TYPE OF ENGINE REMAINED IN ACTIVE SERVICE IN NEW YORK CITY AS LATE AS 1932



BY COURTESY OF WATEROUS COMPANY, ST. PAUL, MINN.

FIG. 6.—GASOLINE-POWERED ENGINE OF 1907, ONE OF THE FIRST ENGINES TO CONTAIN ITS OWN PROPULSION PLANT WITH WHICH IT COULD PUMP 600 G.P.M. THE BULB-SHAPED HYDRAULIC RAM ON THE TANK AT THE REAR OF THE VEHICLE SERVED TO SMOOTH THE FLOW OF WATER FROM THE PISTON PUMP

2. Automatic Fire Alarm Systems.—There is a great variety of automatic fire alarm devices ranging from simple types that ring an alarm inside the building to complex systems that signal the exact location of the fire to the central office of a watch service. An alarm system usually is actuated by thermostats that operate whenever the temperature in a room is raised to a point well above the highest anticipated normal temperature ("fixed-temperature" thermostat) or, alternatively, when the temperature increases at a dangerously rapid rate ("rate-of-rise" thermostat). The thermostats, which may work on principles of thermal expansion, change in electrical resistance or change in magnetic properties, or by the melting of a soft metal link, are usually placed on or near ceilings, where they will be most quickly affected by the heat of a fire.

Other alarm systems include a smoke-detection device comprised of a photoelectric cell and light source. When smoke from an incipient fire reduces the amount of light reaching the photoelectric cell, the alarm is actuated. A later detection device consists of a small chamber containing a minute amount of radioactive material, which ionizes the air within the chamber. When a voltage is applied across the chamber a small electrical current flows through the ionized air, but when products of combustion enter the chamber they reduce the current flow and actuate the alarm. This type of system is much more sensitive than the conventional heat-actuated alarm.

3. Automatic Sprinkler Systems.—The most effective automatic fire extinguishing system is the automatic sprinkler system. The prototype was developed about 1800 in England by John Carey; it consisted of a number of valves held closed by counterbalanced weights attached by string which, upon burning, allowed the weights to fall, opening the valves. Other systems consisted simply of a series of small perforated pipes attached to the ceiling and fed by a main riser equipped with a shut-off valve, generally located in an adjoining area or outside of the building. In case of fire, the shut-off valve was opened manually and water sprayed out through the perforations. This resulted in excessive water damage in areas of the room where there was no fire.

In 1874 the Parmelee sprinkler head was marketed in the United States; this was a great improvement on earlier systems and served as the basis for all modern automatic sprinkler designs. It consisted of a normally closed orifice that would open only when actuated by heat from a fire. In this way, water would be discharged only over the vicinity of a fire.

Modern automatic sprinkler heads utilize a fusible link, a liquid-filled frangible bulb or a chemical-filled bulb to hold the valve closed. The sprinkler head is also provided with a deflector to discharge the water in a spray. Until about 1952 deflectors were designed to discharge the spray in all directions and also to wet the ceiling above the sprinkler. However, with the development

of the "spray sprinkler" at that time, the design of the deflector was changed so as to direct all of the spray downward. This proved to be much more effective and came to be used universally on new installations. Because of its greater extinguishing potential, wider spacing between heads is possible when the spray sprinkler head is used.

The ordinary fusible-link sprinkler head is designed to open at a temperature of approximately 160° F. (71° C.). However, where unusually high temperatures are normally encountered, such as a boiler room, special heads can be installed that are designed to open at higher temperatures.

The customary wet-pipe sprinkler system contains water at all times. However, in locations subject to freezing temperatures a dry-pipe system is used. This contains air under moderate pressure which serves to hold the main control valve closed. When a sprinkler head opens because of a fire, air escapes through the head, the air pressure drops, the control valve opens and water flows into the system and out the open sprinkler head.

Other special types of automatic sprinklers include the deluge and the preaction systems. The deluge system consists of open sprinklers, or a combination of open and closed sprinklers, controlled by a special quick-opening valve activated either by automatic heat-responsive devices or by manual control. This type of system is used to protect high-hazard locations where it may be necessary to discharge a large quantity of water quickly over an entire area. A preaction system is one that has closed heads, is normally dry and in which the piping is under only atmospheric pressure. The main control valve is actuated by automatic heat-sensing devices. This type of system is intended to overcome the major shortcoming of the conventional dry-pipe system: the delay in operation while the air pressure reduces sufficiently to open the main valve.

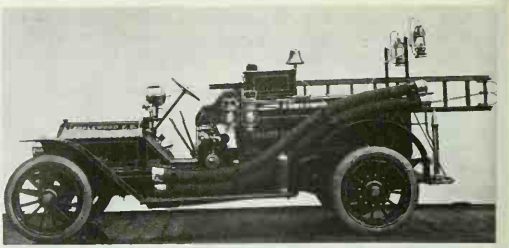
Various types of water-flow detectors are available that can be installed on sprinkler systems to actuate an alarm when a sprinkler head opens. The detector may operate merely a locally audible alarm or it may be connected to signal a fire station or a private central-station service company. In this way the sprinkler system can serve the dual function of an automatic extinguishing and alarm system.

4. Special Automatic Extinguishing Systems.—Certain potentially hazardous installations, such as paint dipping tanks, printing presses, degreasing operations, etc., may require automatic protection but cannot be equipped with automatic sprinkler systems either because water would be ineffective or dangerous or because water damage must be avoided. In such cases, automatic carbon dioxide, dry chemical or foam extinguishing systems are installed. All of these systems operate both automatically, in response to a signal from a heat-responsive device, and manually.

B. Fire Engines

The basic piece of equipment used in modern fire fighting is the triple-combination pumper. This is a specially built motor truck equipped with a pump, water tank (with a capacity of 200 gal. or more) and usually at least 1,000 ft. of fire hose. In addition, ladders, nozzles, pike poles, axes, forcible-entry equipment, gas masks and portable extinguishers are usually carried. A heavy-duty, internal-combustion engine provides the power to propel the apparatus and drive the pump. Fast acceleration and good grade-climbing ability are essential features. The engine must have adequate power to enable the pump to deliver a specified volume of water at a sufficient pressure to develop good fire streams. Pumpers are available in several standard sizes of 500, 750, 1,000, 1,250, and 1,500 gallons per minute (g.p.m.) capacity.

Other basic types of apparatus used by the modern fire services include: (1) the service ladder truck, which carries an assortment of extension and straight ground ladders varying between 10 and 50 ft. in length; (2) the combination pumper-ladder truck, called a "quadruple" or more simply a "quad," which carries the combined equipment of both types of apparatus and which, therefore, is more versatile; (3) the aerial ladder truck, which carries a power-operated ladder from 65 to 144 ft. in length in addition to ground ladders; (4) the quintuple truck, or "quint," which combines the features of a pumper and of an aerial ladder truck.



BY COURTESY OF AMERICAN LAFRANCE

FIG. 7.—PUMPER OF 1910 WITH A GASOLINE ENGINE WHICH OPERATED THE PUMP AND DROVE THE VEHICLE

In addition to the basic pumpers and ladder trucks, fire departments in the larger cities include such specialized equipment as smoke-ejector trucks, equipped with motor-driven fans and large-diameter suction pipe for reducing smoke concentration in buildings; lighting trucks with generators and floodlights for night operations; airport crash trucks; gasoline tank trucks for replenishing fuel supplies at the scene of a prolonged fire; and water tower trucks, although these have largely been supplanted by the practice of affixing hose lines to aerial ladders and by the introduction of the "snorkel," described below. The larger fire departments also may be responsible for operating a public ambulance service.

1. Early Types.—It is not known what fire-fighting facilities were available at the time of the burning of Rome in A.D. 64, but the first use of a device for applying water to a fire in the form of a stream dates back as far as the 2nd century B.C. The practice of fire extinction was still in a very elementary stage in 1666, when the Great Fire of London occurred, and the only fire engines used at that fire were those of the hand-operated type. The early pumping devices were usually in the form of a mammoth syringe. These later evolved into a water tank that was kept filled during the fire by a bucket brigade, the water being withdrawn and ejected by means of a rudimentary form of pump.

The pumps on the early fire engines were hand operated and the range and force of the stream were poor. In many instances the engine was destroyed by the fire because the short range of the stream made it necessary to move the apparatus close to the flames. Subsequently, the development of better pumps that could throw a stream much farther, and the introduction of flexible hose made it possible to locate the engine well away from the fire. A still later development was the use of suction hose to enable the pump to feed from sources other than its own tank.

2. Steam Fire Engines.—Mechanically operated fire engines appeared early in the 19th century, when steam was first used to operate a fire pump, the vehicle on which the pump and steam boiler were mounted being drawn to the fire either by the firemen or by horses. Public interest in steam fire engines was greatly stimulated by competitions held in England at the Crystal palace in 1863, in which engines from the United States took part.

Steam fire engines were used almost exclusively at the Chicago conflagration in 1871, and by the end of the 19th century horse-drawn steam fire engines had been brought to a state of high perfection both in Europe and in the United States. Engineers then turned their attention to further development of a steam-propelled vehicle, but by this time the internal-combustion engine was in the early stages of refinement and application. Motor trucks were adapted as fire engines, and they inevitably supplanted the steamers. However, the last steam fire engine in New York city, drawn by a tractor in its later years, was not retired until 1932, and it is probable that a few others still remained in service elsewhere after that date.

3. Motor Fire Engines.—At first, the application of mechanically propelled vehicles to the fire service was limited to hose carriers and chemical engines. This was due to the difficulty in converting pumps designed for direct drive by reciprocating steam

engines to a type that could be driven through gears by rotary gasoline engines.

The hose carrier, as its name implies, was a vehicle used for carrying hose to a fire where it would then be connected to a pumping engine. A few large city fire departments still operate separate hose trucks.

The chemical fire engine carried a large tank filled with a solution of bicarbonate of soda dissolved in water; enclosed in the tank was a bottle of sulfuric acid. To operate, the tank was turned over, mixing the acid and soda solution, and the mixture was then agitated by a paddle driven by a hand crank. The resulting chemical reaction produced carbon dioxide gas that forced the water solution out through a hose. (The same principle is used in the familiar soda-acid fire extinguisher.)

The first motorized pumpers had two engines, one to propel the vehicle and the other to drive the pump. In 1907 the Waterous Fire Engine works manufactured the first pumper using a single engine to drive both the apparatus and the pump; this unit was sold to the city of Alameda, Calif. In 1911 the New York city fire department placed in service its first pumping engine at

BY COURTESY OF THE LOS ANGELES FIRE DEPARTMENT

FIG. 8.—FIREBOAT DEMONSTRATING WATER-THROWING CAPACITY OF FIVE HIGH-PRESSURE TURRET NOZZLES

Engine Company No. 39 in the old headquarters on east 67th street. Because of its massive motor housing, it was named "The Giant" by the newspapers and soon became famous.

Most of the early motor-driven fire pumps were of the piston or reciprocating type, a heritage of the steam fire engines. However, piston pumps could not be driven by high-speed gasoline engines except through relatively complex gear arrangements. The rotary pump, also a positive-displacement type, came into use at about this time. Later, the centrifugal pump was introduced; this is not a positive-displacement pump and therefore auxiliary priming facilities had to be provided, but despite this handicap, the centrifugal pump soon dominated the field because of its greater flexibility of operation. Practically all modern pumpers are equipped with centrifugal pumps.

C. Fireboats

An important part of the fire-fighting equipment in large river, lake and sea ports is the fireboat, basically a large tugboat equipped with fire pumps of 3,000 to 12,000 g.p.m. capacity. The first of these were steam-propelled and their pumps were steam-driven. Modern fireboats are equipped with internal-combustion engines, usually diesels, to power both the boat and its pumps. A typical modern boat has a pumping capacity of 12,000 g.p.m. at about 100 lb. pressure, is 123½ ft. long, has a 26-ft. beam and 7½-ft. draft, and is designed to travel at a speed of about 14 knots.

In 1961 the Chicago fire department introduced a small, lightweight fireboat, propelled and steered by underwater hydraulic jets, that was capable of speeds as high as 32 knots and had a pumping capacity of 2,500 g.p.m. The absence of propeller and rudder gave the boat a very shallow draft, and the hydraulic jet power made it highly maneuverable; thus it was especially useful in the cramped waters of yacht harbours and along sloping beaches.

D. Ladder, Rescue and Allied Equipment

1. Ladder Equipment.—The development of fire department ladder equipment began in the 18th century with ladders intended exclusively for aiding people to escape from the upper floors of burning buildings. A drawing dated 1789 shows three types of rescue equipment employed in Geneva at that date, consisting of (1) a cloth or canvas chute, (2) a rope and basket (or sling), and (3) sectional ladders fitted with sockets so that several could be joined together to make one long length, the top section having wheels so it could be pushed easily up the walls of a building. Sectional ladders of somewhat similar construction were the first fire escapes to be used in London, when John Braidwood, first chief of the London Fire Engine establishment, put them into service in 1832. They were made in lengths of about 6 ft. for carrying upon the fire engines of the period.

In 1837 Abraham Wivell invented the first portable fire escape ladder mounted on wheels. Wivell's wheeled fire escape was not officially adopted, though it was put into service in London by the Royal Society for the Protection of Life from Fire. A few years later another type of wheeled escape known as the fly ladder was evolved and this, being an improvement upon Wivell's machine, gradually superseded it. The fly ladder had a main ladder about 35 ft. in length mounted upon a spring carriage, with large wheels. At about 10 ft. from the top of the main ladder a folding ladder, the fly, about 20 ft. long, was joined by hinges, and was raised by ropes attached to projecting levers; it was possible also to detach this folding ladder. When greater heights had to be negotiated, a separate short ladder could be placed at the top of the fly ladder, and by this means a height of about 60 ft. could be reached. At the underside of the ladder was affixed a canvas chute protected externally by copper wire netting; this was used to pass persons down whenever it was possible to get the top of the chute upon a suitable window sill. From greater heights persons had to be carried down the ladders in the same way as is done in the present day.

The fly-ladder escape held the field in England until about 1890, when telescopic escapes were introduced. The telescopic ladders were arranged to slide in a framework attached to the axle, and were held in position by means of hand-driven gear arranged on the backfly. They could be pitched at any angle to the building, thus enabling a wide forecourt to be bridged, which was not possible with the older types of fire ladders. However, soon after the sliding-carriage escapes were introduced the motor fire engine came into use, and it became customary to arrange brackets at the rear of the motor vehicles to carry fire escapes (fig. 9), which

BY COURTESY OF MERRYWEATHER & SONS LTD. (LONDON)

FIG. 9.—BRITISH PUMP-ESCAPE, USED WITH VARIATIONS BY FIRE BRIGADES THROUGHOUT THE WORLD. IT INCLUDES CAB FOR FIVE OR SIX MEN, HOSE, LADDERS AND WHEELED CARRIAGE ASSEMBLY (THE ESCAPE) MOUNTED AT REAR

could then be dismounted upon the arrival of the engine at a fire and wheeled by hand to any convenient position for use. This is still the practice in most large British fire brigades.

Another form of ladder that, although introduced many years ago, is still in use, is the pompier ladder. It is a light pole, usually from 16 to 18 ft. in length, with cross rungs and a steel hook at one end so that it can be hooked over window sills to enable firemen to scale the walls of a burning building. In expert hands the pompier ladder is very useful, but it can be used safely only by trained firemen.

2. Aerial Ladders.—The modern aerial ladder is hydraulically operated and can be controlled by one man. In the larger sizes the ladder may be as long as 144 ft., and its turntable mounting makes it a very useful fire-fighting aid. Often a large-capacity nozzle is mounted on the topmost section to direct water into the upper floors of buildings. Because the longer aerial ladders are of considerable length even when folded, the trucks carrying them are equipped with steerable rear wheels in order to negotiate narrow city streets; the rear wheels are steered by a fireman known as the tillerman.

3. "Snorkels."—A more flexible device than the aerial ladder is the "snorkel," introduced and named by the Chicago fire department in 1958. Known in industry as a gooseneck crane, the machine as adapted for fire fighting consists of two hydraulically controlled arms or booms, each usually 40 ft. long, attached to a truck-mounted turntable and carrying a railed platform or basket at the upper end (fig. 10). Permanent piping attached to the

BY COURTESY OF THE CHICAGO FIRE DEPARTMENT

FIG. 10.—GOOSENECK CRANE, KNOWN AS A "SNORKEL" WHEN ADAPTED FOR FIRE FIGHTING, CONSISTS OF HYDRAULICALLY OPERATED BOOM ATTACHED TO TRUCK-MOUNTED TURNTABLE AND EQUIPPED WITH A TURRET NOZZLE. THREE "SNORKELS" ARE SHOWN SURROUNDING AN AERIAL LADDER TRUCK

arms leads to a turret nozzle mounted on the basket, which can hold as many as eight persons in rescue work but which normally is occupied by one or two firemen. The position of the basket and arms can be controlled either from the truck platform or from the basket.

4. Rescue Equipment.—All fire engines carry some rescue equipment, but the larger departments often maintain specially equipped squads whose primary responsibility is rescue work not only at fires but at the scenes of accidents and in disaster areas. The rescue squad truck carries such equipment as special cutting and wrecking tools, gas masks and inhalators, portable lighting and smoke-ejection devices, chemical fire extinguishers, portable short-wave radios, life nets and first-aid kits.

E. Fire Departments (Brigades)

Organized fire brigades existed in civilized communities many centuries before the Christian era and were familiar to the citizens of the Roman empire. In England fire preventive measures are traditionally associated with William the Conqueror's *couvre-feu* or curfew, but the custom of ringing a bell to order the extinguishing of heating fires and candles for the night can be traced back to the days of Alfred the Great. References to organized fire fighting, which was probably not on efficient lines, are occasionally encountered in the history of the middle ages.

1. Great Britain.—The establishment of fire-insurance companies in Great Britain naturally brought about the question of minimizing loss by fire by preventing its spread. Because the public authorities had been indifferent in this connection the companies set about establishing brigades of their own. Probably the first insurance company to possess fire engines was the Royal Exchange, which announced in 1722 that it had provided several engines with firemen and watermen and the necessary equipment for extinguishing fires. This was followed by many other companies, each of which placed "fire marks" on the buildings it insured; it naturally followed that each brigade gave special attention to any premises insured by its own company. In 1833 the London Fire Engine establishment was formed by a combination of insurance companies; this consisted of 76 officers and men who took upon themselves the fire protection of London. However, a year later the houses of parliament were destroyed by fire, and in 1861 the great fire in Tooley street occurred, with damage estimated at £2,000,000. In 1862 a parliamentary committee was formed "to enquire into the existing state of legislation, and of any existing arrangements for the protection of life and property against fires in the metropolis." The inquiry showed a total inadequacy of facilities, and in 1865 the Metropolitan Fire Brigade act provided for the handing over of the fire stations, engines and property of the London Fire Engine establishment, together with the force of firemen, to the board of works; this formed the nucleus of the new metropolitan fire brigade. The insurance companies, being relieved from the burden of maintaining the establishment, not only handed over their freehold and leasehold properties and valuable equipment worth many thousands of pounds, but consented to an arrangement whereby they became liable to contribute to the upkeep of the brigade. Various statutes were subsequently passed by parliament, in relation not only to London but to other towns throughout the country, by which parliament recognized as a public duty of local authorities the maintenance of proper fire protection, the cost to be met from taxes.

Brigades in Great Britain apart from London exhibited considerable variety in equipment and effectiveness until the act of 1938 imposed a recognized standard of efficiency. Prior to 1938 there was no duty at common law for local authorities to maintain fire brigades, and the statutory authority invoked for the organization of a brigade—the Town Police Clauses act in 1847, the Burgh Police (Scotland) act in 1892 and other local government statutes—was invariably only permissive. The act of 1938 substituted compulsion for permissiveness, repealed the enactments under which the existing brigades had been constituted and established government control. Thus, at a single stroke, the multitude of independent brigades, which had previously had little opportunity to co-ordinate their activities and experience, became in effect welded into a single body. The eventual result was an all-around improvement in fire protection.

World War II brought a consolidation of all local fire brigades into the national fire service. After the war the brigades were returned to the jurisdiction of local authorities, but not, in all cases, to the same local authorities that had operated them in the prewar period. The total number of local authority brigades was reduced from 1,400 to 140 as a result of this consolidation, the

purpose of which was to reorganize the brigades to be large enough to operate more effectively.

2. United States and Canada.—Fire departments in the United States began with the purely volunteer form of brigade established in the original colonies. As early as 1647 Gov. Peter Stuyvesant of New Amsterdam appointed fire wardens to patrol the streets of lower Manhattan at night. The wardens were clad in long capes, carried a lantern and a noisemaker for the sounding of alarms, and became known as the "rattle-watch." The first organized volunteer fire company in the new world was founded in 1736 in Philadelphia by Benjamin Franklin and was called the Union Fire company. Each member agreed to furnish at his own expense six buckets and two strong linen bags. This was followed by the formation of many other brigades in the colonies and it was not uncommon, to the dismay of homeowners, for the first company on the scene of a fire to entrench itself and fight off rival companies before its attention to extinguishing the flames. As more and more fire-insurance companies were organized in America, their alliance with volunteer fire-fighting groups grew closer and the English system of identifying insured properties with marks was widely adopted. The later pattern of development found municipalities slowly taking over the operation and financial support of fire departments in a manner similar to that which occurred in England. But even today volunteer fire departments are still found throughout the United States and Canada in the majority of small towns and cities.

The traditional fire department unit in the United States and Canada is the individual fire company in its most rudimentary form, consisting of one piece of fire apparatus, usually a pumping engine with a hose, a few short ladders and enough men to operate it. Even in towns which may have more than one piece of fire apparatus, each piece of equipment has organized around it a "fire company," which works for the most part on its own. Except in large cities it is rare to find an officer directing more than one piece of fire apparatus at a fire.

In larger cities a number of fire companies usually have to work together. United States and Canadian practice is to group 8 to 15 individual fire companies into a battalion. A battalion of ten companies might, for example, consist of six pumping engines, two ladder trucks and two companies performing auxiliary services. The battalion force of a North American fire department is essentially the same grouping of apparatus and men found in a fire company in the practice of British and continental fire brigades. Large departments have divisions made necessary by the geography of the protected area, and some have marine and forest divisions.

Except in cities where all or part of the firemen are on call, fire companies are manned 24 hours a day. This requires a system of shifts, details of which differ. In the United States and Canada, work weeks of 48 to 56 hours are representative. All members of the department, including battalion and division commanders, work on a shift basis. Headquarters staff officers are the exception to this rule. While always on call, they work the customary office hours.

3. Integrated Fire-Fighting Services.—A transition from small single department or brigade operation to a large integrated fire-fighting force has been a noticeable trend in many countries. For example, in Australia there is in most of the states a state fire brigades' board that has certain advisory powers with respect to local fire brigades. There are also state-wide fire departments, operated by the state government rather than the municipalities, in New South Wales, South Australia and Western Australia. In Victoria there are two fire brigades' boards, one serving the metropolitan area of Melbourne and the other supervising fire brigades in the rest of the state.

In New Zealand, after a disastrous fire in a department store at Christchurch on Nov. 18, 1947, in which 41 persons lost their lives, the Fire Services act of 1949 set up a program of supervising fire brigades similar to the British arrangement.

In the United States and Canada there have been only a few instances in which large metropolitan areas have consolidated their fire service under one single authority. The foremost example is Los Angeles county in southern California, where large portions of the county outside of the city of Los Angeles are served by one department. Most urban areas of the United States and Canada have preferred to organize comprehensive mutual-aid plans. These leave control of the fire department with the individual municipality, but in the case of serious fires neighbouring departments respond with equipment and manpower to assist the local department in accordance with a prearranged plan. However, in rural areas there has been a trend toward the formation of fire departments on either a township or a county basis.

V. CONFLAGRATIONS

There is no universally accepted definition of a conflagration. Some authorities list as conflagrations all fires causing more than a specified amount of loss, regardless of the extent of spread or the number of buildings involved. Perhaps the best practice is to apply the term only to fires extending over a considerable area and destroying many buildings. A large fire in a group of buildings such as those belonging to a single industrial plant is not considered a conflagration even though the area and values involved may be considerable. Neither is a fire in a closely exposed group of mercantile or warehouse properties classified as a conflagration unless the fire crosses natural or prepared barriers, such as streets and fire walls.

For certain fires the term "group fire" is more appropriate. These include fires within the limits of an industrial plant property even if several buildings are involved, and fires in a group of mercantile buildings, particularly within a single city block. In both cases, buildings may be so close together that a fire may spread from one to another but is unlikely to spread outside the immediate area because of fire wall barriers, streets or other open spaces.

The conditions described as "fire storms" in cities attacked with incendiary bombs in World War II were conflagrations in the sense of fires burning over large areas, but they differed from peacetime conflagrations because multiple fires were started in such numbers that the flame from the individual fires merged into a single convective column, producing so much heat that all of the buildings beneath were set on fire. Whereas a conflagration spreads along a defined path and the population can retreat, the fire storm is an area phenomenon and the population is trapped. Life loss in fire storms is likely to be far greater than in conflagrations.

1. Peacetime Conflagrations.—Peacetime conflagrations have been of four general types:

1. Fires starting in congested sections that spread in one or more directions before effective resistance is organized to bring them under control. These fires usually spread first to nearby properties, cross streets by means of radiated heat and spread chiefly in the direction in which the wind is blowing. Failure to control such fires is due almost entirely to lack of sufficient heavy-stream fire-fighting equipment and lack of protection against fire spreading between buildings. Buildings equipped with automatic sprinklers, adequately supplied with water, have been notably successful barriers to the spread of such fires.

2. Fires occurring in primarily residential sections that spread beyond control because of closely built combustible construction and wooden shingle roofs. Such conflagrations are probable where fire protection forces are weak and water supplies are inadequate.

3. Conflagrations resulting from extensive forest and brush fires entering a city over a wide frontage at a point where the water distribution system is weak and limited fire-fighting resources are overtaxed.

4. Conflagrations caused by explosions with resulting fire over a wide area.

2. Wartime Conflagrations.—In World War II great fire destruction was visited on the cities of Germany and Japan. British cities suffered severe fires in the early days of the war, but few were conflagrations in the strict definition of the word. German cities, for the most part, were so built that conflagrations in the technical sense were not possible, though the magnitude of destruction by fire far exceeded that of most conflagrations. At-

tacks with incendiaries started thousands of fires, but they burned in individual buildings, with little spread from building to building.

On the basis of incomplete assessments, at least 54 of the largest cities in Germany had their central zones destroyed, destruction varying from 10% to 70% in individual cities with a median of 40%, principally caused by fire. In Hamburg, Kassel, Darmstadt, Stuttgart, Dresden and a few other cities, fires of conflagration proportions occurred with great loss of life. These resulted from the merging of thousands of individual fires.

The U.S. army air forces had practically destroyed 65 Japanese cities before the atomic bombs were dropped. Many of these fires were true conflagrations as the cities were predominantly of low wood-frame construction. Fire storms also occurred in a number of cases where incendiaries alone were used, and at Hiroshima as a result of the mass fire started by the atomic bomb. As in Germany, the centres of the Japanese cities were destroyed by fire, total destruction varying from 12% to 96% in individual cities, with a median of 50%, wholly the result of fires. (G. L. Ma.)

VI. NOTABLE FIRES OF HISTORY

Of many of the early fires of history there are only fragmentary records. In the middle ages many of the towns of Europe consisted of small buildings of wood construction, crowded closely together, which lent themselves to ready destruction by fire both in war and peace. In the accompanying list of major fires, some are included that would be relatively unimportant compared with the destruction of cities in later conflagrations that are listed. A limited selection of later fires had to be made in preparing a representative list and only those of particular significance could be included. Fire destruction during World War II dwarfs all the rest.

Great Britain and Ireland

Year

798 London. Nearly destroyed.
982 London. Greater part of the city burned.
1137 York. Totally destroyed.
1212 London. Greater part of the city burned.
1292 Carlisle. Destroyed.
1544 Leith. Burned.
1612 Cork. Greater part burned, and again in 1622.
1614 Stratford-upon-Avon. Burned.
1666 London. "The Great Fire," Sept. 2. It began in a wooden house in Pudding lane and burned for three days, consuming 13,200 houses, with St. Paul's church, 87 parish churches, 6 chapels, the guildhall, the royal exchange, the customhouse, many hospitals and libraries, 52 companies' halls, three of the city's gates, four stone bridges, and the prisons of Newgate, the Fleet, and the Poultry and Wood street compters. The fire swept from the Tower to Temple church, and from the northeast gate to Holborn bridge. Six persons were killed. The total loss of property was estimated at the time to be £10,730,500. The fire is credited with founding the institution of fire insurance.
1675 Northampton. Almost totally destroyed.
1694 Warwick. More than half burned; rebuilt by national contribution.
1824 Edinburgh. High street, Tron Kirk and Parliament square fires, Nov. 15 and 17; 10 killed; loss £200,000. This fire led to modernization of the Edinburgh fire engines and draft of rules for conduct of police, firemen, magistrates and property owners in event of fire.
1834 London. Houses of parliament destroyed.
1861 London. Cotton's and other wharves, Tooley street shops, steamer, boats and barges destroyed. Loss £2,000,000. This fire led to the passing of the Metropolitan Fire Brigade act of 1865, which combined the London Fire Engine establishment and the Voluntary Society for the Protection of Life from Fire into one body, and the establishment by the Fire (Insurance) Offices' committee of the London Salvage corps.
1915 London. Second Zeppelin raid by Germans, Sept. 8, caused 29 fires and £530,000 damage (air raids of World War I caused 224 fires in London).
1936 London. Crystal palace destroyed.
1940 London. First large air attack of World War II by Germans, Sept. 7, hit docks area, causing great fires. On Dec. 29–30 area around St. Paul's destroyed; 1,500 separate fires.
1940 Coventry. Air raid fire destroyed city centre, Nov. 14. This attack is credited with revealing the destructiveness of incendiary bombs. Lesser raids April 8 and 10.
1941 London. Heaviest single German attack of war, April 16 and 17, 457 tons incendiaries and high explosive bombs dropped. May 10, house of commons destroyed.
1949 Bootle, Lancashire. Gladstone dock fire, Nov. 9. Loss £2,000,000.
1950 Treorky, Rhondda. Factory fire. Loss £1,000,000.
1959 London. Shopping centre fire in suburb of Ilford, March 16. Loss £15,000,000.

France

59 Lyons (Lugdunum). Burned to ashes. Nero made an offer to rebuild the city.
1118 Nantes. Greater part of city destroyed.
1938 Marseilles. Destruction of large part of Canebière, 75 people killed.
1949 Landes district. 355 fires devastated 600 sq.mi. of forest and heathland.

Germany

1491 Dresden. Destroyed.
1758 Pirna. Burned by the Prussians; 260 houses destroyed.
1811 Forest fires in Tirol destroyed 64 villages and hamlets.
1842 Hamburg. A fire raged 100 hours, May 5–7. During the fire the city was in a state of anarchy; 4,219 buildings, including 2,000 dwellings, were destroyed. One-fifth of the population was made homeless and 100 persons lost their lives. Total loss £7,000,000.
1943 Hamburg. Royal Air Force wreaked terrible havoc by a series of attacks, principally those of July 24–25, July 27–28 and July 29–30. Fires were set, respectively, over 18.5, 17 and 10 sq.mi., with 1.5, 5.1 and 2.2 sq.mi. of concentrated fire. The first attack killed 2,000, but the second produced a great mass fire or fire storm which killed 60,000–100,000 people. More than 300,000 dwellings were destroyed in the attacks and 750,000 people were made homeless.
1945 Dresden. In the closing of World War II, Dresden was subjected to air attack which probably dwarfed all previous attacks of the war on German cities. No detailed evaluation of damage was published, but estimated deaths of 35,000 (Russian-East German figure), or 135,000 (according to later independent investigation) and development of fire storm conditions suggest it was the greatest fire of World War II.

Other Europe

64 Rome, Italy. Burned during 8 days. Ten of the 14 wards of the city were destroyed.
1106 Venice, Italy. Greater part of the city was burned.
1624 Oslo, Nor. Nearly destroyed.
1728 Copenhagen, Den. Nearly destroyed; 1,650 houses burned.
1751 Stockholm, Swed. 1,000 houses destroyed.
1790 Karlskrona, Swed. 1,087 buildings destroyed.
1850 Cracow, Pol. Large parts of city burned.
1865 Karlstadt, Swed. Almost entirely destroyed, 10 lives lost.
1910 Brussels, Belg. Brussels exhibition. Loss £1,750,000.
1939 Warsaw, Pol. Devastation of city by Germans, Sept. 24.
1940 Rotterdam, Neth. German air raid fires killed about 900, May 14.
1940 Norway. Elverum destroyed in May, and fires in a number of other cities after German bombings.

U.S.S.R.

1379 Memel (now Klaipéda, Lithuanian S.S.R.). Was in large part destroyed, and again in 1457, 1540, 1678 and 1854.
1752 Moscow. 18,000 houses burned.
1812 Moscow. Russians fired city on Sept. 14 to drive out the army of Napoleon. The fire continued five days. Nine-tenths of the city was destroyed; 30,800 houses burned; loss £30,000,000.
1879 Irkutsk. Loss £4,500,000.
1941 Russia. Many cities burned in face of German invasion; the extent of damage was very great but was not revealed.

Turkey and the Near East

1750 Constantinople (Istanbul). In January 10,000 houses burned; in April property destroyed estimated from £1,000,000 to £3,000,000; later in year 10,000 houses were destroyed.
1756 Constantinople. 15,000 houses destroyed. During the years 1761, 1765 and 1767 great havoc was also made by fire.
1772 Smyrna. 3,000 dwellings burned; 3,000–4,000 shops, etc., consumed. Loss £4,000,000.
1782 Constantinople. Fire burned three days; 10,000 houses, 50 mosques and 100 corn mills destroyed; 100 lives lost. In February 600 houses burned; in June 7,000 more.
1784 Constantinople. Fire destroyed 10,000 houses, most of which had been rebuilt since the fires of 1782. In the same year a fire in Pera destroyed two-thirds of that suburb. Loss estimated at 2,000,000 florins.
1870 Constantinople. Suburb of Pera swept by a fire which destroyed more than 7,000 buildings, including the residences of the foreign legations. Loss estimated at nearly £5,000,000.
1871 *et seq.* Constantinople. Fires of greater or lesser severity continued to be of almost annual occurrence until the 1920s, great fires being reported in 1908, 1911, 1912, 1915, 1918, 1919 and 1922.
1922 Smyrna. Conflagration attributed to the war between the Turkish and Greek armies. Loss £20,000,000.
1954 Istanbul. Fire destroyed ancient covered bazaar Nov. 27; loss $178,000,000.

1960 Amude, U.A.R. Fire in motion-picture theatre, Nov. 13; 152 children killed.

India, China, Japan and the Far East

1923 Tokyo and Yokohama, Jap. Following earthquake, about seven-tenths of Tokyo and most of Yokohama destroyed by fire; loss estimated at £200,000,000.

1924 Canton, China. Conflagration as a result of insurrection; loss £4,000,000.

1938 Canton. Great fires set by Japanese air attacks May 28 and subsequently.

1938 Ch'ang-sha, China. Fire set by authorities burned five days; almost complete destruction of city.

1940 Chunking, China. Japanese air raid caused great fires, Aug. 19–20, and loss of 4,572 lives.

1944 Bombay, India. Explosion on steamship "Port Stikine" and resultant fires destroyed docks and spread into a residential area, April 14; more than 700 deaths; damage estimated at £20,000,000.

1945 Tokyo. Attack by U.S. bombers with incendiaries on March 9 burned over 17 sq.mi. and killed nearly 84,000. Probably more persons lost their lives by fire at Tokyo in a six-hour period than at any one time in the history of man.

1945 Ōsaka, Jap. Air attack of March 13; 8 sq.mi. burned.

1945 Tokyo and Yokohama. Attack with incendiary bombs by U.S.A.F., April 15; burned over 7 sq.mi.

1945 Nagoya, Jap. Air attack of May 17; nearly 4 sq.mi. destroyed.

1945 Yokohama. Air attack of May 28; approximately 9 sq.mi. burned over.

1945 Hiroshima, Jap. Atomic bomb attack, Aug. 6; 68,000 of 75,000 buildings destroyed. A fire storm which developed after the blast contributed to the large life loss of 70,000 to 80,000.

1945 Nagasaki, Jap. Atomic bomb attack, Aug. 9; 20,000 out of 52,000 buildings destroyed. Fire damage was extensive but no fire storm developed. Loss of life more than 35,000.

1952 Tottori, Jap. Conflagration destroyed 5,287 houses; loss 19,300,000 yen.

1955 Yokohama. 100 persons killed in fire-swept home for aged.

Australia and New Zealand

1897 Melbourne. Flinders lane fire; loss £1,000,000.

1925 Melbourne. Knitting mills fire; loss £1,000,000.

1926 Adelaide. Sugar refining company fire; loss £700,000.

1943–44 Victoria. Bush fires, Dec. 1943–Feb. 1944, 51 dead; loss £5,000,000.

1947 Christchurch, N.Z. Department store destroyed, with 41 deaths, Nov. 18. This fire prompted adoption of plans long discussed for a fire brigade administration covering all New Zealand.

Central and South America

1960 Guatemala City, Guat. Fire in city hospital for the insane, July 14; 225 killed.

1961 Niteroi, Braz. Circus fire, Dec. 17; 323 killed, 800 injured.

United States

1835 New York city. Great fire of New York began in Merchant street, Dec. 16, and burned 530 buildings in the business part of the city; area burned over was 52 ac.; loss $15,000,000.

1845 Pittsburgh, Pa. Large part of the city burned April 11; 1,100 buildings destroyed; loss $3,500,000.

1849 St. Louis, Mo 23 steamboats at the wharves and whole or part of 15 blocks of the city burned, May 17; loss $3,500,000.

1851 San Francisco, Calif. Fire destroyed 2,500 buildings, May 4–5; more than three-fourths of the city destroyed; loss $17,000,000.

1851 St. Louis. More than three-quarters of the city and 2,500 buildings burned, May 4; loss $11,000,000.

1864 Atlanta, Ga. Large part of the city burned by Federal forces under Gen. W. T. Sherman.

1866 Portland, Me. Great fire on July 4 involved 1,550 buildings, 200 ac.; loss $10,000,000.

1871 Chicago, Ill. Great fire began in a barn on the night of Oct. 8 and raged until Oct. 10. The area burned over was approximately 2,000 ac. in the heart of the city; at least 300 lives were lost, 90,000 persons were made homeless, and 18,000 buildings were consumed; loss estimated at more than $190,000,000.

1871 Peshtigo, Wis. Forest fires, Oct. 8, destroyed 1,280,000 ac. and many buildings; 1,152 known deaths.

1872 Boston, Mass. Great fire of Nov. 9–10 destroyed richest quarter of Boston. Fire commenced at the corner of Summer and Kingston streets; more than 65 ac. burned over; 767 buildings burned; loss $75,000,000.

1900 Hoboken, N.J. German steamships in dock fire, June 30; 326 killed.

1901 Jacksonville, Fla. Conflagration destroyed 1,700 buildings; loss $11,000,000.

1903 Chicago. Iroquois theatre fire, Dec. 30; 602 killed. This fire led to more stringent regulations for theatres all over the world.

1904 Baltimore, Md. 80 city blocks, Feb. 7; loss $150,000,000.

1904 New York city. Excursion steamer "General Slocum" burned June 15; 1,030 killed.

1906 San Francisco. Great fire following earthquake, April 18; total loss of life about 700; total damage about $400,000,000.

1908 Atlanta. Conflagration of May 8; loss $11,500,000.

1908 Collinwood, O. Lakewood grammar school, March 4; 175 children killed in fire and panic.

1911 New York city. Factory fire, March 25; 145 women killed.

1916 Jersey City, N.J. Warehouses and steamers, "Black Tom disaster"; loss $22,000,000.

1916 Paris, Tex. Conflagration, March 21; 1,440 buildings burned; loss $11,000,000.

1917 Atlanta. Conflagration of May 21 destroyed 1,938 buildings.

1918 Minnesota. Forest fires, Oct. 12; Colquet and 25 other towns involved; 559 killed.

1923 Berkeley, Calif. Fire destroyed 600 buildings; loss $12,500,000.

1929 Cleveland, O. Hospital fire, May 15; 125 killed.

1930 Columbus, O. State penitentiary fire, April 21; 320 killed.

1934 Off New Jersey coast. Steamship "Morro Castle" burned Sept. 8; about 130 killed.

1940 Natchez, Miss. Dance hall fire, April 23; 207 killed.

1942 Boston. A night club fire, Nov. 28; 492 killed.

1944 Hartford, Conn. Circus fire, July 6; 168 killed.

1946 Atlanta. Hotel fire; 119 killed.

1958 Chicago. Elementary school fire, Dec. 1; 95 killed.

1960 New York city. Fire in aircraft carrier "Constellation," under construction in Brooklyn naval shipyard, Dec. 19; 50 killed, 150 injured; loss $50,000,000.

West Indies

1882 Kingston, Jamaica. Loss £6,000,000.

1948 Castries, St. Lucia. Commercial section of town wiped out; loss £2,000,000.

Canada

1825 New Brunswick. Tract of 4,000,000 ac., more than 100 mi. in length, including many towns, burned over; 160 persons killed.

1837 Saint John, N.B. 115 houses and nearly all the business part of the city burned, Jan. 13.

1877 Saint John. Fire extended over area of 600 ac.; loss $15,000,000.

1892 St. John's, Nfd. Loss $15,000,000.

1904 Toronto, Ont. General conflagration; loss $13,000,000.

1917 Halifax, N.S. About 75 ac. of city burned following explosion of munitions ship; 1,000 buildings leveled; 1,500 persons killed.

1949 Toronto. Steamer "Noronic" burned, Sept. 17; 120 killed.

1950 Rimouski, Que. 346 buildings destroyed May 6; loss $16,000,000.

See also references under "Fire Protection" in the Index volume.

(Ho. B.; X.)

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(G. L. Ma.)

FIRESHIP, a vessel laden with combustibles to be floated down on an enemy's ships to set them on fire. Fireships were used in antiquity and in the middle ages. The highly successful employment of one by the defenders of Antwerp when besieged by the prince of Parma in 1585 brought them into prominent notice, and they were used to drive the Spanish Armada from its anchorage at Calais roads in 1588. In 1809 fireships designed by Lord Cochrane were used against French ships anchored in the Aix roads. In the Greek War of Independence fireships employed against Turkish crews were largely responsible for giving the Greek insurgents command of the sea. In April 1862 the Confederates sent fireships against the Union fleet and mortar boats below Fort Jackson in the Mississippi river on five successive nights, but they were towed clear and caused no damage. On April 24, however, while Farragut's fleet was passing the Confederate forts during darkness his flagship the "Hartford" was set on fire by a fireship. The excellent discipline of the officers and men of the "Hartford" enabled them to put out the fire while using their guns against the Confederates to good effect.

Fireships were made by building a fire chamber between the decks from the forecastle to a bulkhead constructed abaft the mainmast. This space was filled with resin, pitch, tallow and tar, together with gunpowder in iron vessels. The gunpowder and combustibles were connected by trains of powder and by bundles of brushwood called bavins. In using a fireship, a body of picked men steered her down on the enemy and when close enough they

set her alight and escaped in a boat which was towed astern. As the service was particularly dangerous a reward of £100 or a gold chain with a medal (to be worn as a mark of honour) was granted in the British navy to the successful captain of a fireship. A rank of *capitaine de brûlot*, next to the full captain, existed in the French navy of Louis XIV. (J. B. Hn.)

FIRESTONE, HARVEY SAMUEL (1868–1938), U.S. rubber manufacturer, was born at Columbiana, O., Dec. 20, 1868. After selling buggies in Detroit and solid-rubber carriage tires in Chicago, he went to Akron, O., (1900) and with a $10,000 investment formed the Firestone Tire and Rubber company. He pioneered the manufacture of pneumatic tires for the Ford model-T automobile, nonskid tire treads, low-pressure balloon tires, motor truck and farm tractor tires. He early supported the ship-by-truck movement which led to long-distance trucking. To break a monopolistic grip on rubber prices held by growers in southeast Asia, he started plantations in Liberia (1926).

When Firestone died Feb. 7, 1938, at Miami Beach, Fla., his company was a leading corporation, already experimenting with synthetic rubber and producing plastics.

See Alfred Lief, *Harvey Firestone: Free Man of Enterprise* (1951) and *The Firestone Story* (1951). (A. Lf.)

FIRE THORN: *see* Pyracantha.

FIRE WALKING is a religious ceremony practised in many parts of the world, including the Indian subcontinent, Malaya, Japan, China, Fiji Islands, Tahiti, Society Islands, New Zealand, Mauritius, Bulgaria and Spain. It was also practised in classical Greece and in ancient India and China.

Fire walking takes several forms, the most common being the practise of walking swiftly over a layer of embers spread thinly along the bottom of a shallow trench. Sometimes the devotees or priests or oracles have to walk through a blazing log fire. Instead of embers from a wood fire, there may be red-hot stones (Fiji and Mauritius), or embers may be poured over the devotee's head in a "fire bath," or the devotee may lash himself with a flaming torch.

Various explanations are offered for fire walking. Its performance is said to ensure a good harvest, a familiar explanation also offered for many other ceremonies. The idea that fire purifies also is present; a man who is accused of a crime or of uttering an untruth may be asked to undergo the ordeal of fire to prove his innocence, and if he emerges unscathed his innocence is proved (*see* Ordeal). Fire walkers believe that only those who lack faith will suffer from injuries from fire, while the faithful are spared. Devotees also undertake fire walking in fulfillment of vows.

While injuries from burns do occur, they seem on the whole to be much less frequent than would be expected. This fact also needs to be explained, especially as devotees do not apply any artificial preparation before the ordeal to protect their bodies.

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FIREWEED, any of several weedy plants that spring up profusely after a forest fire, especially the great willow herb (*Epilobium angustifolium*, family Onagraceae), which occurs throughout North America and in northern Europe and Asia and is readily spread by its windblown downy-tufted seeds. Less common are the American horseweed (*Conyza canadensis*), which is widely naturalized in Eurasia, and *Erechtites hieracifolia* (both belonging to the family Compositae) also introduced into the old world. All but the great willow herb are annuals and hence difficult to eradicate on a scale sufficient to be effective, unless they are chemically destroyed. Spraying with 2,4-D in bright sun will kill it. (N. Tr.)

FIREWORKS. The history of pyrotechnics, or the use of fireworks, may be said to have begun when a prehistoric firemaker, probably in Asia, first mixed saltpetre from his cooking with charcoal from his fire to use as tinder. It seems likely that a knowledge of pyrotechnic mixtures existed in China and India for centuries before it was spread to Europe by the Arabs and Greeks. In the far east and in China particularly, pyrotechnic war devices such as war rockets and explosive missiles, either thrown or launched mechanically, were used in very early times. Fireworks played an important part in civil life at many celebrations and the Chinese devised elaborate and ingenious displays. In spite of their early start, however, their development of pyrotechnics soon lagged behind progress in Europe. The art of making fireworks and rockets for use in war is known to have been well developed in Arabia in the 7th century, which is not surprising since the oxidizing salts of potassium were known to the Muslim alchemists. In subsequent ages other ingredients were added as pyrotechnic mixtures developed and eventually, when the principle of the gun was evolved in the 14th century, the pyrotechnic mixture most suitable for its needs was named gunpowder (*q.v.*).

At about the same time that artillery was introduced, the military fireworker came into existence; his business was to provide pyrotechnic engines of war. To his duties was subsequently added the provision of spectacular fireworks in celebration of victory or peace. During the 17th and subsequent centuries most occasions of national rejoicing were celebrated by displays of fireworks, which were generally provided by the military fireworkers. In these early displays the number of pyrotechnic effects was limited; they were supplemented by others of a scenic or theatrical nature and the use of merely inflammable substances (torches and flares), which cannot, strictly speaking, be classed as pyrotechnics. During the 17th century there were two schools of pyrotechnic thought: that of northern Europe, with Nürnberg as its centre and Clarmer as its leader, and the Italian school. The former, although probably producing better results from a purely pyrotechnic point of view, could not vie with the southern school in artistic elaboration and the scenic accessories introduced.

In the early part of the 18th century displays on a hitherto unprecedented scale were fired at Versailles near Paris, in London and in many western European capitals. During the remainder of the century the size and number increased and firework displays became popular at resorts and public gardens, while continuing to be used for national celebrations.

As yet no real advance had been made in pyrotechnic mixtures; no colour had been introduced; the art still relied on saltpetre. Although some pyrotechnists claimed to produce various tints, there is no doubt that A.-F. de Frezier, in his two books published in 1706 and 1747, came nearest to the truth in describing the flame produced by his compositions as "reddish," "greenish," etc.

In the first quarter of the 19th century, however, the era of modern pyrotechnics began with the use of potassium chlorate, which had been first prepared by C. L. Berthollet (*q.v.*) in the late 1780s. Genuine colour effects were now possible and a field of research was opened that still is not fully explored.

The subject of coloured-fire production was dealt with at length by F. M. Chertier in his book *Nouvelles recherches sur les feux d'artifice*, published in Paris in 1854. This book, which resulted from exhaustive researches and laid the foundations of modern pyrotechnic practice, was a masterpiece for its time. Chertier also introduced the use of lead nitrate into pyrotechnics and was the originator of Chertier's copper, a compound of ammonia, potassium chlorate and copper sulfate that would be considered dangerous by modern standards. However, with the limited range of materials available, he introduced formulas well in advance of the knowledge of the time.

The subsequent introduction of the metals magnesium and aluminum also made possible a brilliancy never before attained and added greatly to the variety of effects produced.

The famous displays at the Crystal palace, near London, instituted in 1865, were one of the greatest factors in the development of the modern display. Old-fashioned limitations and scenic accessories were discarded and new heights in scale and method, both in aerial and ground fireworks, were reached.

Firework Compositions.—The phenomenon known as fire is produced by the combination of certain substances with oxygen in so rapid a manner as to produce flames and heat. When inflammable substances are set on fire in the ordinary way they obtain oxygen from the air. The art of the pyrotechnist lies in the production of mixtures of ingredients that do not depend on atmos-

pheric oxygen for their combustion. These mixtures are known as pyrotechnic compositions. Every pyrotechnic composition contains at least one ingredient having a supply of oxygen with which it readily parts and others that receive and combine with the oxygen and, in so doing, produce the effect for which the particular composition has been designed. The most-used oxygen-supplying ingredients are potassium nitrate (saltpetre), potassium chlorate and potassium perchlorate. Compositions may be divided into two classes: (1) those designed to produce force and sparks and (2) those producing flame, either white or coloured. Certain compositions are designed to produce special effects such as noise, a dense cloud of smoke for military or other purposes, or a whistling sound (such as that produced by picrate of potash in the whistling rocket).

Force and Spark Compositions.—The basis of these compositions is a mixture of potassium nitrate, sulfur and charcoal that is ground to a fairly fine powder. In some cases, finely ground gunpowder is added to give extra force when required, as in sky rockets, turning cases (used to turn wheel devices) and similar fireworks. Additional ingredients are included to produce sparks of various forms. The nitrates of lead and barium are used sometimes in these compositions; aluminum in an extremely finely divided dust is added to produce very brilliant white fire.

Flame Compositions.—In this class are included those compositions that give colour to pyrotechnics: the "stars" in rockets, shells and roman candles, the decorations on revolving and stationary devices and set pieces and the outlines in pictorial (or, as they are technically called, lancework) pieces.

White fire, whose composition varies according to the purpose for which it is used, generally consists of potassium nitrate, salts of antimony, or arsenic and sulfur. With the exception of white fire and a few others of little importance, such as the port fire and blue light used at sea, flame compositions rely for their combustion and their colour on the presence of potassium chlorate or, occasionally, potassium perchlorate.

For coloured fire, the combustion of potassium chlorate or potassium perchlorate in combination with a metal salt has the effect of turning the metal present into a gaseous state, producing a coloured flame. The following salts are used for the various colours: red—the nitrate, carbonate or sulfate of strontium; green —the nitrate, chlorate or carbonate of barium; yellow—the oxalate or carbonate of sodium; and blue—the carbonate, sulfide or arsenite of copper in combination with calomel (mercurous chloride). It is interesting that copper, when burned in a blowpipe flame, produces a green colour but the copper salts used in pyrotechnics produce a blue colour because of the chlorine present in the potassium chlorate or perchlorate; the shade of blue is deepened by the addition of calomel, which produces additional chlorine.

Magnesium powder is used with colour compositions where extra brilliancy is desired. Most colour compositions have, in addition, some burnable substance that serves to increase the mass and effect without detracting from the brightness or colour. The substances most commonly used are shellac, tristearin, pitch and paraffin. Sometimes the burnable substance serves also as an agglutinant, for instance shellac, starch paste, gum water, linseed oil or dextrin.

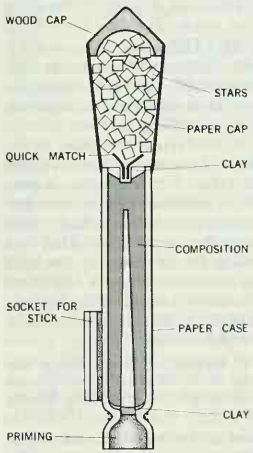
Firework Cases.—The composition of each firework is enclosed in a "case" that is formed by rolling paper around a cylindrical former and then pasting it. It is either "dry-rolled" (that is, only the edge of the paper is pasted) or "wet-rolled" (the paste covers the whole surface of the paper). Generally the paste used for force and spark compositions remains intact during the burning of the firework, while that enclosing a flame composition is consumed as the firework burns.

Filling.—The filling of firework cases is a skilled operation. It is absolutely essential that the composition be consolidated with great care. Failure to consolidate correctly results in cavitation of the filling, which, on ignition, leads to erratic burning and often to explosion. These undesirable events occur because large surfaces are ignited, thus giving rise to pressures greater than those for which the case was designed.

Compositions are introduced into the cases by one of three methods. (1) They may be pushed into a wide-bore case with the thumb and then pressed down with a wooden drift (a mallet on a cylindrical wooden tool exactly fitting the bore of the case). This method is used for small, slow-burning fountains. (2) A second method is by "charging"; *i.e.*, a succession of small quantities of composition are poured in from a scoop of suitable size, each scoopful being consolidated by a number of blows from a drift. Large fireworks may be charged in a hydraulic press, in which the composition is poured into the case in increments and each increment consolidated separately at pressures ranging up to many tons per square inch. (3) A third method, one extensively used, is "funnel and wire charging." In this method a conical funnel or hopper, with a nozzle at the constricted end, is inserted in the case mouth. A "wire" or rod long enough to reach the bottom of the case and protrude above the hopper is passed through the nozzle. The funnel is then filled with composition and the rod is moved rapidly up and down. As the wire lifts, composition flows into the case and the downward stroke consolidates the powder now lying in the bottom. This method is used only with cases of small diameter.

The manual methods have never been superseded satisfactorily by mechanical means, although many experiments have been made. In pyrotechnics, as in some other crafts, handwork maintains its superiority.

Rockets.—The rocket, which is the most elaborate in construction of any single firework, also requires the highest degree of technical skill in manufacture. The skyrocket (its most familiar form) is driven into the air by the recoil produced from a jet of fire thrown out by its burning composition. In order to make this jet as strong as possible, the case, which is wet-rolled, is choked, or constricted, by pulling in with a cord near one end before drying. In addition, the composition is charged into the case in a way that produces a conical cavity extending from the choke, or vent, nearly to the top of the case; because of the cavity, as large an area as possible of composition is burning at the time the rocket is ignited, which is the moment when maximum combustion is required to set the rocket in motion. This cavity is produced by charging the rocket on a tapering spindle and using drifts that are of varying lengths and are pierced with a hole of suitable size. Above the composition in the body of the rocket is a diaphragm of compressed clay that is bored with a central hole through which the fire from the top, or "heading," of the composition is communicated to the "garniture" contained in the cap, which usually has the form of a truncated cone. The garniture consists of "stars" of colour, or other suitable composition, either contained in short, cylindrical cases, when they are known as "pinched stars" from their method of manufacture, or compressed into cylindrical form without a case, when they are known as "pumped stars."



CROSS SECTION OF A SKYROCKET

The solid black portion represents the composition, which, when ignited, produces a recoil that starts the rocket on its spectacular upward flight

Gerbs and fountains are charged without a central cavity, the choke generally being formed by a clay diaphragm. The compositions are similar to those of the rocket, with the addition of spark-producing ingredients. The composition for gerbs (formerly known as Chinese fire) contains iron filings; for fountains (formerly known as brilliant fire), steel filings; and for flower pots, lampblack, which produces remarkable sparks that, from their form, gave to this composition the name of spur fire.

Devices and set pieces consist of frameworks of wood on which

are secured fireworks units that are connected by quickmatch (cotton fuse) and take the form of wheels moving in the vertical or horizontal plane; stationary or, as they are called, fixed devices of various geometrical forms; waterfalls; tree pieces and lancework pieces. The outline of a lancework piece is constructed in cane on a wood lattice framework and the design picked out in appropriate colouring with lances (small cases of colour, or "bright," composition about the size of a cigarette); by this means almost any pictorial design can be carried out.

A great deal of research has been carried out on the possibility of using synthetic resins as fuels and binders. By causing polymerization to take place after the mixing and filling of the composition, hard masses of composition of uniform density may be formed. These masses are relatively impervious to flame penetration, giving more accurate burning times and lessening the danger of explosion resulting from damage to the firework. This would also introduce a different approach to the filling technique, thereby leading to greater safety because of the absence of loose composition and a relatively smaller degree of inflammability of the compound.

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FIRMICUS MATERNUS, JULIUS (4th century A.D.), author of a work on astrology, was a Roman of senatorial rank born in Sicily. Two of his books survive. One, *De errore profanarum religionum*, written *c.* A.D. 346, is an attack on paganism dedicated to Constantius and Constans, calling on them to suppress the old religions. The other, *Matheseos libri viii*, is the most comprehensive, though far from the most intelligent or best informed, ancient textbook of astrology. Firmicus writes a pure Latin idiom in a tolerable style. It is generally held that he first wrote on astrology and later being converted attacked pagan errors. But astrology is not among the errors he attacks; and there are some reasons for regarding the astrology as the later work and none which preclude its being written by a Christian. After a general introduction it explains the casting of horoscopes; but it is notably earnest in defense of purity of morals and tries to argue that astrology is compatible with free will.

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FIRST AID. First aid is defined as the immediate and temporary care given the victim of an accident or sudden illness in order to avert complications, lessen suffering and sustain the person until the services of a physician can be obtained. Proper immediate care is sometimes necessary to save life but the knowledge of what not to do as well as what to do is vitally important. The present article on first aid procedures is a compilation of instructions recommended by various bodies including the Red Cross organizations.

General instructions that apply to all first aid activities are avoidance of excitement or panic, correction of situations that might aggravate the original injury and protection of the accident victim from unnecessary exposure to the elements or to new hazards such as accidents occurring while speeding to a first aid station or hospital. For example, in motor accidents, the victim should be removed from the highway, if this is possible, or guards placed about the area to warn approaching traffic. Certain common conditions such as heart attack, stroke, fainting and epilepsy cannot be readily differentiated by the first aider. When these emergencies arise, they will be best cared for by applying the procedures of first aid for shock.

When the victim is prostrate he should not be moved until the approximate nature of the injury has been determined. The victim should be kept lying in a comfortable position, his head level with the body. If the victim is unconscious, he should be handled as for skull fracture or apoplexy. A smell of alcohol on the breath can be misleading.

First Aid Equipment.—A first aid kit (distinguished from a home medicine cabinet) should consist of a dust-tight durable case containing the following items: several packages of sterile gauze squares of two or more sizes, 2 × 2 in. to 4 × 4 in.; sterile gauze or muslin dressings about 1 yd. square; a roll of 1 in. adhesive tape; six bandages, 1 in., 2 in. and 4 in. widths; one pair bandage scissors; one package sterile cotton applicators; one pair tweezers; one package ready-made adhesive gauze compresses; one first aid bottle (1 oz.) mild antiseptic; one 2½-in. elastic bandage; safety pins; and two ampules of aromatic spirits of ammonia that may be broken when needed. All medication and supplies should be plainly marked and labels read carefully before using.

In addition, the home and automobile should be equipped with wooden splints and the bandages to apply them, a blanket, flashlight, jackknife and a short pencil and pad for recording pertinent information.

Examination.—Look for serious bleeding, stoppage of breathing and poisoning. They must be treated immediately. Then look for evidence of wounds, fractures, dislocations and burns; feel the pulse; try to elicit response from the victim. Never try to have a patient stand or walk until you have determined there is no injury to the spine, pelvis or legs. Keep the injured person warm. He should have blankets under him, but the first aider in covering him must give consideration to the temperature of the environment. Keep the patient comfortable but not hot. Never give water or other liquids to an unconscious person. Do not let the patient see his own injury. Send someone to call a physician or ambulance.

Shock.—In every severe injury shock is a serious condition and may result in death. Severe pain, loss of blood, extensive burns and accidents due to electricity cause a depressed state of all body functions, resulting in a failure of blood circulation. Shock may be more severe in the aged. The symptoms usually develop gradually. The skin is cool and clammy; perspiration is noted on the forehead, above the lips and palms of the hands; the pulse is weak and unconsciousness may occur. Shock is so serious that every effort should be made to prevent it. Elevate the lower part of the body. In chest injuries raise the head and shoulders slightly if breathing is difficult. Keep the patient comfortable but not hot. Fluids such as warm water, broth, tea or coffee may be given in small amounts unless the patient is nauseated, unconscious or has an abdominal wound. Alcoholic drinks are not advised. Avoid unnecessary moving. (*See* also SHOCK.)

Transportation.—In the handling of any seriously injured or prostrate person the transportation of the patient is of prime importance. Improper action might increase the damage at the site of the injury and cause harm to nerves and organs, thereby seriously complicating the original injury. Few cases require hurried or snap decisions. Determine by observation and questioning the approximate nature of the injury. Notify a physician as soon as you have essential information regarding the type of injury (head, back, limb, abdomen) and the age of victim (child, adult, aged). Request advice regarding immediate care and do not end the telephone conversation until you are sure the physician's questions are answered and advice is given. Usually the physician will notify the hospital and call an ambulance. If this is not feasible, determine your transportation method. Exactly what is to be done? What materials are needed to move the patient? If the patient is to be carried to a vehicle, how must he be placed in it? Exactly what is the duty of each helper in carrying the patient to the vehicle? These questions should be answered by the first aider before getting started. The patient should not be bothered or worried by questions or discussion of the matter.

The stretcher is extremely valuable in short or long transportation. Stretchers may be improvised by the use of the following: (1) poles and blanket; (2) a blanket properly rolled; or (3) a door, ladder or screen covered with light board and blanket. If the patient is unconscious, his hands should be tied together with a bandage; if he is conscious, his hands may be left free. Few

cases require breakneck speed; many are benefited by careful movement rather than haste. Seek advice and assistance at the hospital before moving the patient from the vehicle.

INJURY TO BONES AND JOINTS

A fracture is a break in a bone and is generally the result of violence such as a fall or a sudden blow. X-ray examination is the most positive way for determining the nature and extent of any bone injury. There are two kinds of fractures, (1) closed (simple) where the bone is broken but no connecting wound from the broken area through the skin; (2) open (compound) where the broken bone penetrates the skin or a crushing injury has broken the skin and muscle tissues to the depth of the broken bone (fig. 1). An open fracture, because of the entrance of germs, is much more serious than a closed fracture. A history of a fall or violence, pain on motion about the injured area, deformity, tenderness and swelling over the injured bone are characteristic of fracture.

FROM THE DETROIT INDUSTRIAL FIRST AID ADVISORY COMMITTEE, UNIV. OF MICHIGAN INSTITUTE OF INDUSTRIAL HEALTH; BY COURTESY OF FEBRUARY PUBLISHERS

FIG. 1.—(TOP) CLOSED AND (BOTTOM) OPEN FRACTURES (*See* TEXT)

For all fractures and possible fractures keep the broken ends and adjacent joints quiet. Splint the injured area when in doubt. If the fracture is open (compound) and bone or tissue protrudes through the damaged skin, special care must be exercised in the handling of the injury. (*See* also FRACTURES AND DISLOCATIONS; BONE, DISEASES AND INJURIES OF.)

Fracture of Long Bones (Arm, Leg) should be immobilized with a splint. In fractures of the leg, thigh or hip apply the splint before moving the victim. If it is necessary to move the injured person a short distance, someone should place his hand above and below the fracture area to keep it quiet while others support the weight of the body. Use a stretcher if one is available.

Splints should be padded and sufficiently long so that the joint on each side of the fracture is incorporated in the splint. Improvised splints can be made from thin boards of sufficient length covered with padding. Too small or unwieldy boards are likely to cause more harm than good.

Fracture of the Spine (Backbone) is caused by a fall or crushing accident. Backache, pain in the neck, paralysis of one or both lower extremities and shock are symptoms that the spinal cord may be damaged. Extreme caution is important in the handling of this type of injury because permanent paralysis or even death may result from improper first aid. Transport the victim on a rigid frame. This frame may be improvised by using boards or a door; support the head and neck carefully. If the patient is found on abdomen or side, roll him gently to the back, rotating the neck in line as the body rotates and bind him to the frame. Do not use a pillow, particularly if the injury is in the neck or upper back. Place pads on each side of the head to prevent rolling. Place a small padding under the small of the back. Do not permit the patient to sit up. Do not let the head tilt forward, sideways or backward. Do not move the patient from the frame to a stretcher or bed until he has been examined by a physician.

Fracture of the Hip is generally the result of a fall. Symptoms are usually shock, often severe; the foot is frequently turned outward; there is tenderness and pain over the hip. While on his back the patient cannot raise his heel although he can move his ankle and foot. Apply a splint on the injured side of the body from armpit to foot. If a splint is not available bandage the injured limb to the other limb. Give proper shock care. Transport on a stretcher.

Sprains.—Sprains result from a tearing and stretching of ligaments about a joint. There is pain, swelling and possible discoloration. It is often difficult to differentiate a sprain from a fracture; if there is doubt it is best to treat the injury as if it were a fracture. Rest and elevation of the affected area are desirable, as are cold applications. *See* also JOINTS AND LIGAMENTS, DISEASES AND DISABILITIES OF.

WOUNDS

A wound (*q.v.*) is a break in the skin and is classified as an abrasion (scraped), incision (cut), laceration (torn) or puncture (stab) wound. The dangers that might complicate wounds are infection, hemorrhage and shock.

In the first aid treatment of wounds, cleanliness is essential. Do not touch the wound with the hands or fingers or any unsterile material. A minor abrasion or laceration should be cleansed thoroughly with bland soap and warm water, rinsed with warm water and treated with a mild antiseptic; the injury then may be dressed with a ready-made adhesive gauze bandage or sterile gauze and roller bandage. Do not use improvised bandages or dressings unless the material has been thoroughly washed with soap and hot water and freshly ironed. If the wound is of a nature that will require subsequent dressing, it is advisable to consult a physician. Wounds which cause hemorrhage have usually cut or torn a blood vessel. Most vessels close to the surface of the skin are veins and small arteries. All that is needed for control of the bleeding is direct pressure over the wound with sterile gauze from the first aid kit or a clean unused handkerchief. It is not harmful to allow fresh water to run over the bleeding wound before applying pressure with a square of gauze between the fingers and the wound. This is called digital pressure (fig. 2). Do not apply a retaining bandage until the bleeding has been controlled. It is better to add another piece of gauze over the first section than to remove the first gauze from the wound. Contamination of the wound by contact with additional material should be avoided as much as possible. When bleeding is not severe, infection is the chief danger.

When arteries are cut or a number of large veins have been lacerated, severe bleeding ensues. Blood from the arteries is bright red and comes in spurts. The chief duty of the first aider is to stop the loss of blood; determine as quickly as possible the source of bleeding and apply digital pressure close to the wound, but not on the wound's edge. If digital pressure will not stop the flow of blood, it may be necessary to apply a tourniquet but this should be done only as a last resort. The tourniquet is a dangerous instrument and it should be used only when profuse bleeding—such as that which occurs when a large artery or vein in one of the limbs has been cut—cannot be checked by direct pressure. When arterial bleeding (bright blood) occurs, the tourniquet should be applied between the wound and the heart (but not around the neck). When venous bleeding (dark blood) occurs, a tourniquet seldom is necessary but if it is (*e.g.*, a wound involving a varicose vein) it should be applied on the side of the limb farthest from the heart. In preparing the tourniquet do not use rope, wire or any material that might cut into the flesh when drawn tight. Use flat material at least an inch wide, such as a necktie, belt or suspender. Place the tourniquet close to the wound where the skin is unbroken but not on the wound edge. Wrap the tourniquet around twice and draw it tight enough to check the flow of blood. Tie the ends with a slipknot, so that if it is necessary to release the tourniquet it can be done very gradually by undoing the slipknot without removal of the tourniquet and movement of the injured limb. A properly applied tourniquet may be left in place for one to two hours without causing harm by pressure but it is usual to advise cautious release of the pressure for a very short period about every 15 minutes. It need not be reapplied unless severe bleeding occurs again; then it should be tightened until bleeding stops.

FROM THE DETROIT INDUSTRIAL FIRST AID ADVISORY COMMITTEE, UNIV. OF MICHIGAN INSTITUTE OF INDUSTRIAL HEALTH, BY COURTESY OF FEBRUARY PUBLISHERS

FIG. 2.—USE OF GAUZE SQUARE OVER WOUND FOR CONTROL OF BLEEDING (*See* TEXT)

Puncture Wounds caused by penetrating objects should always be regarded as serious because of the danger of tetanus (*q.v.*). Puncture wounds do not cause much bleeding unless a blood vessel has been injured. Frequently foreign material such as street dirt or clothing is carried into the wound. These wounds are difficult to clean out. The important care in first aid consists of thoroughly cleansing deep into the wound with bland soap and water,

applying a first-aid dressing and sending the patient to a physician for the administration of tetanus antitoxin or toxoid. Do not wait to see what will happen even until the next day.

Gunshot Wounds generally penetrate farther than do other puncture wounds and may involve blood vessels or organs where internal bleeding would take place. Shock is a frequent symptom of internal bleeding. The need of a physician, ambulance and hospitalization is imperative.

Infected Wounds.—Infection is caused by germs entering a wound at the time of injury or subsequently. The symptoms are pain, swelling, redness and heat. Sometimes pus, red streaks, swollen lymph glands and fever are present. A physician's care is necessary. First aid until the patient can see a doctor is as follows: rest and elevate the infected part if possible; apply fomentations made with Epsom salts or boric acid and hot water. Do not touch the wound or attempt to squeeze out the pus.

Wounds of the Abdomen.—The danger of abdominal wounds is internal bleeding and rupture of intestines or some other abdominal organ. Surgery is usually necessary. Sometimes injuries to the abdomen do not cause external wounds though the patient may have pain with signs of shock. If there is an external wound, apply a sterile dressing and binder and provide careful, immediate transportation to a hospital.

Wounds in Which Foreign Bodies Remain.—If a small foreign body protrudes from a wound, clean the area with soap and water; apply antiseptic; remove the foreign body with forceps boiled in water; and again apply an antiseptic and ready-made adhesive gauze dressing. If the foreign body is large or deeply embedded, do not attempt to remove it. Apply a sterile dressing and take the patient to a physician.

Eye Wounds.—Vision is sometimes seriously and permanently damaged by delayed or improper care of a foreign body in the eye. Do not rub the lid over the eye. Do not examine the eye with unwashed hands. Do not use a toothpick or other instrument in an attempt to remove the foreign body. Do not use an eye cup. Do not apply ointment or eyewash to the eye. Do not touch the eyeball. A sterile applicator or corner of a clean handkerchief dipped in boric acid solution may be used to remove a foreign body that is in the fold between the eyeball and the lid. If the foreign body is fixed on the eyeball, the patient should be sent to a physician. Retain a sterile dressing over the closed eyelid with a strip of adhesive tape. Wounds that penetrate the eyeball are serious. Do not remove any splinter that is partially embedded in the eyeball. Apply a sterile pad and loose bandage and take the patient to a physician or hospital immediately. (*See* also BANDAGES AND BANDAGING.)

Animal Bites.—Puncture wounds inflicted by pets or stray animals occasionally cause severe infection. Rabies (*q.v.*) may result from a mammal bite, especially a dog bite. Cats and squirrels may also be carriers of the rabies virus. The offending mammal should be kept under observation by a veterinary or police official until it is determined that it is not suffering from rabies. The wound should be cleansed with soap and water and a sterile dressing applied. Obtain medical attention for rabies immunization at once even though the wound is minor. One should never wait to see if trouble develops.

Snake Bites.—The fangs of a poisonous snake cause puncture wounds through the flesh of the person struck. Pain is immediate, and the skin about the bite takes on a dark purple discoloration. As the poison is absorbed into the system, more general effects are noted: weakness, rapid pulse, nausea and vomiting. Prompt first aid is imperative in order to remove as much of the venom as possible. Snake bites on the extremities require the use of a tourniquet applied somewhat above the wound—that is, on the trunk side immediately after the wound is received. Several cuts should be made over the site of the puncture, with a razor blade or sharp knife, sufficiently deep to cause bleeding. Apply suction with the mouth or, preferably, by means of a suction cup to extract the poison. The poison if swallowed is not harmful. Shock should be treated and the victim transported to medical care. Alcoholic drinks have no value in snake bites.

Insect Bites.—Some persons are more susceptible to insect bites than others. In the case of a bee, wasp or hornet bite, the sting is usually seen in the wound and should be removed by scraping. Do not pluck out with the thumb and forefinger because squeezing the sting empties the contents of the poison sac into the wound. Local application of baking soda paste, calamine lotion or ice cold compresses gives relief, and considerable benefit can be obtained by the use of antihistamine pills prescribed by a physician. *See* also INSECT BITES AND STINGS.

COMMON MEDICAL EMERGENCIES

Burns.—A burn is caused by dry heat or flame; a scald is caused by steam or hot liquid; chemical burns are produced by the chemical action on the skin; electric burns are caused by the electric flash which damages the skin. The dangers from burns are shock and infection. Small burns may be cleansed and first aid ointment with sterile dressing applied, the wound being redressed after 12 hours. Do not apply butter, lard, vinegar or similar household items. For extensive burns, remove clothing except where it sticks to the burned area. Keep the patient warm and treat for shock. The outstanding signs of burn shock are thirst, complaint of cold and gray to purple colour of the lips. Cover the burned area with a thin layer of sterile gauze or dressing retained with loose bandage. Do not use absorbent cotton on a burn. Do not remove foreign substance from the burned area or open blisters; this should be done by a physician. Chemical burns should be washed immediately with a large amount of water so that the chemical will not burn deeper. Acid burns should be washed freely with water and a paste of baking soda applied and covered with a dressing. Caustic burns should be washed with a weak vinegar solution and rinsed with water. (*See* also BURNS.)

Frostbite.—Exposure of the body to cold results in a stoppage of the flow of blood to the frozen part. The terminal ends of the circulation such as ears, fingers, nose and feet are often frostbitten.

Experience in World War II and the Korean War indicated that the least damage results when thawing is accomplished by immersion of the frozen part in a water bath maintained at a temperature of 86° to 89° F. until a reddish colour is restored to the frozen part. Restore the general condition of the victim with warm drinks and blankets. After the circulation is restored in the frozen area, the victim should be encouraged to exercise the movable parts. Do not rub or massage the frozen part with snow or any other substance. The patient should not smoke during thawing of the frozen part. Blisters which develop over the frozen areas may be opened on the second day. (*See* also FROSTBITE.)

Nosebleed.—The patient should sit up, loosen collar, clear blood clots and mucus from the nostrils, press the nostrils together firmly or apply pressure on the upper lip just below the nose. If bleeding does not cease in a reasonable time, pack the nose gently with gauze. Be sure the ends of the gauze protrude so that it can be easily removed. Do not use cotton. (*See* also NOSEBLEED.)

Heart Attack.—Such cases generally resemble fainting with complaint of shortness of breath (air hunger) and pain in the chest or upper abdomen which sometimes radiates down the left arm. The patient is often apprehensive. Keep the patient quiet and lying down, loosen collar and tight clothing; coffee or tea may be given. Call a physician immediately.

Abdominal Pain is an early symptom of many disorders, some of which are serious. Disease of the stomach or bowel is generally evident by vomiting, constipation or diarrhea. Appendicitis may begin with pain in the upper abdomen or tenderness in the lower right side, little or no fever and generally some nausea. A laxative should never be given until the diagnosis is certain. If necessary give a one-pint soapsuds enema, apply an ice bag to the abdomen, give no fluids or food by mouth and have a physician come to the patient. After the age of 40, vomiting after meals, passage of dark blood from the bowels or any abdominal distress with distention indicates the immediate need of a thorough physical examination.

Apoplexy (Stroke).—The victim should be recumbent with head and shoulders raised and adequately covered. Cold applications should be applied to the head. Stimulants are harmful. The

patient should not be moved at the time. (*See* also STROKE.)

Convulsions.—Onset is sudden, though sometimes the patient realizes an attack is coming on. The patient may cry out, lose consciousness and bite his tongue. An attack lasts a few minutes and is followed by drowsiness and mental confusion. Protect the patient from self-injury. Protect the tongue from being bitten by placing a pencil or small stick wrapped with a handkerchief between the teeth. Give nothing by mouth. Encourage the patient to sleep. (*See* also CONVULSIONS.)

Fainting.—Fainting generally results from a temporary lack of blood reaching the brain. Some healthy persons faint at the sight of their own blood, and for this reason first aid should never be rendered to a person unless he is seated or lying down. If the patient has fainted, keep him lying down with head level. Aromatic spirits of ammonia on a handkerchief held under the nose often restores circulation of blood to the brain. After consciousness returns, coffee, tea or cold water may be given.

Diabetic Coma.—Many diabetics carry special identification which indicates the possibility of sudden unconsciousness. Symptoms of diabetic coma are mild shock, confusion and history of insulin usage. The victim should be transported to the hospital or nearest clinic for insulin injection. (*See* also DIABETES MELLITUS.)

Insulin Shock is a condition resulting from administration of too much insulin. Symptoms are confusion and sometimes unconsciousness. Give sugar, candy or orange juice at once (an exception to the rule of not feeding an unconscious patient).

Dermatitis.—Dermatitis is an inflammation of the skin evidenced by itching, redness and various types of skin lesions caused by external irritants (poison ivy, nettle, turpentine, glass wool, chemicals, etc.). Allergic dermatitis occurs in persons who are particularly sensitive to substances that do not affect others. Persistent skin disorders of this type should be referred to a physician who specializes in skin disorders. Self-medication may result in serious complications and prolonged disability. (*See* also SKIN, DISEASES OF; POISON IVY.)

Sunburn, Heat Exhaustion and Heat Stroke.—Extensive exposure to sun rays may cause violent reactions in the skin and in the heat regulating mechanism of the body. Light skins react more violently than dark ones. For mild sunburn apply soothing lotions or creams. Blisters should not be broken, but if they are accidentally broken they should be trimmed with scissors sterilized in boiling water. Then cover the blistered area with Vaseline dressings.

The symptoms of heat exhaustion are nausea, vomiting, headache, rapid pulse and excessive perspiration. Rest is imperative. Restore the salt balance in the body by administering salted fluids, one-fourth teaspoonful of salt in each glass of water or other liquid.

Heat stroke is a serious matter. The skin is dry and hot; there is no perspiration; the pulse is fast; cramps develop in the muscles of the arms, legs and abdomen; the temperature is high and should be lowered as quickly as possible by tepid baths and sprays. Massage the arms and legs and give salted fluids by mouth. Ice applications to the head and back of neck are advisable. Keep the victim at rest for 24 hours after the temperature reaches normal (98.6°). (*See* also HEATSTROKE.)

Poisoning by Mouth.—Swallowing a poison creates an emergency that requires immediate first aid. The poison should be evacuated from the stomach as quickly as possible, preferably by dilution and vomiting. If the patient is conscious, give large glasses of milk or water and then induce vomiting by tickling the back of the throat with the index finger or by administering an emetic (such as a tablespoonful of baking soda or a teaspoonful of table salt dissolved in a full glass of warm water). Use force if necessary.

If the patient is unconscious do not attempt to give an emetic, but with the patient lying on his side hold the mouth open with a stick or pencil wrapped with a handkerchief and induce gagging and vomiting by tickling the back of the throat with the index finger. In order to eliminate as much of the poison as possible, if the patient is conscious after vomiting give a drastic cathartic such as Epsom salts in a glass of warm milk. Keep the body warm; give hot coffee, tea or other warm drink. (*See* also POISON; ANTIDOTES.)

Asphyxiation.—A person who has stopped breathing will die if his breathing is not restored immediately. Common causes of asphyxiation are carbon monoxide poisoning (*q.v.*), electric shock, suffocation from poisonous gases in the air, foreign body in the throat or air passage and overdose of sedatives. Start artificial respiration immediately after the person has been rescued and moved to fresh air. The rescuer should not enter a hazardous atmosphere without having a lifeline fastened securely to his body with adequate assistants present. (*See* ARTIFICIAL RESPIRATION.)

Drowning.—The immediate need in every case of drowning is the supply of an adequate amount of oxygen to the brain and the heart. This can be obtained only by first aid rendered promptly and intelligently. *See* ARTIFICIAL RESPIRATION. (J. H. Cs.)

FIRST-FOOT, in folklore, especially that of northern England and of Scotland, the first person who crosses the threshold on New Year's day (or on Christmas or other days). Good or ill luck was believed to be brought the house by first-foot, and a female first-foot was regarded with dread. In Lancashire a light-haired man was as unlucky as a woman. In Worcestershire luck was ensured by stopping the first carol singer who appeared and leading him through the house. In Yorkshire it had to be a male who entered the house first but his fairness was not considered objectionable. In Scotland the custom of first-footing involving a subsequent entertainment was always more elaborate than in England. Customs associated with first-foot have been known in various other countries including China.

FIRST INTERNATIONAL: *see* INTERNATIONAL, THE.

FIRST OF JUNE. The battle of "the Glorious First of June," a British naval victory early in the French Revolutionary Wars (*q.v.*), was so called because it occurred (on June 1, 1794) in the Atlantic ocean about 430 mi. W. of Ushant off the French coast and could not be named after a particular place. It arose out of an attempt by the British fleet under Earl Howe (*q.v.*) to intercept a grain convoy from the United States that was being escorted into Brest by a fleet under Louis Villaret de Joyeuse. When the fleets sighted each other on May 28 Villaret detached his convoy to the south while he attempted to lure Howe away to the north. Sporadic fighting occurred in misty weather for the next two days. In brilliant sunshine on Sunday, June 1, Howe engaged the enemy. He intended to break the line at all points but only seven of his ships got through. This was enough to disorganize the French fleet which had had no experience at sea and six ships were taken. Duels between the flagships "Queen Charlotte" and "Montagne" and between the "Brunswick" (Capt. John Harvey) and the "Vengeur" proved that the navy of the Revolution was capable of hard fighting even though most of the officers of the navy of the *ancien régime* had left France or been executed. Villaret excused the result on the grounds that "while the admiral amused himself refitting his prizes, I saved my convoy and I saved my head."

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FIRTH, SIR CHARLES HARDING (1857–1936), English historian notable for his work on English history in the 17th century, was born at Sheffield on March 16, 1857, and was educated at Clifton and at New college and Balliol college, Oxford. He settled in Oxford in 1883 and lived there for the rest of his life. For many years he worked with S. R. Gardiner (*q.v.*) and produced much work of a specialist nature on the Commonwealth. He also produced several books which achieved a wider popularity including *Oliver Cromwell* (1900), *Cromwell's Army* (1902) and *The Last Years of the Protectorate* (1909) which was a continuation of Gardiner's work. Firth was regius professor of modern

history from 1904 to 1925 and was knighted in 1922. He was active in many fields, helping to launch the *English Historical Review* in 1886, becoming president of the Royal Historical society (1913–17) and president of the Historical association (1906–10 and 1918–20). He also edited Lord Macaulay's *History of England* and gave much help and advice to other historians in their own researches.

Sir Charles Firth died at Oxford on Feb. 19, 1936. Most of his works are included in his book *A Bibliography of the Writings of Sir Charles Firth* (1928).

FIRUZ (PEROZ) "the Victorious," Sasanian king of Iran from A.D. 457 or 459 to 484, was a son of Yazdegerd II. He is chiefly noted for two disastrous wars against the Hephthalites (*q.v.*). Firuz had drawn support from these invaders to contest the succession of his full brother Ormizd III; meanwhile their mother ruled as regent at Ctesiphon. The defeat of Ormizd at Rayy in A.D. 459 and his eventual execution left Firuz supreme. A seven-year famine followed, in which the historian al-Tabari praises the king's efforts to relieve hardship. Soon his preoccupation was the growing power of the Hephthalites. His first expedition against them was led into a trap. Captured by their chief, Khushnavaz, Firuz secured his release only by giving his son Kavadh as hostage and promising good behaviour. Nevertheless he ransomed Kavadh and returned to the attack. Confronted in Bactria by the enemy, he charged his cavalry into a hidden ditch and perished with all his troops (*c.* Jan. 1, 484). (A. D. H. B.)

FIRUZABAD, chief town of a district in the Fars (*q.v.*) *ostan* or province of Iran, lies in a fertile intramontane plain about 55 mi. S. of Shiraz. Pop. (1956) 5,746. It is well watered by a river which flows through it from north to south. The climate is intermediate between the cool plateaus and the hot lowlands along the gulf. The district is largely pastoral; wheat is also grown and the rice of the plain is famous. A motorable road passing through the town connects Shiraz with the gulf plain. Firuzabad used to be the winter seat of the ruling family of the Kajar tribe before its prominent members were exiled in 1946.

Northwest of the town are the ruins of the Sasanian city of Jur, or Gor (once the capital of one of the five divisions of Fars). According to Persian tradition it was founded by Ardashir I, founder of the Sasanid dynasty, who built it at the site of an older town which is said to have been flooded by Alexander the Great (when unable to capture it) by damming the river. The city was laid out in a circular pattern like Darab (*q.v.*). It later received its present name (meaning "the abode of Firuz") after one of Ardashir's successors. The ruins of Ardashir's first palace are at the entrance of the river gorge; in the gorge are two Sasanian bas-reliefs and on a spur above it the ruins of a castle. (H. Bo.)

FIRUZABADI (ABU'L-TAHIR MAJD AL-DIN AL-FIRUZABADI) (1329–1414), Arabian lexicographer who compiled the famous dictionary *al-Qamus* ("The Ocean"), was born at Karazin near Shiraz. His student days were spent in Shiraz, Wasit, Baghdad and Damascus. He taught for ten years in Jerusalem and afterward traveled in western Asia and Egypt. In 1368 he settled in Mecca where he remained for 15 years. He next visited India and spent some time in Delhi, then remained in Mecca another ten years. The following three years were spent in Baghdad, in Shiraz (where he was received by Timur) and in Ta'izz. In 1395 he was appointed chief cadi (*qadi*) of Yemen, married a daughter of the sultan and died at Zabid in 1414. During this last period of his life he converted his house at Mecca into a school of Malikite law and established three teachers in it. He wrote a huge lexicographical work of 60 or 100 volumes uniting the dictionaries of Ibn Sida, a Spanish philologist (d. 1066), and of Sajani (d. 1252). A digest of or an extract from this last work, *al-Qamus* has been published in Egypt, Istanbul and India, has been translated into Turkish and Persian and has itself been the basis of several later dictionaries.

FISCHART, JOHANN (1546?–1590), the greatest German satirist of the 16th century, was born in Strasbourg late in 1546 or early in 1547. He received a good education there and at Worms. Before 1570 he traveled widely, visiting the Netherlands and probably England, and studying in Paris, Strasbourg and Siena, Italy. A later period of study in Basel ended with the degree of *doctor juris* (Aug. 10, 1574), but from 1570 to 1580 he lived mostly in Strasbourg, working for his brother-in-law Bernhard Jobin, the printer and publisher. In this decade his main literary works appeared. Three years in Speyer as advocate at the *Reichskammergericht* (imperial court of justice) were followed by appointment in 1583 as magistrate at Forbach, Lorraine. In the same year he married in Wörth, Alsace, Anna Elisabeth, daughter of the Alsatian chronicler Bernhard Hertzog. He probably remained at Forbach until his death there, late in 1590. Of his main works, the earliest are attacks on the papacy, Franciscans and Dominicans: *Nacht Rab* (1570); *Der Barfüsser Secten und Kuttenstreit* (1571); and *Von S. Dominici . . . artlichem Leben* (1571), and two of the latest are polemical satires against the Catholic Church and especially the Jesuits: *Bienenkorb des heiligen römischen Immenschwarms* (1579, virtually a translation of a Dutch satire by Philipp Marnix); and the *Jesuitenhütlein* (1580). Fischart is the principal German literary opponent of the Counter-Reformation. His Protestantism, however, was never rigidly sectarian. Beginning as a Lutheran, he came to defend Calvinist doctrines—the only major German writer to do so. His more general didactic and satirical writings include *Eulenspiegel reimensweis* (1572), a moralizing version of the Eulenspiegel stories; *Aller Praktik Grossmutter* (1572), a parody of the farfetched prognostications in contemporary almanacs; and *Der Flöhhatz* (1573), where the hunted flea's lament develops into a satire on women. Well-established genres are represented in the comical *Podagrammisch Trostbüchlein* (1577) in praise of gout, and the more serious *Philosophisch Ehezuchtbüchlein* (1578, based on treatises by Plutarch and Erasmus), in praise of marriage.

Fischart's principal work is the *Affenthewrliche und Ungeheurliche Geschichtsschrift* (1575)—renamed *Geschichtklitterung* in later editions (1582, 1590)—a free and greatly expanded prose version of Rabelais's *Gargantua*. Perhaps his most attractive work to the modern reader, however, is *Das glückhafft Schiff von Zürich* (1576), one of the most carefully constructed 16th-century narrative poems, commemorating the boatload of Zürich citizens who rowed to Strasbourg and brought a basin of porridge, cooked in Zürich in the morning, still warm to Strasbourg at night.

Fischart was a man of wide learning and experience, and his writings, with their exuberant wit and serious moral purpose, continue—and end—the didactic and satirical tradition of Sebastian Brant and Thomas Murner, combining it with that of Rabelais, and providing a detailed picture of the German culture of his day. In subject matter, however, they are mostly adaptations of existing literary works, and their construction is often faulty and their versification sometimes rough-and-ready. Fischart's originality lies rather in the profusion of his ideas, his independent development of his subjects and, above all, in his style, especially in prose. With his vast vocabulary—much of it coined by himself—his delight in playing on words and his exuberant and sometimes grotesquely complex syntax, this "German Rabelais," although largely neglected until well into the 18th century, foreshadows at least some aspects of 17th-century style.

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FISCHER, EMIL (1852–1919), German chemist, awarded the Nobel prize for chemistry in 1902 in recognition of his services in connection with his synthetic experiments in the sugar and purine groups of substances, was born at Euskirchen, Rhenish Prussia, on Oct. 9, 1852. He studied at Bonn and at Strasbourg, where he graduated Ph.D. in 1874. He acted as assistant to A. von Baeyer at Munich for eight years, after which he was appointed to the chair of chemistry successively at Erlangen (1882) and Würzburg (1885). In 1892 he succeeded A. W. von Hofmann as professor of chemistry at Berlin.

Fischer devoted himself entirely to organic chemistry, and his investigations were characterized by an originality of idea and readiness of resource which made him the master of this branch of experimental chemistry. The merit of his researches was recognized by all the important scientific societies in the world. In 1890 he was awarded the Davy medal of the Royal society and elected a foreign member in 1899. Under his control the laboratory at Berlin became one of the most important in existence and attracted to itself a constant stream of brilliant pupils. Fischer died at Wannsee, Berlin, on July 15, 1919, and is buried there.

In 1875, he published his discovery of the organic derivatives of hydrazine and investigated their relation to the diazo compounds. Fischer's research concerned with compounds related to uric acid was on ground that had been broken, more especially by Baeyer, but almost all the knowledge of the purine group (*see* PURINES) is attributable to Fischer. In 1881–82 he established the formulas of uric acid, xanthine, caffeine, theobromine and some other compounds of this group.

His greatest work was instituted in 1894, when he commenced his great series of papers, wherein the foregoing compounds were all referred to a nitrogenous base, purine. The base itself was obtained after much difficulty, and an immense series of derivatives were prepared, some of which were patented in view of possible therapeutical applications. These researches were published in a collected form in 1907 with the title *Untersuchungen in der Puringruppe*. When the work on the purine group was progressing satisfactorily he attacked the sugar group. Here again Fischer may be regarded as the prime investigator in this field. His researches may be taken as commencing in 1883; and the results are unparalleled in importance in the history of organic chemistry. The chemical complexity of these carbohydrates, and the difficulty with which they could be got into a manageable form—they generally appeared as sirups—occasioned much experimental difficulty; but these troubles were little in comparison with the complications due to stereochemical relations. However, Fischer synthesized fructose, glucose and a great number of other sugars, and showed how to distinguish the formulas of the 16 stereoisomeric glucoses. The study of the sugars made it necessary to examine the nature, properties and reactions of substances which bring about fermentation. Fischer attacked the problem presented by ferments and enzymes, and although little is as yet known of this complex subject, to Fischer and his co-worker Abderhalden is due the credit of having laid the foundation of enzyme chemistry.

In addition to important research on proteins Fischer also made a number of investigations on the Walden inversion and on gallic acid derivatives of the sugars which were related to the tannins. During World War I he was very active in organizing German chemical resources. He increased the supply of ammonia available from coke ovens, encouraged the synthetic nitric acid industry, suggested camphor substitutes and new sources of glycerin. He was particularly concerned with the problem of conserving the food supply. He was concerned with methods of education, the training of chemists and the establishment of national research institutes. His autobiography *Aus meinen Leben* appeared in 1922.

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FISCHER, HANS (1881–1945), German biochemist, best known for his researches on hemin and chlorophyll, was born in Höchst, July 27, 1881. He received his doctorate in chemistry from Marburg in 1904 and in medicine from Munich in 1908. After some years of medical work he took up chemical research in Berlin under Emil Fischer. In 1916 he became professor of medical chemistry at Innsbruck; in 1918 went to Vienna; and in 1921 returned to Munich as professor of organic chemistry and director of the Institute for Organic Chemistry of the technical high school. He died in Munich on March 31, 1945.

He was awarded the 1930 Nobel prize for chemistry for his researches into the constitution of hemin and chlorophyll, especially for his synthesis of hemin. Hemin is a crystalline product of hemoglobin. By splitting in half the molecule of bilirubin, the related bile pigment, Fischer obtained a new acid in which a section of the hemin molecule was still intact. Its structure was identified and found to be related to pyrrole. This made possible the artificial synthesis of hemin from simpler organic materials of which the structure was known. Fischer also showed that there is a close relationship between hemin and chlorophyll, and when he died had nearly completed the synthesis of chlorophyll. He also studied the yellow pigment carotene, which is a precursor of vitamin A, and the porphyrins, iron-free derivatives of hemin widely distributed in nature and secreted by man in certain diseases. (W. J. Bp.)

FISCHER, THEOBALD (1846–1910), German geographer who gave the concept of the "Mediterranean region" to geography, was born at Kirchsteitz, Thuringia, on Oct. 31, 1846. Having been educated at the universities of Heidelberg and Halle, he pursued his geographical studies in many parts of Europe, and more especially in the Mediterranean lands including the Atlas mountain region of north Africa.

Fischer's thesis for the rank of *Privatdozent* in the University of Bonn (1877) was entitled *Beiträge zur physischen Geographie der Mittelmeerländer . . .* His most important publications are a collection of *Mittelmeerbilder* (1906) and his work on the Mediterranean peninsulas of Europe in A. Kirchhoff's *Allgemeine . . . Länderkunde,* a masterpiece of methodology which much influenced future geographical studies. He held professorships of geography at Kiel (1879–83) and at Marburg from 1883 until his death on Sept. 17, 1910. (H. G. Kg.)

FISCHER VON ERLACH, JOHANN BERNHARD (1656–1723), Austrian baroque architect most noted for his work in Vienna, was born at Graz, July 20, 1656, and died in Vienna, April 5, 1723. While studying sculpture in Rome, he came under the influence of Francesco Borromini and turned to architecture. Returning to Austria about 1683, he was soon employed by the archbishop of Salzburg to design the grand entrance to the archepiscopal court stables. Then followed four important churches in Salzburg, including the large Kollegienkirche (1694–1707). He began rebuilding the great imperial palace of Schönbrunn about 1700, and erected the fine Clam-Gallas palace, Prague, in 1707. His largest work in Vienna is the magnificent Karlskirche (1715–37). Other buildings there were the Trautson palace (1710–12), the Schönborn palace (1700), the palace of Prince Eugen (1695–97, enlarged 1707–10), afterward the ministry of finance, the Schwarzenberg palace (1696–1725) and work in the Hofburg (imperial palace) begun *c.* 1722.

Many of his later buildings were completed by his son Joseph Emanuel (1693–1742). (M. S. B.; X.)

FISCUS was the term applied to the imperial Roman treasury. The Latin word means literally "basket," and as money in ancient Rome was commonly stored in baskets the word came to be used figuratively, like the English "purse" in "Privy Purse," for an account or fund. Under the Roman republic *fiscus* might mean the private funds of an individual, but was technically used for the public funds in the hands of a provincial governor. From the time of Augustus the word was primarily, and soon exclusively, used for the moneys, including both public funds and his personal fortune, under the control of the emperor, and for the financial organization which handled these moneys.

The financial arrangements of the early principate are most obscure, but it seems likely that Augustus and his successors were granted an annual allocation from the treasury, and authorized to draw this money, as convenient, from the *aerarium* (*q.v.*) at Rome, or from the provincial *fisci* or the *publicani* (tax farmers). In effect this meant that in the imperial provinces the emperor normally spent all the local revenue in order to pay the troops stationed in them. Only Egypt produced a surplus, which was remitted to the *aerarium*. But since imperial expenditure must have greatly exceeded the revenues of the imperial provinces, the emperors also must have drawn upon the *fisci* of the public provinces and upon the *aerarium*. Vespasian (emperor A.D. 69–79) created a *fiscus Alexandrinus* and a *fiscus Asiaticus* under his own control at Rome. This probably meant that the surplus revenues of Egypt and Asia, the two most productive provinces of the em-

pire, no longer flowed into the *aerarium*, but passed directly into the emperor's hands. The *fiscus* henceforth became entirely independent of the *aerarium*, and handled the bulk of the revenue of the empire. During the 1st and 2nd centuries the emperors do not seem to have had a central treasury. Their money was stored either in the *fisci* of their provinces, or in sundry departmental *fisci* at Rome, such as the above-mentioned *fiscus Alexandrinus* and *fiscus Asiaticus*, the *fiscus frumentarius*, which supplied funds for the corn supply of Rome, the *fiscus Iudaicus*, which from A.D. 70 received the Jewish poll tax, or the *fiscus castrensis*, which probably supplied the needs of the imperial household.

Augustus and his successors used their personal servants and agents to manage their financial affairs. At the head of the organization stood the emperor's financial secretary (*a rationibus*), normally one of his freedmen. In each province there was an agent (*procurator*), sometimes, but rarely, a freedman, normally a citizen of equestrian rank (*see* EQUITES). There were also procurators, freedmen or equestrians, of the sundry departmental *fisci*. Under these there was a large staff of accountants (*tabularii*), cashiers (*dispensatores*) and so forth, all slaves or freedmen of the emperor. Gradually the *fiscus* came to be regarded as a ministry of finance rather than as the emperor's personal staff of accountants, and from the end of the 1st century the post of *a rationibus* was normally held by an equestrian: the subordinate staff of clerks, however, continued to be imperial slaves and freedmen.

From the time of Claudius (emperor A.D. 41–54) there appears a *procurator patrimonii*, in charge of the private funds of the emperor. The term *fiscus*, however, continued to be used to cover all imperial moneys, including the private funds, and the *a rationibus* probably remained responsible for all imperial finances. In the imperial provinces the procurators managed both the private property of the emperor and the public finances, collecting the taxes and paying the troops. In the public provinces the procurators were concerned only with the imperial estates. The *patrimonium* grew steadily, as it absorbed the private fortunes of successive emperors, and received a regular flow of gifts and bequests. It also came to receive confiscated estates, and apparently eventually absorbed what remained of the public lands of the Roman people.

Septimius Severus (emperor A.D. 193–211) reorganized the financial structure of the empire. He created a new department of the *res privata*, presumably to manage his private property, as opposed to the *patrimonium*, which now had come to be regarded as crown property; the *res privata* was swelled by the confiscated lands of his political opponents. He also separated the administration of the crown lands, the *patrimonium*, from that of the tax revenues in the provinces. The *patrimonium* was later amalgamated with the *res privata*, whose chief, the *rationalis* or *magister rei privatae* ("treasurer" or "master of the privy purse") thus came to control all imperial lands. The tax revenue came under the successor of the *a rationibus*, now known as the *rationalis rei summae* or *summarum* ("general treasurer"). The term *fiscus* and the adjective *fiscalis* continued to be used by both departments. These arrangements went on under the later Roman empire, the *magister rei privatae* becoming under Constantine the *comes rei privatae* ("count of the privy purse") and the *rationalis rei summae* the *comes sacrarum largitionum* ("count of the sacred largesse"), but the importance of the latter office declined, since the bulk of the revenue was henceforward collected in kind by the praetorian prefects.

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FISH, HAMILTON (1808–1893), U.S. lawyer, state governor, U.S. senator and secretary of state, was born in New York city on Aug. 3, 1808, the son of Col. Nicholas Fish, a Revolutionary War veteran and friend of George Washington. After graduating from Columbia college in 1827 he studied law and was admitted to the bar in 1830. He soon built a prosperous practice and in 1837 married Julia Kean, daughter of a distinguished New Jersey family. In 1842 he turned to politics, entering congress as a Whig. In quick succession thereafter he was elected lieutenant governor (1847) and governor (1848) of the state of New York, forming close ties with the Whig leaders, W. H. Seward and Thurlow Weed. Their support gave him a seat in the U.S. senate in 1851.

During his six years in the senate Fish met the events of a stormy time with caution and moderation. A moderate antislavery man, he opposed the Kansas-Nebraska act, but struggled to keep the Whig party alive as a pacifying force. Not until 1856 did he join the Republican party, voting that year for John C. Frémont. In 1861 he laboured for conciliation, beseeching Republican leaders to offer concessions to the South. But when war began he became chairman of the Union Defense committee, which organized regiments, purchased arms and ammunition, sent troops to the front and provided home relief. Later the war department appointed him one of two commissioners to investigate and alleviate the condition of Union prisoners in the South.

Devoting himself after the war to business, educational and church activities, Fish was called by Pres. U. S. Grant in March 1869 to be secretary of state. He accepted with the expectation of staying only a few months but remained more than eight years. His labours in this period fell into two groups. As head of foreign affairs he dealt with critical problems in various areas, particularly Anglo-American and Spanish-American relations. Meanwhile, as the oldest, most experienced and most respected cabinet officer he brought dignity to a floundering administration and gave Grant much-needed counsel.

His entry into office coincided with a menacing crisis between London and Washington, and with the outbreak of a bitter revolt against Spain in Cuba. The U.S. senate rejected a treaty for the settlement of American wartime claims against Britain, while Charles Sumner and others began a campaign for the annexation of Canada. But by tactful management of congress on one side and the British government on the other, Fish gradually composed the quarrel. Co-operating with Sir John Rose in Canada, and the foreign minister, Lord Granville, in England, he brought about a conference that drafted the treaty of Washington in 1871. This provided for the first great international arbitration of modern history. The tribunal that met in Geneva arranged for the settlement of the U.S. bill of damages arising from the depredations of the British-built cruiser "Alabama," serving the Confederate cause (*see* "ALABAMA" ARBITRATION). Other arbiters provided an agreement on North Atlantic fisheries, and drew the U.S.-Canadian boundary in the Juan de Fuca strait. Meanwhile, Fish had to conduct a desperate contest with American interventionists who wished to land troops in Cuba and help the rebels there overthrow Spanish rule. Their pressure became almost irresistible when in 1873 hotheaded Spanish authorities seized on the high seas the ship "Virginius," belonging to the Cuban revolutionary committee in New York, and shot 53 Americans and Britons as filibusters. But by a display of patience and determination Fish maintained peace. In the end Spain restored the "Virginius" with apologies and indemnities.

In an era of shockingly low political standards and much dishonesty even in high places, Fish headed an element in the cabinet that laboured to keep Grant vigilant against trickery and graft, to save him from improper appointments of old friends and to prevent gross violations of civil liberties in the South. He fought successfully against a group that persuaded Grant to attempt the annexation of Santo Domingo, co-operating with congressional opponents of the step. When the worst scandals were exposed, Fish insisted that Secretary of War W. W. Belknap be dropped, and played a major part in forcing Grant to get rid of a private secretary, Orville E. Babcock, who was implicated in the Whisky Ring scandal. Meanwhile, he dealt effectively with Mexican and Central American affairs.

Returning to private life in 1877, Fish devoted his last years to public-spirited activities, giving special attention to the development of Columbia university. He died on Sept. 6, 1893.

Fish's three sons, NICHOLAS (1846–1902), HAMILTON (1849–

1936) and STUYVESANT (1851–1923), attained some prominence in business and professional life. A grandson, HAMILTON FISH (1888–), had a long career of public service. He was a member of the New York assembly (1914–16) and served in World War I as an officer of volunteer troops. Elected to the U.S. house of representatives in 1919 to fill an unexpired term, he continued to serve there without interruption until 1945. In congress he was a vigorous opponent of the policies of Pres. Franklin D. Roosevelt.

See Allan Nevins, *Hamilton Fish: the Inner History of the Grant Administration* (1936). (A. N.)

FISH, as popularly conceived, is any "cold-blooded" aquatic animal that swims by means of fins and breathes by means of gills; it is usually thought of as having scales. There are, however, many fishes that do not thoroughly correspond to this conception: some do not have scales; some spend a considerable period out of water; some have vestigial gills and therefore breathe by means of lungs or other specialized organs; some are finless, or nearly so, and swim exclusively by undulating movements. A more technical definition of a fish includes more anatomy: among other characteristic structures a fish has a skin with many mucous glands; a backbone consisting of numerous distinct units (vertebrae), which allows for a great degree of flexion of the body; eyes with no lids; and a heart formed of a single folded tube with several chambers.

This definition excludes all the aquatic invertebrates that have "fish" as a part of their common names: cuttlefish (*q.v.*) are cephalopod mollusks, relatives of the octopus; jellyfish (*q.v.*) are coelenterates; starfish (*q.v.*) are echinoderms; and shellfish is a popular term loosely given to bivalve (*q.v.*) mollusks such as the oyster and clam and to the crustacean arthropods (*see* CRUSTACEA) such as the lobster.

Fishes are usually grouped into four classes: (1) Agnatha, including the cyclostomes (lampreys and hagfishes) and extinct armoured fishes known as ostracoderms, none of which has gill arches (bony frames for the gills) or definite jaws; (2) Placodermi, extinct armoured fishes with jaws; (3) Chondrichthyes, the cartilaginous fishes, including sharks, rays and their allies, all of which have a predominantly cartilaginous skeleton; and (4) Osteichthyes, the bony fishes, including the great majority of food and game fishes popular today.

Pisces, a term formerly applied to all fishes, has been restricted by many to the bony fishes, which to avert confusion are better termed Osteichthyes. The classes evolutionarily higher than the agnathans are sometimes grouped as the Gnathostomata ("jawed-mouthed").

This article deals chiefly with the Osteichthyes, other classes being treated only for comparison or for completeness of discussion. For more complete information on these latter classes *see* CYCLOSTOME; CHONDRICHTHYES; OSTRACODERM; PLACODERM.

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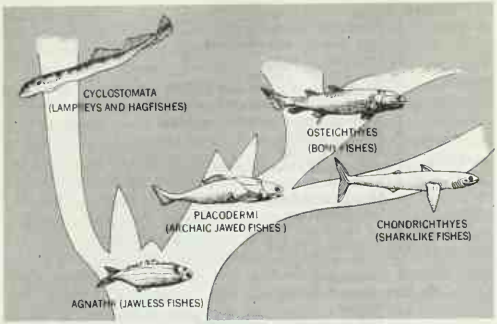
I. INTRODUCTION

1. Importance of Fish.—In view of their numbers (the bony fishes alone are far more abundant than any one class of land vertebrates) and their ease of harvesting, fish have long formed a large portion of man's food. They are no less important in the economy of the sea, serving as consumers of smaller organisms and as food for larger ones. (*See* MARINE BIOLOGY; OCEAN AND OCEANOGRAPHY: *Biological Oceanography.*) The economies of many nations depend to a large extent on the fishing industry. Besides furnishing fresh and processed food for man, fish also yield many other valuable products, among them oils (from cod-liver oil to crude oils), meal, fine leather, fertilizer, glue and isinglass. Furthermore, as a recreation fishing is enjoyed by sportsmen throughout the world (*see* FISHING).

It was earlier assumed that the mass of fish in the seas and fresh waters formed an unlimited natural resource that would replenish itself as fast as it was depleted by fishing. Unfortunately, such is not the case; efforts being made to conserve this resource and to regulate the intensity of fishing so as to provide a continuing supply of fish are discussed in FISHERIES and in WILDLIFE CONSERVATION: *Conservation of Sea Mammals and Fish.*

2. Fish in Symbolism and Myth.—Since very early times the fish has appeared in the folklore of many peoples. This is not surprising in view of the ubiquity of fish and their importance as food in many parts of the world. It has been said that certain cults originating in early Syria, regarding fish as holy, would not eat them. Tabu as food among some African tribes, recommended in the Talmud and highly favoured among many peoples as being beneficial to long life and to intelligence (neither of which quality is peculiar to fish or any other single type of food), fish have been involved in the dietary regulations of many groups.

The fish was early adopted as a Christian symbol (sometime in the 2nd century): it stands for Christ, also for the newly baptized and for the Eucharist. It is frequently found in religious art in combination with bread and wine, symbols of the body and blood



FROM A. S. ROMER, "THE VERTEBRATE STORY," UNIVERSITY OF CHICAGO PRESS, 1959

FIG. 1.—SIMPLIFIED FAMILY TREE SHOWING EVOLUTION OF CLASSES OF FISHES

of Christ. The use of the fish as a Christian symbol probably derived from the combination of the initial letters of the Greek words meaning Jesus Christ, Son of God, Saviour, which approximates the Greek word for fish. In classical Greek and Roman literature and in early Christian art and heraldry, the dolphin (both the fish and the mammal of that name) appears frequently, symbolizing diligence, love or swiftness. (*See* SYMBOL.)

In astronomy and astrology the 12th sign of the zodiac is Pisces, the Fishes (*see* PISCES).

In myth appear the fanciful mermaids and mermen, half human and half fish, probably inspired more by aquatic mammals such as the dugong and the manatee than by fish. Reports of sea serpents probably have their bases in sightings of basking sharks, giant eels or snakelike oarfishes. (*See* also MERMAIDS AND MERMEN; SEA SERPENT.)

3. The Rise of Fishes.—The vertebrates probably evolved from an unusual ancestral type similar to amphioxus (*q.v.*) (*see* also VERTEBRATE). The lampreys and hagfishes are nearly as different from the ancestral type as are any of the other vertebrates. The most primitive true vertebrates are agnathans: the oldest known are the ostracoderms, which appear to have had gills contained in a series of separate muscular pouches that were expanded and contracted during respiration, and to have been without jaws. Two kinds of ostracoderms, one a free-swimming form (Anaspida), another a bottom form covered with a hard bony shield in front (Aspidocephali or Cephalaspida), are known from the Silurian and Devonian periods. The most primitive known ostracoderms are already quite specialized creatures; their more primitive ancestors are not known.

The Palaeozoic ostracoderms were of smallish size, seldom more than a few inches long, but there are remains of armoured fishes, the class Placodermi, in Devonian and Lower Carboniferous strata, some of which grew to be 20 ft. or more. These are probably evolved from the ostracoderms; their scattered fossil fragments are found in Upper Silurian and Lower Devonian rocks. The placoderms in turn probably gave rise to both the cartilaginous and the bony fishes.

A rather complete fossil record of a primitive shark, *Cladoselache,* which might have been the ancestor of more recent sharks, is known from the Upper Devonian. No remains that can definitely be referred to modern sharks are known before the Mesozoic; most of the modern sharks appeared by the close of that critical era.

It is thought that the bony fishes (Osteichthyes) arose as an offshoot from the Placodermi at a very early period, sometime during the Silurian. The earliest known family of Osteichthyes, the Palaeoniscidae, were present throughout the Devonian, attained their maximum development during the Carboniferous and lasted until toward the end of the Jurassic period. A few scattered representatives of families related to them are still living, but it was not until the middle of Mesozoic time that the orders comprising the great majority of living species began to appear. Their evolution was rapid, and most modern families were represented in the Eocene, the beginning of Cenozoic times.

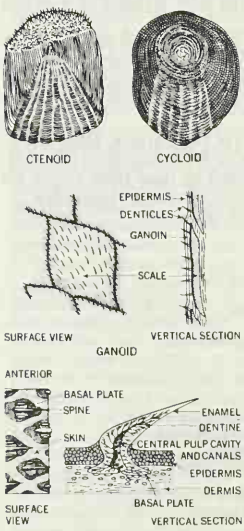
Fishes rose and became abundant during the three late periods of Palaeozoic history, Silurian, Devonian and Carboniferous, but were particularly numerous and varied during the Devonian, which has been called the age of fishes. But it was not until the Carboniferous that bony fishes became dominant; not until the succeeding age of reptiles that any fish comparable to species now living appeared; and not until the more recent age of mammals that the families now most abundant arose. *See* also ANIMALS, PHYLOGENY OF; PALEONTOLOGY.

II. DESCRIPTION: GENERAL FEATURES

In the world today there are more species of bony fishes than of any other class of vertebrate animals; 30,000 is a conservative estimate of the number. They show a great diversity of structure as well as of size and colour.

1. Body Form.—The fish is essentially a bilaterally symmetrical animal. The typical elongate, spindle-shaped body of the earliest vertebrates has, over geological time, modified considerably in many groups of fishes. Among the cyclostomes the body has become snakelike. Among the cartilaginous fishes the sharks have become very streamlined, with powerful, fleshy fins; the rays and skates have become dorsoventrally flattened, with extended winglike fins. The bony fishes have become extremely variable in body form and in the shape, structure and function of fins; some are long and spindle-shaped, others are short, with deep bodies greatly compressed from side to side and still others are snakelike.

The evolutionary position of the fishes is near the base of the great vertebrate subphylum, a group characterized by an axial vertebral column or backbone, composed of a series of separate elements known as vertebrae, which affords protection for main longitudinal nerves and blood vessels as well as support for other parts of the body. The body cavity of a fish, which contains the vital organs, is situated in the lower, anterior part of the body. The posterior part, behind the body cavity, consists mainly of skeleton and muscle, and usually has the primary function of propelling the animal through water. It is technically called the tail and is indeed homologous with the shrunken and often useless tails of various land vertebrates in which locomotion has become a function of the paired limbs.



FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957. MCGRAW-HILL BOOK COMPANY. USED BY PERMISSION

FIG. 2.—SCALES OF BONY FISHES (ENLARGED)

For purposes of discussion a perch or bass may be taken as the representative type of a modern bony fish. Here the head and body merge, the whole animal being spindle-shaped, compressed from side to side and streamlined. Beneath the thin skin the head is covered with bony plates and the body with numerous thin, overlapping scales.

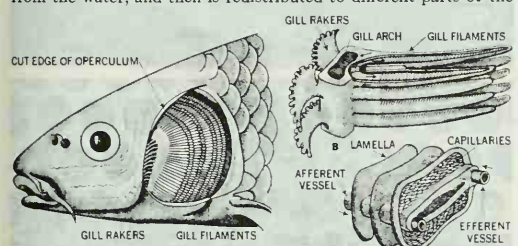
2. Body Covering: Skin and Scales.—All living fishes have a more or less smooth, flexible skin dotted with various kinds of glands; some fishes have protective scales also embedded in the skin. Mucus-secreting glands are especially abundant in fishes, particularly in the cyclostomes and the cartilaginous fishes. Poison glands occur in the skin of many cartilaginous fishes and some bony fishes; these glands are frequently associated with spines on the fins, tail and gill covers. Photophores, luminous organs embedded in the skin, are found in many fishes, especially deep-sea forms; these organs are thought

to be modified mucous glands (*see* BIOLUMINESCENCE).

Also formed within the skin of many fishes are skeletal elements called scales. On the basis of their composition and structure they may be divided into cosmoid, placoid, ganoid, cycloid and ctenoid scales. Cosmoid scales, characteristic of the extinct lungfishes and not found in any living fish, are similar to ganoid scales. Placoid scales (or denticles), spiny, toothlike processes consisting primarily of enamel and dentine, are found in the skin of many cartilaginous fishes. Ganoid scales, sometimes considered a modification of the placoid type, are chiefly bony, but covered with an enamellike substance called ganoin; these rather thick scales, found in some of the primitive bony fishes, are particularly well developed in the gars. Cycloid scales appear to be the inner layer of ganoid or cosmoid scales. They are found in the carps and similar fishes, are thin, large, round or oval scales that are arranged in an overlapping pattern; growth rings are evident on the free edges. Ctenoid scales are similar to the cycloid, except that they have spines or comblike teeth along their free edges; these scales are found in the higher bony fishes including the perches and sunfishes.

As already indicated some fishes are without any dermal armour; these include the living cyclostomes and, among the bony fishes, catfishes and some eels.

3. Gills.—Backward and downward from the eye the bones of the sides of the head form a flat gill cover or operculum beneath which are several bony gill arches, the posterior edges of which bear the gills. Water, continually taken in through the mouth, passes backward over the gills and escapes under the free back edge of the gill cover. The gills themselves, which look like a broad, flat, dense red fringe, consist largely of numerous finely divided blood vessels. Blood is pumped to the gills by the heart, passes through these fine blood vessels, where it absorbs oxygen from the water, and then is redistributed to different parts of the

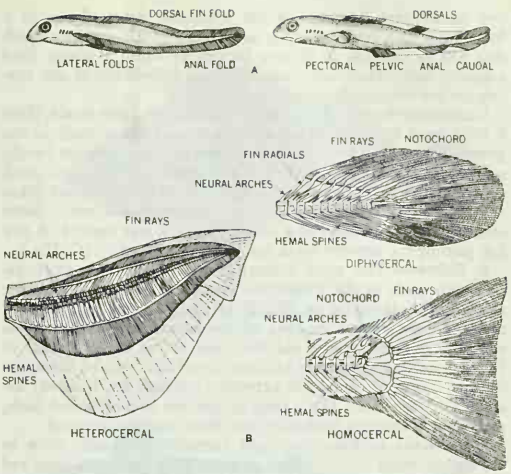


FROM T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957. MCGRAW-HILL BOOK COMPANY, USED BY PERMISSION

FIG. 3.—GILLS OF A CARP: (A) GILL CHAMBER; (B) PART OF A GILL; (C) PART OF ONE FILAMENT (ENLARGED). DARK (AFFERENT) VESSELS CARRY DEPLETED BLOOD TO THE GILL LAMELLA FOR AERATION; LIGHT (EFFERENT) VESSELS TRANSPORT AERATED BLOOD FROM THE GILLS TO THE REST OF THE BODY

body, where the oxygen is used up in the production of various kinds of energy. In other words, a fish utilizes oxygen just as land vertebrates do, but takes it from the water by means of its gills.

4. Fins.—In the mid-line of the back of a perch or bass there are one or two dorsal fins, more or less separate, connected or nearly so. These fins are membranous extensions of the skin and are stretched between supporting rods called fin rays, or simply rays. The rays of the anterior dorsal fin (or part of a single dorsal fin) are stiff, sharp spines; of the posterior, soft, flexible, jointed and more or less divided or branched. At the posterior end of the body there is one caudal or tail fin, with soft rays, which helps to propel the fish through the water. In the mid-line below the posterior dorsal fin is the anal fin, with one to three spines at its front end, followed by several soft rays. In addition to the dorsal, caudal and anal fins there are two sets of paired fins: (1) the pectoral or breast fins, of flexible rays only, one on either side of the body behind the head; and (2) the pelvic or ventral fins, close together, one on either side of the mid-line of the body below the pectorals (farther back in more primitive



FROM (A) T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957. MCGRAW-HILL BOOK COMPANY, USED BY PERMISSION. (B) A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 4.—FINS: (A) POSSIBLE ORIGIN OF FINS OF BONY FISHES FROM FIN FOLDS SUCH AS THOSE IN AMPHIOXUS; (B) STRUCTURES OF MAIN TYPES OF MODERN TAIL FINS

fishes). In a perch or bass the pelvics consist of an initial spine and five soft rays.

In the light of modern investigation, there can be little doubt that the paired fins of fish are homologous with the limbs of higher animals, that the latter's complex structures were derived from the former's relatively simple ones. They are, as it were, a marker pointing to the trend of evolution.

The primary purpose of the spines of a perch or bass's anterior dorsal fin is defense. The posterior dorsal and the anal fins steady the fish's course, like feathering steadies an arrow; the paired fins are used to balance, steer and brake; and the caudal fin helps to steer and propel the body forward. The primitive fin arrangement probably consisted of a simple fin fold extending along the mid-line of the back, around the end of the tail and forward along the lower mid-line of the tail to opposite the hind end of the body cavity, there dividing into two folds to follow along the two sides of the lower surface to back of the head. The paired fins could then be explained as being anterior and posterior relics of the double fold; the vertical fins—the dorsals, the anal and the caudal fins—as relics of the simple median fold.

The original tail fin was presumably weak for driving purposes. In a very primitive living shark (*Chlamydoselachus*), which must mostly swim in an eellike manner, the axis of the tail runs straight back (diphycercal type), but may be bent upward somewhat in swimming. In the numerous species of modern sharks (families Carcharinidae, etc.) the tail axis bends into a long upper lobe from the base of which extends a short lower lobe (heterocercal type). In the mackerel sharks (Isuridae), particularly strong, swift swimmers, the lower tail lobe has become almost equal to the upper one, to form a firm crescentic, driving tail fin. In the great majority of modern bony fishes the tail fin is superficially symmetrical (homocercal type), but anatomically it shows an ancestral upward flexure of its axis.

5. Size and Age.—The smallest fish is reputed to be a tiny goby (*Mistichthys luzonensis*), from a lake in the Philippines, only one-half inch long when mature. The largest of all fishes is probably the whale shark (*Rhincodon*), said to reach 70 ft. and to weigh several tons. Among the bony fishes the largest sturgeons and ocean sunfishes probably exceed 2,000 lb., the largest bluefin tunas and some marlins more than 1,000 lb.

The size to which each species of fish grows is less standardized than that of most other animals. Most fishes probably continue to grow throughout life, although at a diminishing rate, much as a

tree does. Size, however, is not a reliable index of age in a fish. Most of a fish's growth is made in its youth, and how much that will be depends on various factors, of which available food supply is one. Therefore, unusually large individuals of any species are not necessarily unusually old ones.

Concerning the normal and maximum age that fishes attain, there is little exact information for most species. From a study of the growth marks on their scales it is known that the different Pacific salmons (*Oncorhynchus*), which spawn and die at maturity, reach an age of two to six years. The life span of many smaller fishes (*e.g.*, the South American *Cylolebias*) is less than a year. Some catfishes and carps may live about 50 years, but reports of any fish passing the century mark are unsubstantiated. (C. Hu.)

6. Colour.—The most colourful insects and the most resplendent birds of the tropics are rivaled in gorgeous colour by some fishes. It would be difficult to find or paint or imagine a more brilliant blue than that of the neon tetra of the home aquarists, a more intense red than that of the redbelly dace of North American streams, a brighter silver than that of the ocean bream. These of course are extreme (although not isolated) examples. Most fishes, like a large proportion of insects and birds, are coloured no more brilliantly than their usual background.

The colours of fishes are most commonly greenish, olive or brown but range through most of the visible spectrum from red and orange through yellow and green to blue, with such mixtures as orange-brown and purple being common. The colours may be mixed with black to produce dark shades or combined with white to yield such colours as pink and lavender. A single colour may cover the entire fish, but more commonly two or more colours are combined to form definite markings, particularly on the back. The lower surfaces are very often light gray, white or silvery. Black spots, bars or streaks are common elements in colour patterns. As in many groups of animals the different species and often the different sexes are distinctively coloured.

The almost limitless range of colours and patterns that fishes exhibit is attributable to variations in the number, distribution and mode of combination of only a few kinds of minute pigment cells (chromatophores). Black pigment cells (melanophores), each containing myriad microscopic granules of melanin, are of almost universal occurrence. They produce black markings as well as general shading and are involved in the elaboration of the iridescent greens and blues that appear on most fishes. These latter "physical (or structural) colours" result from the play of light on tiny, needlelike crystals of guanine that overlie a background of melanin. The underlying black absorbs the red and yellow components of light. When the iridocytes or leucophores (the guanine-containing cells) occur alone, a silvery or white appearance results. When yellow pigment is added to an appropriate mixture of melanophores and iridocytes, green is produced. Although certain fishes, particularly the needlefishes (Belonidae) and sculpins (Cottidae), have a green chemical pigment in the bones, the greens and blues that appear in the skin are almost invariably the result of such combinations of colour cells as are mentioned above, rather than to special pigments or to special chromatophores. Yellow, orange and red areas when viewed under high magnification are stippled with yellow xanthophores or red erythrophores, or with both of these carotenoid pigment cells. Pink, purple and lavender colours in fishes are the result of different combinations and arrangements of erythrophores and iridocytes—a mixture or fine pattern of spots and streaks of red and white, red and blue or red, blue and white. When small areas of yellow are interspersed in a darker background, the result is a brown or some other secondary colour.

The colour cells "expand" or "contract" in response to visual stimuli, to the physiological state of the fish and to various internal secretions and drugs. By this mechanism fishes are able to change their appearance rapidly as they move from one environment to another. What actually happens is that the pigment granules within the colour cells either become dispersed throughout the whole somewhat star-shaped cell, to intensify the colour, or become aggregated into a dot at the centre of the cell, to accomplish a fading of the colour.

The melanophores react particularly fast, and those in different parts of the body may respond differentially. As a result, changes in shade and in dark and light patterns may be accomplished almost instantaneously. Changes in other colours, as from green to brown, are less rapid and less universal; they often require time for the decrease or elimination of certain pigments and for the increase or deposition of other pigments. Actual changes in the amount of melanin, and of guanine also, take place when fishes are shifted from a light background to a dark one, or vice versa.

Because of their capacity to change colour, fishes are remarkable at camouflage. In this self-protective scheme the flatfishes (flounders and soles) are famously adept. As these fishes move about over the sea bottom, the upper side (bearing both eyes) quickly takes on the colour of the surrounding mud, sand or rock. The pattern is also matched. Thus white fragments of shells are imitated by white spots on the body. Even the size and the abundance of dark and light objects are reproduced. These changes take place within a few minutes and are effected through the sense of sight. Similar transformations, even more rapid, although not

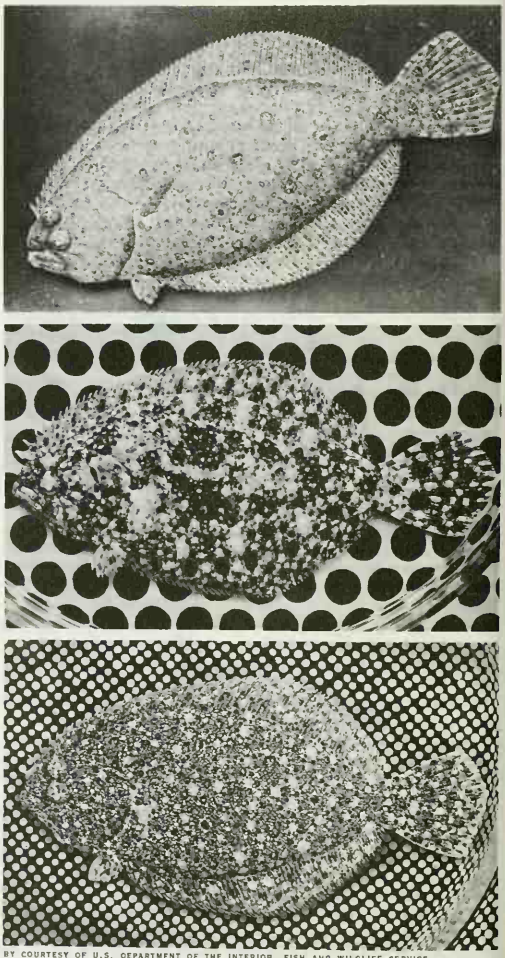


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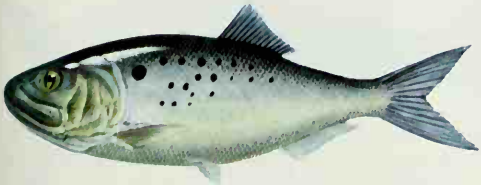
FIG. 5.—FLOUNDER (PARALICHTHYS ALBIGUTTA) ILLUSTRATING ITS ABILITY TO MODIFY ITS PATTERN TO BLEND WITH THE BACKGROUND

Herring (*Clupea harengus*); 12-17 in. Both sides of the North Atlantic

Redfish or ocean perch (*Sebastes marinus*); 10-22 in. North Atlantic; North sea to Spitsbergen; iceland; Greenland south to New Jersey



Atlantic menhaden (*Brevoortia tyrannus*); 15 in. Nova Scotia to Florida

Mackerel (*Scomber scombrus*); 12-24 in. North Atlantic: Norway to Spain and Gulf of St. Lawrence to North Carolina

Pacific sardine (*Sardinops sagax*); 8-14 in. Southeast Alaska to Lower California; Peru and Chile

Sablefish (*Anoplopoma fimbria*); 20-36 in. Northwest Alaska to southern California

Yellowfin tuna (*Thunnus albacares*); 5-9 ft. Tropical and temperate Atlantic and Pacific

Pink salmon (*Oncorhynchus gorbuscha*); 20-30 in. North Pacific: Asia, Alaska to Oregon

Atlantic halibut (*Hippoglossus hippoglossus*); 7-8 ft. North Atlantic: south to Bay of Biscay, south to New Jersey

Atlantic cod (*Gadus morhua*); 40-50 in. Greenland to the Carolinas

COMMERCIALLY IMPORTANT FISHES

PAINTED ESPECIALLY FOR "ENCYCLOPÆDIA BRITANNICA" BY TOM DOLAN, UNDER THE SUPERVISION OF LOREN P. WOODS, CHICAGO NATURAL HISTORY MUSEUM

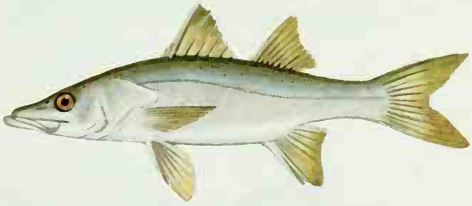
FISH

King mackerel or kingfish (*Scomberomorus cavalla*); 36-65 in. Tropical Atlantic

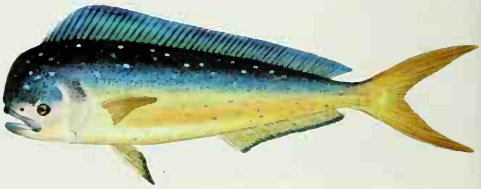
Wahoo (*Acanthocybium solanderi*); 30-78 in. All tropical oceans

Tarpon (*Megalops atlantica*); 30-74 in. Tropical Atlantic

Bonefish (*Albula vulpes*); 15-42 in. Tropical seas and north to Japan, San Francisco and Long Island



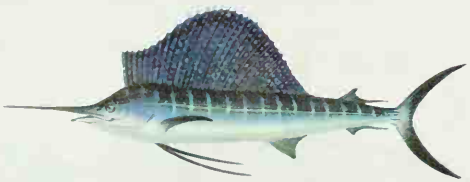
Snook (*Centropomus undecimalis*); 24-55 in. Gulf of Mexico, West Indies, south to Panama and the Guianas



Dolphin (*Coryphaena hippurus*); 24-63 in. All warm oceans

Cobia (*Rachycentron canadum*); 30-70 in. All warm seas

White seabass (*Cynoscion nobilis*); 25-65 in. California to southern Alaska



Atlantic sailfish (*Istiophorus albicans*); 60-124 in. Western Atlantic, Gulf of Mexico, West Indies to Brazil

Striped marlin (*Makaira audax*); 161 in. Tropical Pacific

GAME FISHES OF THE WORLD

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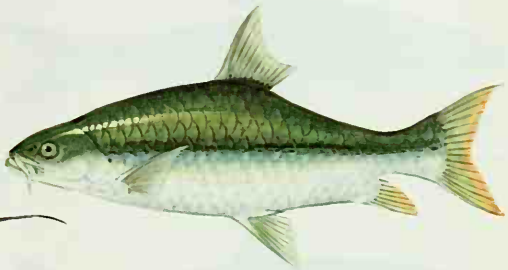
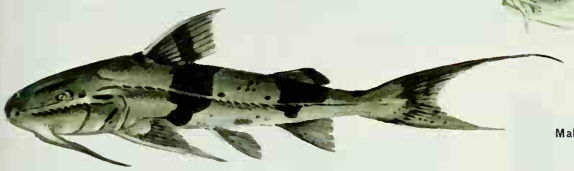
Wels (*Silurus glanis*); 6 ft., occasionally to 10 ft. Central and eastern Europe, Baltic to Caspian seas

Pike perch (*Lucioperca lucioperca*); 6-20 in. Central Europe and U.S.S.R.

Sturgeon (*Acipenser sturio*); 6-10 ft., to 18 ft. Atlantic; Baltic, Mediterranean and Black seas; Danube river

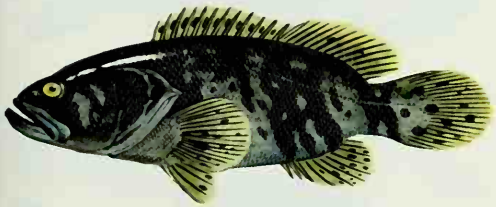


Mahseer (*Barbus tor*); 66 in. Rivers of India, Assam and Burma



Goonch (*Bagarius bagarius*); 6 ft. Rivers of India

Indian "trout" (*Barilius bola*); 12 in. Rivers from northern India to Thailand



Giant sea perch (*Promicrops lanceolatus*); 8 ft. Western Pacific and Indian oceans

Tucunare (*Cichla ocellaris*); 2.5 ft. Amazon river system and the Guianas

Pirarucu (*Arapaima gigas*); 8 ft. Rivers of South America from the Guianas to Argentina

Dorado (*Salminus maxillosus*); 3 ft. Paraná and Orinoco rivers, South America

GAME FISHES OF THE WORLD

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FISH

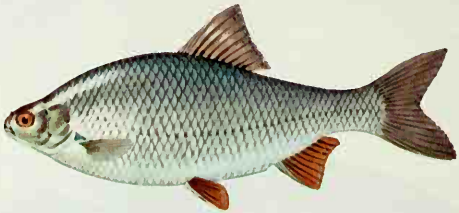
Chub (*Squalius cephalus*); 12-24 in. England; Europe to Asia Minor

Brown trout (*Salmo trutta*); 6-12 in. Europe and Asia Minor; introduced into North and South America, Africa, India and New Zealand

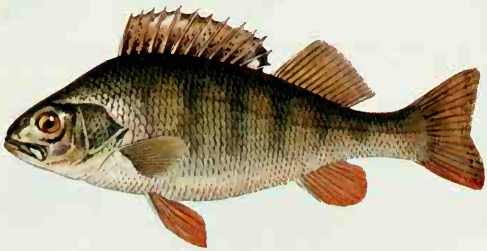
Barbel (*Barbus barbus*); 12-30 in. Engand, France and Germany to the Danube

Arctic char (*Salvelinus alpinus*); 10-16 in. Circumpolar, south to the Alps, Japan to about 55° N. lat. and North America

Atlantic salmon (*Salmo salar*); 20-48 in. North Atlantic coastal regions south to New England and France



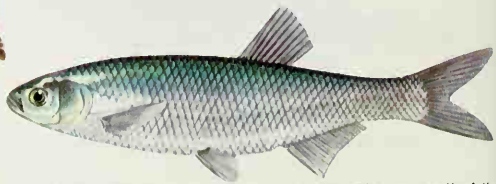
Roach (*Rutilus rutilus*); 6-12 in. Europe, north of the Alps and Pyrenees



Perch (*Perca fluviatilis*); 6-12 in. England, Europe and northern Asia

Grayling (*Thymallus thymallus*); 10-20 in. All of Europe except Spain, southern France and Italy

Northern pike (*Esox lucius*); 16-40 in. Cool and cold waters of Europe, Asia and North America



Bleak (*Alburnus alburnus*); 4-8 in. England and Europe, north of the Alps

GAME FISHES OF THE WORLD

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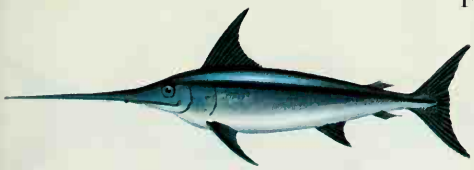
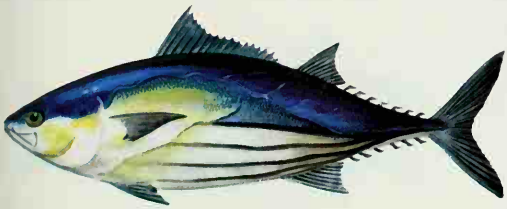
FISH



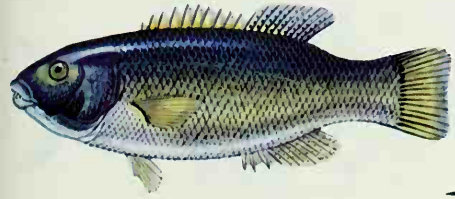
Swordfish (*Xiphias gladius*); 15 ft. All temperate and tropical oceans

Murray cod (*Maccullochelia macquariensis*); 6 ft. Murray river system, southern Australia

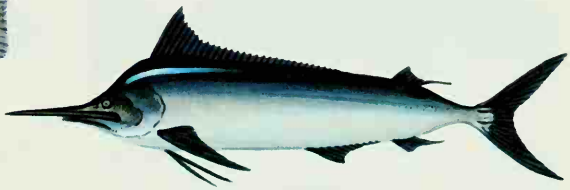


Skipjack tuna (*Euthynnus pelamis*); 3 ft. Pelagic temperate and tropical oceans

Barrácouta or snoek (*Thyrsites atun*); 4 ft. Coasts of South Africa, southern Australia and New Zealand

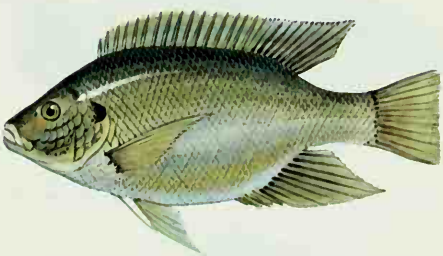


Groper (*Achaerodus gouldi*); 3.5 ft. Rocky coasts of Australia

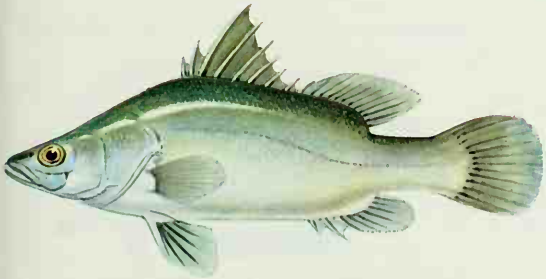


Black marlin (*Makaira indica*); 14.5 ft. New Zealand and Australia

Tigerfish (*Hydroscion lineatus*); 2 ft. Large rivers and lakes of Africa



Tilapia (*Tilapia nigra*); 12 in. Athi river system, British East Africa



Nile perch (*Lates niloticus*); 6 ft. West Africa and Nile drainage

Red steenbras (*Dentex rupestris*); 4 ft. Cape seas, Africa

GAME FISHES OF THE WORLD

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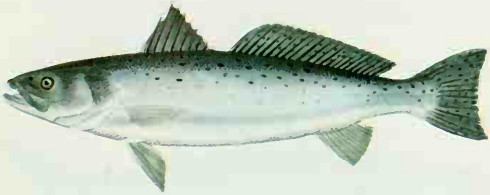
FISH

Yellowtail (*Seriola dorsalis*); 65 in. Pacific coast, southern California and Lower California

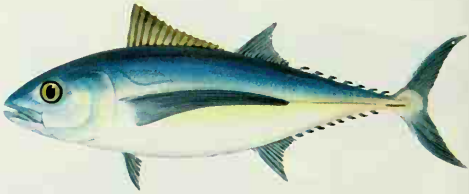
Bluefish (*Pomatomus saltatrix*); 40 in. Temperate and tropical oceans except waters of Oceania and eastern Pacific



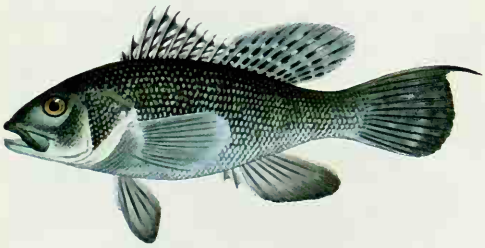
Spotted seatrout (*Cynoscion nebulosus*); 34 in. Atlantic and Gulf of Mexico coasts

Weakfish (*Cynoscion regalis*); 46 in. Atlantic, Nova Scotia to Florida

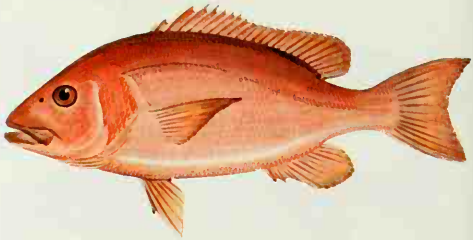
Red drum (*Sciaenops ocellata*); 52 in. Atlantic and Gulf coasts, New York to Texas



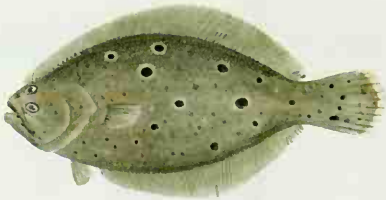
Albacore (*Thunnus alalunga*); 42 in. Alaska to Lower California through temperate Pacific to Hawaii and Japan



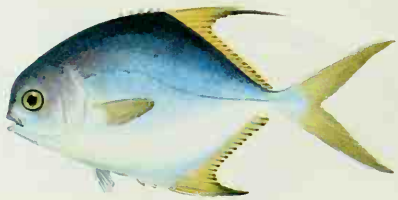
Black sea bass (*Centropristes striatus*); 24 in. Atlantic coast, Cape Cod to northern Florida



Red snapper (*Lutjanus blackfordi*); 30 in. Western tropical Atlantic



Summer flounder (*Paralichthys dentatus*); 36 in. Atlantic coast, Maine to Florida



Permit (*Trachinotus falcatus*); 43 in. Tropical Atlantic

NORTH AMERICAN MARINE FISHES

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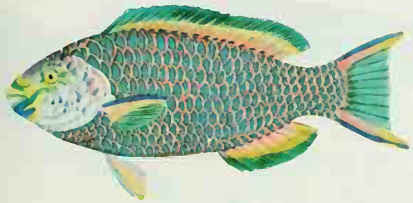
Spotted goatfish (*Pseudupeneus maculatus*); 10 in. Warm Atlantic

Longspine squirrelfish (*Holocentrus rufus*); 10 in. Bermudas, West Indies and Gulf of Mexico

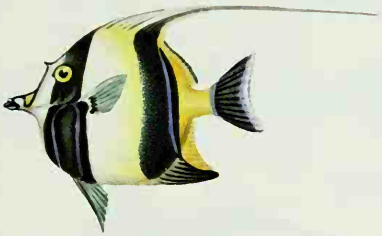


Queen parrot fish (*Scarus vetula*); 24 in. Warm Atlantic

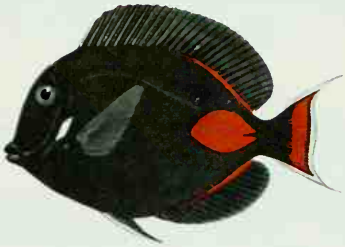
Anemone fish (*Amphiprion percula*); 3 in. Indo-Pacific

Hogfish (*Lachnolaimus maximus*); 26 in. Warm Atlantic

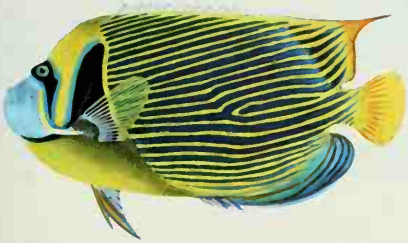
Foureye butterfly fish (*Chaetodon capistratus*); 6 in. Western tropical Atlantic



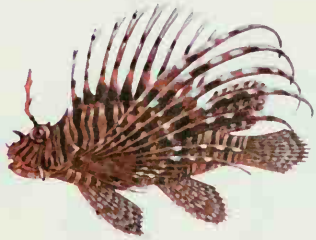
Moorish idol (*Zanclus cornutus*); 8 in. Indo-Pacific



Achilles tang (*Acanthurus achilles*); 12 in. Indo-Pacific



Imperial angelfish (*Pomacanthus imperator*); 14 in. Indo-Pacific



Lionfish (*Pterois volitans*); 8 in. Indo-Pacific

CORAL REEF FISHES

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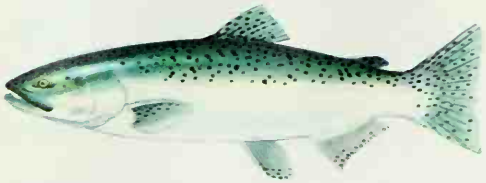
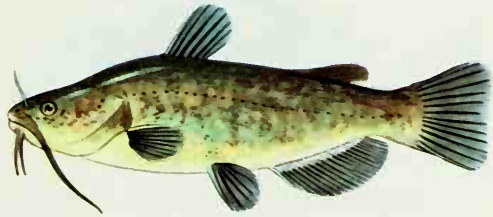
FISH

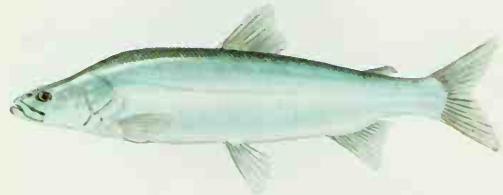


Chinook salmon (*Oncorhynchus tshawytscha*); 36-58 in. Pacific coast, California to Alaska and south to China. (Salmon migrate from the sea to fresh water to spawn)

Channel catfish (*Ictalurus punctatus*); 11-30 in. Central U.S., Appalachians to Rockies



Brown bullhead (*Ictalurus nebulosus*); 6-16 in. Eastern U.S. and southern Canada



Inconnu (*Stenodus leucichthys*); 40-60 in. Yukon and Mackenzie rivers; also in northern Asia

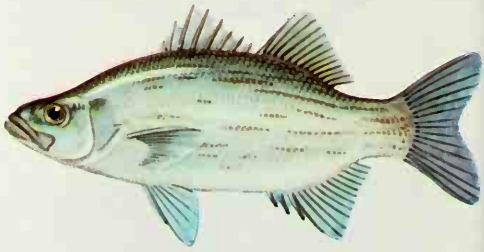
Freshwater drum (*Aplodinotus grunniens*); 12-30 in. Great Lakes, Mississippi River system south in Mexico to Campeche

Cutthroat trout (*Salmo clarki*); 12-30 in. Western U.S. and Canada

Brook trout (*Salvelinus fontinalis*); 5-18 in. Northeastern U.S. and eastern Canada

Lake trout (*Salvelinus namaycush*); 15-36 in. Alaska; Canada south to the Great Lakes

Rainbow trout (*Salmo gairdneri*); 20-45 in. California to southeastern Alaska; introduced into Europe and New Zealand



White bass (*Roccus chrysops*); 7.5-16 in. Great Lakes, Mississippi river valley to northeastern Mexico

NORTH AMERICAN FRESH-WATER GAME FISHES

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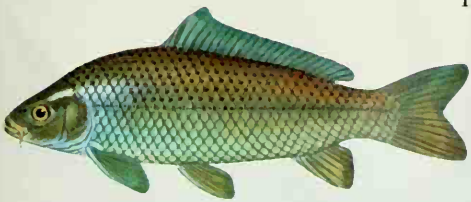
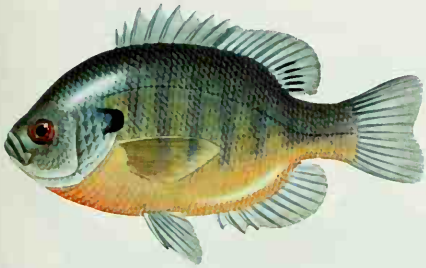
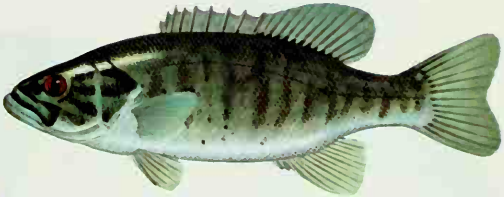


Carp (*Cyprinus carpio*); 10-40 in. Also found in Europe and Asia

Black crappie (*Pomoxis nigromaculatus*); 5-12 in. U.S., east of Great Plains, but not found in New England

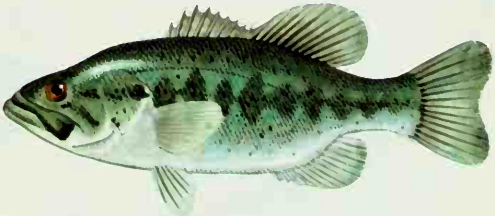


Bluegill (*Lepomis macrochirus*); 6-8 in. Throughout most of conterminous U.S., but originally from central states

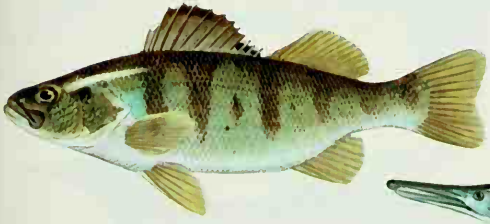


Smallmouth bass (*Micropterus dolomieui*); 10-22 in. North central U.S. and adjacent parts of Canada

Walleye (*Stizostedion vitreum*); 12-30 in. Northeastern U.S. and Canada

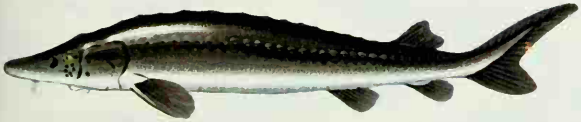


Largemouth bass (*Micropterus salmoides*); 10-20 in. U.S., east of Great Plains



Yellow perch (*Perca flavescens*); 6-12 in. Northeastern U.S. and Canada

Alligator gar (*Lepisosteus spatula*); 5-9 ft. Lower Mississippi river and tributaries; Gulf coast of Florida to Tampico, Mexico



Lake sturgeon (*Acipenser fulvescens*); 20-55 in., occasionally to 96 in. Great Lakes, upper Mississippi, lakes and streams of Canada to latitude 60° N.

Muskellunge (*Esox masquinongy*); 24-45 in. Great Lakes basin, Ohio and upper Mississippi rivers

NORTH AMERICAN FRESH-WATER GAME FISHES

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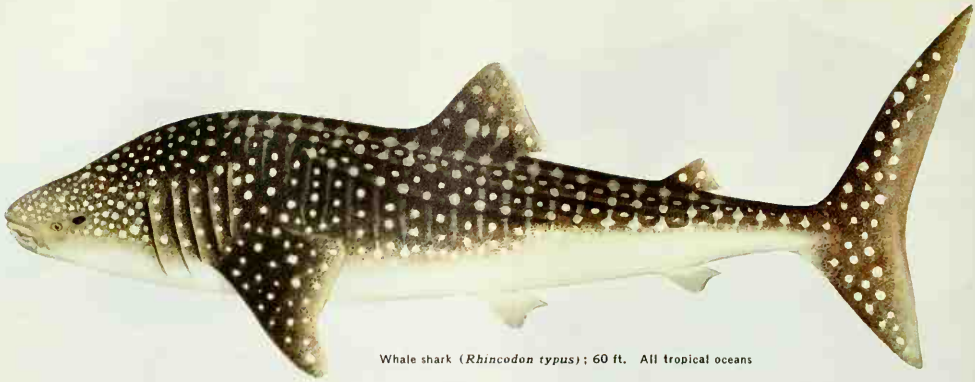
FISH



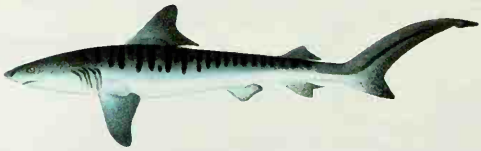
Whale shark (*Rhincodon typus*); 60 ft. All tropical oceans

Note: Specimens on this page are all drawn to the scale of man 6 ft. tall

Basking shark (*Cetorhinus maximus*); 45 ft. Temperate and boreal (subarctic) ocean waters

Bluefin tuna (*Thunnus thynnus*); 10 ft. Tropical and temperate oceans

White shark (*Carcharodon carcharias*); average 36 ft.; may reach more than 40 ft., as shown. All tropical and temperate oceans



Tiger shark (*Galeocerdo cuvieri*); average 18 ft.; may reach 30 ft. as shown. Tropical and subtropical oceans

Atlantic manta (*Manta birostris*) (*below*): 22 ft. across the wings. Tropical and warm temperate Atlantic

Mako shark (*Isurus oxyrinchus*); 12 ft. Tropical and warm temperate Atlantic

Thresher shark (*Alopias vulpinus*); 20 ft. Tropical and warm temperate oceans offshore

GIANT FISHES

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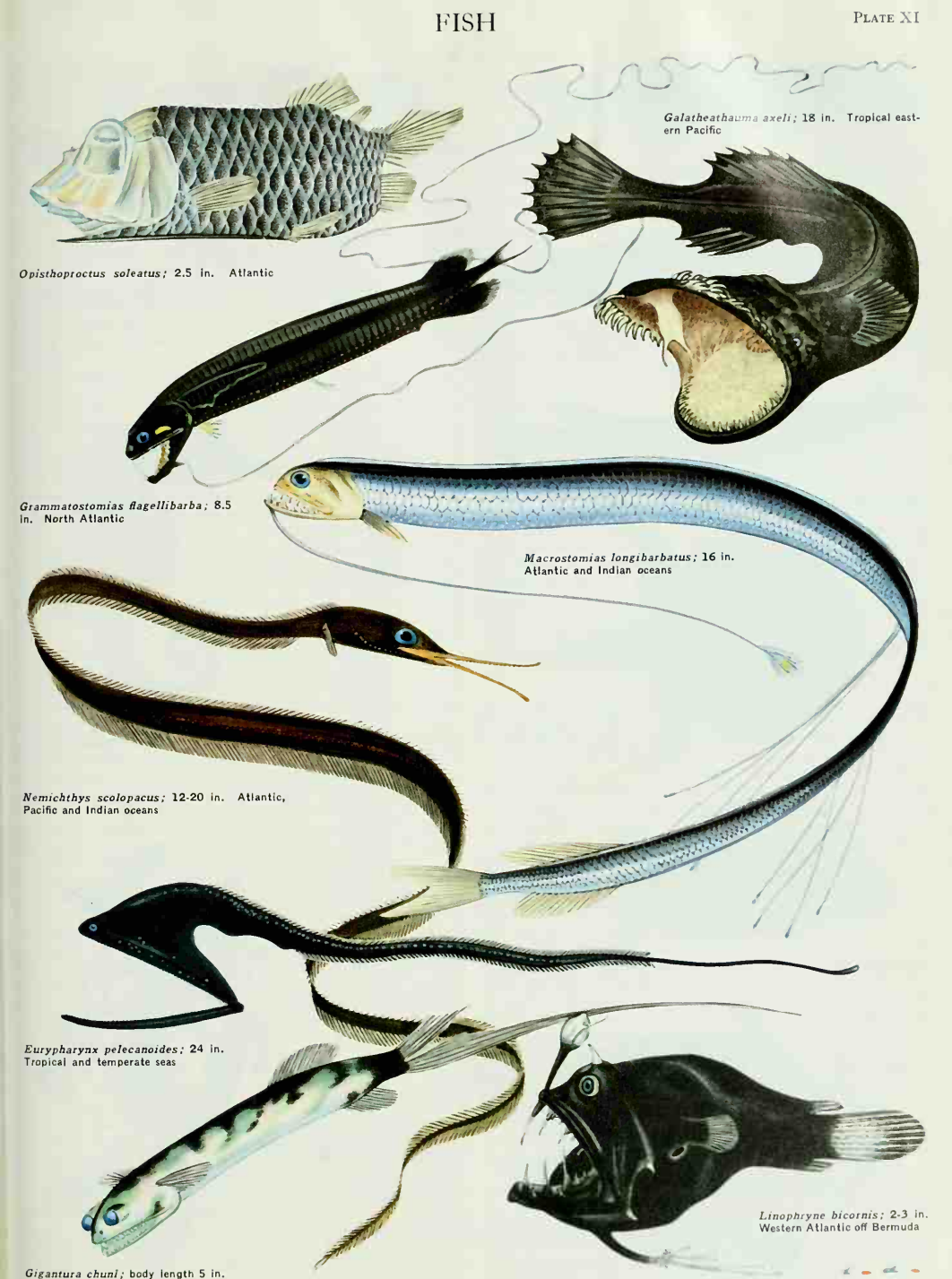

Galatheathauma axeli; 18 in. Tropical eastern Pacific

Opisthoproctus soleatus; 2.5 in. Atlantic

Grammatostomias flagellibarba; 8.5 in. North Atlantic

Macrostomias longibarbatus; 16 in. Atlantic and Indian oceans

Nemichthys scolopacus; 12-20 in. Atlantic, Pacific and Indian oceans

Eurypharynx pelecanoides; 24 in. Tropical and temperate seas

Linophryne bicornis; 2-3 in. Western Atlantic off Bermuda

Gigantura chuni; body length 5 in. Tropical Atlantic off west Africa

DEEP SEA FISHES

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FISH

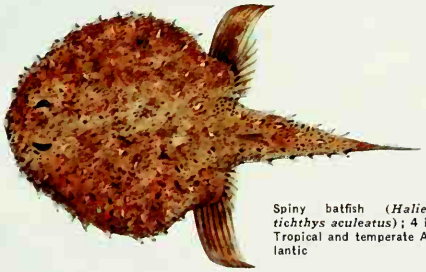
Tropical two-wing flying fish (*Exocoetus volitans*); 6 in. All tropical oceans

Striped burrfish (*Chilomycterus schoepfi*); 10 in. Southern coasts of U.S., West Indies

Mud skipper (*Periophthalmus schlosseri*); 8 in. East Indies

Four-eyed fish (*Anableps anableps*); 12 in. Rivers of eastern South America

Sea horse (*Hippocampus erectus*); 6 in. Atlantic coasts, New York to Brazil



Spiny batfish (*Halieutichthys aculeatus*); 4 in. Tropical and temperate Atlantic

Shrimp fish (*Centriscus scutatus*); 6 in. East Indies

Cowfish (*Lactophrys quadricornis*); 15 in. Western tropical Atlantic, Carolinas to Brazil

Sea dragon (*Phycodurus eques*); 12 in. South Australia

Sargassum fish (*Histrio histrio*); 5 in. Tropical Atlantic

FISHES OF CURIOUS SHAPES AND HABITS

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quite so perfect, are exhibited by other fishes, such as the groupers of tropical shore waters. Some reef fishes show vertical bars when at rest but horizontal stripes when swimming.

Even more astonishing colour adaptations are attained by some fishes that live among marine plants of different colours, although the change may require days or weeks, since some pigments in the skin must be lost and others gained. Thus the giant kelpfish (*Heterostichus rostratus*) of California, which is able to change its colour pattern, is wonderfully well concealed whether it lives among the large brown blades of the giant kelp (*Macrocystis*) or in the beds of slender eelgrass (*Zostera*). In the kelp this fish is uniformly brown, almost like the alga; in the eelgrass it is striped with intense green and brilliant silver, a colour pattern that matches the green of the eelgrass and the streaks of light between the slender blades of the plant. The two colour phases could hardly be more unlike and certainly appear to represent different species. They may, however, be changed back and forth experimentally.

In its imitation of these backgrounds the giant kelpfish does not rely solely on perfect colour matching: It seldom swims horizontally; ordinarily it heads up or down in line with the plants and may even waft its tail back and forth to simulate the movements of the blades. A South American leaf-mimicking fish (*Monocirrhus*) drifts along just like a leaf. Baby gars (*Lepisosteus*) look like tiny twigs and float stiffly at the surface. Other fishes also increase the efficacy of camouflage by imitating in posture or movement the environmental objects that they match in colour.

Species that live on sand or other drab-coloured backgrounds do not possess a capacity to change colour that is at all comparable to the abilities of the giant kelpfish. Those that live in a single kind of plant may imitate that plant only. The sargassum fish (*Histrio histrio*) does not show great range in colour variation but does simulate closely the floating sargassum weed in which it invariably occurs. The resemblance is so perfect that the fish is almost invisible even at close range as it slowly crawls about among the plants. Like other animals of the floating sargassum, it shows white marks that look like the white growths of bryozoans that normally occur on the seaweed.

Some biologists have suggested that fishes and other animals take on the colour of the particular plant on which they live merely because they imbibe the plant pigment either directly by feeding on the plant or indirectly by eating smaller herbivorous animals. For fishes this is not true. Their colours are usually otherwise constituted, and the changes can be effected experimentally. Tests show that colour matching, like bottom mimicry in flatfishes, is effected somehow through the sense of sight.

That coloration involving only darkness and lightness in fishes really has survival value has been experimentally proved. Even before such proof was obtained field naturalists firmly believed that background mimicry arose through the evolutionary process of natural selection. The simulation of the background colour by fishes is too universal to admit of any other explanation. Nearly all species that swim near the ocean's surface—such as herrings, flying fishes and mackerels—are bright green or blue above, more commonly green inshore and blue offshore, thereby blending with the colour of the water. The blue coloured fishes of the coral reefs are the reef-dwelling fishes that swim into open water. Seen from beneath, all surface swimmers (*e.g.*, halfbeaks and silversides) are silvery and thus match the surface film of the water, which shines from below like a mirror. Most gobies, flatfishes and other species that live on the bare bottom are uniformly coloured, speckled or mottled with neutral colours. Tide-pool sculpins and blennies, which habitually live among varicoloured aquatic plants, in contrast, are brightly and variously coloured, commonly grading from bright green through browns to red and often matching the peculiar pinkish-lavender of the coralline algae. Most fishes of the twilight zone of moderate depths are actually red when viewed in white light, but in their own environment they are probably inconspicuous and concealed. The reason for this phenomenon is that only green rays penetrate such depths (red rays penetrate less deeply); since some of the green rays are absorbed by the red-pigmented fish and since there are no red rays to be reflected, the fish assumes much the same dark colour as the murky water surrounding it.

Cryptic (concealing) coloration is effected in almost all fishes that live in lighted water, as in most other animals that live in light, by "obliterative countershading" (first stressed by the artists A. H. and G. H. Thayer). That is, the back is enough darker than the lower parts to offset the shadows below so that the whole image appears flat and indistinct. The exceptions among fishes interestingly prove the rule. Many deep-sea fishes, living below the zone of light, are uniformly dark. The remoras (Echeneidae) are lighter above, but since they adhere by their backs to sharks, the lighter portions are thus usually in the shadow of the shark. The batensoda (*Synodontis*), a catfish of the Nile, also reverses the usual scheme of countershading, but this fish habitually swims upside down so that its light side (its back) blends with the sky as seen through the surface layers of the water. Some critics have suggested that the darkening of the most exposed parts is the direct effect of light, but it has been demonstrated that countershading is inherited and, therefore, is almost certainly the result of natural selection.

Although they render a fish in hand or in an ordinary picture very conspicuous, black bands and stripes are also regarded as concealing and protective, for at a moderate distance they disrupt the telltale fish outline. The most effective patterns have the markings extended to the very edge of the body and fins. The eye is a particularly revealing organ, but in many fishes it is more or less completely obliterated by a black streak or bar, or by radial markings. These markings pass across the whole eye or through the otherwise conspicuous pupil. That they are of definite significance is suggested not only by their frequent occurrence but also by the fact that they extend across several entirely different tissues. Such coincident disruptive markings can hardly be the result of chance or have any other basis than natural selection. Many fishes have dark eyelike marks ("ocelli") elsewhere on their bodies, which may also serve to confuse predators.

Usually the sexes in fishes are coloured alike, or the male in the spawning season is merely more intensely or more deeply pigmented, but in many species having a complicated breeding behaviour the male is much more colourful than the female. The guppy (*Lebistes reticulatus*) of aquarium fame is a familiar example. The darters—dwarfed perches that inhabit the riffles of streams in the eastern U.S.—exhibit nuptial male colours that are among the brightest found in animals. Among marine fishes the dragonets show a similar sexual dichromatism. Darwin's theory of sexual selection (*see* SELECTION: *Sexual Selection*) explains in part the development of such sexual differences in colour. Sex recognition and intimidation of rivals, however, are probably more significant.

Some pigmentation appears to have a simpler significance in that it serves a physiological function primarily. Thus the melanin that is usually concentrated over the brain presumably shields this vital organ from harmful effects of light rays. The black pigment in the peritoneal lining of the body cavity may similarly protect the viscera; in herbivorous fishes it may also furnish necessary protection for enzymes that aid in digestion of plant tissues. Melanin and guanine are excretory products of metabolism; their discharge through the skin may be a method of elimination, but the pigments also provide protective coloration.

There is little evidence that fishes with poisonous flesh or foul taste are conspicuously coloured for their own protection as many insects are supposed to be. Even the dangerous sting rays and the poison-spined mad toms (small catfishes of eastern North America) are as concealingly coloured as their innocuous relatives. "Warning coloration," however, may be exhibited by some of the surgeonfishes (Acanthuridae), which have a needlelike spine on the tail. The fleshy orange of the garibaldi, or ocean goldfish (*Hypsypops rubicunda*), of southern California, appears to "advertise" the presence of this fish, which boldly fights to defend its home territory. Since revealing coloration seems seldom to have evolved in fishes, it is not surprising that in this group (unlike in the insects) there are few examples of the mimicry of a poison-

ous or unsavoury species by an innocuous one.

Vivid colours have been developed in some fishes through selective breeding by man. For many centuries the Chinese and Japanese have produced goldfish breeds as bright and varied in colour as they are bizarre in form. Over the years aquarists have selectively bred many tropical fishes, producing beautiful colour phases and fancy forms. *See* also ANIMAL COLORATION; AQUARIUM; PIGMENT, ANIMAL. (C. L. Hs.)

III. DISTRIBUTION: HABITATS AND GEOGRAPHY

Almost every known type of water has its fish life, from mountain torrents to the depths of the ocean. There are three main aquatic habitats, each with fishes peculiar to itself, namely fresh water, shore water and deep sea; certain fishes, however, range over two or all of these habitats.

1. Distribution According to Habitat.—*Fresh Water.*—There is some evidence that the ancestors of the bony fishes (Osteichthyes) inhabited fresh water, where several relict forms still live. Be that as it may, almost every modern order of freshwater fishes has marine species or relatives, and presumably came out of the sea, which its ancestors may have entered at an earlier epoch. An exception is the continental order Cypriniformes (or Ostariophysi), including catfishes, characins and minnows or carps, with no known marine relatives and no marine species except a few catfishes that are doubtless secondarily marine.

In fresh water, which does not support the abundance of fishes to be found in salt water, competition is less keen and specialization less pronounced than in salt water, and its fishes are, in general, more primitive. Some fishes are most abundant in the transition zone of brackish water between salt and fresh, as about the mouths of streams. Most of these can also live in fresh or salt water, some better in the one, some better in the other; several of these forms can live in salt concentration greater than that of the open ocean. Some fishes, notably species of the trout and herring families, make regular migrations between salt water and fresh water. In the arctic regions fishes cross the line between fresh and salt water more freely than do fishes in warmer climes. Tropical salt-water fishes, however, rather freely enter local fresh water that is heavily impregnated with lime.

Shore Water.—The line between fresh-water and marine shore fishes is a somewhat intangible one. In spite of the fact that living conditions are so similar in the two habitats that many of their fishes are much alike, the boundary between the two is one of the most effective barriers, in general, to the distribution of fishes.

Various shore fishes go to considerable depths at times. Shore fishes are dominant on offshore banks and on the continental shelves in general. Certain cold-water species, found in shallow water along coasts to the north, range farther south in deep water. The deep-sea fish life becomes dominant below the 100-fathom line shoreward; and, at intermediate depths, representatives of both faunas are found. Although deep-sea fishes were presumably derived from fishes of shore waters, their specializations are so pronounced that there is seldom difficulty in assigning a species (where the two faunas mingle) to one or the other category. There furthermore seems to be a narrow transition zone on the continental slopes between shore and deep-sea faunas, which has some fishes, with shore affinities, peculiar to it but not related to those in nearby shore waters. Pelagic fishes, found at the surface of the open ocean far from land, for the most part belong to a division of the shore fish life, not to the deep-sea fish life. On the other hand many little lantern fishes, which at night follow the zone of darkness to the surface, obviously belong to the deep-sea fish life. Not only are they specialized for life in dim light, but their relatives live deeper down.

Deep Sea.—The deep-sea habitat is the most peculiar of the three major aquatic habitats; its fish life, the most specialized of all, is unlike that found anywhere else. Competition is less keen in the deep sea than in shore waters, enabling primitive types and groups to persist there. The three obvious physical characters of the depths of the ocean to which fishes living there must become adjusted are pressure, cold and darkness. The bodies of deep-sea fishes are so permeable to water that pressure evidently is balanced and makes surprisingly little difference to them, provided they do not change their level too quickly. Cold obviously acts as a deterrent, preventing warm-water shore fishes, especially, from entering the domain of, and competing with, deep-sea forms. Most of the peculiarities of deep-sea fishes are directly or indirectly traceable to the darkness of their environment.

It would be possible to subdivide the deep-sea fish life according to the zones of depth that its members occupy. It is thought that a large number of its species have a more or less limited range in any particular sea. On the other hand they live in a remarkably uniform environment with few natural barriers, and closely related, if not identical, forms have turned up in the most widely separated parts of the continuous ocean.

2. Geographical Distribution.—*Fresh-Water Fishes.*—There are, and were, various natural barriers to the dispersal of fresh-water fishes. To begin with, these fishes do not cross salt water. Those of one part of the world differ from those of another, correlated not only with differences in the aquatic environment but with the geological history of the lands. The fresh-water fish life is separable into a number of divisions and subdivisions that makes an interesting contribution to the science of zoogeography (*see* ZOOGEOGRAPHY; ANIMALS, DISTRIBUTION OF). The order Cypriniformes (catfishes, characins and minnows or carps), which dominates continental fresh waters today, appears to have been distributed from the larger land masses of the north. The dispersal of catfishes reached South America prior to the long isolation of that continent by sea in the Tertiary (a period beginning about 70,000,000 years ago and ending 1,000,000 years ago), and, with few competitors, the catfishes expanded there into a great variety of forms. The dispersal of carps came later; and not being able to cross salt water, they have not reached South America. Cypriniformes are dominant in the larger islands of the East Indies, but entirely absent, except for marine groups of catfishes, from Australia, New Guinea and Madagascar, which have been isolated by sea for a longer period than have the East Indies. The eastern limit of their range is approximately at Wallace's line, a transitional zone between the Oriental and Australian faunal regions. In such ways the subdivisions of the fresh-water fish life correlate with what is known of geological history from other sources.

Each of the various elements of the fresh-water fish life has a different derivation. Its subdivisions should be based not only on the presence or absence of one or another element but also on the balance between those that are present. The Continental division (including G. S. Myers' primary and secondary divisions), having the Cypriniformes dominant, is opposed to the Peripheral division, where a large portion of the fishes have marine affinities. The former includes the continents (except Australia) and most continental islands. It gives way to the Peripheral division in the arctic fringe, where relatives of the pikes and the trouts are abundant. The genus *Galaxias*, which occurs in the southernmost margin of South America and the tip of Africa, gives these small areas a Peripheral complexion.

The following outline will help clarify the relationships of these divisions:

I. Continental
  A. Northern (Boreal)
    1. Holarctic
      a. Palaearctic
      b. Nearctic
    2. Oriental
  B. Southern (Austral)
    1. Ethiopian
    2. Neotropical

II. Peripheral
  A. High Latitude
    1. Arctic and Subarctic
    2. Edge of Southern Land Masses
  B. Tropical
    1. Australian
    2. West Indian
    3. Insular-Oceanic

I. The Continental division may be subdivided into: the

Northern (Boreal) zone, which includes Eurasia and North America, with minnows or carps and their relatives very abundant; and the Southern (Austral) zone, covering Central and South America and Africa. The Holarctic region (including the Palaearctic and Nearctic regions) of the Boreal zone includes Europe, North America and crosses Asia, where it is separated geographically from the Oriental region, China, India, etc., by mountains and deserts. The Palaearctic fish life, in Eurasia, is characterized by the presence of loaches; the Nearctic, in North America, by an abundance of suckers. The Ethiopian (most of Africa and part of Arabia) and the Neotropical (South and Central America and tropical Mexico) regions of the Austral fish life are very comparable, being characterized by a great variety and abundance of catfishes, characins and cichlids, which has led to a recurrent but probably erroneous belief that there was a fresh-water (land) connection between Africa and South America in the Tertiary. There is an abundance of mormyrids in Africa and of gymnotids in South America, families parallel in some ways, but presumably unrelated.

Such are the main components of the continental fish life, but still further differences exist within each of these components. For instance, the minnows or carps make up a greater proportion of fresh-water fish life in eastern and southern Africa than in western Africa. These relatively recent arrivals from Asia found more room in the periphery than in the centre of abundance of the already established Nile-Congo fishes. In temperate North America fishes in the elevated or broken terrain from the Rocky mountains westward are different from those of the eastern part of the continent. In Asia and North America, particularly, the fish life varies according to temperature zones, dependent on differences in latitude or altitude.

II. The Peripheral division is characterized by groups of fishes found in the fringes of, and penetrating more or less deeply into, the Continental division; these fishes become dominant only where the Continental fish life is scant. It is less tangible, has less unity and is less correlated with the history of the lands. Its High Latitude part consists of an arctic and subarctic fringe where the trout family is abundant, and a barely recognizable touch at the edge of southern land masses, which do not extend into such high latitudes. Its Tropical part is dependent on long isolation of fresh waters by the sea, and may be divided into the Australian, West Indian and Insular-Oceanic fish faunas. The Australian, in Australia, New Guinea and the Sunda Islands, is characterized by the fresh-water cardinal fishes, halfbeaks, representatives of marine catfishes, etc.; the West Indian by fresh-water mullets and an abundance of cyprinodonts; the Insular-Oceanic is still more reduced, and gobies are its principal factor, augmented in the western Pacific by fresh-water species of *Kuhlia,* a primitive perchlike fish.

Marine Fishes.—Marine fish life varies in different parts of the world, primarily on the basis of water temperatures, which are much affected by ocean currents. Although some marine fishes range widely in the oceans, most of them (except for some deep-sea species; see *Deep Sea,* above) are more or less restricted along the shores of continents; various fish life zones can be distinguished. The following outline will serve to show the relationships of some of these zones:

I. Tropical
  A. Pelagic
  B. Coastal
    1. East Indian
    2. American
II. Boreal
III. Temperate
IV. Polar

I. The Tropical component extends around the globe, and is little varied, with representatives of the same fishes throughout. One branch of this tropical fish life, the Pelagic, is characterized by a few cosmopolitan species found across the surface of the open oceans far from land: the blue shark, pilot fish, dolphin, oceanic bonito, two or three flying fishes and sargassum fish in drifting sargassum. The majority of tropical fish life belongs to the Coastal branch; these species have more limited ranges and occur along coasts or about islands. For them there are two main centres of abundance, the East Indies and the Americas. Extending from the East Indian centre the Tropical Indo-Pacific fish life is remarkably uniform from the East Indies west to the Red sea, and east to the Hawaiian Islands. Although it becomes progressively less rich eastward, and many species occur only limited distances beyond the East Indies into the Pacific ocean, others are found all the way from the Red sea to Hawaii, and a few, such as the Moorish idol (*Zanclus* species) and a puffer (*Tetraodon hispidus*) extend even to tropical American waters.

The Tropical fish life of the southwest coast of North America and southward contains several Indo-Pacific elements, but is primarily American. Distance—in this case between the American coast and the Hawaiian Islands—seems to have been, in general, a more effective barrier to the distribution of shore fishes than have certain geologically recent land barriers. Tropical American fish life is found about coral reefs; it usually has a fringe to the north and south that lacks the reef elements but is otherwise little changed; drums or croakers (Sciaenidae) are abundant on sandy shores. On the east coast of North America the Tropical fringe extends north to the Carolinas.

II. The Boreal fish life is characterized by cod, sculpin, smelt, northern blenny, flatfishes and northern herrings. Best developed in the northern North Atlantic, it changes its character little as it fades into the arctic. Temperate fish faunas between the Boreal and Tropical are less strong and less well marked; they are largely dependent on ocean currents and configuration of the lands, and are isolated from one another and difficult to classify.

III. The Temperate zone occupies those areas of the ocean in which the waters have a rather wide range of temperature but are always warmer than Boreal waters and colder than Tropical waters. On the east coast of North America the Boreal extends south to Massachusetts; the area between the Boreal and the Tropical is dominated by the former in summer, by the latter in winter, and the two faunas are well contrasted. There is the merest suggestion of a warm Temperate fauna between them, in the presence of the tautog (*Tautoga onitis*), in abundance of the black sea bass (*Centropristes striatus*), etc.

On the west coast of North America a different condition prevails. The Boreal merges into a strong, widely distributed Cold Temperate North Pacific fish life in the southern Bering sea, which is characterized by rockfishes (*Sebastodes* species), greenlings (Hexagrammidae) and others of the suborder Cottoidea. Farther south, the Warm Temperate California fauna corresponds with the Warm Temperate Mediterranean fauna of the eastern Atlantic and amalgamates southward with the northern fringe of the Tropical (the Tropical becomes pure only at about Cape San Lucas). The Warm Temperate Peruvian fish life is of especial interest, although it occupies only a narrow strip of relatively cool northward flowing or upwelling sea along the west coast of South America. It is characterized by a very great abundance of a species of anchovy (*Engraulis ringens*), an abundance of drums and several fishes that have their closest relatives in widely separated and distant parts of the ocean. But its closest affinity is with the Californian fauna to the north. The configuration of ocean currents is such that the warm water of both hemispheres spreads poleward along the east coasts of the continents and cool water extends equatorward along the west coasts (*see* Ocean and Oceanography). It follows therefore that the Tropical faunal area is particularly narrow along the west coast of America, and is or was crossed by various fishes of Warm Temperate zones.

IV. At the southern pole an antarctic fish life, characterized by the codlike family Nototheniidae, extends northward to New Zealand, the southern end of South America and Kerguelen Island.

Notable among the fishes that range above the Arctic Circle are the northern pike (*Esox lucius*), long-nosed sucker (*Catostomus catostomus*), arctic char (*Salvelinus alpinus*), trout perches (*Percopsidae*) and several cyprinids. The Alaska blackfish (*Dallia pectoralis*), a small mud minnow, is limited to an arctic habitat; it lives in shallow water on the tundra and is able to withstand freezing for a time.

3. Factors Affecting Distribution.—The distribution of fish

life in the past was influenced by the same agencies and barriers that affect it at present. Few barriers are insurmountable. Environmental differences, as between fresh and salt waters, coastal waters and the dark depths of the ocean, warm water and cold, are the most effective barriers in the long run. It is also probable that each strong fish fauna is to some extent a closed corporation that can only be penetrated to a limited degree by that fauna adjacent to it. This very likely keeps the line between fresh-water and shore fishes—or, in the western Atlantic, between cold-water and warm-water fishes—as distinct as it is.

Wide stretches of relatively currentless ocean, free from islands, are a barrier to the dispersal of marine shore fishes. On the other hand many of these, which have pelagic young that can drift great distances in ocean currents, have a very wide distribution. Currents are often a factor in the migration of the individual to and from its nursery grounds, which may differ ecologically and geographically from those it occupies when grown.

As regards fresh-water fishes, the isolation afforded by different drainage systems is apparently too temporary to have more than a slight effect on their distribution.

IV. ECOLOGY AND BEHAVIOUR

A. The Place of Fish in Nature

Fish are the principal free-swimming aquatic animals. Most of the vast number of aquatic invertebrates are either more dependent on the bottom, or, because of lowly organization or small size, drift about in the currents. The molluscan squids, like the mammalian whales and porpoises, are exceptional in having invaded the fishes' sphere. Thus removed from serious competition by other groups, fish are abundant everywhere; they have expanded into every conceivable ecological niche and have evolved a much greater diversity of forms than any of the other classes of vertebrates. Fish competition, one species balanced against another, made for evolutionary divergence in every direction; therefore, fishes present a particularly fertile field for the student of evolution.

1. The Eaters and the Eaten.—The basic food supply of all animals, including fish, is plant life. The mass of rooted vegetation, such as is found in terrestrial environments, is relatively small in aquatic environments. This is compensated by the very great abundance of microscopic, planktonic (drifting) plants (diatoms and other tiny algae) in water that is within the reach of sunlight. Although their mass is quite adequate, these plants are too tiny to be utilized directly as food by more than a very few fishes; but they do serve as pasturage for smaller animals that are eventually eaten by fishes. Most important of these intermediate creatures are small, also planktonic, crustaceans (shrimp-like animals), frequently so abundant as to cloud the water. They are a principal food of many, if not most, newly hatched fishes.

Some fishes are omnivorous, feeding on both plants and animals; some are herbivorous, subsisting mainly on such water plants as there are in fresh water, along the shore or adrift; but the majority are carnivorous, feeding exclusively or chiefly on animals. An increasing proportion of the larger ones eat other fishes smaller than themselves, simply because these are the most available food. The saying "fish eat fish" is by no means an invariable rule, but is rather generally applicable. The carnivorous fishes living in the dark, miles down in the ocean, subsist almost entirely on animal detritus showering down from sunlit waters.

The great divergence of fishes depends, to some extent, on how far back toward the base of the food pyramid each group reaches for subsistence. The menhaden goes all the way and feeds on diatoms. The predaceous bluefish feeds on menhaden and other fishes of comparable size. There is also a basic cause for the diversity of fish life in the vastness of aquatic environment. Fishes of one heritage may have been superseded by those of another in centres of abundance and competition yet persist somewhere else, perhaps in fresh, perhaps in deep, perhaps in isolated waters.

Fish utilize every available food resource. Many fresh-water species eat insects that drop upon the surface by chance, or eat the aquatic larvae of terrestrial insects (the rationale behind fly-fishing). The former are a main food supply of trout in summer (the trout go on comparatively short rations through the winter). Rivers wash waste products of the land into the sea, which products nourish fishes or marine animals on which fishes feed. It follows then that off the mouths of great rivers fish life is usually abundant.

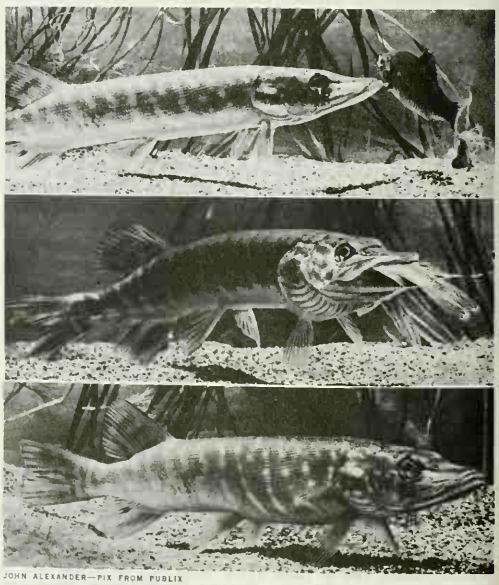
Fishes are also abundant and in great variety about coral reefs, but coral-reef fishes do not lend themselves to becoming the basis of a fishery more extensive than that for local consumption. There are three reasons for this: (1) the irregular bottom makes it easy for fishes to escape and (2) difficult for man to operate fishing equipment; (3) no one species is dominant or sufficiently abundant to be captured and handled in quantity conveniently. As a rule, the coral-reef habitat is narrow and isolated, easily fished out by local fishermen and slow to recover by influx from similar areas.

The extensive offshore cold-water banks of the North Atlantic show an opposite condition in these respects, and have been one of the chief sources of commercial fish. Here the supply of bank cod, which range widely in schools, seeking favourable pasturage, is still adequate in spite of intensive commercial fishing; but that of the more sedentary halibut has given out at spots that used to be the most favoured by that species.

Fish life is abundant where two environments meet, but relatively scarce over monotonous stretches. Fishes abound along shores, and are especially plentiful on offshore banks where the life of the bottom meets that of the upper waters; they are scarce across the open ocean. Their great abundance in cool waters off the Peruvian coast is probably correlated with the upwelling of deeper waters, which provides the plants of the lighted waters with stored nutrients from the deeps.

From the time that a tiny fish leaves the egg until it becomes full grown and lives out its life span, it is an important part of the intricate balance of aquatic life. The fish links together the different food levels of aquatic life, devouring organisms lower in the food pyramid and providing food for animals higher. (*See* also Ecology, Animal; Marine Biology.)

2. Friends and Foes.—Like land life, aquatic life has its beneficial associations. Among fishes some species have developed



JOHN ALEXANDER—PIX FROM PUBLIX

FIG. 6.—PREDATORY BEHAVIOUR: PIKE (TOP) STALKING AND (CENTRE) EATING A CARP; (BOTTOM) PIKE RESTING DISTENDED AFTER EATING

associations that are advantageous in securing food, shelter or protection, or relief from parasites. The remora, which attaches to sharks and other large fishes, is assured not only transportation but the scraps of food that elude its host's mouth. "Cleaning stations" set up by certain small fishes are visited fairly regularly by larger fishes beset with parasites; oddly enough, many of these larger forms, which are predators that would in other circumstances very likely devour these "cleaners," eagerly submit, without apparent aggression against their benefactors, to the tendings of the smaller fishes. *Nomeus gronovii* lives among the stinging tentacles of the Portuguese man-of-war, a large colonial jellyfish; this small fish, an artful dodger that avoids the poisonous stings of its host, is well protected against predators. Another fish lives within the hollow of a sea cucumber, darting in and out with impunity and apparently not harming its host in any way.

Life in water is not without its hazards, however. Lurking behind gently swaying water plants or among corals or rocks may be a patient predator awaiting the right moment to strike. Among the many predators of fishes are other fishes, squids, octopuses, coelenterates and cetaceans.

Predators are not the only enemies of fish, numerous parasites plague all fish. They range from the microscopic—glochidia of clams, parasitic copepods ("fish lice"), bacterial and fungal organisms—to the gross—parasitic lampreys and others.

B. Behaviour

It is assumed, probably correctly, that fish behaviour is more mechanical than that of the higher animals—in no way to be compared psychologically with man's behaviour. Nevertheless, fish behaviour has many features to suggest an anthropomorphic interpretation.

1. Schooling and Territorial Defense.—One underlying factor in fish behaviour seems to be that the individual fish seeks to swim at a given distance from others of its kind, no more and no less. This distance varies according to the fish's condition, and still more according to its species. It is a very short interval in herrings and mackerels, which swim in dense schools, and varies all the way to fishes that are essentially solitary, such as pikes.

Many sedentary fishes living in a circumscribed area at or near the bottom defend their property rights to the area, being domineering within its confines or driving intruders from it; these property rights, when asserted, tend to be respected by both neighbours and strangers. This behaviour is most marked in, but by no means confined to, fishes protecting their mates, eggs or young (see *Reproduction and Development*, below.)

2. Sound Production.—Sound does not pass readily from air to water, and vice versa. For this reason it was believed for many years that fishes were mute. It has been definitely established, however, that some are, on the contrary, very vocal, and certain species particularly so during the breeding season. The range of noises that they make is not very great—grunting, tooting, chirping, clicking, rattling, humming or drumming sounds—the voice of one species differing from that of another. A school of sea drums (*Pogonias*) in spring make a considerable noise, which can be heard through the bottom of a boat lying at anchor in a quiet bay. They are easily recognized by man, and it may be assumed that their voices can be heard and recognized by others of their kind.

The capacity of fishes to make noises apparently has evolved several times; therefore a variety of sound-producing structures are found among different groups.

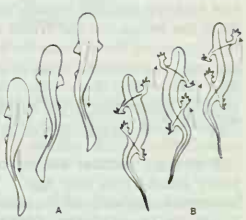
Drums, also called croakers or pumpers, make soft drumming sounds or harsh froglike croaks by rapidly contracting and expanding the muscles associated with the air bladder; this action causes the walls of the air bladder to vibrate, and the organ itself acts as a sounding board. Grunts produce grunting noises by grating their teeth.

3. "Sleep."—Fishes, lacking eyelids, cannot close their eyes, yet they recoup their strength by a behaviour analogous to sleep in mammals. Some simply remain suspended motionlessly in the water; others settle on a surface, resting either upright or on their sides; and a few partially wriggle into the mud or sand on the water's floor. Fishes that assemble in schools during the day often disperse at night to retire alone or in small groups.

4. Locomotion.—By far the greater majority of fishes are capable of transporting themselves by swimming, some species being more efficient than others in this regard. Greatest swimming speed is very likely attained by some member of the group of mackerel-like fishes, to which tuna and marlin belong. Exact knowledge is scant, but it is safe to say that, unless in short spurts, very few attain 20 m.p.h. One may well be skeptical of records, however circumstantial, of speeds more than 50 m.p.h. claimed for any fish.

On the other hand some fishes have almost given up locomotion. Holdfast devices, or suckers, have been developed in some species (these are specializations of certain fins). Examples are the remoras, mentioned earlier; and the gobies and clingfishes, which live between the tide marks and fasten to objects to avoid being carried away by the rushing tide.

Swimming.—Among the lower classes of fishes cyclostomes are inefficient swimmers; they propel themselves almost exclusively by body undulations, making a great deal of motion but little forward progress. Although the cartilaginous fishes are good swimmers, they are not among the swiftest; the sharks swim like the bony fishes, but the skates and rays propel themselves by means of waves that pass backward along the winglike fins.



FROM A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955, REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 7.—SIMILARITY OF LOCOMOTION BETWEEN (A) FISH AND (B) SALAMANDER

The fish swims by thrusting the body against the water in successive waves of curvature that travel backward along the trunk and tail. The salamander, using limbs, relies basically on these same movements for progression on land

Among the bony fishes many species are well-adapted for swimming by having a streamlined body and a well-developed tail. Lateral undulations of the tail are most important in propelling the fish's body; these are produced by alternate contractions of the musculature on either side of the body. When analyzed, a fish's motion through water is found to have a somewhat weaving character, the body being thrown into curves that press backward against the water, sending the body forward. As already mentioned, the other fins are used primarily for maintaining balance, for steering and for braking. Departures from the streamlined shape are numerous, however, and are associated with reduction in swimming efficiency and usually with the development of some kind of protective mechanism, *e.g.*, coloration, armour, spines, etc.; many of these fishes have become bottom dwellers, as the catfishes, flatfishes and others.

Jumping, Gliding and "Flying."—Besides swimming, other methods of locomotion have been employed by various fishes. Many bony fishes are able to jump out of the water; some of them, as the salmon, leaping as much as nine feet into the air. The devilfish, one of the large rays, also breaks the surface of the water, leaping a few feet. Flying fishes (Exocoetidae) have the pectoral fins enlarged, a specialization that enables them to break the surface and, in some species, glide for several hundred yards over the water. Individual fishes of many species occasionally jump spontaneously out of water. This behaviour may be an attempt to capture prey (in trout), to breech a barrier (in salmon) or to loosen parasites. Some have suggested that certain jumps are simply expressions of well-being or of illness. Many game fish, upon being hooked, break the surface before diving in an effort to free themselves.

"Walking."—Among a few families of bony fishes (lungfishes and others) the pectoral fins have been modified into lobed structures that allow these fishes to "walk" on the bottom; some, for example the mudskipper, occasionally venture on land in an attempt to capture crustaceans and insects.

5. Migration.—Birds are the only other vertebrates that have migrations as regular as, or more extensive than, fishes. Fish migration, however, appears to be much more complicated than

that of birds. It is usually similarly correlated with the change of seasons, but less predominantly with reproduction. Search for food and optimum temperatures are larger factors in it. Furthermore, a fish has three directions to migrate into a different environment, north and south (latitudinal), onshore and offshore (horizontal) and up and down (vertical). The migration of shore fishes commonly combines the three.

Spawning Migrations to Fresh Water.—As regards spawning migrations, there is a strong tendency for fresh-water bony fishes to run upstream to spawning grounds. The value of this habit is obvious. It provides the young fishes with an appropriate nursery ground in narrower waters where they have fewer enemies to contend with.

A similar migration is better developed in anadromous fishes, those bony fishes that grow in the sea but ascend fresh waters to spawn. These fishes have appreciably fewer eggs than comparable species that spawn in salt water, an adaptation probably correlated with less wastage of eggs and fry (young). The Chinook and sockeye salmons wander an unknown distance in the Pacific from the mouths of the rivers in which they spawn, and later return to ascend these rivers for hundreds of miles to their spawning grounds. Like other Pacific salmons they spawn only once and then die. The return downstream and out to sea is made by the succeeding generation, after spending its early life in fresh water. There is thus a single complete round-trip migration in the life of an individual Pacific salmon.

Fishes are peculiar among vertebrate animals in that the majority hatch from tiny eggs. There is such discrepancy in size between young and old that more often than not they occupy different ecological niches. Not infrequently young and old belong to different faunal zones. The young salmon, for example, is a part of the fresh-water fauna, the older salmon a part of the marine shore fauna.

The best known anadromous fishes belong to the relatively primitive order Clupeiformes (Isospondyli); like other anadromous fishes they can become landlocked and go through their entire life cycle in fresh water. As previously mentioned, there is some evidence that the ancestors of bony fishes were inhabitants of fresh water; the question of theoretical interest therefore suggests itself: whether the Clupeiformes are not to be considered a fresh-water group that has become adapted to life in the sea. Probably not, since most primitive Clupeiformes are marine and have typical marine-fish pelagic larvae, as in the big-eyed herring (*Elops*) and the bonefish (*Albula*).

The anadromous shad (a more advanced Clupeiformes) runs up rivers to spawn, from Florida to New Brunswick, progressively later in the spring northward, but this does not imply northward migration along the coast, for it is different fish that come into each river from the sea. It is not improbable, however, that some northward movement is associated with the shad's spring migration from its winter range in warm waters offshore or southward. There is an anadromous Chinese herring (*Hilsa*), corresponding to the American shad and an equally prized food fish, which runs up the Yangtze river 1,000 mi. or farther from the sea.

Spawning Migrations to the Sea.—A few species of fishes are catadromous, *i.e.*, live in fresh water but spawn in the sea. Among these the fresh-water eels (*Anguilla*) are pre-eminent. European and American *Anguilla*, which are very much alike, are known to spawn in adjacent areas of the open Atlantic southeast of Bermuda, at a probable depth of 200 fathoms or more. Their young are larval, elongate but flattened, transparent, pelagic and not eellike; they live near the surface of the Gulf stream drift, on the first leg of the long two-way migration in the life of an individual. The larval stage of the European species—until it metamorphoses into a tiny cylindrical, although still transparent replica of its parents—lasts nearly three years; that of the American species about one-third as long. By the time they have reached the end of the larval stage, they have drifted to the shores of Europe and America, respectively, and then enter coastal waters. Such tiny eels are sometimes very abundant in New York harbour in spring. They work into shallow water, quickly lose their transparency (becoming dark in colour) and begin to grow. Some remain in salt water along the coast. Others travel upstream, as far inland as the rivers are quiet (sometimes hundreds of miles), or get into ponds and live their adult years in fresh water. When fully adult and ready to spawn, those in fresh water return to the coast. In fall such mature eels change in appearance, becoming more or less silvery in colour and somewhat goggle-eyed, and head out to sea on the long migration back to the spawning grounds, from which only the next generation will return. Marine or pelagic larval young, unsuited to a fresh-water existence, are characteristic of eels in general; occasional individuals that become hopelessly landlocked in fresh water cannot reproduce their kind.

Migrations Within the Sea.—The migrations of marine shore fishes are largely determined by water temperatures and availability of food. Their breeding migrations are for the most part of lesser extent or are combined with the other migrations. The common mackerel of the east coast of North America is an example. It is not known exactly where schools of this species spend the winter, perhaps at a considerable depth in the ocean, but they appear off the Carolinas in spring and work northward. They spawn in summer abundantly in favourable feeding grounds from Massachusetts bay to the Gulf of St. Lawrence and over offshore banks. It seems that they move into these grounds when water temperatures permit; their spawning there appears to be more or less incidental. The bluefin tuna and the swordfish, of the western Atlantic, invade the same grounds in summer, but have certainly spawned elsewhere. The mackerel's migration presumably combines a movement to and from a greater depth farther offshore with a northeast-southwest movement along the coast. Its young follow along the coast for some distance in fall, those which are abundant in Long Island sound at that season presumably having come from New England.

As has been said earlier, the shore waters between Cape Cod and the Carolinas are occupied by warm-water fishes in summer and by cold-water fishes in winter. Of the former the tautog and striped bass may be little migratory, merely becoming less active in the colder months. Bottom fishes such as the summer flounder and sea robins move offshore into warmer, deeper water when shore-water temperatures fall. To what extent they edge southward while doing so is uncertain. The arrival in spring and departure in fall of the menhaden is closely correlated with water temperatures; its migration along the coast is probably combined with an inshore-offshore movement, but it is very improbable that it goes to any considerable depth. It is abundant southward at any season, but temperatures at the edge of the Gulf stream would be sufficiently warm for it. It spawns to the south in winter, progressively later northward and in the area under consideration in summer, so different lots of fishes must be involved. The pattern of bluefish migration seems to be somewhat intermediate between that of mackerel and menhaden; it spawns in its summer range. Its young grow rapidly and have a well-marked southwesterly migration along the coast in fall.

To cite examples of fishes of northern distribution that are abundant in shore waters south of Cape Cod in winter, schools of cod, which normally wander considerable distances in search of food, invade the area from the northeast when shore-water temperatures fall to a suitable level and the warm-water fishes withdraw from it. As a rule only an occasional individual of the little tomcod is to be met with here in summer, but in late fall a wave of this species invades inshore waters, presumably coming up along the bottom from a greater depth to spawn in winter in shallow bays and estuaries. The long-horned sculpin, which is abundant in the colder months and which spawns in late fall and winter, doubtless also comes up along the bottom, probably with little or no southward movement from northern shore waters where it is plentiful the year round. Much remains to be learned about the migration of any fish, even in this narrow and comparatively accessible area where a large part of the species are migratory.

Whatever north-south migration there may be along coasts in the northern hemisphere is complicated by retreat to offshore or deeper waters, which have less seasonal temperature change. More favourable spawning grounds for most fishes, be they warm-water or cold-water species, are inshore; they spawn inshore in summer

or winter as the case may be, and the temperature migration is also a spawning migration. A series of fishes could be selected showing every gradation in spawning migration pattern between that of strictly marine species, which spawn when they approach the coast, and that of anadromous species, which run far up the rivers to spawn.

Some warm-water marine fishes are pelagic; and many shore fishes have pelagic young. When their nursery grounds lie in a well-marked ocean current, the young may be drifted great distances. How they get back to where they came from is puzzling. The young of many tropical species are drifted northward along the American coast by waters of the Gulf stream, which latter becomes noticeable in temperate latitudes in summer and fall. In the majority of cases they occur merely as stragglers, and the presumption is they are lost and do not get back. But young of the common pompano, for instance, are frequent in small schools on sandy ocean shores in autumn, far north of where adults occur; they have by then reached a sufficient size to migrate southward along the coast, and presumably do so. The several species of tropical jacks (*Caranx*) common on the Atlantic coast of America have somewhat different nursery grounds from one another. A known nursery ground of *Caranx crysos* is in the Gulf stream, where these little fishes were found in numbers so far to the eastward as to raise the question whether they might seek African rather than American shores when large enough to navigate independently of currents. In support of this conjecture is the fact that this particular species does occur along African as well as American coasts. (Grown fish, even though not ordinarily pelagic, would be capable of crossing back from Africa to South America, or young of another generation might drift back in equatorial currents.) Little is definitely known of the migrations of these and other marine fishes. (J. T. N.; C. Hu.)

V. STRUCTURE AND FUNCTION

The fundamental pattern of fish organization and anatomy is so much like that of the higher "warm-blooded" animals as to be excellent evidence that the latter evolved from fishes even when direct evidence from the fossil record is not considered.

1. Jaws and Teeth.—The cyclostomes have no jaws in the strict sense; they do have, however, a complex dental arrangement within the round, suckerlike mouth and a flexible rasping tongue. These adaptations are especially well developed in the parasitic lampreys and hagfishes.

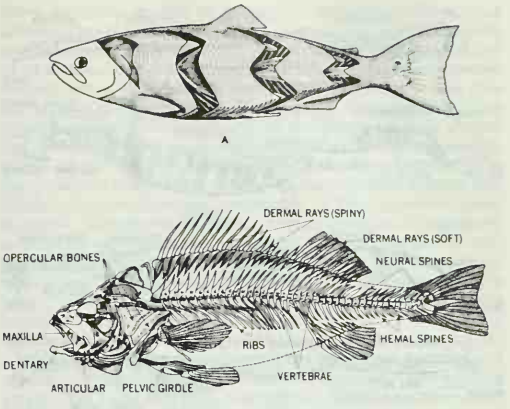
Among the cartilaginous fishes, which have powerful cartilaginous jaws, some sharks have sharply pointed teeth with rough cutting edges, as suits these predators of other large fishes. Other sharks, and the skates and rays, have flattened teeth, useful in crushing shells of crabs and mollusks on which they feed.

Most bony fishes have few to many sharp teeth in the bony jaw. The variations in mouth, jaw and dental complement are especially numerous and will be treated in some of the subsections of *Survey of the Bony Fishes* (below).

2. Musculature and Skeleton.—The major portion of the musculature of a fish, forming most of the bulk of the body, is arranged in more or less distinct ≷-shaped segments along either side of the body. This musculature forms the main organ of locomotion, producing the body undulations necessary for swimming (see *Locomotion*, above). The fin musculature is usually simple, consisting of two blocks of muscles, one on each side of the fin, attached to various parts of the skeleton.

The internal skeleton (endoskeleton) of cyclostomes is wholly cartilaginous; there is no exoskeleton, or skin armour. The notochord (which appears in the early development of all fishes) persists as the main supporting structure in cyclostomes; it is a continuous, flexible rod running dorsally the entire length of the animal and giving rise to slender upward-directed processes. The skull and gill regions are supported by a complex of cartilaginous pieces. The related extinct ostracoderms had a bony exoskeleton.

Cartilaginous fishes have an exoskeleton present only as prickly denticles in the skin. The endoskeletal elements are composed of cartilage ("gristle") more or less reinforced with limy deposits (but are not true bone); these elements include a backbone of distinct units, a substantial skull case and the numerous pieces supporting the fins.



FROM A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

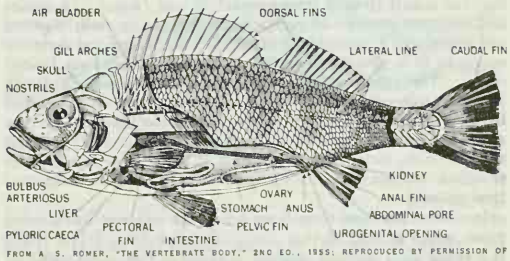
FIG. 8.—SUPPORTING STRUCTURES OF BONY FISH: (A) AXIAL MUSCULATURE OF A SALMON WITH GROUPS OF MYOMERES REMOVED TO SHOW INTERNAL FOLDING OF THESE SEGMENTED STRUCTURES; (B) SKELETON OF A PERCH

In bony fishes the skull, backbone, ribs, shoulder girdle and some elements of the fins constitute the endoskeleton; the scales, the bony plates and the spinous processes of the fins constitute the exoskeleton. Although most of these elements are formed of bone, cartilaginous pieces are found in many parts of the body. Elaborate bony rods extend from the vertebrae. The skull and gill regions contain numerous contiguous elements for their support and protection.

3. Digestive Tract.—As already indicated, though there are many types with different and more specialized feeding habits, most bony fishes are carnivorous. In these forms the jaws are set with teeth to hold prey, which ranges from small crustaceans to other smaller fishes. Food, as well as water, is taken into the mouth. There is a row of short, stiff rods, known as gill rakers, on the inner, concave face of one or more of the gill arches, opposite the convex face that bears the gills. The gill rakers, which help to retain the food until it is brought against the opening to the gullet and swallowed, permit the water to pass over the gills and to the outside from under the gill cover. The front of the gullet is otherwise kept closed by muscular control to avoid swallowing more than a small amount of water.

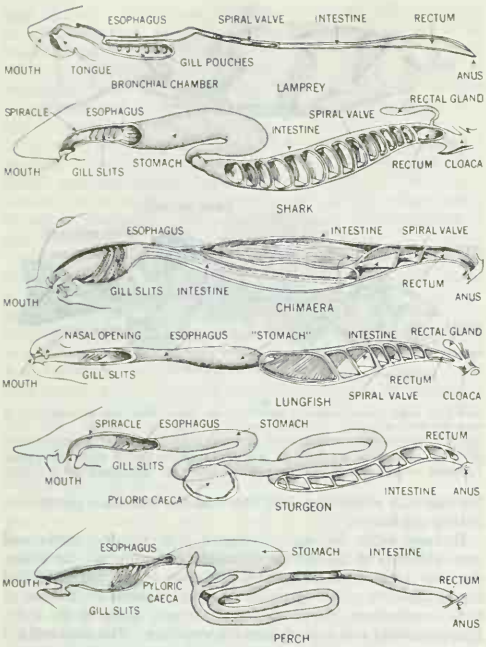
Food passes from the gullet or esophagus, which is a simple tube, into the stomach, which usually has a greater diameter than the gullet. The stomach may be a U-shaped tube or a blind sac, with openings to the gullet and intestine (which latter is behind the stomach) lying close together.

The character of the stomach in different fishes varies greatly, correlated with their type of food. In some, this organ is relatively straight and simple, as in the gray mullet (*Mugil*) and gizzard



FROM A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 9.—DIAGRAMMATIC DISSECTION OF A PERCH



FROM A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 10.—DIGESTIVE TRACTS OF VARIOUS KINDS OF FISHES. THERE IS NO STOMACH IN LAMPREYS OR CHIMAERAS, AND IN LUNGFISHES IT IS MERELY AN ENLARGEMENT OF THE ESOPHAGUS

shad (*Dorosoma*) in which it resembles the straight gizzard of a fowl. Many fishes, however, have a varying number of blind, tubelike sacs, the pyloric caeca, which increase the surface area available for absorption; these sacs are attached near the area where the stomach joins the intestine.

The beginning of the intestine is generally marked by the presence of a ringlike thickening of the walls of the tube and by openings of the ducts leading from the liver and the pancreas. The liver is a large organ, variable in size and colour in different fishes, that usually has a gall bladder. The pancreas is a smaller gland, which may be embedded in the liver, strung out along the intestine or scattered.

After having been digested in the stomach, food enters the intestine in a liquid condition and is assimilated, or absorbed, by the intestinal wall and passed on to the blood via the complex of vessels in the wall. The length of the intestine is correlated with the nature of the fish's food. In species that feed almost exclusively on other fishes, the intestine may be looped slightly or may run almost straight from stomach to vent (anus). In species that eat large amounts of vegetable matter, not so easily digested and assimilated as animal matter, the intestine is long and variously coiled to fit a great amount of absorptive surface into limited space. The stone roller (*Campostoma anomalum*), a North American minnow, is unique in having the intestine wound around the air bladder (*see* below). At its termination the intestine may enlarge somewhat, becoming the large intestine, and proceeds straight to the vent. This enlarged part is the large intestine, its principal function in most bony fishes being to carry off undigested food material.

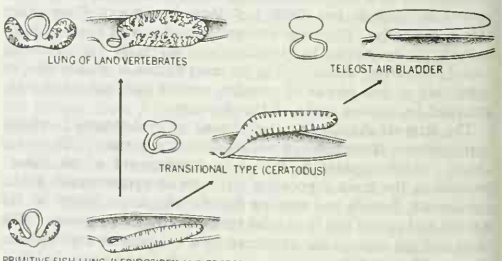
In sharks, rays and some bony fishes, the intestine has a spiral valve, which is built so that the nutritive products travel round and round as if down a winding stairway. The spiral valve of sharks has the same function of increasing absorptive surface as the variously lengthened small intestine of other fishes; a short tube, which extends between the spiral valve and vent, allows for the passage of undigested food material. In some fishes the waste products from the kidney may also empty into this section. But in most bony fishes the kidney ducts open to the outside just behind the vent.

4. Circulatory System.—The blood stream carries raw materials (food), and the oxygen to burn them, to the various parts of the body. It also transports hormones and various salts within the body and takes toxic wastes to the kidneys where they can be removed from the body. The pump that controls the flow of blood is the heart. A fish's heart is situated anteriorly, immediately behind and below the gills, in the pericardial cavity, which is separate from the main body cavity behind it. The fish heart is a folded tube with three or four enlargements. Venous blood, collected from veins throughout the body, flows into (1) a sinus venosus, passes to (2) the auricle and then enters (3) the thick-walled, muscular ventricle. The rhythmical contraction of the ventricle drives the blood into a bulb at the base of the main artery, which latter carries the blood to the gills. One-way valves ensure that blood does not flow backward. In the gills the blood picks up oxygen as it passes through small capillaries and then empties into a main lengthwise artery above the body cavity and below the vertebral column, whence branches distribute the oxygenated blood to capillaries in all parts of the body. Deoxygenated blood, containing waste products, then travels back to the heart via the veins.

5. Respiratory Organs and the Air Bladder.—Most fishes breathe by extracting oxygen dissolved in water by means of gills; these kinds of fishes cannot survive out of water. But some fishes, which normally breathe by gills when in the water, are able to survive for varying periods of time out of water. Eels, for example, which may wriggle onto marshy patches of grass, can absorb through the moist skin considerable amounts of oxygen from the air. Lungfishes, when they venture out of water, are able to breathe by absorbing oxygen trapped in the air bladder.

The air bladder (or swim bladder), an expandable thin-walled sac lying dorsal to the intestine, is an organ unique to the bony fishes. In most fishes it is filled with a mixture of gases. It has various functions, the primary one in most fishes being that of a hydrostatic organ, to accommodate the animal to varying pressure at different depths of water. A fish can control its depth in the water by adjusting the amount of air in its air bladder in much the same way a submarine varies its depth by adjusting its ballast.

A study of the embryological development of the air bladder shows that it arises from the gullet, much as the lungs of higher vertebrates do. (The lunglike function of the gullet is still evident in those fishes that can supplement their oxygen supply with air taken into the gullet. For example, goldfish do this when they gulp air at the surface of their bowl, when the oxygen in the water is exhausted.) In a few fishes in which the inner walls of the air bladder are richly supplied with blood vessels, this structure normally acts as a secondary organ of respiration. Whereas lungs



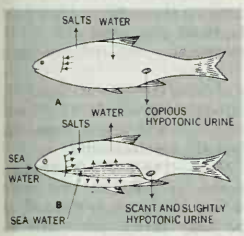
FROM A. S. ROMER, "THE VERTEBRATE STORY," UNIVERSITY OF CHICAGO PRESS, 1959

FIG. 11.—EVOLUTION OF LUNGS AND SWIM BLADDER. IN EACH EXAMPLE THE FIGURE TO THE LEFT IS A CROSS SECTION THROUGH THE GUT AND THE SACLIKE OUTGROWTH; THE FIGURE TO THE RIGHT, A LONGITUDINAL SECTION

might be said not to have evolved from an air bladder, both lungs and air bladder presumably arose from a simple pouch of the gullet, a pouch that originally had a respiratory function.

The probabilities are that the air bladder arose in fishes inhabiting fresh water, for such an organ was advantageous in supplementing the fishes' supply of oxygen. (Compared to the sea, fresh water is often lower in oxygen content.) Sharks have no air bladder, but one is generally present in the diverse groups of marine as well as fresh-water bony fishes, thus strengthening the hypothesis that modern bony fishes evolved from fresh-water forms of the past. In one direction these early forms would have given rise to the majority of fish species of today, both fresh-water and marine, in the other to long-breathing amphibia, and through them to the higher vertebrates, reptiles, birds and mammals.

6. Excretory System and Osmoregulation.—Fishes, like other animals, must eliminate accumulated liquid wastes (the elimination of solid wastes has already been treated above). In cyclostomes and cartilaginous fishes the kidneys consist of two elongated masses of tissue lying dorsally in the body—within the coelom in cyclostomes, and outside the coelom in cartilaginous fishes. A tubular urinary duct (ureter) passes from each kidney, collecting urine from a series of more or less segmental and tortuous tubules, to the cloaca (a common reservoir for urine, sex cells and solid wastes) and thence to the exterior.



FROM M. FLORKIN AND S. MORGULIS, "BIOCHEMICAL EVOLUTION," 1949. AFTER BALDWIN

FIG. 12.—OSMOREGULATION IN BONY FISH: (A) FRESH-WATER COMPARED WITH (B) MARINE SPECIES (*see* TEXT)

Bony fishes also have the two elongate kidneys lying dorsally within the coelom, above the air bladder and below the backbone. Urine is collected in the ureters (one from each kidney) passing to the urinary sinus, thence to the exterior via the urogenital aperture, there being no cloaca.

Life in a watery medium poses certain problems of osmoregulation (balancing the osmotic pressure of blood and tissues against that of the surrounding water) (*see* OSMOSIS). In great part osmotic pressure depends on salt concentration. With regard to salt balance between a fish and the exterior water, a fish is said to be: (1) hypotonic (lower osmotic pressure), less salty than the surrounding water (marine bony fishes); (2) isotonic (balanced osmotic pressure), having the same salt concentration as the water (marine cyclostomes and cartilaginous fishes); or (3) hypertonic (higher osmotic pressure), more salty than the water (fresh-water bony fishes).

Water tends to move from an area of higher concentration of salt to one of lower concentration. If this movement of water were not regulated, fresh-water bony fishes would tend to swell and burst, and marine bony fishes to dehydrate and shrink.

In fresh-water bony fishes the kidneys serve as osmoregulators, removing nitrogenous liquid wastes and large amounts of water from the body, and resorbing salts and other physiologically important substances in the process (small quantities of salt are also absorbed through the gills).

Marine bony fishes have an osmoregulatory problem the reverse of that found in fresh-water species: they must keep water in the body and remove excess salts. Sea water is freely taken into the body by absorption through the skin and by ingestion through the mouth; excess salt is probably removed by cells present in the gills.

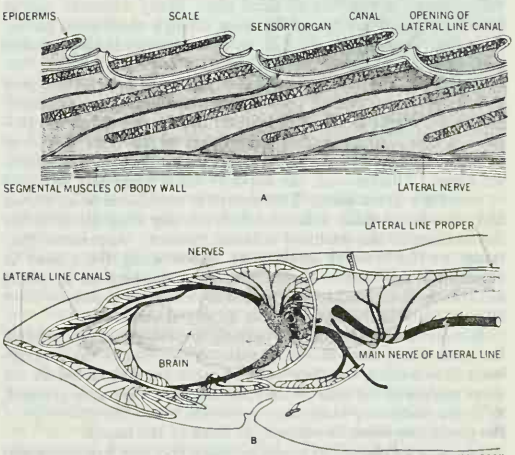
7. Nervous and Endocrine Systems.—*Nervous System.*—All fishes possess the essential features of the vertebrate nervous system: an anterior brain, a spinal cord and cranial and spinal nerves. The system, however, is relatively small and much less developed than in higher vertebrates. And great changes in the size and complexity of different portions of the brain and spinal cord may be seen in the progression from cyclostomes to cartilaginous fishes to bony fishes. (*See* also BRAIN; NERVOUS SYSTEM.)

Endocrine System.—So far as is known the endocrine system of fishes approximates that of mammals. Although there is some difference in the names of the hormone-producing endocrine glands, the functions are similar. The thyroid controls body growth and basal metabolism. The interrenal (adrenal cortex of mammals) controls water, salt and associated metabolism. The gonads control gamete maturation and secondary sex characteristics. The pituitary controls the activity of all the other endocrine glands; and directly controls water, protein and carbohydrate metabolism as well as growth and coloration. The ultimobranchial bodies, in the vicinity of the last pair of gills, appear to control calcium metabolism and are therefore comparable to the mammalian parathyroids. The chromaffin tissue (adrenal medulla of mammals) controls blood pressure and coloration. Although the general pattern of endocrine activity in fishes is the same as it is in mammals, malfunction of any particular endocrine gland has less drastic effects, which may indicate that fish metabolism is less delicately balanced.

8. Sensory Organs.—*Sight.*—In many bony fishes the eye has a large, spherical lens of relatively fixed focus (not flattened and capable of accommodation as in many land animals), features that suggest that these fishes are nearsighted. Generalizations cannot be made, however, since the eyes vary greatly among different groups of fishes. Some fishes certainly have colour vision, and there is no good reason to suppose that fishes in general do not. From experiments on bass it appears that red and yellow are most readily perceived, but that green, blue and black are not distinguished each from the other.

A fish's vision is doubtless somewhat more restricted than a man's in various ways. The deflection of light at the surface of the water doubtless hinders fishes seeing objects out of water, in varying degrees with light conditions. The archerfish (*Toxotes*), however, sees insects on overhanging vegetation sufficiently clearly to knock them off with jets of water squirted from its mouth; a speeding dolphin sometimes follows the course of a flying fish in the air, to seize it when it drops back into the sea; and the behaviour of trout in a stream leads one to suppose that they can see a man on the bank when he is close enough to see the fish. Many free-swimming predaceous fishes, like the mackerels and bluefish that strike at a glittering metal lure and the trout that rises to an artificial fly, are presumably largely dependent on sight. Fishes with weaker vision rely more on the other senses.

Lateral Line System.—One system unique to fishes and aquatic larval amphibians, associated with the cranial nerves, is the lateral line system. Its function, though still uncertain, seems to be con-



FROM (A) T. I. STORER AND R. L. USINGER, "GENERAL ZOOLOGY," 1957. MCGRAW-HILL BOOK COMPANY. USED BY PERMISSION. (B) A. S. ROMER, "THE VERTEBRATE BODY," 2ND ED., 1955; REPRODUCED BY PERMISSION OF W. B. SAUNDERS CO.

FIG. 13.—LATERAL LINE SENSORY SYSTEM OF (A) CARP; (B) SHARK. (A) A LONGITUDINAL SECTION THROUGH THE BODY WALL IS MUCH ENLARGED; (B) A PERSPECTIVE VIEW OF THE LEFT SIDE OF THE HEAD IS REDUCED

cerned with the detection of changes in pressure (see *Hearing*, below) and perhaps with the initiation of movement. It consists of the lateral line organs, which may be randomly distributed in the skin, but more often are arranged along canals or grooves on either side of the head and body. The lateral line in the strictest sense is the main element of the system; it connects the widespread smaller canals and the groups of pressure-sensitive cells called pit organs.

Hearing.—As every fisherman knows, fish hear—not, however, with the typical auditory apparatus that is found in mammals. It is logical to assume that since many fishes are vocal (see *Sound Production*, above), and some particularly so during the breeding season, these same fishes also have the ability to detect sound.

It is thought that a fish cannot readily perceive sound waves in the air, but their behaviour in water indicates that fishes are very sensitive to disturbances set up in the water. The slap of an oar on the water's surface or the roar of a motorboat can quickly disperse the wary fish.

The mechanism of hearing in fishes is not outwardly indicated by a sound-collecting organ like the outer ear in mammals. An inner ear is present, however; it plays a large role in maintaining equilibrium, but certain areas are suspected of performing an auditory function as well. Certain kinds of fishes are thought also to hear by means of the conduction of sound waves through bone; these vibrations may influence the auditory mechanism of the inner ear.

An object, such as a fish, that moves through the water sets up a pressure wave that would reflect from any solid object in the background. A pressure-sensitive structure such as the lateral line could pick up these reflected pressure waves and ascertain the location of the solid object. Specially produced pressure waves (sound) would improve the object-locating mechanism. It would be only a minor modification to have sound production an inherent function of a schooling fish so that the production and reception of sound waves becomes a method of keeping the school intact, particularly when light is weak. Further modification of this system would result in the use of sound in recognizing other individuals. This might include signals against trespassers, as may occur in toadfishes, and even mate recognition, as occurs in gobies, minnows and killifishes.

Smell and Taste.—These two simpler senses are responses to chemical stimulation, which either repels or attracts the fish. Fishes have well-developed senses of smell located in the nasal epithelium. Primitive species have the sense organs, olfactory cells, located at the base of blind pits. Many advanced species have the pit modified into a tube or sac through which water passes. As in most animals, the sense of smell varies considerably. Odour perception is well developed in fishes that have poor sight. Catfishes, sharks and many other fishes appear to locate their prey and to distinguish various possible food organisms in this manner. Odour also serves as an alarm system; that is, an injured fish produces a chemical that causes other fishes of the same species to swim about excitedly. This appears to be best developed in schooling fishes. Furthermore, the sense of smell apparently is useful in locating a given area. This aspect is most notable in salmon and other anadromous fishes in which the migrating fish probably can distinguish the smells of different streams. Apparently they return to the breeding grounds by remembering the odours to which they were exposed when they went downstream as young fish. It is also possible that fish may recognize mates by their odours, but this has not yet been clearly documented.

The organs of taste, the taste buds, are elongated pits sunk in the epithelium; they consist of many cells. Unlike the arrangement in mammals, the taste buds of fishes are distributed on the outer surface of the body; widely, as in some catfishes, or grouped, as in the sturgeons, where they are restricted to the underside of the projecting snout or rostrum, in front of the mouth.

Touch and Pain.—The senses of touch and pain are ubiquitous throughout the animal kingdom. Several kinds of fishes (catfishes, sturgeons, goatfishes, cods) have special tactile organs, long, fleshy feelers or barbels, similar to the whiskers of a cat or a dog, that enable these fishes to explore their environment.

Although it is certain that fishes have nerve endings that act as pain receptors, these structures are not so well developed nor so abundant as they are in land animals. A fish probably does not feel pain to the degree that man does; but it is perhaps begging the point to say that it simply feels varying degrees of discomfort.

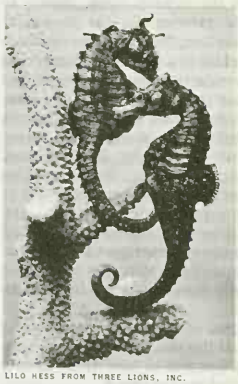
9. Electric Organs.—Organs capable of producing electricity are found in several different kinds of fishes; *e.g.*, certain rays (*Torpedo*), the electric "eel" (*Electrophorus*, which despite its common name is not a true eel) and the electric catfish (*Malapterurus*). These fishes are capable of giving a considerable electric shock to any animal that touches them. In some other rays and higher bony fishes a weaker electric charge is produced.

These organs consist of closely grouped cells or multinucleated flattened plates that are probably derived from striated muscle cells. Their arrangement and appearance vary greatly in the different electric fishes, but they are sometimes piled like the metal plates of a voltaic battery. The value of such organs to these fishes is in discouraging predators and immobilizing prey. *See* also MUSCLE AND MUSCULAR SYSTEM: *Microscopic Structure and Function: Sarcolemma and Muscle Excitation;* ELECTRIC EEL.

VI. REPRODUCTION AND DEVELOPMENT

All fishes (except the live-bearers, which produce but few young at a time) are very prolific, producing large numbers of sex cells (eggs and sperms). This is an adaptation associated with life in a very rigorous environment where mortality, especially of eggs, is very high.

1. Sexes.—In the great majority of fishes the sexes are separate, but among many groups hermaphroditic individuals have been reported in addition to the distinctly male and female members. Hagfishes and some sea basses are typically hermaphroditic.



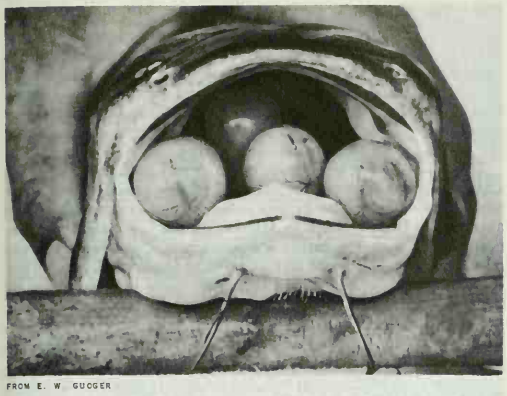
LILO HESS FROM THREE LIONS, INC.

FIG. 14.—FEMALE SEA HORSE (AT RIGHT) APPROACHING MALE WHO WILL RECEIVE, FERTILIZE AND INCUBATE HER EGGS IN A POUCH AT THE BASE OF HIS TAIL

Male.—The male fish produces sperm (or milt) in two more or less united testes situated in the body cavity, posteriorly in the bony fishes and anteriorly in the cartilaginous fishes. From the testes a sperm duct passes to the urogenital aperture, an opening behind the vent (in bony fishes), or to the cloaca (in cyclostomes and cartilaginous fishes). Accessory organs, modified portions of certain fins, are used to transfer milt in most of those fishes that fertilize eggs internally. Examples of these organs are the claspers of sharks and rays (parts of the pelvic fins) and the gonopodia of guppies and swordtails (parts of the anal fins).

Female.—In the females of most bony fishes (oviparous forms) eggs pass from two united ovaries through the oviducts and uterus (if developed) to the urogenital aperture and thence to the outside water. Among some cartilaginous fishes and certain bony fishes the ripe eggs are held inside the body, fertilization taking place internally; in these (viviparous) forms the developing embryos are nourished within the uterus and are eventually born alive.

2. Mating and Parental Care.—Most bony fishes reproduce themselves by means of small (often less than one-eighth inch), usually spherical eggs that are laid and fertilized in the water and then left to develop. Among these fishes reproduction is effected simply: the males and females come close together and extrude their sex cells into the water. Some bony fishes take part in courtship and nest-building activities before mating; examples are the sticklebacks and the bowfin, in which a nest of sorts is formed by the male to receive the egg-swollen female, which latter is often attracted by the male's graceful movements. In the sea horses and pipefishes, which have internal fertilization,



FROM E. W. GUDGER

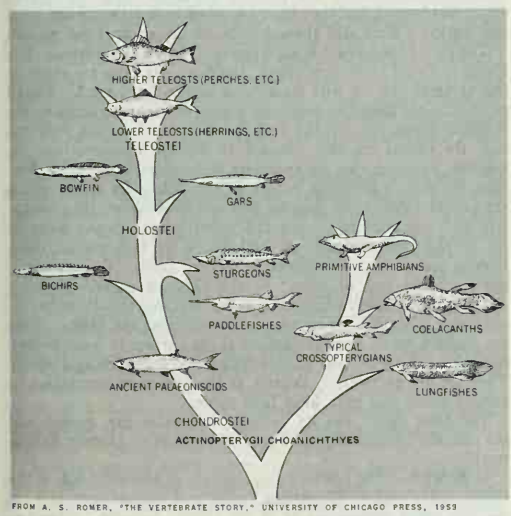
FIG. 15.—INCUBATION OF FERTILIZED EGGS IN THE MOUTH OF THE MALE GAFFTOPSAIL CATFISH (BAGRE MARINUS)

a reversal of the usual mating procedure occurs: the female deposits the eggs, by means of an intromittent organ, into a broad pouch of the male. In certain catfishes and cichlids the males incubate the fertilized eggs in their mouths. The female gouramis blow bubble nests around their eggs, which then float to the water's surface where they are more secure from predators. Despite these examples, courtship and "parental concern" for eggs and young are not common among the majority of fishes.

3. Development.—The embryological development of fishes is essentially the same as that of any other vertebrate having a moderate amount of yolk in the egg. *See* VERTEBRATE EMBRYOLOGY for a detailed discussion of this subject. (C. HU.)

VII. SURVEY OF THE BONY FISHES

The following discussion deals with the major groups of bony fishes in the approximate order of their supposed degree of specialization, from the most primitive forms to the most advanced. The class of bony fishes (Osteichthyes) may be divided into two major subclasses: Choanichthyes, the fleshy-finned fishes; and Actinopterygii, the ray-finned fishes.



FROM A. S. ROMER, "THE VERTEBRATE STORY," UNIVERSITY OF CHICAGO PRESS, 1959

FIG. 16.—SIMPLIFIED FAMILY TREE OF THE BONY FISHES (CLASS OSTEICHTHYES), SHOWING THEIR RELATIONS TO EACH OTHER AND TO THE AMPHIBIANS

A. FLESHY-FINNED FISHES

The Choanichthyes, having fleshy-lobed fins and internal nostrils, include aberrant living members—coelacanths and lungfishes—as well as extinct forms that probably gave rise to the primitive amphibians. For convenience this subclass is divided into two superorders: Crossopterygii (coelacanths and extinct relatives) and Dipnoi (lungfishes).

1. Coelacanth.—It was in the Carboniferous period, in the latter part of the Palaeozoic era, that one of the first families of bony fishes of which there is a living representative appears. This family, Coelacanthidae (superorder Crossopterygii), is known from fossils all through the ensuing Mesozoic era, and was thought to have become extinct about 60,000,000 years ago. It was indeed astounding, therefore, when, in 1938, a trawler caught a living coelacanth in 40 fathoms of water off the South African coast. The specimen was a large-mouthed, ugly-looking fish, five feet long and weighing more than 100 lb. It was named *Latimeria chalumnae*. *Latimeria* has hard scales, most of its fins elevated with fleshy bases and a peculiar tail fin with a projection in the centre. Such a tail was characteristic of its probably numerous and varied relatives that lived in the Jurassic period. (*See* COELACANTH.)

2. Lungfishes.—Another archaic living fish, previously known only from fossils, is the Australian lungfish (*Neoceratodus*, or *Epiceratodus, forsteri*). This fresh-water species, found in Queensland in 1871, is very like members of its family (the genus *Ceratodus*) that lived in the Triassic and Jurassic periods of the Mesozoic era, beginning about 200,000,000 years ago. The fossil record shows lungfishes, as a group, to be among the most ancient bony fishes. There are also two other genera that survive today, the South American (*Lepidosiren*) and African (*Protopterus*) lungfishes. The three genera of living lungfishes, widely separated in different parts of the world, are relics of a distant past when their tribe was more numerous and more generally distributed; they are spoken of as relict forms.

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

FIG. 17.—YOUNG AFRICAN LUNGFISH (PROTOPTERUS ANNECTANS), ABOUT 3 IN. LONG, WITH LARVAL GILL FILAMENTS ABOVE THE PECTORAL FINS

Neoceratodus is a large, sluggish fish, said to reach a length of more than five feet. It has a rather elongate body, pointed in front and behind, compressed from side to side and covered with large, overlapping scales. Its paired fins are placed low, the pectorals near the head, the pelvics near the tail; they have the form of paddles with fleshy bases. Otherwise there is only a pointed tail fin. This fish has a small mouth and feeds on crustaceans, worms and other small animals dwelling among the abundant water plants of more or less stagnant pools. Its air bladder, which opens into the gullet by a duct, extends back the whole length of the body cavity. From time to time *Neoceratodus* comes to the surface and renews the air in its air bladder, supplementing the oxygen obtained through the gills. In the hot, dry season when the oxygen content of the water of the shrunken pools is depleted by decomposing plant or animal matter, *Neoceratodus* uses its air bladder almost exclusively.

South American and African lungfishes superficially resemble the Australian, except that they have fine, inconspicuous scales and very narrow, filamentous paired fins. The South American lungfish (*Lepidosiren*) is more elongate and eellike than the other lungfishes. The African lungfish (*Protopterus*) has been much studied. It is a voracious predatory fish, feeding indiscriminately on any aquatic animals small enough to be handled. A favourite

habitat for it is floodwater swamps and marshes. It is said to rise to the surface for air as the Australian lungfish does. When the swamps dry up seasonally, it burrows into the mud, curls up with its nose toward the surface and lies dormant, breathing air into its lungs by a small aperture through the caked mud and subsisting on its accumulated fat and other tissues until the water accumulates again. Lungfishes thus encapsuled in the hardened mud are frequently dug up and shipped dry to distant parts of the world without injury; they can then be revived by submergence in water.

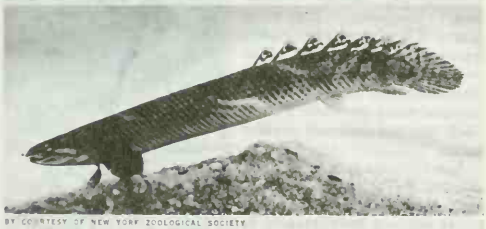
The air bladder of *Protopterus* consists of an anterior unpaired part and two long, tapering lobes that extend backward for the length of the body cavity, having a more complicated structure and being more lunglike than the air bladder of *Neoceratodus*. Although this fish somewhat parallels the Amphibia in passing through a larval tadpole stage (wherein it breathes with plumelike external gills in the manner of various larval salamanders), amphibians are presumably not directly descended from lungfishes but rather from an earlier extinct but related fleshy-finned fish. *See* also LUNGFISH.

B. Ray-Finned Fishes

The Actinopterygii, the more advanced of the two subclasses of Osteichthyes, comprise the great majority of the bony fishes living today. The distinguishing characteristics of this subclass are the lack of typical internal nostrils and the presence of rayed fins. The fins are composed of webs of skin supported by fin rays, which are soft and flexible in some forms and spinous in others.

For convenience the subclass is divided into three superorders: the primitive ray fins are (1) Chondrostei, the bichirs, sturgeons, paddlefishes and extinct palaeoniscids, and (2) Holostei, the gars and the bowfin; the advanced ray fins are (3) Teleostei, the fishes dominant in the world today.

1. Bichirs.—In tropical African fresh waters are fishes of an ancient type belonging to a family (Polypteridae) so far unknown in the fossil record. The head is covered with hard plates; the



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

FIG. 18.—BICHIR OR LOBEFIN (POLYPTERUS RETROPINNIS), OF TROPICAL WEST AFRICAN FRESH WATERS

body with rhombic, thickly enameled (ganoid) scales. Other characteristics include: broad, rounded pectoral fins behind the head; pelvic fins placed far back; a series of finlets, each with an initial spine, along the back; and a rounded tail fin. *Polypterus bichir* is said to reach four feet and to be mainly predaceous, feeding on smaller fishes. The air bladder of *Polypterus* is used in respiration, supplementing the gills, rather than as a hydrostatic organ, and its young have plumelike external gills. A second genus, *Erpetoichthys* (or *Calamoichthys*), resembles *Polypterus* but is more elongate and eellike. These two genera form the family, which is included in the order Polypteriformes (or Cladista).

2. Sturgeons and Paddlefishes.—Other living representatives of ancient types of fishes are the sturgeons (Acipenseridae) and the related paddlefishes (Polyodontidae), belonging to the order Acipenseriformes.

Sturgeons are among the largest fresh-water fishes. Some of the sturgeons, however, descend to and get their growth in the sea. Species that enter American Atlantic and Pacific rivers from the sea were recorded to lengths of 18 ft. and more than 12 ft. respectively, and a Russian species is said to reach 30 ft. It is not unusual for exclusively fresh-water forms to reach more than six feet. The sturgeon has a long snout, with tactile barbels before the mouth; a longitudinal series of bony plates, with nodules between them, instead of scales; fins without spines, the pectoral fins being behind the head, the pelvics far back; a small dorsal fin; an anal below the dorsal, near the tail; and the vertebral column bent upward to form the long upper lobe of the tail fin (heterocercal tail). Thus, in several repects, notably in the shape of the tail fin, sturgeons resemble modern sharks.

The family Acipenseridae is not of great antiquity; it is not known to have occurred before the Tertiary period (when more modern fishes were also present), but extinct sturgeonlike fishes ancestral to them go back to Middle Mesozoic, apparently a connecting link with the earlier Palaeoniscidae. Sturgeons are the most generally distributed archaic types of fishes still living. They are excellent food fishes, and their roe, made into caviar, is an item of commercial importance.

The North American paddlefish (*Polyodon spathula*), belonging to the family Polyodontidae, is one of the strangest large fishes living. It has the general contours of a sturgeon, with a similar unsymmetrical heterocercal tail, but its skin is smooth and naked, lacking scales, plates or nodules. It has a large mouth and two very small eyes at the base of a very long, flat, paddle-shaped snout (about half as long as the rest of the head and body). The paddlefish inhabits sluggish waters of the lower Mississippi valley. It grows to be more than four feet long (rarely more than six feet) and weighs between 100 and 200 lb. It has been reduced in numbers by commercial fishing, for its roe, like that of the sturgeon, is sought for caviar.

Polyodon feeds largely on minute free-floating animals (plankton), which are taken into its large mouth and strained through exceptionally long, fine gill rakers; but this is not its only method of feeding, for it will sometimes take a baited hook. The paddle, which is richly supplied with sense organs, doubtless helps in locating food.

Besides the American paddlefish, one similar species, *Psephurus gladius*, is found in the rivers of China, where it grows to a larger size, sometimes 20 ft. or more.

These two species are generally considered relicts from an age when their family had a more general distribution; though fossil evidence is scant the family goes no further back than the Cretaceous.

3. Gars.—There is no known fossil record of the gar family (Lepisosteidae) before the Eocene, when they were more generally distributed, but they have persisted with little change from that period. They still abound in North American fresh waters.

The gar (*Lepisosteus*) is an elongate, cylindrical predaceous fish found in rivers of eastern North America. Its jaws are more or less elongate and set with formidable needle-sharp teeth. Paired pelvic fins are placed at about the centre of its lower surface; the rounded dorsal fin, and the anal below it, are far back near the tail; the caudal fin, also rounded, is slightly unsymmetrical externally, evidence that its ancestors had heterocercal tails. Perhaps the most interesting feature of this fish is its scales, which are ganoid, thick, hard, rhombic and nonoverlapping; they articulate with one another by peg-and-socket joints. Scales more or less of this type evidently evolved before the thin, elastic, overlapping scales that are common in modern fishes. On large individuals (nine feet or more) of the alligator gar (*Lepisosteus spatula*), of the lower Mississippi valley, it is said that these heavy, enameled, platelike scales may even withstand axe blows. Gars are sluggish fishes, lying motionless at the surface in quiet waters, but they can rush upon approaching prey with lightning speed. They are not particularly desired, as they are very destructive to smaller fishes and have little food value.

The term "gar" and its variants salt-water gar, garfish and gar pike are often loosely used for the needlefishes (family Belonidae).

4. Bowfin.—The bowfin (*Amia calva*), an abundant fish in the Great Lakes region, Mississippi valley and southeastern U.S., is the sole living representative of the family Amiidae (characterized among other things by a single, large bony plate at the throat), known from fossils far back to the Jurassic period of

Mesozoic time. It is, nevertheless, a very ordinary appearing fish, one to two feet in length, with normal, rather small scales, a large mouth, a long dorsal fin of flexible rays and rounded pectoral and caudal fins. Several unrelated, generalized modern fishes resemble it in superficial appearance. At first glance the bowfin would not be suspected of belonging to the archaic category; however, its caudal fin, being slightly more heterocercal than that of modern fishes, indicates its relict status. The bowfin is a strong, tough, voracious fish, feeding on any animals that come its way, mostly smaller fishes. It is exceedingly tenacious of life; it can breathe air via its air bladder and thus can live in foul water or, for some time, out of water.

5. Herrings, Trouts and Salmons, Pikes, etc.—The oldest and most primitive living order of the superorder Teleostei is presumably the Clupeiformes (or Isospondyli), to which the herring, trout and many other more or less related fishes belong. What seem to be true herrings occur as far back as the middle of the Mesozoic era (Lower Jurassic), and there were species of the herringlike bonefish (*Albula*), not unlike the bonefish of today, in the Eocene. There is also evidence that the Clupeiformes are ancestral to various other groups of more specialized fishes of today.

Herrings and Other Clupeids.—A typical herring (*Clupea*, family Clupeidae) is a compressed, streamlined, silvery fish, a few inches to a foot long, with large, thin, overlapping scales, modified along the ventral mid-line to form a sharp, serrated keel. It has no evident lateral line. It has a single, rather short, soft-rayed dorsal fin near the middle of the back, small paired pelvic fins near the middle of the ventral surface and a well-forked caudal fin. Although it has a large mouth, it feeds on small food; the teeth are small or lacking and the gill rakers long and numerous. All herrings swim in schools.

There are many variations within the Clupeidae. Different species are more or less elongate or deep-bodied, compressed or cylindrical and covered with larger or smaller scales. The keel along the lower mid-line may be strong or weak (lacking in the round herring family, Dussumieriidae). Clupeidae are of great commercial importance. The northern sea herring (*Clupea harengus* in the Atlantic, and *Clupea pallasii* in the Pacific), because of their great abundance, are the basis for perhaps the most important of commercial fisheries.

Several species of temperate North Atlantic clupeids are anadromous, that is, run up rivers into fresh water to deposit their spawn. Of these the North American shad (*Alosa sapidissima*) reaches an unusually large size for this family, weighing between two and six pounds, and is particularly prized for the table. The shad lends itself to fish culture; its eggs have long been hatched artificially and the fry liberated into favourable waters. It was successfully introduced into rivers of the U.S. Pacific coast, where it was not native; here, however, it meets with less favour than in the eastern U.S. There are comparable species (*Hilsa*) that enter the rivers of China.

The menhadens (*Brevoortia*), marine clupeids of warm and temperate waters of the western North Atlantic, reach a length of more than one foot. They carry the herring tendency to be plankton feeders to an extreme, subsisting largely on diatoms, minute drifting plants that are the basic food supply of the ocean. Menhadens become plentiful and get very fat on this lowly but abundant pasturage. They swim in dense schools, which are much preyed upon by predaceous fishes. Menhadens are taken commercially for the oil and fertilizer that can be processed from them.

The gizzard shads (*Dorosoma*), found in muddy, fresh, brackish and salt water, are another genus of clupeids. Their most obvious superficial difference from the rest of the family is in their possession of a small mouth, placed more or less below the snout. They are plankton strainers whose muscular stomachs appear to be adapted for eating items difficult to digest.

There are several allied, but more primitive, herringlike fishes. One is the heavy-scaled tarpon (*Tarpon atlanticus*), which grows to a large size, feeds on smaller fishes and is much sought by big game anglers. The elongate, predaceous ladyfish or ten-pounder (*Elops saurus*), in the same family (Elopidae) as the tarpon, is another; it has fine scales, a conspicuous lateral line and is cosmopolitan, though varying slightly (probably only racially) in different warm seas. Two other fine-scaled species, each representing a distinct family, belong in this category: the cylindrical bonefish or banana fish (*Albula vulpes*, family Albulidae), with a small mouth and somewhat piglike snout, which inhabits all tropical seas; and the milkfish (*Chanos chanos*, family Chanidae), a valued food fish, inhabiting warm waters of the Indo-Pacific ocean. Another primitive herringlike family, the mooneyes or toothed herrings (Hiodontidae), of North American fresh waters, is characterized by strong, sharp teeth.

Anchovies.—The anchovies are a family (Engraulidae) of smaller, more fragile fishes, particularly abundant along continental shores, and are closely related to the herring. They are easily recognized by the rounded or conical snout projecting beyond the very large mouth, and commonly have a silvery band along each side of the body. Although a warm-water family, the most important species occur in temperate seas, as *Engraulis encrasicholus* of the Mediterranean and *Engraulis ringens* of Peru. This last is excessively abundant in the cold, upwelling waters of the Humboldt current along that coast, and a principal food of the sea birds (which are the basis of the Peruvian guano industry) as well as of other aquatic animals. A genus (*Coilia*) of estuarine fishes belonging to the anchovy family, wherein the posterior portion of the body is lengthened and tapering and the anal fin very long and confluent with the small, pointed caudal fin, is abundant in fresh and coastal salt waters of the orient. This little fish is caught in vast numbers with special nets in Tung-T'ing Hu, China, and dried in the sun for food.

Trouts, Salmons and Allies.—Contrasted with herrings, trouts and salmons are predaceous in habit, and, as a rule, have strong teeth to seize and hold their prey. There is little difference between a trout and a salmon. They belong to a northern, cold-water family (Salmonidae) extending into the arctic regions. Those species that are regularly anadromous, getting their growth in the sea and returning to fresh water to spawn, and that reach the largest size are generally known as salmon. In temperate latitudes the great majority of trouts spend their entire lives in fresh water; but, wherever found in the lower courses of the streams, they enter salt water to some extent, and in the far north they run in and out of fresh and salt water rather indiscriminately.

A trout is a somewhat elongate, symmetrical fish with a large mouth and strong teeth. Its body is covered with small, smooth scales, often so fine as to escape notice. Its fins are entirely of soft rays (without spines): the pelvic fins are near the centre of the lower mid-line; a short dorsal fin is near the middle of the back; and the tail fin is broad and squarish to more or less forked. In the mid-line of the back, in the tail region well behind the dorsal fin, there is a small flap without rays, known as the adipose fin, of uncertain function. (Such an adipose fin is a peculiar superficial characteristic of several primitive groups of fishes.)

Salmonids fall naturally into two main divisions, the black-spotted trouts (including the salmons) and the chars. These two groups differ in the shape of the central bone in the roof of the mouth (vomer) and in the arrangement of teeth on that bone: the vomer is straight, with teeth present its entire length (deciduous in the Atlantic salmon), in the black-spotted trouts; boat-shaped, with teeth only on the raised front end, in the chars. The superficial characteristic of colour will differentiate these groups more readily. The black-spotted trouts have few to many small black spots on the body and fins; the chars have either red, blue or pale spots, but no black ones. Both the Atlantic salmon and Pacific salmons belong to the black-spotted trouts, which, except as represented by the sea-run Atlantic salmon or its landlocked races, or as planted artificially, are absent from eastern North America but occur native from the eastern slope of the Rocky mountains westward. The European black-spotted trouts and the Atlantic salmon belong to the genus *Salmo*. The trouts of western America are referred to that genus also, but Pacific salmons which have a slightly longer anal fin and a different life history—they spawn once and then die—are usually separated as a distinct genus, *Oncorhynchus*. Although the evidence is not certain, western trout

may actually be more closely related to the Pacific salmon (*Oncorhynchus*) than to the black-spotted trouts of Europe and to the Atlantic salmon (*Salmo*).

In the mountainous region of western North America there are many varieties of black-spotted trouts (*Salmo*) that tend to merge except where isolated by physiographic barriers. Those inhabiting fast-flowing water at high altitudes have fine scales and brighter colours, and there is a Rocky mountain series differing from that of the Sierras and coast ranges. There are also strains of coast range trouts, or rainbow trouts, that run to sea, reach a large size and are then known as steelhead salmon or sea-run trout, though they are no more related than other *Salmo* to the true Pacific salmons (*Oncorhynchus*), of which there are five well-marked species.

The chars (*Salvelinus*) are a circumpolar group abounding in the far north and occurring southward in cold hill streams or isolated lakes, where they were apparently left by the retreats of glaciers in earlier times. They, as well as the eastern American black-spotted trouts (referred to *Salvelinus* also), are represented by many local varieties, which merge into one another, and by few distinct species. One North American char is the eastern brook trout (*Salvelinus fontinalis*). Silvery, sea-run *Salvelinus* are difficult to differentiate from sea-run individuals of other species.

The lake trout (*Salvelinus namaycush*) of northern North America, is a large, distinctive char. The vomer is boat-shaped with teeth in front and also a ridge or crest of teeth extending back in the centre. The body is dark above, usually profusely spotted with pale colours. This fish has a large mouth and strong teeth. Generally common northward and in temperate latitudes, it inhabits the cool depths of deep lakes.

Closely related to and sometimes included in the Salmonidae are the grayling family (Thymallidae) and the whitefish family (Coregonidae).

Several species of graylings (*Thymallus*) are found in arctic and northern fresh waters and extend more or less southward in the mountains. The grayling differs from the closely related trouts and salmons in having a smaller mouth, weaker teeth, less fine scales and an expanded dorsal fin, which is high, broad and brightly coloured.

The whitefishes differ from the trouts and salmons in having a smaller mouth, weaker teeth, slightly larger scales and in being plain coloured, usually whitish on the sides and darker along the back. They are found in fresh water, primarily in lakes, except in the far north where they sometimes enter the Arctic ocean or its tributary bays. All are good food fishes, particularly the lake whitefishes (*Coregonus*), with deep, compressed bodies, weighing up to 20 lb. or more. The round whitefishes (*Prosopium*) are chiefly river fishes. Smaller, schooling coregonids called "lake herrings" (*Leucichthys*) are herringlike in superficial structure and in habits, but have the adipose fin characteristic of trouts and whitefishes. A large, predaceous, pikelike coregonid known as the inconnu, sheefish or coney (*Stenodus mackenzii*), which reaches 15 lb. (occasionally 30 lb.), occurs in the larger rivers of far northwestern North America, from the Mackenzie to the Yukon rivers; a similar fish is found in Siberia. The inconnu has weak, bristlelike teeth in bands, evidence that it is a specialized whitefish, not a transition form between the whitefishes and the strong-toothed trouts.

Smelts.—The smelts are a family (Osmeridae) of small, active, carnivorous marine fishes allied to the trouts, which they resemble in general contours and fin arrangement. They are commonly 6 to 12 in. long, and are dark along the back, with silvery sides. They are an important item in the diet of larger fishes and are delicious food fishes. Smelts are abundant coastwise in northern and temperate seas. Some species, *e.g.*, the common smelt of eastern North America (*Osmerus mordax*), run into fresh water to spawn, and even become landlocked in inland lakes. Others are confined to considerable depths in the ocean. A fine-scaled arctic smelt known as the capelin swarms along the beaches where it deposits its eggs at spawning time.

Glassfishes.—In the orient are found small, elongate, fragile, translucent, troutlike fishes known as glassfishes (Salangidae). They occur in both fresh and salt water, and are represented by numerous species. In this family the body is scaleless or has fine deciduous scales; a small adipose fin is present; the dorsal fin is placed well behind the pelvics, which latter are near the middle of the body; the anal fin is rather long, still farther back; and the tail fin is forked. Glassfishes have large mouths and very variable dentition. Many have elongate heads and large canine teeth; they are predaceous fishes in miniature, being slender and usually less than six inches long. They are considered a delicacy by the Chinese.

Bony Tongues and Mormyrs.—Two important families of fresh-water fishes related to and sometimes included in the Clupeiformes, though quite unlike herring or trout, are the Osteoglossidae (bony tongues) and Mormyridae (mormyrs). The former has only five species: two in South America, one in Africa and two in northern Australia and the East Indies. Mormyridae, with many divergent species, is confined to Africa. In the Osteoglossidae the pelvic fins are placed well back; the dorsal and anal fins, with soft rays only, are variously long or of moderate length and not far removed from the caudal fin. The scales are large except in one of the South American bony tongues known as pirarucú, paiche or arapaima (*Arapaima gigas*). The pirarucú is one of the largest fresh-water fishes, reaching a length of 15 ft. or more and a weight of hundreds of pounds. It has a large mouth, small eyes, pelvic fins behind the middle of the body, a low dorsal fin, an anal fin and a small, rounded tail fin.

The Mormyridae are small-mouthed, slimy fishes with small often fine and inconspicuous scales. The fin rays are soft. The dorsal and anal fins are placed well back; the caudal fin is forked; the pelvic fins, well behind the pectorals, are about in the centre of the body. In *Mormyrus* the dorsal fin is long, occupying most of the back, and the anal fin short; in *Hyperopisus* the dorsal fin is short and the anal fin long. In other genera the dorsal and anal fins are approximately the same length. The brain is extremely large relative to the body, a proportion comparable to the brain-body size ratio in man. The outline of the head and position of the mouth vary greatly, even in related species, but tend toward a few contrasting types. In *Mormyrops* the front of the head is narrow and the mouth horizontal and terminal; in *Petrocephalus* the snout is short, bluntly rounded in profile, and the mouth is more or less beneath it. In *Gnathonemus* the lower jaw usually projects somewhat beyond the upper; in *G. petersii* it tapers into a thick, fleshy, forward directed barbel; in *G. rhyncophorus* and others the snout is narrow, elongate and curved downward to suggest the trunk of an elephant, with the little mouth at its tip. Such a trunklike snout finds its extreme development in *G. curvirostris* and *G. numenius* in which it is about four times as long as

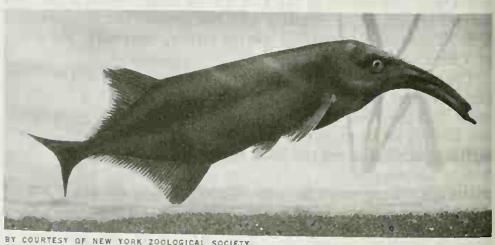


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FIG. 19.—LONG-SNOUTED MORMYR (GNATHONEMUS NUMENIUS), OF AFRICAN FRESH WATERS

the portion of the head behind the eyes. Muscles in the tail are often modified into electric organs.

Pikes, Mud Minnows and Blackfishes.—Two more families of fresh-water fishes typically referred to the Clupeiformes are the pikes (Esocidae) and mud minnows (Umbridae). Both are composed of only a few species living in North America and Eurasia. The typical pike (*Esox*) is a predaceous fresh-water fish. It has a long, streamlined body, covered with small, smooth scales, a long

head and a great mouth with projecting lower jaw and formidable teeth. The paired pectoral fins are placed low, under the hind margin of the head; pelvic fins are about midway along the body; rounded dorsal and anal fins, of about equal size and one above the other, are far back near the caudal, which is moderately forked. The few species of pikes, found across the northern continents, are very much alike. They are strictly fresh-water fishes of lakes and sluggish streams; they lurk along the edge of the water or near vegetation and rush upon and seize any hapless fish (or other animal in the water) that comes within range, not excepting smaller individuals of their own species.

The mud minnows—*Umbra*, of eastern North America and Austria and Hungary, and *Novumbra*, limited to certain streams near Seattle, Wash.—grow to four or five inches. Structurally, these fishes more closely resemble a fossil pike known from the Miocene than they do present-day pikes. These active, very hardy fishes are found in streams and stagnant pools with a bottom of deep mud into which they dive when alarmed.

The related Alaska blackfish (*Dallia pectoralis*) is a large-mouthed, hungry little fish so abundant in some of the fresh-water summer pools in Siberia and northern Alaska as to be an important food item with the natives, although it grows to only about eight inches.

Other Clupeiformes.—Several other less well-known fishes belong to the Clupeiformes. Among them are the members of the family Galaxiidae. These fresh-water fishes, which inhabit many southern streams and which superficially resemble trout, minnows, etc., have a high tolerance for salt water and have obviously recently evolved from marine ancestors. Other Clupeiformes live in the ocean depths where daylight fades into a perpetual abyssal darkness that is lighted only by gleams of phosphorescence produced by various animals. Among these fishes are the black, scaleless *Astronesthes*, predaceous fishes characterized by long fangs, an adipose fin, many fine luminous spots on the body and a long, fleshy barbel at the throat. The hatchet fishes *Argyropelecus* are a common group of deep-sea Clupeiformes that may come nearer the surface; they are small, deep-bodied, flat from side to side, bright silvery coloured and are thought to swim in schools.

6. Lizard Fishes, Lantern Fishes, etc.—The order Myctophiformes (Iniomi) comprises a number of marine fishes, often from the depths, that have descended from clupeiformous ancestors.

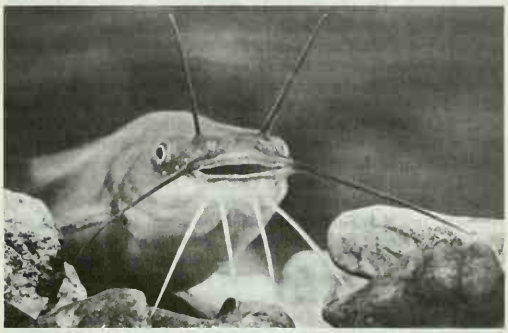
Lizard Fishes.—The lizard fish family (Synodontidae) is a group of fishes that are strictly marine, occurring along the shores of all tropical seas. They are troutlike superficially. The typical lizard fish has an adipose fin like a trout; pelvic fins more anterior in position, though well behind the pectorals; somewhat coarse scales; strong teeth; and a very large mouth that opens to well back of the eye. They are elongate fishes, about one foot long, and live in water of moderate depth along sandy shores. They frequently lie on the bottom, where their gray or reddish mottled colours render them inconspicuous. They are swift, predaceous and very destructive to smaller fishes. A member of the lizard fish family, *Harpodon nehereus*, is found along the shore and in the mouths of the rivers of India, where it is a prized food fish known as Bombay duck when salted and used as a relish. It has an enormous mouth, a small eye near the tip of the snout and large pelvic fins; it reaches a length of about 16 in.

Lantern Fishes.—The fragile, little lantern fishes (family Myctophidae) are very abundant in individuals and species in the open sea. A typical member has large eyes; a large mouth; a fin arrangement, including an adipose fin, much like that of a lizard fish or trout; a series of small, luminous spots, suggesting portholes, along the lower sides. Many usually have large, silvery scales that are easily detached. Most lantern fishes live deep down in the daytime and come to the surface at night; others are confined to the depths.

Other Myctophiformes.—Deep-sea fishes of this order include the lancet fishes (*Alepisaurus*), with long fanglike teeth; *Cetomimus*, with an enormous mouth; and *Ipnops*, which is eyeless but has the top of the head occupied by a pair of peculiar organs that may function as eyes, though more probably as luminous organs.

7. Catfishes, Characins, True Minnows, etc.—The order Cypriniformes (Ostariophysi) comprises several superficially unlike series of fishes—catfishes (suborder Silurodea), characins or tetras and minnows or carps (suborder Cyprinoidea)—the relationships of which are proved by their having a similarly complicated structure of earbones, which would hardly have evolved independently in these different groups. They were presumably derived in fresh water from clupeiformous ancestors, though direct evidence of this is lacking. Cypriniformes first appear in the fossil record of the Lower Tertiary, and were then already separated into these main series.

Catfishes.—The families of catfishes are very diverse. The typical catfish, of the North American family Ictaluridae, is scaleless and often has a broad head. It has fine teeth in bands; a more or less transverse mouth surrounded by several barbels; a strong spine in the front of both the dorsal and the pectoral fins; the ventral fins near the middle of the body; and a small adipose fin over the anal, which latter is of moderate length. Numerous species of catfishes occur in the fresh waters of North America, Asia,



JOHN H. GERARD

FIG. 20.—YELLOW BULLHEAD (ICTALURUS NATALIS), A FRESH-WATER CATFISH FOUND IN THE EASTERN UNITED STATES

Africa and South America, varying progressively more widely around this type in the respective continents in the order mentioned. In North America the most obvious difference between the various species is one of size. The Mississippi catfish (*Ictalurus furcatus*) may reach a length of five feet and a weight of about 150 lb.; on the other hand, the tadpole catfish (*Schibeodes gyrinus*) is only about four inches long. The latter is one of several small, related, bottom species that have poison glands at the base of the pectoral spines, a prick from which is like the sting of a bee but more severe.

In Asia, and particularly in Africa, there are catfishes without an adipose fin, but with a long soft-rayed dorsal fin occupying most of the back and an only relatively shorter anal fin below it (*Clarias*). Others have a small weak-spined dorsal fin placed well forward and a long anal fin. *Parasilurus*, which is abundant in Asia, and *Schilbe*, which occurs in Africa, have no adipose fin; *Eutropius*, which is abundant in Africa, has a small adipose. In Africa some catfishes have a broad suckerlike mouth on the lower side of the head, with which they cling to and presumably scrape the moss off rocks (*Euchilichthys*). The African electric catfish (*Malapterurus electricus*), which has a thick, soft skin, an adipose fin, no dorsal fin and no spines, is capable of giving a severe shock.

In South America the catfishes reach their maximum expansion; in addition to the standard forms superficially similar to those occurring in the other continents, there are many others very unlike them. Catfishes were presumably among the few modern fresh-water fishes that reached South America prior to its long isolation from the other continents by sea during the Tertiary; lacking competitors, they expanded there in many directions. They occur in every kind of water, even in mountain torrents where one small catfish (*Cyclopium*), by means of a sucking disc surrounding the mouth and by use of the pectoral fins, can edge along the bottom against the current and can even climb up a vertical wall out of the water. The family Pygidiidae comprises tiny, slender catfishes,

some of which are parasitic and can attach themselves, leechlike, to other fish or animals. One of these, the candiru (*Vandellia*), which commonly lives inside the gill cavity of other fishes, on the blood of which it subsists, has the evil reputation of at times entering the urethra of unwary bathers. Catfishes are without true scales, but some South American forms (*Callichthys, Corydoras,* etc.) have the body armoured with a double series of scalelike plates that meet along the middle of the sides. The neotropical family Loricariidae, comprising extremely aberrant, bottom catfishes with a sucking disc surrounding the mouth, have the body more or less completely armed with smaller scutes. Among the loricariids that reach a large size are *Plecostomus* and its relatives; they are not unlike ictalurid catfishes and have an adipose fin with an initial spine. *Loricaria* and its relatives are most peculiar: the armoured body—slender, flattened and elongate—tapers backward from the dorsal fin.

Catfishes are, and presumably always were, a continental, freshwater group, but two types are also marine. Species of *Arius* and related genera (family Ariidae), which are quite standard in appearance, inhabit warm coastal waters around the world. Many catfishes guard their eggs and newly hatched young; some ariids have very large eggs that they carry in their mouths until hatched. Relatives of *Plotosus* are another dissimilar and less generally distributed type, plentiful in the orient. Back to the level of the pelvic fins they are normal appearing catfishes, but the posterior part of the body is lengthened. A long anal fin extends evenly around the tip of the tail and runs forward on the back as the dorsal fin. These two kinds of marine catfishes have reached, and established distinct species and even genera in, the fresh waters of Australia and New Guinea, although the group as a whole is continental and absent from land masses that have not been connected with the northern continents after the beginning of the Tertiary.

Although all catfishes are not used as food, so far as is known all of them are good to eat.

Characins or Tetras.—The characins or tetras constitute a varied family (Characidae) of fresh-water fishes confined to Africa and tropical America. Typical characins are active, streamlined fishes, with spineless fins; a short dorsal fin more or less in the middle of the back and over the pelvics; pectorals behind the head and placed low; a small adipose present over the longer or shorter anal; and a forked caudal fin. Their mouths and feeding habits vary greatly; the mouth may be very small, the teeth insignificant or even absent, or large, with highly developed fangs. A common condition, especially in short-bodied, compressed forms, is the presence of a rather small mouth, with a hinged lower jaw that drops down very freely, and strong incisor teeth. In a few genera the adipose fin is absent. There are many genera, some of the predaceous ones being moderately large fishes; but most are small, usually attaining two to three inches. African species of the genus *Alestes* are variously short-bodied and compressed, or more slender; the tiger fishes (*Hydrocyon*) are salmon-shaped characins with notably large, strong, sharp teeth. The largest tiger fishes grow to three or four feet and are usually silvery on the sides, with a tendency to narrow, parallel, lengthwise streaks. The large-mouthed, pikelike *Sarcodaces odoe* grows to one or two feet. In *Distichodus* and *Citharinus* the mouth is small, with small or minute teeth. *Citharinus* has a very deep, compressed body and attains two to three feet in some species.

In South America numerous small, more or less short-bodied and compressed species related to *Astyanax* correspond to those related to *Alestes* in Africa. The deep-bodied, fine-scaled fish known as piranha (*Serrasalmus*) has a somewhat larger mouth and stronger teeth. It has a long anal fin with an oblique base, and the lower edge of the body is keeled and serrated. Piranhas reach a maximum length of about 18 in. At perhaps half that size they occur in some rivers in immense schools, and are reputed to attack and consume any warm-blooded animal that falls or ventures into the water. Fishes of the genus *Hydrolycus*, which may grow to two feet or more, have a large mouth and two very long fangs in the front of the lower jaw. *Curimatus* and related genera comprise small species with a very small mouth and no teeth. Species of *Pyrrhulina* are handsome, slender, small-mouthed little fishes, wherein the adipose fin is lacking. They are often kept in aquaria. *Hoplias*, a very ordinary looking, large-mouthed, strong-toothed fish, which grows to one or two feet, also lacks the adipose fin, and has little in its superficial appearance to suggest its belonging to the characin family.

Resemblances between certain South American and African characins was considered evidence of a land connection between the two continents, presumably in Tertiary times. Taxonomic ichthyologists most familiar with this family as a whole, however, are rather unanimous in the belief that the family differentiated independently in the two areas and that these resemblances are parallelisms, the subgroups comprising both African and South American species being matters of convenience rather than being truly phylogenic.

Gymnotids and the Electric "Eel."—In the fresh waters of South America is an abundant and varied family of eellike fishes (Gymnotidae) thought to be a derivative or branch of the characins. The body is relatively deep but tapers to a long, slender tail. The anal fin, which is very long, occupying most of the lower edge of the body, is finely dimpled or rippled. Very slight movements of this rippled fin enable the fish to move slowly forward or backward. There are well-developed pectoral fins behind the short gill slits and no pelvic fins, and the dorsal fin is insignificant or absent. There is sometimes a narrow caudal fin, or the anal may extend back around the tip of the tail or project in a finless filament. The profile, snout and mouth are very variable. In most species the snout is moderate or short and blunt, the mouth being rather small. In some the snout is long and narrow, with a tiny mouth at its end, and even decurved (*Sternarchorhynchus*) as in some of the Mormyridae. In fact there are certain parallels, though presumably no relationships, between the Gymnotidae and the Mormyridae.

Most gymnotids can produce an electric current, which is thought to act as a direction-finding system. One species, the electric eel (*q.v.*) (*Electrophorus electricus*) has a powerful electric organ. The electric eel differs from most other gymnotids in having a projecting lower jaw, the body cylindrical instead of compressed, and lacking even rudimentary scales. Large individuals can give the most powerful electric shock, that produced by a specimen five feet long being sufficient to knock a man down. This faculty is doubtless used in defense. It is also used to stun, without killing, the small fishes on which the electric eel feeds, and one of the remarkable things about it is the perfect control the eel has over its severity, appropriate to a given application. The electric eel is generally distributed throughout northern South America, frequenting pools and well-shaded places in narrow, sluggish waters. Although the electric eel is rather generally avoided on account of its electric potentialities, it is occasionally used as food.

True Minnows, Carps and Allies.—The family Cyprinidae, minnows and carps, are presumably the most recent group of Cypriniformes, as they have not reached South America, which continent was isolated by sea from the others for a considerable period in the Tertiary. Their differentiation and distribution are sufficiently recent to be traceable with reasonable certainty. They are ordinarily symmetrical fishes with scales. The dorsal and anal fins are rather short, the former being near the middle of the back; the pelvic fins are about at the level of the dorsals; the pectoral fins are behind the head and placed rather low; and the caudal fin is emarginate or forked. Teeth are lacking in the mouth but are present on the pharyngeal (throat) bones. There are ordinarily no spines in the fins, but an initial spine (occasionally more) is often present in the front of the dorsal fin and rarely in the front of the anal fin also. One or two pairs of barbels may be present about the mouth. The family is large and there are many variations from the type. The minnow occur in greatest abundance and variety in eastern and southern Asia. To mention a few of the numerous types represented there, the genus *Barbus*, of which numerous subgenera may be recognized, are mostly symmetrical, free-swimming fishes with moderate or large eyes and moderate or small mouths. There may or may not be an initial spine in the dorsal fin and there usually are two pairs of barbels (sometimes only one, or none). Southern species usually have compressed bodies and

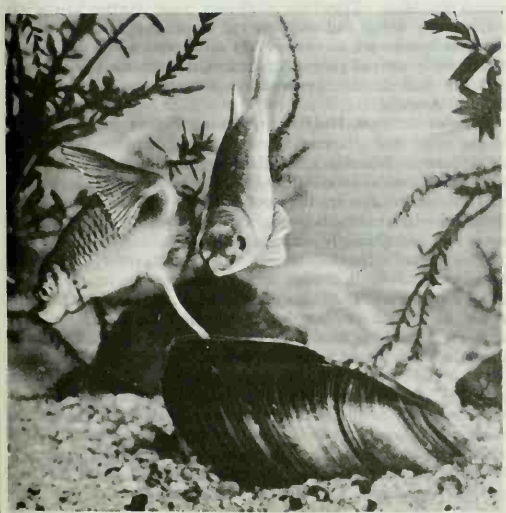
large scales; highland and northern species tend to be more elongate with finer scales. The common carp (*Cyprinus carpio*) and the related goldfish (*Carassius auratus*) are not unlike *Barbus*, but have a long dorsal fin (likely a primitive character), a serrated spine in the front of the dorsal and the anal fins. The carp has well-developed molar teeth, a specialized characteristic.

What seems to be an evolutionary line is traceable from *Barbus* through bottom-feeding forms represented by *Garra*, which has a broad sucking disc on the chin, then through *Varicorhinus* to numerous, closely related silvery fishes of the genus *Xenocypris* (with a characteristic small cross-shaped mouth more or less below the snout), which are probably secondarily freer swimming. There are several more or less related genera with a sharp keel of variable length along the lower edge of the body.

Most cyprinids are well compressed from side to side. Some are deep-bodied; others are slender and elongate. Among the latter kinds are the abundant Chinese knifefishes (*Hemiculter*), small- or moderate-sized silvery fishes with a smooth spine in front of the dorsal fin. Another group of minnows comprises genera related to *Schizothorax*, abundant in high central Asia with a few representatives farther east in hilly country. These have a characteristic row of enlarged scales bordering the vent and the base of the anal fin; the scales over the body are small, sometimes rudimentary or even lacking.

Elopichthys bambusa, common in China, is a large, slender, fine-scaled, swift predaceous minnow with long, firm jaws. Predaceous species of the genus *Opsariichthys* have on the upper jaw a protuberance that fits into a notch in the side of the lower jaw; this modification compensates for the lack of teeth in these species. There are also groups of mostly small-sized minnows. *Phoxinus* are fine-scaled minnows, perhaps most nearly related to those that are so abundant in genera and species in North America. *Pseudorasbora parva*, with a small, very oblique mouth, is abundant and widely distributed, represented by several poorly defined geographical forms. There are numerous bitterlings (*Rhodeus*, etc.); these are deep-bodied, compressed, large-eyed, active little fishes, usually less than three inches long, though some species grow to moderate size. Bitterlings lay their eggs inside the shells of fresh-water mussels, where they are relatively safe until hatched and the fry leave. The oviduct of the female is protruded as a long tube, an adaptation for the curious method of egg-laying.

The gudgeon series (*Gobio* and related genera) is abundant and varied in eastern Asia, very scantily represented in Europe and is not yet present in Africa or America. Gudgeons vary from very minnowlike or carplike fishes of moderate or small size (*Leucogobio, Gnathopogon*) to bottom species with small mouths, fringed with papillae, placed under the snout. Gudgeons occupy an ecological niche comparable to that of the suckers in America. They comprise numerous small species of *Pseudogobio* and more elongate, generally larger species of *Saurogobio*.



J. J. DUYVENE DE WIT

FIG. 21.—FEMALE BITTERLING (RHODEUS SERICEUS) DEPOSITING HER EGGS BY MEANS OF A LONG OVIPOSITOR INTO THE MANTLE CAVITY OF A LIVING CLAM FOR INCUBATION

Suckers.—The suckers (Catostomidae), like various minnows, are bottom feeders with small sucking mouths; they differ from the minnows in having the pharyngeal teeth simple and in a single comblike row. The teeth of the minnows are fewer in number, variously specialized and often in two or three rows. Suckers, presumably derived from ancestors of the minnows, evolved and lost their oral teeth at a period when sluggish drainage, which they still favour, was widely distributed. The valleys of Asia, south of the line of deserts (presumably of great antiquity), may be the centre of differentiation of the suckers and probably also have been the centre of distribution for minnows. But in this centre only a single, specialized Chinese species of sucker (*Myxocyprinus asiaticus*) remains. There are numerous species of suckers in North American fresh waters.

Loaches and Allies.—The loaches (Cobitidae) are usually rather small fishes, frequently somewhat eellike. They tend to have fine inconspicuous scales (sometimes none at all) and usually have more barbels than the two pair frequently present in the carps. In some superficial characteristics the loaches seem intermediate between catfishes and carps, but they are probably a more recent group even than the latter, and may have been derived from them. Loaches are more variable than minnows or suckers and very likely have a multiple origin. They have a peculiar anatomical feature in that the air bladder is enclosed in a bony capsule. Some loaches are very sensitive to weather changes, and this encapsuled bladder may be correlated with sensitivity to atmospheric pressure. The eellike pond loaches (*Misgurnus*), which are sometimes kept in aquaria and are called weatherfish, become restless at the approach of a storm. Some small species (allied to *Barbatula*), which are numerous in high regions of Asia where barometric pressures run very low, have the capsule more or less incomplete. Loaches have no spines in the fins, but in some there is a concealed, erectile, defensive spine on the side of the head, more or less beneath the eye. Of these species the spined loach (*Cobitis taenia*) is abundant, with a certain amount of geographic variation, across Eurasia from England to Japan. There are a number of shorter-bodied, freer-swimming, more streamlined Asian species of the genus *Botia*, also with a facial spine, which tend to be boldly patterned or brightly coloured and usually have a forked caudal fin.

The family Homalopteridae comprises a miscellaneous lot of loachlike fishes. *Gastromyzon* and related genera, which cling to the bottom in swift water, have a short, much depressed body, wide from side to side and flat below; a small cross-shaped mouth on the under side of the head; and the paired fins expanded in a horizontal plane. Loaches, abundant in Asia, also occur in Europe, and one small species is found in Ethiopia.

8. True Eels.—The true eels (order Anguilliformes or Apodes) are fishes with the body form of, but no relationship to, a snake. They were almost certainly derived from more normal fishes; their differences, such as the lack of pelvic or posterior paired fins, are correlated with their different manner of life and locomotion. There are eels everywhere, from inland fresh waters to the depths of the ocean. Superficially more or less alike, they differ so greatly among themselves that they are classified in a number of families. It is possible that eels were derived from divergent groups of fishes. There are other eellike fishes whose relationships to eels are more obvious.

The lampreys and hagfishes (Cyclostomata) discussed earlier are not true eels, although commonly so called. The electric "eel" is in the order Cypriniformes (*see* above).

Of the several families in the order Anguilliformes, the common eels (Anguillidae), conger eels (Congridae), snake eels (Ophichthidae) and morays (Muraenidae) might form an evolutionary series in which the common eels are closest to, and the morays

farthest removed from, normal fishes. So far as is known all species of these and related families spawn in the sea, with the possible exception of the morays. The young pass through a larval, transparent stage quite unlike the adult.

Common Eels.—The common eels (*Anguilla*), sometimes called fresh-water eels, were likely derived from the Clupeiformes. They differ from all other families of Apodes in having the body covered with small, embedded, rudimentary scales (easily seen with a hand lens). The scales are elongate and have a peculiar arrangement; they are placed obliquely, in groups, those in each group running at right angles to those in an adjacent group. *Anguilla* has strong teeth in a large mouth, with the lower jaw usually slightly projecting. It is an active, predaceous bottom fish, eating hungrily any animal food, living or dead. It has well-developed pectoral fins, each having a short slit before its base. These slits are the only posterior openings from the gill chambers. The dorsal fin, running along the back, and the anal fin, below, join broadly around the tip of the tail. *Anguilla* inhabits not only shallow coastal salt waters but fresh waters as well, penetrating far inland and not infrequently becoming landlocked and reaching a large size in lakes or ponds. Possibly little eels can reach such places by underground seepage, through which large ones are unable to escape. Eels can live in foul water and even for some time out of water, often moving overland in wet weather. They must return to the sea to spawn. The spawning grounds of the European and American species are far out in the deep water of the Atlantic. Common eels are extensively and generally used for food; eels of the other families are not so used as a rule, and the flesh of some, for instance the morays, locally is thought to be unwholesome.

Conger Eels.—The conger eel of the North Atlantic (*Conger conger*), which is abundant off the coast of Europe, and extensively marketed there, is superficially so like a common eel that it might easily be mistaken for one. It is strictly marine, found in somewhat deeper water, and reaches a larger size. Its dorsal fin commences not far behind the head instead of toward the middle of the back as in *Anguilla*, and it is entirely without scales. There are several other genera also in the family Congridae.

Snake Eels.—The snake eels (Ophichthyidae) are a very varied group abundant in the shore waters of the tropics and comprising a number of genera. They are characterized by the tip of the tail being finless and the dorsal and anal fins not meeting around it. The pectoral fins may be well developed, rudimentary or absent. Some species are very slender and elongate, even for an eel; some are feeble, others strong and aggressive. The latter kinds, when stranded at the edge of the water, as they sometimes are, become threatening, simulating a snake. Some snake eels are plain coloured, whereas others are brightly marked. In the East Indies one or more have a colour pattern that resembles that of poisonous sea snakes (predators of eels) found in the same waters.

Morays.—The morays (Muraenidae) have a very small gill opening, never have a trace of a pectoral fin and the dorsal and anal fins, which may be rather high, especially the dorsal, are continuous around the tip of the tail. A number of genera and many species are particularly abundant about coral reefs in the tropics. The typical morays (*Gymnothorax*, etc.) are heavy-bodied, somewhat compressed eels, with a rather high dorsal fin beginning well forward, before or behind the hind border of the head. The snout is pointed; the nape convex; the jaws about even; the mouth large, extending to well back of the eyes; and the teeth numerous, strong and sharp. Morays are strong and predaceous, hunting in the crevices of the reef where fishes on which they prey find security from other enemies. The largest morays reach five feet or more. They may be plain coloured, mottled or more boldly patterned. The genus *Echidna* comprises less aggressive, short-bodied, compressed species with blunt teeth. There are several species in the East Indies, one small one in the West Indies and others elsewhere in tropical waters. They are commonly dark coloured with pale markings.

Deep-Sea Eels.—There are several peculiar deep-sea families of Anguilliformes, of which the snipe eels (Nemichthyidae) constitute one of the strangest. These are very slender and elongate, the tail often ending in a finless filament; the finely-toothed jaws are narrowed and lengthened to suggest the bill of a snipe. In some species the jaws are twice as long as the rest of the head and are spread apart at the tips. It is difficult to see how such a mouth would be used in feeding; it has been suggested that the snipe eel uses its long jaws to cling to other larger fishes in order to be carried about. Snipe eels have large eyes and well-developed pectoral fins. These forms are recorded from water two or three miles deep and rarely within 50 fathoms of the surface.

9. Eellike Fishes.—Several orders of eellike fishes, not closely related to each other or to the true eels, are the rarely seen deep-sea spiny eels (Notacanthiformes or Heteromi), the Asian and African spiny eels (Mastacembeliformes or Opisthomi), the gulper eels (Saccopharyngiformes or Lyomeri) and the swamp, or synbranch eels (Synbranchiformes or Synbranchii).

Deep-Sea Spiny Eels.—The Notacanthiformes occur in all but the coldest ocean deeps, usually from 1,200 to 8,500 ft. Most of the members are less than two feet long. Some have a series of spines in place of a soft dorsal fin.

Spiny Eels.—The typical spiny eels (*Mastacembelus*), of which there are a number of species in the fresh waters of southern Asia, the Indies and Africa, are not closely related to other so-called eels. The body is not greatly lengthened, is more or less compressed and is covered with fine scales. The pectoral fins are well developed and the soft dorsal and anal fins (of about equal length) join broadly around the tip of the tail. There are spines on the side of the head, two or three in the front of the anal fin and many short, sharp ones along the mid-line of the back. Spiny eels are further characterized by a pointed, more or less proboscislike snout and are considered excellent food fish.

Gulper Eels.—The gulpers are deep-sea eellike fishes that, although they superficially resemble the Anguilliformes, are considered to descend separately from the Clupeiformes. These black creatures of the depths rarely come to light. They have an enormous mouth and a distensible stomach and thus are capable of swallowing fishes much larger than themselves. The body tapers backward into a slender lash and the tiny eyes, which are probably functionless, are placed near the tip of the snout. *Saccopharynx* is known to attain up to six feet in length.

Synbranch Eels.—The synbranch eels inhabit sluggish fresh waters and water holes, also penetrate underground drainage. These types differ from the Apodes in that the gill openings, instead of being separate, one on either side of the neck, join below across the throat. They have small eyes, a tail tapering to a point, rudimentary dorsal and anal fins and no pectoral fins. Only two or three species are known. *Fluta alba*, represented by two or three poorly defined geographical races, is abundant in the orient and the East Indies; *Synbranchus marmoratus* is common in tropical America.

10. Needlefishes, Halfbeaks, Flying Fishes, etc.—Included in the order Beloniformes (Synentognathi) are the families of needlefishes (Belonidae), halfbeaks (Hemiramphidae), flying fishes (Exocoetidae) and sauries (Scomberesocidae). It is thought that the needlefishes are the most primitive of the order and the flying fishes the most advanced. Presumably the habit of leaping came first and gradually made possible flight.

Needlefishes.—Needlefishes, or salt-water "gars" (Belonidae), are slender, elongate marine species abundant along the shores of all warm seas. They have large eyes; the jaws, set with numerous sharp teeth, are lengthened to form a beak that is longer than the rest of the head. The fins are entirely without spines; the pelvics are placed well back, behind the middle of the body. The body is covered with fine, inconspicuous scales. The dorsal and anal fins are placed opposite one another near the tail, and the caudal fin is forked or crescent-shaped. Needlefishes are silvery in colour, but darker, usually greenish, along the back. They swim near the surface, singly or in small groups, preying on lesser surface fishes. The smaller species grow to one or two feet and the largest to at least four or five feet. Many of them frequently leap above the surface of the sea, hurling themselves through the air like a thrown javelin or spear; it is said that there are instances of men in small boats being struck and seriously wounded by them. The large kinds, especially, have the lower

lobe of the caudal fin somewhat larger and firmer than the upper, a modification no doubt correlated with the leaping habit. In most needlefishes the body is cylindrical and little if at all compressed (*Tylosurus*, etc.), but one genus (*Ablennes*) has a flat, compressed body; the latter form turns on its side in the air. Probably all this family are good food fishes, even the large species with green bones, though most of them are used only locally.

Halfbeaks.—The halfbeaks (Hemiramphidae) are related to the needlefishes, but differ from them in having only the lower jaw lengthened as a pointed, toothless spear. Exceptionally, both jaws are short (*Chriodorus*). Halfbeaks have a small mouth and are mainly plankton-eaters. Just how the spearlike lower jaw functions is uncertain. They are small fishes, seldom more than a foot long, abundant coastwise in warm seas, a few occurring in fresh water. Those found farthest offshore (*Hemiramphus*) have a forked tail fin with the lower lobe longer than the upper, as in the flying fishes and some of the houndfishes. This fin is usually emarginate, but there are more or less fresh-water or estuarine species wherein it is rounded. These latter types, found in the East Indies and elsewhere, are viviparous (*Hemirhaphodon, Zenarchopterus*).

Some halfbeaks skitter along the surface of the water, sculling vigorously with the tail fin; with the body thus raised out of water at an angle, the short pectoral fins are spread to balance and support it. It is logical to suppose that, in view of this habit, halfbeaks gave rise to the related flying fishes, that in the course of evolution the halfbeak's pectorals lengthened and strengthened to make of the flying fish the efficient aerial glider that it is. It is generally thought, however, that both the halfbeaks and the flying fishes arose from a common ancestor at the same time.

Flying Fishes.—The flying fishes (Exocoetidae) are large-eyed, blunt-headed, silvery-sided fishes that swim at the surface of all warm seas. They have moderate-sized smooth scales and short posteriorly placed dorsal and short anal fins, of soft rays only. They are notable for the very long, firm pectoral fins, which are used in "flight." The tail fin is forked, its lower lobe being firm and longer than the upper. Two types of flying fishes are common. The "four-winged" species have the pelvic fins placed more or less behind the centre of the body. These fins are spread in flight to supplement the lift from the pectorals. The largest of these species reaches a length of about 18 in. and makes the longest aerial excursions. The "two-winged" species, which are somewhat short-bodied and seldom more than six inches long, have the pelvic fins much smaller, less far back and not spread in flight.

An adult flying fish leaves the water with vigorous thrusts of the tail, spreading its "wings" rigidly as it does so. The wings cannot be used to propel the fish; thus the flying fish does not actually fly, but glides. Flying fishes rise highest above the water and make their swiftest and longest flights across the wind in a strong breeze. They usually fly to escape predaceous fishes or the bow of an approaching ship, but under optimum flying conditions they seem to take flight also for sport, schools of the smaller ones often being seen in the air together, glistening in the sun. They cover considerable distances entirely clear of the water; a fourth of a mile was estimated as the maximum flight for large individuals.

A few species of flying fishes are cosmopolitan and pelagic, being among the commonest fish life one sees at great distances from land, especially in the trade-wind belts. A number of others have a more restricted distribution, being commoner along coasts or near islands. All are excellent eating. Local native fisheries sometimes employ lights to attract them at night. On dark nights flying fishes frequently leap aboard ship; they strike the deck or lose their balance by hitting the rigging and fall aboard. By day they usually see where they are going and sheer off.

11. Cods and Grenadiers.—The Gadiformes are very distinct from any other order of fishes. Recent classifications derive them from the Clupeiformes, but their position is by no means certain. The tails and caudal fins are termed isocercal, since they lack the slight structural asymmetry characteristic of the homocercal tails of most bony fishes. This tail modification is doubtless a secondary characteristic, and was probably inherited from ancestors with eel-like tails. The fins are without spines, but this condition might easily have been secondarily acquired. The number of rays in the pelvic fins is very variable: 1 to 9 in the Gadidae and as high as 12 in the Macrouridae. In any event the Gadiformes are highly specialized rather than primitive fishes, as evidenced by the complexity of the cod skull.

The Atlantic cod (*Gadus morrhua*) is probably the best-known fish to seafaring peoples of the North Atlantic. It is a cold-water species that abounds on offshore banks, and from early days fishermen have made long voyages in its pursuit. It frequently reaches a weight of 50 lb. (and may attain four times that weight) and a length of six feet. It has good-sized eyes, a large mouth, with the upper jaw projecting slightly beyond the lower, and a barbel at the chin. Its body is covered with small, smooth scales, its fins are without spines and, like its close relatives, it has three separate dorsal and two separate anal fins. Cod come close inshore and also range far down the continental slopes into deep water. They usually swim near the bottom but occasionally rise into upper waters in pursuit of surface swimming fishes. They range about in hungry schools, devouring any animal food that comes their way, from crabs and mollusks on the bottom to fish and squid higher up in the water.

Several close relatives of the cod, found in the same waters, are all excellent food fishes. The haddock (*Melanogrammus aeglefinus*) has a smaller mouth and is more exclusively a bottom feeder; the pollack (*Pollachius pollachius*) is more streamlined, with a slightly projecting lower jaw (its barbel minute) and a larger, more forked caudal fin, and usually swims at or close to the surface; the little tomcod (*Microgadus tomcod*), which runs into shallow water and enters estuaries in late fall and winter, rarely exceeds one foot, being usually smaller.

The cod family (Gadidae) also comprises somewhat different fishes. The European lings (*Molva*), which have large eyes and a well-developed chin barbel, are more slender and elongate, with but two dorsal fins, the anterior being short, the posterior long. The single long anal fin is at the level of the posterior dorsal. The common species, which is around five feet long, is extensively dried for food in Iceland. Fishes known as hake or ling in America, as forkbeards in England (*Phycis*), have a similar fin arrangement except that the pelvic fins are each reduced to a long, two-branched filament and are placed at the throat. One fresh-water member of the cod family, the burbot (*Lota*), is found in northern lakes. The European hake and American silver hake (*Merluccius* species) are other cods. In these predaceous fishes the mouth is large and bears numerous sharp, slender teeth, the lower jaw projects and the chin has no barbel. There are two dorsal fins and one anal fin, but the typical cod condition is approached in that the long, posterior dorsal and anal fins are emarginate, imperfectly divided in two.

The grenadiers or rattails (Macrouridae) are strange bottom fishes that inhabit the deep sea, rarely straying up the continental slopes to inside the 25-fathom line. They have rather large, sometimes angular heads. The mouth and the eyes are of varying size, the latter often being large, and there is usually a small barbel at the chin. The short, anterior dorsal fin is placed about over the pectorals, which are about over the pelvic fins. The long posterior dorsal and anal fins are often very low or vestigial. The long body, covered with small scales, tapers backward into a slender ratlike tail; there is no caudal fin. Among the deep-sea fishes the rattails are numerous in individuals and in species; they inhabit varying depths.

12. Trumpet Fishes, Sea Horses, Sticklebacks, etc.—Several families of tube-mouthed fishes form the order Gasterosteiformes (Solenichthyes); included among these groups are many bizarre forms that have an elongate snout through which food is siphoned. The sticklebacks and tube-snouts, sometimes considered a separate order, are included here for reasons that are discussed below under *Relationships*.

Trumpet Fishes and Cornetfishes.—The trumpet fishes (Aulostomidae) and cornetfishes (Fistulariidae) are elongate species that occur in tropical shore waters. They have a slight but entirely superficial resemblance to the unrelated needlefishes. Instead of long, toothed jaws, they have small mouths at the end of long

tubular snouts. Trumpet fishes reach a length of one or two feet; cornetfishes are more slender and sometimes attain four or five feet, though usually smaller. Both have short, soft-rayed dorsal and anal fins opposite one another near the tail, and *Aulostomus* has a row of short spines in the mid-line of the back, suggesting those of a stickleback. Its relationship to the sticklebacks, though not close, is probably real, for there is a singular small fish (*Aulorhynchus*), in the cool coastal waters from California northward, in some respects intermediate between *Aulostomus* and the sticklebacks. *Aulorhynchus* has paired pelvic fins placed under the pectorals as in the sticklebacks, not well back as in trumpet fishes. The cornetfish has no spines on the back; it has a very peculiar tail with a long, threadlike lash extending backward from the centre of a small, forked caudal fin.

Snipefishes and Others.—There are several strange, compressed little fishes, usually uncommon in warm seas, with long, tubular snouts; they are presumably related to the trumpet fishes. They are of three quite unlike types, represented by the genera *Solenostomus* (ghost pipefish), *Macrorhamphosus* (snipefish) and *Centriscus* (shrimpfish). The small, soft-rayed dorsal and anal fins are far back near the tail, and there is an anterior, more or less spinous dorsal fin. In *Centriscus* the body is covered with thin scutes; the anterior dorsal fin has a heavy initial spine more or less coalesced with the armature of the back and projecting backward beyond the tail, which, with its soft dorsal, anal and caudal fins, is bent abruptly downward. *Centriscus* is translucent; it may be found swimming in a vertical position.

Pipefishes and Sea Horses.—The pipefishes and sea horses form the family Syngnathidae. The pipefish genus *Syngnathus* is the typical and most abundant group. They are very slender, elongate marine fishes. The tiny mouth is at the end of a tubular snout. The body, angular in cross section, consists of numerous bony rings; keels and ridges, of variable development, are found on the head and body. The eyes are large. A short dorsal fin, of numerous slender, flexible, simple rays, is placed more or less in the middle of the back, above usually a tiny anal fin; a small fan-shaped caudal fin terminates the long, narrow, segmented tail. The pectoral fin is short and broad, and pelvic fins are lacking. The eggs and the young, until these are large enough to fend for themselves, are carried by the male, usually in a pouch placed behind the vent (the anal fin in the male is inconspicuous or absent).

Pipefishes inhabit all warm and temperate seas and are abundant in species and individuals particularly about the shores of continents and continental islands. A few are commonly found in estuaries or in fresh water. They customarily live among seaweed, and one species (*Syngnathus pelagicus*) is plentiful across the eastern North Atlantic in drifting sargassum, where its mottled colours give it a low visibility. They normally glide through the water so slowly, propelled by their weak fins, that often they may be captured easily by hand. They can make better speed for short distances by an eellike motion of the whole body. Pipefishes vary in size from one inch to two feet. Most species are sufficiently alike to be placed in one comprehensive genus (*Syngnathus*), but other genera are recognized for the more aberrant forms.

The sea horse (*Hippocampus*), perhaps the most unfishlike true fish, is little more than a very peculiar pipefish that has become short-bodied and compressed, with its neck constricted, its head bent downward at right angles to the rigid body and its slender tail devoid of a terminal fin and made prehensile. Sea horses frequently assume an erect position with the head up, either clinging to seaweed with their tails or swimming free in the water. The head and arched neck are quite horselike in outline, strongly suggesting the chess piece known as the knight. The breeding and general habits of sea horses are quite like those of other pipefishes. When full grown they vary from about two inches to one foot. There are numerous species along the shores of warm seas, differing from one another in such minor characteristics as size, relative length of snout, development of kelps and knobs and the number of bony rings. The most aberrant member (*Phyllopteryx*) lives among the rockweed in Australian waters; it is camouflaged by a very irregular form and by membranous flaps from head to tail, the whole simulating the weed.

Sticklebacks.—Sticklebacks (*Gasterosteus*, family Gasterosteidae) are very small fishes of northern fresh, brackish and shore waters, usually three inches or less long. The typical stickleback has large eyes, a small mouth and a symmetrical, streamlined body that ends in a very narrow, firm peduncle. The caudal fin may be squarish or slightly rounded or emarginate. This fish is well armed with a varying number of rather short, pointed spines: several are located in front of the soft-rayed dorsal fin, one in front of the anal and each of the pelvic fins; the pectorals, above and slightly in front of the pelvics, consist mainly of a pair of daggerlike spines.

Sticklebacks become very abundant in shallow water where aquatic vegetation supports the tiny animals on which they feed; they also drift into more open stretches in small schools. Their breeding habits are highly specialized: at spawning time the male assumes bright colours; selects a territory where he builds a more or less barrel-shaped nest, mostly of bits of vegetation, and attaches it to water plants; induces usually more than one female to enter the nest and deposit her eggs; and guards the nest against intruders or rivals. Although the male is not ordinarily a rapid swimmer, he shows great speed and dexterity when the occasion demands. Battles between males are frequent and sometimes to the death.

Relationships.—The trumpet-fishlike *Solenostomus*, already mentioned, is less completely armoured than the pipefishes but resembles them in sufficient other structural characters to indicate a true though distant relationship, thus tying up the family Syngnathidae with the stickleback-trumpet fish series. A logical evolutionary picture of this series would start with unknown, primitive spiny-finned fishes, superficially not unlike the modern ones; consider *Solenostomus*, etc., and the trumpet fishes divergent, specialized fragments remaining from transition forms; and end with two modern groups in different habitats: the family Gasterosteidae, little sticklebacks, abundant inhabitants of northern fresh, brackish and salt waters; and the Syngnathidae, pipefishes and sea horses, abundant in warm seas.

The spines in the fins of the stickleback and its relatives are similar to those of the modern spiny-rayed fishes of the order Perciformes (perches, basses, tunas, etc.). This resemblance is probably due to the fact that their common ancestors had spiny fin-rays. The absence of spines in some of the fishes dealt with in the remaining sections of this survey is not always an indication of the primitive condition of these fishes; in many groups spinelessness is probably a degenerate condition.

13. Opahs, Ribbonfishes and Allies.—The order Lampridiformes includes the opahs, crestfishes, oarfishes and ribbonfishes. They have soft-rayed fins and protrusible jaws of a sort not found in any other group of fishes. The opah or moonfish (*Lampris regius*) is the only member of the family Lamprididae; it is a large, laterally flattened fish, attaining a length of six feet and a weight of more than 500 lb. Oarfishes and ribbonfishes (family Trachypteridae) are much longer—some giant oarfishes (*Regalecus*) may reach up to 30 ft.—and are bandlike or ribbonlike in body form. The crestfishes (family Veliferidae) have flaglike crests, like some of the others do, for the dorsal fins.

14. Squirrelfishes and Allies.—The order Beryciformes are a somewhat transitional group intermediate between the primitive ray-finned fishes (those that have few or no spiny rays) and the advanced ray-finned fishes (described below under *Perches and Perchlike Fishes*).

Squirrelfishes or soldierfishes (Holocentridae) are rather small, blunt-headed, large-eyed, active, symmetrical fishes, one or more species being plentiful in shallow water along the shores of all tropical seas. They have moderate or rather small mouths with bands of small teeth. The two dorsal fins are connected at their bases, the anterior, with strong spines, being longer than the soft-rayed posterior; the latter is close to the narrow peduncle; and the caudal fin is firm and well forked. The anal fin, placed under the soft dorsal, has four initial spines, the first being very small and the third very long, strong and sharp. The pectoral and pelvic fins are of moderate size, the pelvics being under or slightly behind the pectorals, and consist of an initial spine and seven flexible

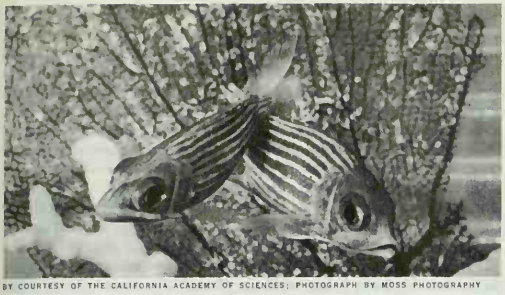


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FIG. 22.—COURTING ACTIVITY OF STRIPED SQUIRRELFISHES (HOLOCENTRUS XANTHERYTHRUS), COMMON IN HAWAIIAN WATERS

soft rays. There is a backwardly directed spine near the lower, posterior edge of the side of the head (on the corner of the preopercle). The body is covered with rather large- or moderate-sized firm scales with toothed edges. Squirrelfishes are predominantly red, with white and sometimes yellow lengthwise stripes; not infrequently black markings are on the fins. *Myripristis* is a not uncommon, somewhat shorter-bodied close relative of the squirrelfishes; it is found in the same waters, probably living somewhat deeper down, unless perhaps at night. It is more uniformly red in colour and has larger eyes. It lacks the daggerlike spine at the lower edge of the head, and the spines in its fins are not so large and strong. (Fishes that swim deeper tend to be red in colour, as compared with their close relatives in shallow water, and it is not unlikely that the squirrelfishes are a shallow-water invader from greater depths.)

Two related families, Polymixiidae (beardfishes) and Berycidae, also inhabit relatively deep water.

In superficial characters the berycoid fishes parallel the more advanced group of perches and basses (percoid fishes). Beryciformes are of an older lineage; they are known to have been abundant in the Upper Cretaceous, and are presumably ancestral to Perciformes. There are a number of percoid families very like the sea basses, etc., all of which have standardized pelvic fins consisting of one unsegmented spine and five branched soft rays, whereas the berycoids more often have a larger number of branched rays in the pelvics.

There are divergent groups of specialized fishes that give evidence of descent from standard spiny-rayed forms, whether from the percoids, berycoids or preberycoids is not always clear. Those supposed to have been derived from the percoids often have the number of pelvic soft rays reduced below five, seldom if ever increased to more than five. Two interesting little North American fresh-water fishes called trout perch (*Percopsis* and *Columbia*, order Percopsiformes) are probably specialized derivatives of the Beryciformes, as are the pirate perch (family Aphredoderidae). Trout perch are characterized by two true spines in the front of the soft-rayed dorsal fin and one or two in the front of the anal, small rough scales and an adipose fin like a trout or catfish.

15. John Dories and Boarfishes.—The relationships of these fishes of the mid-levels are still uncertain. They are placed in the order Zeiformes. They are spiny-rayed fishes with thin, laterally compressed bodies. John Dories, which reach three feet, are considered by some to be gourmet items, but are disdained by others.

16. Killifishes, Live-Bearers, etc.—Killifishes and top minnows (family Cyprinodontidae) and their relatives constitute the order Cyprinodontiformes (Microcyprini). The order includes both egg-layers (Cyprinodontidae) and live-bearers (Poeciliidae); several popular aquarium fishes, such as guppy, molly and swordtail; and oddities such as the blind cave-dwelling fishes (Amblyopsidae) and the four-eyed fish (*Anableps*).

Killifishes and Top Minnows.—These names are applied to various species of cyprinodonts; as a group they are sometimes called toothed carps or minnows, though they are not closely related to the carps and minnows (family Cyprinidae).

The cyprinodonts, of which many and varied species abound in coastal salt water and in brackish and fresh water, particularly of the tropics and subtropics, are soft-rayed fishes that have secondarily lost their spines and are rarely more than a few inches long. Some are slender, not unlike the pikes in shape, though others have deep, compressed bodies. Some are erroneously called minnows, but unlike true minnows, their caudal fins are usually not forked, but rounded. Instead of being large, their mouths are relatively small. Some are carnivorous, with small, firm pointed teeth, but only tiny creatures need fear them. They themselves are an important item in the food supply of larger fishes. Unlike the females, the males of these and many other Cyprinodontiformes have bright colours, especially at breeding time.

Live-Bearers.—Species of the family Poeciliidae, represented in tropical American fresh waters, instead of laying eggs, give birth to living young (are viviparous). The anal fin, which is more anterior in position than in the other Cyprinodontiformes, is developed into an intromittent organ (gonopodium) in adult males. The males, frequently considerably smaller than the females, often have more decorative fins and are more brightly coloured. Various species are of very small size, multiply rapidly and become very abundant in quiet streams. They are a natural check on mosquitoes by consuming the aquatic larvae of these pests. One North American species called the mosquito fish (*Gambusia affinis*), with a usual maximum length of about two inches (the males are considerably smaller), has been widely introduced to control mosquitoes. Another small live-bearer is the well-known guppy (*Lebistes reticulatus*), a prolific fish popular with aquarists. One of the larger cyprinodonts is the four-eyed fish (*Anableps*), which may grow to be one foot long. *Anableps* is an elongate fish, with very peculiar eyes that project upward like those of a frog; the eye is divided into an upper part adapted for vision in air and a lower part for vision in water.

Cave Fishes.—Another family (Amblyopsidae) contains the blind cave fishes, which inhabit the totally dark limestone caves of central and eastern North America. This group shows some affinities with the pikes. The most specialized of these is the northern cave fish, or Mammoth cave blind fish (*Amblyopsis spelaea*), a blind, elongate, sluggish, whitish fish, reaching a length of about five inches. It has a large mouth but tiny functionless eyes, and the body and head have many vertical ridges of tactile nipples. A peculiar feature of this family is that the anus is placed anteriorly, close behind the gill openings. Besides the blind species the family comprises normal sighted forms, one of which, the swampfish or ricefish (*Chologaster cornuta*) is abundant in streams and lowland swamps in the southeastern U.S.

17. Mullets, Silversides, Barracudas, etc.—The order Mugiliformes, including the mullets and mulletlike fishes, is sometimes placed with the higher spiny-finned fishes (order Perciformes) as a suborder Mugiloidea. But they are different enough in many respects to deal with them as a separate but closely related group.

The mullets (family Mugilidae) and barracudas (Sphyraenidae), with a small, well-separated, anterior spinous dorsal fin, are superficially quite unlike each other and the silversides (Atherinidae), but the differences are perhaps merely correlated with their different habits of life.

Mullets.—Mullets are schooling fishes of small or moderate size. The short soft-rayed dorsal and anal fins are placed one above the other, well back. The body is streamlined and more or less cylindrical. The small, transverse, toothless mouth is slightly on the underside of the head. Mullets are bottom feeders. They are strong swimmers and are proficient at leaping out of water. The marine species, which are abundant in shallow water on muddy or sandy shores, often running into brackish water, are gray, and white or silvery in colour. One of the largest (*Mugil cephalus*), one or two feet in length, with dark streaks along the rows of scales above, occurs in all warm seas. There are a few fresh-water mullets, one of which (*Agonostomus monticola*) inhabits most of the streams in the West Indies and Central America. Mullets are a favourite table fish in some countries and are raised by the Chinese in coastal ponds.

Silversides.—The silversides (family Atherinidae), slender fishes a few inches long, are very abundant in salt water on mainland

shores of warm and temperate seas, and include many fresh- or brackish-water species. They swim near the surface. Most of them are pale-greenish above and white below, with a bright silvery band along the side. In the economy of the sea they are an important food item for larger fishes and for sea birds. Their colouring presumably decreases their visibility, especially to enemies below, and prevents their ranks being depleted. They are carnivorous and prey on smaller aquatic creatures.

Two well-separated dorsal fins are present; the anterior, near the middle of the body, is very small, with a few flexible spines and a connecting membrane; the posterior of soft rays is more or less over the hind part of the usually somewhat longer anal fin. The spinous dorsal fin would seem to be a nonfunctional rudiment, inherited from more perchlike species, and the paired pelvic fins, placed somewhat farther back than the pectorals, have five soft rays as in percoid fishes; silversides, however, are generally considered more primitive than, rather than derivative from, perches. They have large eyes, streamlined bodies and are active swimmers, usually with rather well-forked caudal fins.

Silversides are good to eat. A large form (*Basilichthys bonariensis*), resembling a smelt, is abundant in Argentina, where it is called *pejerrey* (kingfish) and is particularly highly prized. A small brackish-water species, the tidewater silversides (*Menidia beryllina*), often called white bait or smelt, is a desirable food fish along the eastern seacoast of the U.S.

Barracudas.—Contrasted with mullets, the barracudas are moderate or large-sized, highly predaceous, pike-sized marine fishes,

PAUL DROZ

FIG. 23.—SCHOOLING BEHAVIOUR: TWO SCHOOLS OF BARRACUDA CROSSING, WITH STRIPED PORGIES BETWEEN THEM

with a large mouth, projecting chin and formidable teeth. The smaller species grow to one or two feet in length; the largest, the great barracuda of the West Indies (*Sphyraena barracuda*), questionably distinct from an East Indian form, to five or six feet. The smaller species of barracuda are usually considered excellent eating, but the larger ones are thought to be unwholesome in some localities. Their flesh may be intrinsically toxic. The danger to swimmers from barracudas is doubtless exaggerated, but almost any large, predaceous fish may strike at anything moving in water, and accidents in which a barracuda is the culprit certainly occur.

Threadfins.—The threadfins (Polynemidae), with comparatively few marine bottom species, have the spinous dorsal fin not greatly smaller than the soft dorsal. The soft dorsal and anal fins are short and the caudal fin is well forked. The pectoral fins are low down, consisting of two parts, the lower part of free threadlike filaments that can be moved independently and that serve as organs of touch.

Phallostethids.—The Phallostethidae, small (one and one-half inches long), translucent, mulletlike fishes, inhabit fresh, brackish and salt waters from the Philippines to India. They have two dorsal fins, the first having one or two spines. Under the throat the male has a bony copulatory organ used to clasp the female as he fertilizes the eggs.

18. Perches and Perchlike Fishes.—The three large central percoid (order Perciformes) families are the perches (Percidae), of northern fresh water; the sunfishes (Centrarchidae), confined to North American fresh waters; and the sea basses (Serranidae), which are abundant in the shore waters of warm and temperate seas. All are symmetrical fishes with the spinous anterior and soft-rayed posterior dorsal fins being more often confluent than separate. The pelvic fins, placed nearly under the pectorals, have consistently one spine and five branched rays. The scales are of moderate or small size, more often rough than smooth. The mouth is usually of moderate size; the caudal fin is rounded, truncate or emarginate, rarely well forked; and the spinous dorsal, soft dorsal and anal fins are about equally long.

Perches and Allies.—In the perches the spinous and soft-rayed dorsal fins are more or less separate, though often contiguous. The perch (*Perca*) is abundant in quiet waters of Europe and America. It very exceptionally approaches five pounds, usually being much smaller, and is an excellent pan fish, familiar to all fresh-water anglers. It has a pointed head and black crossbands extending from the back onto the sides; the lower fins are variously yellow or red. The few species of pike-perches or walleyes (*Stizostedion*) are more elongate fishes with large mouths and formidable teeth. Their fin arrangement and other structures show them to be nothing more than large, predaceous perches that have assumed the habits and superficial characteristics of pikes. One of these, the so-called walleyed pike, is a food fish of importance in America. In America there are also numerous genera and species of slender small perches known as darters, inhabiting rapids and other flowing waters. They have mottled colours that render them inconspicuous on the bottom or among waterweeds. They usually move about slowly but show great agility when they have occasion to do so. Male darters, as a rule, become differently, often brightly, coloured in the breeding season.

Sunfishes.—The sunfishes (Centrarchidae), of which there are a number of species especially in the Mississippi valley drainage, are typically pond fishes. They have deeply compressed bodies, with the spinous dorsal fin continuous with the soft-rayed dorsal behind it. They are of small size, only a few of the larger being of any importance as food fishes. Most sunfishes assume bright colours, often in an intricate pattern of red, orange and iridescent blue or green; hence their name. The American basses (*Micropterus*) belong to the sunfish family but are more elongate, active and predaceous, and reach a larger size, commonly 2 or 3 lb. and sometimes between 5 and 20 lb.; they rank very high as fresh-water game fishes and are excellent for the table. They lack bright colours, approach the true basses in form and have a notch between the spinous and soft dorsal fins, which are only confluent at the base. Most members of this family scoop out a hollow nest in the bottoms of ponds or streams where they deposit and guard their eggs.

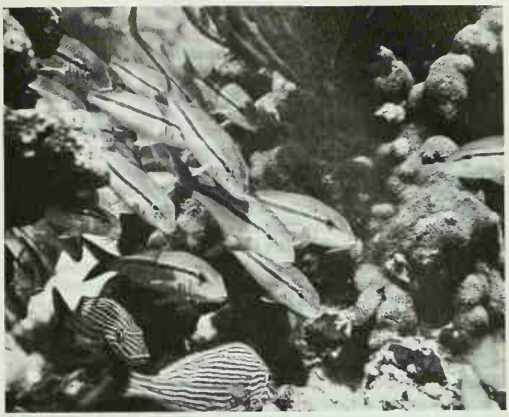
Sea Basses and Groupers.—The sea bass family (Serranidae) is one of the largest and most varied of fish families, comprising very many genera and species of carnivorous marine fishes that range close to the bottom in shallow or moderately deep water. They vary greatly in size and are usually excellent food fishes. The body is generally symmetrical and streamlined, with at most a shallow notch between the spinous and soft portions of the dorsal fin. A few species found in north temperate waters, however, have two separate dorsal fins (at most in contact at the base) and other characteristics that make of them a well-defined subfamily (Moroninae), which is sometimes given full family rank. These are the true basses in the narrow sense; they are not strictly marine. Belonging to this group are the European bass (*Morone labrax*); two large, comparable species found in both fresh and salt water, the American striped bass (*Roccus saxatilis*) and oriental spotted bass (*Lateolabrax japonicus*); the American fresh-water white and yellow basses; and the brackish water white perch. Unfortunately, in the vernacular, the smaller species of this group are known as perches; the larger, as basses. To further compound the confusion of popular names, perch and bass are frequently and less appropriately used for similar but more or less unrelated fishes belonging to other families.

In tropical seas fine-scaled sea basses related to the groupers (*Epinephelus*) are abundant, being represented by a number of genera and many species. Some attain a very large size, the largest reaching five to seven feet and weighing 600 to 800 lb. The number of spines in the dorsal fin in this group is unusually standardized, differing by only one or two. This variation is sometimes used as a criterion to separate not only the species but the genera as well. Many serranids are unusual in that they are functional males when small but change into females when they become larger. This trait is carried to its extreme in the hermaphroditic *Serranellus*, which has functional sperm and eggs at the same time.

Snappers, Grunts and Porgies.—In addition to the three central percoid families just described, there are several other important families of related marine percoid fishes, mostly inhabitants of warm shore waters. These forms differ from perches and basses in that the gill covers are spineless, the maxillary (upper jaw) slips under the edge of the preorbital bone when the mouth is closed and there is a specialized axillary scale at the upper corner of the base of the pelvic fins. The snappers (Lutianidae), of moderate size, are characterized by a large mouth and strong teeth. They usually have deeper, more compressed bodies and emarginate caudal fins; they are more active swimmers, ranging about in small schools and preying on smaller fishes. The somewhat similar grunts (Haemulidae), so called from the grunting sounds they make, are mostly small species with weaker teeth; they are particularly abundant in West Indian waters. The porgies (Sparidae), varying in size, have molar teeth on the sides of the jaws, and the front teeth are frequently incisorlike. In the Leiognathidae, more active, weak-toothed fishes with well-forked caudal fins, the mouth parts are excessively protractile and can be thrust out or drawn back.

Drums.—The drums or croakers (Sciaenidae) are a large family of carnivorous fishes generally abundant on the sandy shores of all warm seas. They are somewhat less closely related to the central percoid families. The drum has a long soft-rayed dorsal and a short anal fin; the anal spines are reduced in size and number to two or even one. Most drums feed on or close to the bottom, but a few, like the weakfish or so-called sea trout (*Cynoscion regalis* and *C. nebulosus*) of the eastern U.S., swim actively higher up in the water. The shape of the body and the size and shape of the mouth varies greatly in this family. The weakfish has a symmetrical, streamlined body, a large mouth with projecting lower jaw and a slightly emarginate caudal fin. Bottom-feeding species such as the croaker (*Micropogon*) and kingfish (*Menticirrhus*) have rather small mouths, the lower jaw somewhat the shorter, and sometimes barbels on the chin. In the croakers the caudal fin tends to be rounded, sometimes pointed and never deeply forked. Croakers are notable for their croaking or grunting sounds and for their unusually large, more or less ivorylike otoliths or free ear bones. One of the largest species is the sea drum (*Pogonias*), reaching a length of four feet and a weight of nearly 150 lb.; the smallest are seldom more than a few inches long. One of the very few drums found in fresh water is *Aplodinotus grunniens* of the Great Lakes and Mississippi valley; it grows to three or four feet and weighs 50 or 60 lb.

Goatfishes and Cardinal Fishes.—The goatfishes (Mullidae) are an easily recognized family of moderate-sized marine fishes, closer than the drums to the central percoid families. There are numerous species in warm seas, usually valued for food. A goatfish has two dorsal fins, spinous and soft-rayed, of approximately equal size; pelvic fins placed about under the pectorals; and a well-forked caudal fin. It has a long, curved snout, which may project slightly beyond the tip of the lower jaw, and a pair of long, fleshy tactile barbels at the chin. The prized "red mullet" of Europe is a goatfish. The cardinal fishes (Apogonidae) are another easily recognized family. The typical cardinal fish is short-bodied, from two or three to ten inches long, with two separate dorsal fins not greatly different in size, a large oblique mouth and unusually large eyes. There are numerous species, the majority of which are referred to genus *Apogon*, common in the shallow shore waters of all tropical seas and in fresh waters in New Guinea. They have a tendency to be nocturnal; some species carry their eggs in their mouths. Small West Indian species (*Apogonichthys*) are known to inhabit the shells of living conchs. There are a few longer-bodied, stronger-toothed genera of this family in deeper waters.



DR. W. H. LONGLEY; FISH AND WILDLIFE SERVICE

FIG. 24.—YELLOW GOATFISH (MULLOIDICHTHYS MARTINICUS) AND BLUE-STRIPED GRUNT (HAEMULON SCIURUS), COMMON CORAL-REEF FISHES OF BAHAMAN WATERS

Jacks, Scads, Pompanos, etc.—In the family Carangidae, the jacks, scads and pompanos, the spinous dorsal fin is much shorter than the soft-rayed fin behind it and its spines are weak; the premaxillaries are more or less protractile; and the snout and upper jaw are not fused. The lateral line has an anterior arch and often has enlarged scutes over the keel on the caudal peduncle.

There are at least three natural divisions of the Caragnidae. The large, predaceous, wide-ranging amberjacks (*Seriola*), abundant in all warm seas, are perhaps the most primitive division. In these the spinous dorsal fin is very small and low; the anal fin is considerably shorter than the soft dorsal; and the pectoral fins are short. The largest amberjacks reach a length of five or six feet. The young, which have dark crossbands on the body, hover about driftwood or small boats, or follow coastwise sharks. Of two or three related genera the pelagic pilot fish (*Naucrates ductor*), which follows offshore sharks, is most interesting. It is quite like an amberjack but somewhat more slender and cigar-shaped, with a smaller mouth; with age, first the membranes connecting the spines of the dorsal fin, then the spines themselves, become obsolete. It attains only one or two feet in length, is blue above (instead of greenish as in young amberjacks), and its crossbands, which are persistent through life, are somewhat broader than those of young amberjacks. In short, it is essentially a somewhat specialized young amberjack that retains its youthful habits and colours to maturity.

In the jacks or crevalys (*Caranx*) the anal fin is preceded by two short, stout spines, separate from the rest of the fin, and is a little shorter than the soft-rayed dorsal above it. As the fish grows, the pectoral fin becomes long and falcate. A number of genera allied to *Caranx* differ widely from one another and yet are so connected by intermediates that the number recognized becomes a matter of judgment; there is little doubt that they evolved from a common ancestor. In the jack mackerels (*Trachurus*), cooler water fishes than the others and more abundant in temperate than in tropical seas, enlarged scutes extend the whole length of the lateral line, though usually less firm and without keels on the anterior arch. The scads (*Decapterus*) are more elongate and cigar-shaped. Contrasted with them are several genera of deep, short-bodied, compressed carangids (*Selene, Vomer* or *Argyreiosus, Alectis*). A young moonfish (*Vomer*), being flattened and circular (one and one-half inches in diameter), looks a good deal like a silver dollar. Young African pompanos (*Alectis ciliaris*) are also almost circular in outline, with dark crossbands and with a number of anterior rays of soft dorsal and anal fins prolonged as threadlike

filaments that extend back well beyond the tail. Both fishes drift widely in ocean currents and are indistinguishable in all warm seas. In most species the young fishes are more slender than the adults, but there is a tendency for young Carangidae to be considerably deeper and more compressed than their elders, probably correlated with a drifting habit.

The true pompano (*Trachinotus*) has a small, horizontal mouth beneath a blunt, rounded snout. The pectoral fins are short, and, as in *Caranx*, the anal fin is little shorter than the soft dorsal above it. The very small spinous dorsal fin is reduced to isolated rudimentary spines in the adult. The leatherjacket (*Oligoplites*) is quite different from, although probably related to, the pompano. They are usually elongate, more compressed fishes. The mouth is large, with a projecting lower jaw. The linear more or less fused scales give the skin a leathery texture and a bright silvery colour.

Dolphins.—The dolphins are mackerellike fishes that belong to a distinct family (Coryphaenidae). The dolphin (*Coryphaena hippurus*) is a slender, streamlined, very swift swimming fish that reaches a length of about six feet; it is one of the most truly pelagic fishes. Small groups of dolphins swim at the surface of all warm seas, when far from land preying on flying fishes for the most part. The dolphin is very beautifully coloured, marked with blue above and bright yellow below. When taken from the water, pink and green flushes run over its sides. It has an even-bordered, undifferentiated dorsal fin extending the whole length of the back. In old males there is a high, narrow crest, which gives the forehead a vertical profile. This fish is the dolphin of sailors. (The name dolphin is also used for aquatic mammals, not fish at all. This sometimes caused confusion that extended far back in language, for the dolphin of heraldry, as depicted, usually combined characters thought to pertain to both the fish and the mammal dolphin; *see* also DOLPHIN.)

Bluefishes.—The bluefish (*Pomatomus saltatrix*), a highly predaceous schooling species found in the Atlantic and Indian oceans, is particularly valued as a food fish on the Atlantic coast of the U.S. It has much the contours, fin arrangement and appearance of an amber jack, the most obvious differences being an appreciably broader peduncle without a trace of a keel and slightly rough ctenoid scales. The bluefish is a wide-ranging representative of the family Pomatomidae.

Surf Perches, Cichlids and Damselfishes.—There are several series of fish families supposed to have been derived from the modern percoids. The surf perches (Embiotocidae), cichlids (Cichlidae) and damselfishes (Pomacentridae) are mostly small, active centrarchidlike (sunfish) fishes with the anterior part of the dorsal fin, of strong spines, confluent with the posterior part, of soft rays. The surf perches, of which a number of species are abundant in shore waters from British Columbia to California and off Japan, are notable for giving birth to a relatively small number of large young, instead of laying eggs. The cichlids and damselfishes are characterized by a single nostril on each side, instead of the usual two. The former are fresh-water fishes of Africa and South America; the latter, many of them brightly coloured, are very abundant about coral reefs. The distribution of these two families suggests that they had a common origin in tropical seas and diverged on the basis of this habitat difference. The cichlids all care for their eggs and young; a number of African species carry the eggs until hatched and harbour the young in their mouths.

FIG. 25.—DISCUS (SYMPHYSODON DISCUS) WITH YOUNG FEEDING ON A MUCOUS SUBSTANCE SECRETED BY CELLS IN THE PARENT'S SKIN

Butterfly Fishes.—The butterfly fishes (Chaetodontidae) are an abundant coral-reef family. They have small mouths and deep, compressed bodies, covered with rather small, rough scales. The anterior spinous and posterior soft-rayed parts of the dorsal fin are continuous. The base of the latter, and of the similar anal fin below it, are masked with fine scales. The butterfly fishes are of small size, and a profusion of different species are mostly boldly marked with black bands and frequently with eye marks or ocelli, especially in the young. Many have similar patterns, but those of no two are quite identical. Their markings, combined with bright colours, mostly yellows, make them very conspicuous. A coral reef itself is often monotone or has its colour in masses. It is its great variety of gay, active fishes, pre-eminently conspicuous as one looks down through clear water, that makes it one of the most colourful phenomena in nature. The fishes in most environments are coloured so as to give them a low visibility, a protection from their enemies and a concealment from their prey. The colours of active reef fishes were called "immunity colours," the hypothesis being that the reef is a labyrinth, providing so many avenues of escape that the danger from predators is minimized. It is also to be noted that these highly coloured fishes are not themselves predatory.

The limits of the Chaetodontidae are not well defined, there being several different fishes more or less obviously allied to, but not properly belonging in, this family.

Wrasses and Parrot Fishes.—Another, perhaps the most numerous, coral-reef group, the wrasses and parrot fishes, is more clearly set apart. The wrasses (Labridae) are characterized by a small mouth; rather thick lips; strong, well-spaced, usually pointed teeth in the jaws; and heavy throat bones bearing teeth that are often blunt grinders. Most have moderately elongate, compressed bodies, covered with large, smooth scales. The anterior spinous and posterior soft-rayed parts of the dorsal fin are continuous, usually even, and the spinous is as long as, or longer than, the soft part, which is opposite and approximately equal to the anal fin. The wrass has a characteristic manner of swimming; it glides about by a rowing motion of the pectoral fins, only using the tail when extra speed is requisite. The tail is usually deep and compressed. The caudal fin, although large and deeply forked in the adults of some species, is an adornment rather than a propeller. The reef species are, as a rule, brightly coloured; any colour may be present, according to species, in a fine intricate pattern or in masses. Some species feed on parasites of other fishes. Comparatively very few wrasses are found outside the tropics in cooler northern waters. One such, the tautog or blackfish (*Tautoga onitis*) of the Atlantic coast of the U.S., is an excellent food fish; another, the bergall or cunner (*Tautogolabrus adspersus*), is found as far north as Labrador.

The parrot fishes (Scaridae) are little more than heavy-bodied, large-scaled wrasses, in which the jaw teeth, instead of being well spaced, are fused above and below to form a hard, parrotlike beak, no doubt capable of biting off bits of coral. Most parrot fishes are highly coloured also, although some found over muddy or weedy bottoms are dull or mottled so as to be inconspicuous. The colours are usually massed; a few species are red or blue, but in most green predominates, with red, orange, yellow or blue used as markings.

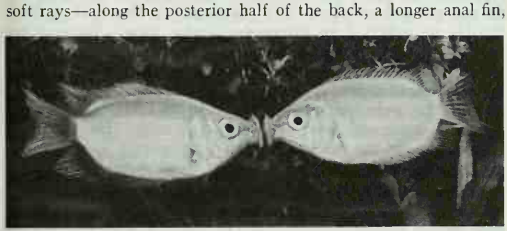
A great many wrasses are small, but some are of moderate or large size; the parrot fishes on an average are larger.

Labyrinth Fishes.—The labyrinth fishes (family Anabantidae) are fresh-water species with an air-breathing organ accessory to the gills, which enables them to live out of water for protracted periods. Two or three snakeheads and a number of small fishes

allied to the climbing perch, which belong to this group, are plentiful in Africa, but the family is primarily south Asian. At the base of the labyrinth fish series are the snakeheads (*Ophicephalus*), in which a pair of pouches from the top of the pharynx, lined with thickened and puckered membrane richly supplied with blood vessels, function as might rudimentary lungs. The snakehead is a vigorous, elongate, large-mouthed fish, more or less cylindrical in front and compressed behind, with a single, long, even-bordered dorsal fin of soft rays only, occupying most of the length of the back. The anal fin is only slightly shorter than the dorsal; the small pelvics are about under the rounded pectorals. The caudal fin is also rounded. The body is covered with rather small, smooth scales. This is a generalized type of fish suggesting the bowfin in appearance, but of course having no relationship to it beyond that of a not dissimilar manner of living. Snakeheads are very tenacious of life, can push themselves along the ground out of water with the pectoral fins and can survive being buried in the mud of marshes and pools when these have temporarily gone dry. The largest species reach a length of three or four feet.

Other fishes of this group have a more complicated labyrinthlike accessory breathing organ in a chamber above the gills. One of these, the climbing perch (*Anabas testudineus* or *scandens*), found in fresh or brackish water of southern Asia and adjacent continental islands, is not unlike a snakehead in shape and general appearance, with a smaller mouth, blunter head and larger eyes. Its long dorsal and anal fins are spinous except for a short posterior part of soft rays. It reaches a length of nine or ten inches. Climbing perches migrate from pond to pond at night and use their spread gill covers as well as their fins in hitching along overland. When in water they frequently come to the surface to gulp air; it is said that they will suffocate if unable to do so. It is also reported that after a rain they come out of water and invade gardens in search of earthworms and that the natives of some parts of India dig them up with a shovel for food where they lie dormant in the mud of temporarily dried-up ponds.

The gourami (*Osphronemus*) is a deep-bodied, compressed fish, with a dorsal fin—which has about an equal number of spines and soft rays—along the posterior half of the back, a longer anal fin,



GENE WOLFSHEIMER—AQUAPHOTO

FIG. 26.—KISSING GOURAMIS (HELOSTOMA TEMMINCKI)

with more rays than spines, and the first soft ray of each pelvic fin produced in a very long filament, about as long as the head and body combined. Gouramis reach a length of 20 in. and are an excellent food fish; they have been introduced in various tropical countries where they are not native. Smaller, similar fishes of the genus *Trichogaster*, frequently kept in aquaria, have the pelvic fins reduced to a single, long filament and a rudimentary spine. Several small labyrinth fishes are favourites for household aquaria because of their bright colours and interesting breeding habits. The paradise fish (*Macropodus*) has large, decorative fins; the dorsal and anal are pointed behind, and the caudal fin is forked in the common species. It makes a floating nest of foam by blowing bubbles of air through a sticky mucus; the bubbles adhere and the eggs are attached to the underside. Unlike the paradise fish, the fighting fish (*Betta*) has a short dorsal fin with not more than one initial spine, spines in the front of the long anal fin being few or absent. The dorsal fin, although short, may be high, and the caudal fin is large and somewhat pointed. Fighting fishes are about three inches long. They build a bubble nest, like the paradise fish, and the males guard nest and eggs assiduously. These fishes are so combative that they are sometimes pitted against one another for sport, as are gamecocks. Another small aquarium fish, seldom over two inches long, is called the purring gourami (*Ctenops vittatus*) because of the sound that it makes, especially during the mating period. In making this sound, the fish, with gill covers and fins extended, shakes itself violently, and the vibrations can sometimes be heard more than 25 ft. away.

Surgeonfishes.—The surgeonfishes (Acanthuridae), another tropical marine family, have well-compressed, usually deep bodies, covered with fine, inconspicuous scales. Typically, there is a narrow peduncle; an emarginate to forked caudal fin; good-sized eyes, placed high; and a small mouth, placed low. Surgeonfishes are largely herbivorous. There are a number of species characterized by a strong, sharp-edged spine on the caudal peduncle; the spine, depressible in a groove, can be erected forward and outward. Most of these fishes are dull coloured, but some are yellow or blue and have bright markings. Some species have the dorsal and anal fins excessively high; one species has immovable nodules on the peduncle in place of the depressible spine. Just how the Acanthuridae are related to the Chaetodontidae is uncertain. The peculiar Moorish idol (*Zanclus*), widely distributed across the Indo-Pacific ocean, seems to occupy a somewhat intermediate position between the two families. In some respects the Acanthuridae approach the tetradontiform fishes, the triggerfishes and allies.

Mackerels, Tunas, Billfishes, etc.—In the mackerels and tunas (Scombridae) the snout and upper jaw are fused into a more or less pointed beak. The spinous dorsal fin may be short and well separated from the posterior dorsal fin of soft rays, or long, depressible in a slot in the back, and very low posteriorly, extending approximately to the front of the soft dorsal. The soft dorsal, as well as the anal fin below or slightly behind it, is short, but both are followed by a series of independent small finlets, each of a single-branched ray, which extend back to the peduncle. The billfishes (Istiophoridae) and swordfishes (Xiphiidae) are strange, large fishes in which the fused snout and upper jaw project far forward as a hard spear or sword, round in cross section in the former and horizontally flattened in the latter.

In the true mackerels (*Scomber*, family Scombridae), the spinous dorsal fin is short and distant from the soft dorsal; there are a pair of small keels at the bases of the upper and lower lobes of the forked caudal fin but none in the centre of the peduncle. Members of this genus are less than two feet long and weigh less than four pounds. They swim at the surface in close-ranked schools. These schools are sometimes of immense size in the Atlantic mackerel (*Scomber scombrus*) of the North Atlantic, a familiar and important food fish. In summer this species invades and spawns in cooler waters than are frequented by most of this family. It is remarkable in that it is a surface fish that is also able to swim at considerable depths. It lacks an air bladder, and on this basis was considered generically distinct from its close allies; the lack of an air bladder, probably correlated with the great difference of pressure at varying depths, is considered here as no more than a species characteristic. The mackerel schools disappear in winter, and where they go is not well understood.

Other members of the mackerel family have a central, gristly keel on the peduncle and the spinous dorsal fin usually extending along the back to approximately the front of the soft dorsal, although low behind and depressible in a slot. Those of the genus *Scomberomorus* (or *Cybium*) are slender and of moderate or large size. The Spanish mackerel (*Scomberomorus maculatus*), a very choice food fish, has a maximum weight of about ten pounds, and the king mackerel (*Scomberomorus cavalla*), a well-known game fish, may reach a length of five feet and weigh 100 lb. There are several genera of mackerels of moderate or large size, those reaching a weight of 20 lb. or less are commonly known as bonitos and the larger species as tunas. The largest is the tunny or bluefin tuna (*Thunnus thynnus*) which not infrequently exceeds 1,000 lb. It has the body covered with fine, inconspicuous scales and silvery marks on the sides. It is a very active, full-blooded fish, with body temperature appreciably above that of the water in which it swims. This species and two or three of its close relatives have a somewhat different structure of the vascular system from other mackerels, which led to their unjustifiable classification in a different

family by some authors. Skipjack tuna (*Euthynnus pelamis*), which reaches a maximum weight of about 20 lb., has enlarged, more or less fused scales forming a corselet in the shoulder region but most of the rest of the body is scaleless. It is a heavy barrel-shaped fish, pointed at both ends, with lengthwise dark stripes on the lower parts. It is truly pelagic, roaming the open ocean far from land in small schools and preying on flying fishes.

The billfishes include the sailfishes (*Istiophorus*) and marlins (*Makaira*). They are characterized by a long dorsal fin extending on the front of the back to over the first anal fin; small, low, second dorsal and anal fins farther back; slender pelvic fins, reduced to one or two rays; a body covered with irregular, linear scales; and a small keel at the base of each lobe of the deeply forked caudal fin, but no central keel on the peduncle. In the sailfishes the pelvic fins are long, the dorsal fin being very high throughout, although depressible in a slot in the back; in the marlins it is moderately high in front and becomes low behind. Sailfishes are slender and compressed, and although they reach a length of more than eight feet, seldom weigh more than 100 lb., whereas the largest marlins exceed 1,000 lb.

The swordfish (*Xiphias*) has a short, high dorsal fin on the front of the back; pectoral fins placed very low; pelvic fins absent; a keel in the centre of the peduncle; and smooth, scaleless skin. The largest swordfish exceed 1,000 lb. They prey on smaller schooling fishes such as mackerel and herring, apparently killing or disabling them with their sword so they can be picked up easily. Swordfishes are taken commercially with the harpoon, a dangerous pursuit, as they not infrequently drive their swords through the bottoms of small boats. There are also many instances of the swords of swordfishes and spears of marlins being driven into the timbers of wooden ships at sea and broken off. Hatching from a tiny egg, the swordfish passes through two or three unlike phases before it approaches the form and appearance of the adult. At one time it has a long, high dorsal fin and at another it has scales, showing its relationship both to sailfishes and marlins.

The several mackerellike fishes just reviewed contain highly valued food fishes. A few of the many species of jacks and mackerels are locally considered unwholesome, probably because of toxic substances in their food that are stored in their viscera and muscles.

Through close relatives of the mackerels, a series leads to increasingly slender, deep-water forms, in which a typically mackerellike though tiny caudal fin is evidently vestigial. The elongate, band-shaped, bright silvery cutlass fish (*Trichiurus*, family Trichiuridae) of shore waters seems to be a terminal member of this series. It has a large mouth and canine teeth, the dorsal fin extending the length of the back, no pelvic fins and the finless tail tapering to a slender filament.

Butterfishes.—The butterfishes (Stromateidae) are small, deep-bodied, compressed shore species, usually valued for food. They bear a strong, superficial resemblance to some of the Carangidae but are not closely related to them. They are characterized by small pelvic fins present in the young, but reduced or altogether absent in the adult, and an esophagus armed with numerous horny teeth. Several peculiar pelagic species are usually placed near this family; *e.g.*, the little banded man-of-war fish (*Nomeus gronovii*), which accompanies the Portuguese man-of-war (*Physalia*) and when alarmed swims up close under the iridescent bubblelike float of this dangerous jellyfish for protection, familiarity enabling it to avoid its long, stinging tentacles.

Gobies, Sleepers, etc.—The gobies (Gobiidae) are mostly small, bottom fishes, comparable with although not directly related to the sculpin series. They are very abundant in individuals and in species in the shallow waters of all warm seas. A relatively small number occur in fresh water, but they are an important factor in the meagre fresh-water fish fauna of tropical oceanic islands. Gobies are variously elongate or shorter-bodied, usually with smooth scales of moderate to small size, but sometimes scaleless. There is no evident lateral line. The size of the mouth varies. The eyes, placed rather high, are usually moderate sized, but there is a blind species (*Typhlogobius californiensis*) living in holes and crannies of the sea bottom off the California coast, in which the eyes are rudimentary. Two separate dorsal fins are present; the anterior, supported by weak spines, and the posterior, of soft rays, which is similar to the anal fin below it. The pectoral fins are usually rounded, with the pelvic fins below or slightly in advance of them. The pelvic fins are joined to form a shallow cup, which may serve to cling to the bottom. Gobies are fairly active little fishes. When at rest on the bottom or in seaweed they are difficult to see because of their concealing coloration. Among the many other forms in this family that have a more or less limited distribution, one of the most abundant (*Bathygobius*), characterized by having the upper pectoral rays free from one another, slender and silklike, is found at the edge of tropical shores.

The mudskipper (*Periophthalmus*) is a specialized goby that spends much of its life out of water, skipping about actively on moist mud or among rocks at low tide, chasing insects or other small fry on which it feeds. It has bulging eyes at the top of a froglike head, and supports the front of its body with the pectoral fins, which have fleshy, muscular bases and are bent downward, while its tail rests on the ground behind; these fins are also used to propel the fish in its longest leaps. When out of water the mudskipper's gill chambers are kept filled with air. It probably breathes to some extent also through the skin, as when it clambers out and rests on a tree root with only its tail in water. It is said that the mudskipper is unable to live submerged for any length of time.

The sleepers (Eleotridae) are related to the gobies and differ primarily by having the pelvic fins separate. Sleepers may grow to two feet, whereas few gobies exceed two inches. Sleepers are found along the shore or in brackish water in tropical or warm temperate areas.

Weevers, Stargazers, etc.—Unlike the families of fishes described above, which are obviously related to and presumably derived from the percoid stem, the following families are a variety of modern, specialized groups, the derivation and relationships of which ichthyologists are in less agreement. The weevers (Trachinidae) are fishes growing from 6 to 18 in., found in the Mediterranean and on other European shores. They are notable for having a spine on the gill cover and for having the spines of the dorsal fin grooved and associated with poison glands, thus making them capable of inflicting an extremely painful sting. Weevers are elongate, compressed fishes. The eyes are near the top of the head, over the large mouth, which slants upward, and the body is covered with small scales. There are a short, anterior, spinous dorsal fin and long, even, soft-rayed dorsal and anal fins, which extend along the upper and lower outlines of the body. The caudal fin is squarish, and the pelvics are placed appreciably in advance of the pectoral fins. The shallow-water lesser weever (*Trachinus vipera*) often buries itself in the sand with only the eyes, mouth and tip of the dorsal spines exposed. The sand stargazers (Dactyloscopidae) of similar body form and presumably similar habits, are exceedingly fragile sand-coloured little fishes, less than five inches long, with no pungent spines; they are not uncommon on sandy tropical shores. The stargazers (Uranoscopidae) are sluggish bottom fishes that may grow to be one foot or so in length. They are characterized by a large, cuboid head, more or less covered with bony plates, and small eyes, directed upward, placed near the front of the head, over an almost vertical mouth.

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FIG. 27.—SOUTHERN STARGAZER (ASTROSCOPUS Y-GRAECUM) WITH ITS EYES DIRECTED UPWARD

Blennies, Klipfishes, etc.—The blennies and related families are a very large and varied series of marine fishes in which the pelvic fins, when present, are placed well forward, often at the throat, and have a reduced number of rays. There are two principal families of blennies. The combtooth blennies (Blenniidae) are tropical or subtropical. They lack scales and for the most part are little fishes with more or less froglike heads, rather small, transverse mouths with a row of comblike teeth in each jaw. There is a rather high, continuous dorsal fin; the front part, with rather weak spines, is about as long as the soft-rayed part behind. The caudal fin is rounded. Numerous species are found associated with gobies in shallow shore waters, resting on or moving deliberately over the bottom, ready to dart away with agility and hide in some hole or cranny. The klipfishes (Clinidae) are also small, tropical fishes, with more symmetrical, compressed bodies covered with scales. In these there is a more normally shaped head, a larger, more normal mouth and rather large eyes. The long dorsal fin is supported by sharper spines for most of its length, usually with a few, frequently only one, soft ray at its hind end. Klipfishes hide among seaweed, rather than living actually at the bottom.

There are a number of elongate mostly cold-water families, closely or more distantly related to the blennies. The gunnels (Pholidae) are primarily fishes of cold northern seas. They have elongate, compressed, more or less eellike bodies, with usually fine, inconspicuous scales. The long, low, even dorsal fin is spinous, with no soft rays; each of the pelvic fins, when present, is often reduced to a tiny spine and single soft ray. The wolf fishes (Anarhichadidae) comprise a few large species of the north, with deep, compressed heads and fore parts of the body, large mouths and heavy formidable teeth. The long, high, even dorsal fin is supported by flexible spines; the pectorals are broad, and there are no pelvic fins. Wolf fishes of the not especially elongate genus *Anarhichas* reach a length of three or four feet; the eel-shaped *Anarrhichthys* is said to grow to eight feet.

Most of the species of the rather stocky eellike eelpouts (Zoarcidae), in which the short, rudimentary pelvic fins are under the gill cleft, and the cusk eels (Ophidiidae), in which the pelvic fins are near the chin, each developed as a long, forked barbel, are found in moderately deep water.

The genus *Brotula,* which inhabits shore waters of tropical seas, comprises fishes one foot or more long, with moderately elongated, compressed bodies, covered with fine scales. Typical features include good-sized eyes and mouth; small teeth in bands; several barbels on the jaws; long, even, soft-rayed dorsal and anal fins meeting in a point around the tail; and pelvic fins reduced to a pair of filaments placed under the gill cleft. The family to which *Brotula* belongs (Brotulidae) is large and varied, comprising about 50 genera, most of which occur at varying distances down in the cool depths of the ocean. Strangely enough, two inhabit subterranean fresh-water streams of Cuban caves. These are almost colourless little blind fishes, with tiny rudimentary eyes.

Other forms, of uncertain affinities, that may be mentioned here are the little, slender, silvery sand lances (Ammodytidae), which swarm along northern beaches, darting in and out of the loose sand; they are an important item in the diet of various fishes and sea birds. Also to be mentioned are the iridescent pearlfishes (Carapidae), which spend most of their lives inside mollusks or echinoderms; they are slender little fishes in which the long tail tapers to a thread and in which there is no caudal fin. They have been observed to enter sea cucumbers, through the small posterior opening, with remarkable facility either headfirst or tailfirst, and to rest inside with the head projecting from the apertures on the lookout for food.

19. Toadfishes and Remoras.—*Toadfishes.*—The toadfish (*Opsanus tau*) is a representative of another family (Batrachoididae, order Batrachoidiformes). It is a sluggish, tadpole-shaped bottom fish of shallow shore waters, reaching a length of one foot or more, with a big, flat head, a bulldoglike mouth with strong, blunt teeth, rounded fins, no scales and a fringe of skinny tabs along the lower jaw. Toadfishes place their eggs in some crevice, empty shell or other receptacle, and one or both parents guard them until hatched. The young hide in seaweed before taking up life on the bottom.

Remoras.—Where the remoras (Echeneidae, order Echeneiformes) belong in the evolutionary system is even more uncertain. These singular fishes are characterized by a large, oval sucking disc occupying the top of the flattened head and extending more or less onto the front of the back, with a central lengthwise ridge and a series of slightly movable transverse plates, like the slats of a blind, with which they attach themselves to sharks and other large fishes. Remoras are almost invariably associated with such hosts, which, at least, furnish them free transportation to distant waters. They are more or less slender and elongate, streamlined fishes, with minute scales which are easily overlooked. Other features include fair-sized eyes; a projecting lower jaw; pelvic fins about under the pectorals; dorsal and anal fins of soft rays, placed well back; and an emarginate caudal fin. They are usually grayish in colour and lack countershading; inasmuch as they rarely swim free in the water, countershading would have no significance for them. The one (*Echeneis*) most commonly attached to coastwise sharks is elongate and has a dark, lengthwise band. *Remora australis,* which attaches to small whales, is especially stout-bodied, with the sucking disc relatively large. *Remora remora* is the species usually attached to offshore sharks; *Remora brachyptera* is often found within the gill cavity of large fishes; and *Remora osteochir* is particularly associated with marlins. The sucking disc of the remoras represents, and is presumably derived from, a spinous dorsal fin. Remoras have superficial characteristics that suggest relationship to the cobia (*Rachycentron*), which has that fin reduced to isolated, short spines; this relationship, however, is remote.

20. Flatfishes or Flounders.—The flatfishes (order Pleuronectiformes or Heterosomata) are in one respect the most remarkable of any fish in the sea. Fishes in general, be they shark, sea horse, perch or something in between, are bilaterally symmetrical, but a flatfish lies on one side on the bottom and has both eyes on the other (upper) side. Furthermore, the upper side is dark, usually mottled gray or brown; the underside, with rare exceptions, is white. Flatfishes can change the tint and even the pattern of the upper side to make it correspond more completely with the surroundings. At rest they lie motionless on the bottom, with their flat, compressed bodies at times being more or less covered with sand or mud and the eyes, which protrude slightly and can be moved freely, exposed. They glide short distances and settle to rest again, but many of them occasionally swim up freely into the water in pursuit of small fishes or other creatures on which they feed.

Their bilateral asymmetry is made no less remarkable by the fact that when a tiny flatfish hatches from the egg it swims or drifts freely in water for a time and has an eye on either side of the head, like a typical fish. The Atlantic halibut (*Hippoglossus hippoglossus*), largest of the order, reaches a maximum length of about nine feet and a weight of 700 lb.; it settles to the bottom when one or two inches long; smaller species, when only a fraction of an inch long. As the time approaches for giving up its free-swimming habits, one eye of the larval flatfish travels around the top of the head from that which will be the lower side to the upper. Most species lie consistently with one or the other side up, according to their kind; a few species are variable in this respect, with sometimes one, sometimes the other, side up in different individuals.

The soles (family Soleidae) are well distinguished from other flatfishes by the very small eyes (on the right side), small crooked mouth and frequent absence of pectoral fins. For the rest, species with a large symmetrical mouth and symmetrical pelvic fins are sometimes placed in a "halibut tribe"; those with a smaller crooked mouth and ventral fins nearly or quite symmetrical, in a "flounder tribe." These tribes are of northerly distribution and are dextral (lie with the right side up). Species with the mouth symmetrical, large or small, and the pelvic fins unsymmetrical are placed in a "turbot tribe," which extends into warmer waters and comprises sinistral species (lie with the left side up). This is still a convenient way to classify these fishes, although it does not express all the phylogenetic relationships worked out within the group. There are many genera and species of flatfishes, especially along the shores of northern seas. They are common enough in the tropics also, but

are there represented by usually smaller species, which constitute a less important factor of the fish fauna. So far as is known, all flatfishes are good to eat and some are very highly prized for the table. They are important food fishes in the cool and temperate shore waters of all seas.

21. Sculpins and Sculpinlike Fishes.—Typical marine sculpins (family Cottidae) are abundant, smallish fishes inhabiting shallow coastal waters of northern seas. The typical sculpin has good-sized eyes placed near the top of a large, spiny head and a large mouth with bands of small teeth. It is a greedy and omnivorous fish. The tail is slender, and the small caudal fin is usually squarish. The skin is mostly smooth, with a few wartlike tubercles or a few scales. Sculpins spend much time resting on the bottom, moving forward a few inches and then coming to rest again. Their mottled colours afford them a low visibility in their environment. An abundant Atlantic species, the longhorn sculpin (*Myoxocephalus octodecimspinosus*), which has an unusually long spine on the side of the head, when taken from the water commonly assumes a defensive attitude by drawing the upper jaw down and forward, slanting these long spines up and back at an angle of 45°, meanwhile emitting a low, drumming sound.

The sculpins comprise a northern cold-water family containing many genera. The fresh-water genus *Cottus* comprises similar smaller fishes with big, broad heads, which are spineless except for one or more small, concealed spines on the edge of the preopercle. Other marine forms, especially those in deep water, differ more widely from this type.

Scorpion Fishes and Rockfishes.—A skeletal peculiarity of sculpins, namely, a bony stay across the cheek, is shared by various related marine families. Scorpion fishes (Scorpaenidae) replace the sculpins in the tropics. The scorpion fish is deeper bodied and more compressed. It is a less strictly bottom species, commonly found among seaweed. As in the sculpins the head is spiny, although smaller and less broad; in the dorsal fin and at the front of the anal fins there are usually stronger spines which are capable of inflicting painful, sometimes serious wounds. The stonefish (*Synanceja*), of the western Pacific, has definite poison glands associated with the dorsal spines. It is a sluggish fish that lies on the bottom, sometimes partly buried in the sand where it could be stepped on easily, and is greatly feared. The freer-swimming, brightly mottled, more conspicuous lion fish (*Pterois*), with very wide spreading fins, which is found in the same seas, also has a bad reputation. Fishes of this family that are allied to the genus *Sebastodes* are misnamed rock cod and are more appropriately known as rockfishes. They are plentiful in cooler water along the shores of the North Pacific. They are more active, have weaker spines, reach a larger size and are of considerable market value, as is their single Atlantic representative, the redfish, rosefish or ocean perch (*Sebastes marinus*). They are ovoviviparous. The eggs hatch within the body of the mother and hundreds of tiny young are born. Other scorpion fishes, and sculpins, although little is left of them when their big heads have been removed, are good to eat, but are little used as food. The flatheads (Platycephalidae), with much depressed, flattened spiniferous heads, are an allied warm-water family, represented by numerous species along the shores of the Indian and western Pacific oceans.

Poachers, Lumpfishes, etc.—The poachers and alligator fishes (Agonidae) are more or less slender and elongate relatives of the sculpins. The angular body is covered with longitudinal rows of scutes. The peculiar lumpfish (*Cyclopterus lumpus*), a member of the Cyclopteridae, inhabits the North Atlantic. It has a short thick, lumpy body and the pelvic fins are rudimentary, forming the bony centre of a sucking disc on the breast. It is a bottom species, but its young are found in detached, drifting rockweed. Lumpfishes are usually green or purplish, sometimes mottled gray in colour, with whitish markings, a pattern obviously designed to give them a low visibility in the rockweed. The snailfish (*Liparis*), which also has a pectoral sucking disc, is a small, sluggish, tadpole-like bottom fish, wherein the body and even the fins are veiled in smooth thin skin. Snailfishes mostly inhabit arctic seas. The greenlings (Hexagrammidae) are food fishes living about rocks and kelp in the North Pacific. The body is covered with small scales and is notable for the presence of several well-developed lateral lines. They are usually elongate and compressed. The dorsal fins are confluent, occupying the length of the back, and the spines of the anterior dorsal are weak. The head is essentially spineless. The related lingcod (*Ophiodon elongatus*) has a single lateral line, a less compressed body and a very large mouth with strong teeth. It reaches a length of more than three feet and a weight of 30 or 40 lb. and is one of the most important cold-water food fishes of the Pacific coast of America, although its flesh is bluish or greenish in colour. The sablefish or so-called "black cod" (*Anoplopoma fimbria*), of these same waters, is highly valued for food about Seattle, Wash. It is a streamlined fish, mostly blackish in colour, with two well-separated dorsal fins and a forked caudal fin.

Fishes of the above and related families, which comprise the sculpin series, are present in greatest variety in the cool waters of the North Pacific. Many types of them are not found elsewhere, and comparatively few found elsewhere are not there represented. The scorpion fishes are the most perchlike; the sculpins have the characteristics of the group best developed and obviously adapted to their manner of life; and there are other peculiar, more highly specialized families. It is reasonable to suppose that the tropical, cosmopolitan scorpion fishes were ancestral to the series, which expanded in North Pacific waters, and that the sculpins, one of its few divisions represented in the Atlantic, reached that ocean via the arctic.

Sea Robins and Gurnards.—The sea robins and gurnards (Triglidae) are well-defined, warm-water marine fishes of rather small size, presumably related to the sculpin series. The rather large, pointed head, encased in a complete armature of more or less spiny plates, with the eyes placed high and the mouth low and horizontal, are very characteristic. The body is covered with small scales; the pectoral fins are large and broad, with the three lower rays detached, thickened and used to finger the bottom. American species (*Prionotus*), known as sea robins, are little used for food, although they are perfectly good to eat after the large head is removed. Mediterranean species (*Trigla*), with smaller and less spinous heads, are of market importance. The deep-water gurnards (*Peristedion*) are peculiar fishes from deep water of the continental slopes; they are obviously closely related to the Triglidae. The snout is produced in two long, flat processes that extend forward beyond the mouth, and the body is covered with longitudinal rows of large, keeled scales. Also present are two free tactile rays at the base of the pectoral fins and branched barbels at the chin. The deep-water gurnards are characteristically bright red in colour. Also related are the flying gurnards (*Cephalacanthus*), which, though not common, are generally distributed in tropical seas. The head is blunter, with a long, backwardly directed spine at its lower hind corner, and the broad pectoral fins are exceptionally large. Sea robins have the habit of swimming upward, then spreading their pectoral fins and gliding slowly back through the water to the bottom.

22. Triggerfishes, Puffers, Molas, etc.—None of these fishes (order Tetraodontiformes or Plectognathi) has paired pelvic fins, their place being taken by a spinous projection at the end of the long pelvic bone in the triggerfishes and some of the filefishes, and no trace of them remaining in other of the filefishes, trunkfishes, porcupine fishes, puffers or molas. The triggerfishes and filefishes have crowded incisor-shaped teeth on the jaws, and the trunkfishes have a single series of narrow teeth. In the porcupine fishes the jaws are covered with a bony plate and resemble the beak of a parrot fish; in the puffers such a beak is divided into four parts by a median suture in each jaw, and in the molas it is relatively weak.

The order Tetraodontiformes is considered the terminal group of the central line of specialization evolved from percoid fishes. They comprise several unlike families that are clearly more closely related to one another than to families of other orders. In all of them the mouth is small and pincerlike; the soft-rayed dorsal and anal fins are alike, placed well back and over one another; and the scales are abnormal or absent. They are weak swimmers.

Some of the species are truly pelagic, occurring in small schools in mid-ocean. The offshore species tend to have the dorsal and

anal fins high and pointed and to swim by moving them from side to side. Those with low, even fins doubtless ripple them much as the filefishes do. The puffers, with short dorsal and anal fins, scull with them in normal swimming, and the offshore species have the higher and more pointed fins. The mola, wherein these fins are particularly high, firm, pointed and placed far back, must propel itself entirely by moving them from side to side, as it lacks any tail. This fish is usually seen lying more or less on its side at the surface of the sea, often far from land. Most Tetraodontiformes may at times have chemicals in their tissues that are toxic to humans. The toxins are accumulated from items in their diet.

Triggerfishes.—The outstanding characteristics of the triggerfishes and filefishes (Balistidae) are a leathery skin reinforced with small, nonoverlapping scales; a spinous dorsal fin placed well forward, consisting of one strong and one or two weak, depressible spines behind it. The first weak spine locks the strong spine in place when the latter is erected. The mechanism involved suggests the trigger of a gun, thus the name triggerfish. The related filefishes are more strongly compressed and thinner bodied. The leathery hide has fine, inconspicuous asperites only, and there is a single high but more slender spine on the front of the back, with the small one behind it being inconspicuous or obsolete.

The filefishes are the most sluggish members of the order Tetraodontiformes. They swim to some extent by rippling the even-bordered dorsal and anal fins, and are great drifters, floating motionlessly among weeds where they are concealingly coloured, as often as not with the head down. They can frequently be caught in the hand. Filefishes abound coastwise and are occasionally carried offshore by currents. The triggerfishes are more active, using the caudal fin more for propulsion, but the young are great drifters in floating weed and are found far out to sea.

Trunkfishes.—The trunkfishes or boxfishes (Ostraciidae) have the head and body completely encased in fused bony plates, leaving only the tail and bases of other fins free to act as propellers. The armour may be four-angled, squarish, or, with a raised ridge in the centre of the back, triangular in cross section; in some species, called cowfish, there are hornlike spines projecting forward above the eyes.

Porcupine Fishes and Puffers.—The porcupine fishes and burr fishes (Diodontidae), covered with long, strong spines, can inflate their bodies so that the spines project in every direction. The puffers or swellfishes (Tetraodontidae), which have loose skins, variously smooth or with fine prickles, can inflate themselves with water or air until they become approximately spherical.

Molas.—All the above fishes are of small or moderate size, but the molas or great ocean sunfishes (Molidae) grow to eight or ten feet and weigh more than a ton. These fishes have short, deep and compressed bodies, with rounded outlines. There are a thick, tough, wrinkled skin; a tiny mouth; small eyes; small, rounded pectoral fins behind short gill slits; and high, pointed dorsal and anal fins, the distance between their tips being somewhat greater than the fish's total length. The body ends abruptly without tapering backward, and is fringed from top to bottom by a narrow caudal fin.

GENE WOLFSHEIMER—AQUAPHOTO

FIG. 28.—SPAWNING BALLOONFISH OR PORCUPINE FISH (DIODON HOLACANTHUS)

23. Other Specialized Fishes.—In reviewing the principal types of fishes, those of peculiar structure correlated with some unusual and standardized manner of life are the most difficult to place. They were presumably successful and persisted, while any relatives that might give a clue to their position were swept away long ago in the tide of evolution.

Clingfishes.—Such are the tadpole-shaped little clingfishes (Gobiesocidae). They are characterized by a large sucking disc between and behind the pelvic fins, which form a part of it; this disc is more efficient and different in structure from any similarly placed sucker in any other group. The clingfish has a smooth, scaleless skin, eyes near the top of the round, flattened head and dorsal and anal fins of soft rays, placed well back. Those found in deeper water are most often reddish or pinkish in colour. Some species exceed a length of six inches, but most are only one or two inches. Some match the colour of the rocks to which they cling in the wash of the surf.

Flying Gurnards.—The flying gurnards (Dactylopteridae) resemble the true gurnards but are placed in a separate family because of certain primitive features in the arrangement of the head bones. They are said to be able to jump out of water, but evidence is not convincing on this point. Probably related to the flying gurnards are the sea moths or dragonfishes (Pegasidae), which are typified by greatly enlarged pectoral fins and a snout like a sea horse.

Ragfishes.—The deep-sea ragfishes (Icosteidae) are aptly named, for when out of water, the fish collapses like a rag. Its inability to hold its shape is probably due to the reduction of bony elements in its skeleton.

Anglerfishes.—There is general agreement that the order Lophiiformes or Pediculati (anglers, etc.) are a most specialized side branch of the spiny-rayed fishes. They are usually short-bodied, more or less shapeless forms characterized by a short, fleshy arm to support the broad pectoral fins; small gill openings, somewhat behind, in or near the axil of the pectorals; and reduction of the anterior dorsal fin to more or less isolated, slender spines.

The North Atlantic monkfish or anglerfish (*Lophius piscatorius*), which reaches a length of three or four feet and may weigh as much as 50 lb., is common in cold, shore waters and ranges well south at considerable depths. It has a very large, broad head, about as long as its tapering, scaleless body, and an enormous transverse mouth, with a projecting lower jaw and bands of formidable pointed teeth. Its eyes are on the top of its head. Its first slender dorsal spine, situated near the tip of the snout, has a skinny tab or "bait" at its apex, which lures smaller fishes to their doom over the great mouth of the angler as it lies inconspicuously on the bottom.

The frogfishes (Antennariidae) are small, sluggish fishes of irregular outline that hide in seaweed where their colours and markings render them inconspicuous. There is a good-sized mouth, opening obliquely upward, and a very slender, movable spine with a bait at its apex over the tip of the snout. Frogfishes probably either "fish" for little shrimps and the like or clamber through the weeds stalking their prey. The Sargassum fish (*Histrio*) is wonderfully camouflaged in the drifting weed where it lives.

The deep-sea anglers, sometimes called sea devils, are the most remarkable of the Lophiiformes. There are numerous mostly small species of these, of different strange shapes, commonly black in colour, often with large mouths and many fanglike teeth. They live in the darkness of the oceanic abyss, and frequently have

phosphorescent, luminous baits. A unique feature in the life history of these fishes is that the male, which is tiny compared to the female, attaches himself to some part of her exterior with his mouth and becomes a parasite for the rest of his life. His organs, except those connected with reproduction, degenerate and he becomes organically fused with her, even to the extent that their vascular systems connect.

Batfishes (Ogcocephalidae) are flat-bodied bottom dwellers; they swim awkwardly. When hungry, a batfish dangles its fleshy lure, which is otherwise retracted into a tube between the eyes, to attract its prey. (J. T. N.; C. Hu.)

C. Some Important Food Fishes

The flesh of fish supplies a high and relatively cheap source of complete and well-balanced protein (about 20% of fresh weight) of a sort that is not readily degraded by usual cooking methods. The amount of fat (which is unsaturated, unlike that of beef, pork and other stock meats) varies from about 1% (cod, haddock, whiting, flounder) to about 20% (salmon, mackerel, lake trout). Fish flesh and softened bones (the latter in canned fish) include satisfactory amounts of vitamins A, B and D; and such minerals as magnesium, phosphorus, calcium, iron, copper and iodine salts.

The following table includes some of the more important kinds of bony fishes that are commercially fished and used as food in a variety of ways.

Table of Important Food Fishes

Fish	Habits	Description
Herring (*Clupea* species)	Northern; inshore; pelagic; schooling; plankton feeders	8 to 17 in.; silvery, rather deep-bodied; compressed; sawlike scales on belly
Pilchard and Sardine (*Sardinops* and *Sardinella* species)	Temperate; inshore; pelagic; schooling; plankton feeders	6 to 8 in.; silvery, with row of dark spots on side behind head; cylindrical
Menhaden (*Brevoortia* species)	Temperate to subtropical; inshore; pelagic; schooling; plankton feeders	12 to 15 in.; silvery, with row of dark spots on side behind head; compressed; sawlike scales on belly
Anchovies (family Engraulidae)	Tropical; inshore; pelagic; schooling; plankton feeders	To 6 in.; usually cylindrical; piglike overhanging snout
Shad (*Alosa* species)	Temperate; anadromous; schooling; plankton feeders	12 to 30 in.; silvery, with row of spots on sides; sawlike scales on belly
Atlantic salmon (*Salmo salar*)	North temperate; anadromous; loose schooling; fish eaters	24 in. or more; silvery or brown, with many spots on sides; slightly compressed; adipose fin on back
Pacific salmon (*Onchorhynchus* species)	North temperate; anadromous; loose schooling; fish eaters	18 in. or more; silvery or dark, with spots on sides; slightly compressed; adipose fin on back
Tuna (*Thunnus* species)	Tropical; offshore; pelagic; schooling; fish eaters	2 to 10 ft.; darkish above; compressed; row of finlets on back and belly
Mackerel (*Scomber* species)	Temperate; offshore; pelagic; schooling; fish eaters	10 to 30 in.; gray above, silvery below; cylindrical; row of finlets on back and belly
Cod (*Gadus* species)	Northern; bottom; mollusk eaters	2 to 5 ft.; greenish or reddish; cylindrical; three dorsal and two anal fins
Haddock (*Melanogrammus aeglefinus*)	Northern; bottom; mollusk eaters	10 to 30 in.; grayish, with dark spot on shoulder; cylindrical; three dorsal and two anal fins
Whiting or hake (*Merluccius* species)	Temperate; inshore; loose schooling; fish eaters	10 to 30 in.; grayish; cylindrical; two dorsal and one anal fin
Drums or croakers (family Sciaenidae)	Warm temperate; inshore; on sand bottom	To 2 ft.; usually deep-bodied; two dorsal and one anal fin; all make noises
Redfish or ocean perch (*Sebastes* species)	Temperate; bottom; shrimp eaters	10 to 24 in.; reddish; deep-bodied; with spines on head
Flounders and halibut (families Pleuronectidae and Bothidae)	Bottom; most food types northern or temperate	To 3 ft.; very compressed; both eyes on one side of the head

VIII. CLASSIFICATION

The following taxonomic outline is one of several in use; authorities differ considerably in the constitution of the higher taxa (subclass, superorder, order). The subordinate groups of each of the first three classes are given in separate articles. Extinct groups are followed by an asterisk (*). Synonyms for some of the groups, based on earlier classifications, are given in parentheses.

Class Agnatha, living cyclostomes and jawless armoured fishes*
Class Placodermi*, jawed armoured fishes
Class Chondrichthyes, sharks, skates, rays and chimaeras
Class Osteichthyes (Pisces), bony fishes
  Subclass Choanichthyes (Sarcopterygii), fleshy-finned fishes
    Superorder Crossopterygii
      Order Osteolepiformes* (Rhipidistia)
      " Coelacanthiformes (Coelacanthini or Actinistia)
        Family Latimeriidae, Coelacanths
    Superorder Dipnoi
      Order Lepidosireniformes (Dipneusti or Dipnoi)
        Family Lepidosirenidae, lungfishes
        " Ceratodontidae, Australian lungfishes
  Subclass Actinopterygii (Teleostomi), ray-finned fishes
    Superorder Chondrostei
      Order Palaeonisciformes*
      " Polypteriformes (Cladista)
        Family Polypteridae, bichirs
      Order Acipenseriformes (Chondrostei)
        Family Acipenseridae, sturgeons
        " Polyodontidae, paddlefishes
    Superorder Holostei
      Order Amiiformes (Protospondyli)
        Family Amiidae, bowfin
      Order Lepisoteiformes (Ginglymodi)
        Family Lepisosteidae, gars
    Superorder Teleostei
      Order Clupeiformes (Isospondyli)
        Suborder Elopoidea
          Family Elopidae, tarpons
          " Albulidae, bonefishes
        Suborder Clupeoidea
          Family Alepocephalidae, smoothheads
          " Clupeidae, herrings
          " Dussumieriidae, round herrings
          " Engraulidae, anchovies
        Suborder Gonorhynchoidea
          Family Chanidae, milkfishes
          " Gonorhynchidae [deep-sea fishes]
        Suborder Stomiatoidea
          Family Gonostomidae, anglemouths
          " Sternoptychiidae, hatchet fishes
          " Stomiatidae [deep-sea fishes]
        Suborder Salmonoidea
          Family Salmonidae, trouts and salmons
          " Coregonidae, whitefishes
          " Thymallidae, graylings
          " Osmeridae, smelts
          " Galaxiidae, galaxiids
          " Argentinidae, argentines
          " Bathylagidae, deep-sea smelts
          " Opisthoproctidae, barreleyes
        Suborder Esocoidea
          Family Esocidae, pikes
          " Umbridae, mud minnows
          " Dallidae, blackfishes
        Suborder Osteoglossoidea
          Family Osteoglossidae, bony tongues
          " Hiodontidae, mooneyes
        Suborder Mormyroidea
          Family Mormyridae, mormyrs
        Suborder Giganturoidea
          Family Giganturidae [deep-sea fishes]
      Order Myctophiformes (Iniomi)
        Family Synodontidae, lizard fishes
        " Myctophidae, lantern fishes
        " Alepisauridae, lancet fishes
        " Sudidae [deep-sea fishes]
      Order Saccopharyngiformes (Lyomeri)
        Family Saccopharyngidae, gulper eels
      Order Cypriniformes (Ostariophysi)
        Suborder Cyprinoidea
          Family Characidae, characins and tetras
          " Catostomidae, suckers
          " Cyprinidae, minnows and carps
          " Cobitidae, loaches
          " Homalopteridae, loaches
          " Gymnotidae, gymnotids and electric eels
        Suborder Siluroidea
          Family Ariidae, sea catfishes
          " Doradidae, noisy catfishes
          " Plotosidae, sea catfishes
          " Siluridae, Eurasian catfishes
          " Ictaluridae, North American catfishes
          " Bagridae, bagrid catfishes
          " Sisoridae, mountain catfishes
          " Clariidae, air-breathing catfishes
          " Malapteruridae, electric catfishes
          " Pimelodidae, South American catfishes

Family Pygidiidae, parasitic catfishes
" Loricariidae, armoured catfishes
Order Anguilliformes (Apodes)
Family Anguillidae, common or fresh-water eels
" Muraenidae, morays
" Moringuidae, worm eels
" Nemichthyidae, snipe eels
" Congridae, conger eels
" Ophichthidae, snake eels
" Echelidae, worm eels
Order Notacanthiformes (Heteromi)
Family Notacanthidae, spiny eels
Order Beloniformes (Synentognathi)
Family Belonidae, needlefishes
" Scomberesocidae, sauries
" Hemiramphidae, halfbeaks
" Exocoetidae, flying fishes
Order Gadiformes (Anacanthini)
Family Gadidae, cods and hakes
" Macrouridae, grenadiers
Order Gasterosteiformes (Solenichthyes)
Family Gasterosteidae, sticklebacks
" Aulorhynchidae, tube-snouts
" Centriscidae, shrimpfishes
" Macrorhamphosidae, snipefishes
" Aulostomidae, trumpet fishes
" Fistulariidae, cornetfishes
" Syngnathidae, pipefishes and sea horses
Order Percopsiformes (Salmopercae)
Family Percopsidae, trout perches
" Aphredoderidae, pirate perches
Order Lampridiformes (Allotriognathi)
Family Lampridiidae, opahs
" Veliferidae, crestfishes
" Trachypteridae, oarfishes and ribbonfishes
Order Beryciformes (Berycoidea or Berycomorphi)
Family Polymixiidae, beardfishes
" Berycidae, berycids
" Holocentridae, squirrelfishes and soldierfishes
Order Zeiformes (Zeomorphi)
Family Zeidae, dories
" Caproidae, boarfishes
Order Cyprinodontiformes (Microcyprini)
Family Amblyopsidae, cave fishes
" Cyprinodontidae, killifishes and top minnows
" Poeciliidae, live-bearers
Order Mugiliformes
Family Phallostethidae, phallostethids
" Sphyraenidae, barracudas
" Mugilidae, mullets
" Atherinidae, silversides
" Polynemidae, threadfins
Order Perciformes (Percomorphi or Acanthopterygii)
Suborder Percoidea
Family Serranidae, sea basses and groupers
" Centropomidae, snooks
" Lutjanidae, snappers
" Haemulidae, grunts
" Priacanthidae, bigeyes
" Apogonidae, cardinal fishes
" Centrarchidae, sunfishes
" Percidae, perches
" Branchiostegidae, tilefishes
" Pomatomidae, bluefishes
" Rachycentridae, cobias
" Carangidae, jacks, scads and pompanos
" Coryphaenidae, dolphins
" Gerridae, mojarras
" Pomadasyidae, grunts
" Sciaenidae, drums
" Mullidae, goatfishes and red mullets
" Sparidae, porgies
" Kyphosidae, sea chubs
" Girellidae, nibblers
" Ephippidae, spadefishes
" Chaetodontidae, butterfly fishes
" Cichlidae, cichlids
" Embiotocidae, surf perches
" Pomacentridae, damselfishes
" Labridae, wrasses
" Scaridae, parrot fishes
" Notothenidae [antarctic fishes]
Suborder Anabantoidea
Family Anabantidae, labyrinth fishes
Suborder Bathyclupeoidea
Family Bathyclupeidae [deep-sea fishes]
Suborder Acanthuroidea
Family Acanthuridae, surgeonfishes
Suborder Scombroidea
Family Gemphylidae, snake mackerels
" Trichiuridae, cutlass fishes
" Istiophoridae, billfishes
" Scombridae, mackerels and tunas
Suborder Stromateoidea
Family Stromateidae, butterfishes
Suborder Gobioidea
Family Eleotridae, sleepers
" Gobiidae, gobies
" Microdesmidae, worm fishes
" Callionymidae, dragonets
Suborder Trachinoidea
Family Trachinidae, weevers
" Opisthognathidae, jawfishes
" Bathymasteridae, ronquils
" Uranoscopidae, stargazers
" Dactyloscopidae, sand stargazers
Suborder Blennioidea
Family Clinidae, klipfishes
" Blenniidae, comhtooth blennies
" Anarhichadidae, wolf fishes
" Pholidae, gunnels
" Stichaeidae, pricklebacks
" Zoarcidae, eelpouts
Suborder Ophidioidea
Family Brotulidae, brotulas
" Ophidiidae, cusk eels
" Carapidae, pearlfishes
Order Batrachoidiformes (Haplodoci)
Family Batrachoididae, toadfishes
Order Pleuronectiformes (Heterosomata)
Family Psettodidae, primitive flatfishes
" Bothidae, left-eyed flounders
" Pleuronectidae, right-eyed flounders
" Soleidae, soles
" Cynoglossidae, tonguefishes
Order Echeneiformes (Discocephali)
Family Echeneidae, remoras
Order Cottiformes
Suborder Cottoidea
Family Scorpaenidae, scorpion fishes and rockfishes
" Triglidae, sea robins and gurnards
" Anoplopomatidae, sablefishes
" Hexagrammidae, greenlings
" Cottidae, sculpins
" Agonidae, poachers and alligator fishes
" Cyclopteridae, lumpfishes and snailfishes
Suborder Dactylopteroidea
Family Dactylopteridae, flying gurnards
Order Pegasiformes (Hypostomides)
Family Pegasidae, dragonfishes
Order Icosteiformes (Malacichthys)
Family Icosteidae, ragfishes
Order Mastacembeliformes (Opisthomi)
Family Chaudhriidae [deep-sea fishes]
" Mastacembelidae, Asian and African spiny eels
Order Synbranchiformes (Synbranchii)
Family Synbranchidae, swamp eels
Order Gobiesociformes (Xenopterygii)
Family Gobiesocidae, clingfishes
Order Lophiiformes (Pediculati)
Family Antennariidae, frogfishes
" Ogcocephalidae, batfishes
" Lophiidae, goosefishes and monkfishes
" Ceratiidae, deep-sea anglers
Order Tetraodontiformes (Plectognathi)
Family Triacanthodidae, spikefishes
" Balistidae, filefishes and triggerfishes
" Ostraciidae, trunkfishes
" Tetraodontidae, puffers
" Diodontidae, porcupine fishes
" Molidae, molas

See the many separate articles on various fishes under their common names; *see* also references under "Fish" in the Index volume.

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FISH AND WILDLIFE SERVICE: *see* WILDLIFE CONSERVATION.

FISH COOKING: *see* FOOD PREPARATION.

FISH CULTURE in the broad sense can be considered a branch of animal husbandry, if the latter term is used to include both the rearing of domestic animals and the harvesting and management of wild game. The maintenance of fish indoors in aquariums is treated under AQUARIUM. This article, concerned with the culture of fish for food and sport, is divided into the following sections:

I. Growing Fish for Consumption
  1. Pond-Fish Culture in Temperate Climates
  2. Tropical Pond Culture
  3. Brackish-Water Pond Culture
II. Stocking Open Waters
  1. Release of Fry
  2. Release of Fingerlings and Larger Fish
  3. Rearing Warm-Water Fishes for Distribution
  4. Introduction of New Species
III. Improvement of the Habitat
  1. Changes in Lakes and Streams
  2. Fish Passes and Screens
  3. Reduction of Mortality From Predation
IV. Regulation of Fishing for Best Yield
  1. Best Exploitation of Existing Stock
  2. Obtaining Maximum Recruitment

I. GROWING FISH FOR CONSUMPTION

1. Pond-Fish Culture in Temperate Climates.—The most widely used fishes in pond culture are those of the great cyprinid or carp family, which is dominant throughout tropical and temperate Eurasia. In Europe the carp (*Cyprinus carpio*) is by far the most popular species because of its hardiness, its unfastidious food requirements and the relative ease with which its fry can be reared. As with other domesticated animals, several recognized varieties of carp have been bred by selection for such qualities as rapid growth, plumpness and resistance to disease. Moderate production can be achieved by maintaining carp as a wild population cropped annually. Much better yields are obtained by having specially designed brood ponds where the adults spawn. Young fry are removed at an early age and transported to nursery ponds in which suitable small foods are cultured or supplied. Later they are placed in the large rearing ponds, in numbers computed to give best yield. The fish are harvested after one, two or three years' growth, depending on the fertility and temperature of the pond, the length of the growing season and the density of stocking. Ponds should be fertilized to promote growth of animal foods for the carp; manure is excellent and even chopped vegetation is useful. Near time of marketing, the fish may be fattened by feeding coarse grains.

In continental Europe carp culture is widely distributed, but it is best developed in the central region, above all in Czechoslovakia, which has no sea fisheries. Fishponds were maintained in England during the middle ages, but have been largely abandoned.

Other species of fishes are sometimes reared in European fishponds, either intentionally or because they enter accidentally with the water supply. Among these are such cyprinids as the tench (*Tinca tinca*), bream (*Abramis brama*), rudd (*Scardinius erythrophthalmus*), roach (*Leuciscus* [*Rutilus*] *rutilus*) and ide (*L.* [*Idus*] *idus*). These are useful only under special conditions—for example, the tench can survive very low-oxygen conditions, the rudd consumes a good deal of vegetation and so on. Only the tench compares in value with the carp, but it grows much more slowly. A noncyprinid fish of some importance in pond cultures is the pike (*Esox lucius*); it is readily sold, and because of its predacious habits can be used to reduce the numbers of cyprinid fry when these are for any reason excessive. The perch (*Perca fluviatilis*), sander (*Lucioperca lucioperca*) and the largemouth bass (*Micropterus salmoides*) have been used for the same purpose.

For centuries in Asia carp and crucian carp (*Carassius carassius*) as well as other species have been extensively used. The Chinese make much use of several cyprinids which are rarely bred artificially. Instead, fry about a third of an inch long are taken in fine nets from the large rivers and reared in small ponds until the various kinds can be sorted out. Then they are distributed to ponds and lakes over considerable distances. The most useful species are four. The grass carp or *huan yu* (*Ctenopharyngodon idellus*) is one of the few fishes that consume pondweeds and coarse vegetation. The fathead or *lien yu* (*Hypopthtalmichthys molitrix*) is valuable because it feeds largely on phytoplankton, the microscopic algae which produce green blooms in fertile waters. The *ching yu* (*Mylopharyngodon piceus*), the black amur of the Russians, has heavy grinding teeth in its throat and favours clams and snails as a diet. *Aristichthys nobilis* consumes zooplankton—the cladocerans, copepods and other small animals that live suspended in the water.

Along the Yangtze river alone there are about 1,800 shallow flood-plain lakes, totaling 8,000,000 ac., which are to varying degrees controlled for fish rearing, using combinations of these four noncompeting species. Each species also may be used separately, or two or more in rotation, depending on the nature and condition of the pond. For example, a pond full of weeds provides excellent food for grass carp for a season; when these are cropped down, a bloom of phytoplankton will probably develop, followed by abundant zooplankton—each of which can be used by the appropriate species.

In India similar use is made of wild cyprinid fry from rivers, especially in Bengal, Bihar and Orissa. Among the most used species are the catla (*Catla catla*), mrigal (*Cirrhina mrigala*) and rohu (*Labeo rohita*), but several other species of *Labeo* and *Cirrhina* are also taken. Little exact information is available concerning these fisheries; they tend to be family affairs whose methods of operation are kept confidential. Certain fishery establishments having large catchment areas, called *bundhs*, are able to produce fry of these Indian cyprinids successfully.

Japan has an extensive pond culture that annually produces several thousand tons each of carp and eels (*Anguilla* species). Israel and Formosa also have extensive pond-fish culture; but none of the really large pond-fish countries report pond-fish statistics separately from wild fresh-water fish.

Rearing trout for market is a somewhat different industry; the fry, hatched artificially, require cool running water and must be fed. The most popular species is the rainbow trout (*Salmo gairdneri*), but brown trout (*S. trutta*) and the American brook trout (*Salvelinus fontinalis*) are also used. Horse meat, slaughterhouse wastes and scrap fish are used for feeding. Biggest producers are the United States, Denmark and Japan. Japan and Formosa also raise quantities of the tasty ayu or sweetfish (*Plecoglossus altivelis*), a salmonid that feeds on plankton and filamentous algae.

Trout fed on the various foods listed above do not, generally speaking, acquire the delicate flavour of wild trout, so as the time for marketing approaches the trout are given special diets or, if possible, a sojourn of a few weeks in ponds containing natural foods.

2. Tropical Pond Culture.—In the tropics large-scale pond-fish culture is complicated by high temperatures, rapid decomposition and rapid growth of floating vegetation, all of which make it difficult to keep a proper supply of oxygen in a pond. Particularly in Thailand, extensive use is made of air-breathing fishes on that account; for example, the gourami (*Osphronemus goramy*) and the murrel or snakehead (*Ophicephalus* species). Indonesia, particularly Java, has many ponds in which are raised carp; crucian carp; a native cyprinid, tawes (*Puntius javanicus*); a catfish, lélé (*Clarius batrachus*); and air breathers. In the Celebes some use is made of Chinese cyprinids whose fry are imported annually—especially the grass carp.

A notable development in tropical pond-fish culture has been the increased use of species of *Tilapia*—called mouthbreeders because in some species the female incubates the eggs and carries the young in her mouth. This genus may actually be the oldest object of pond culture: Pierre Chimits has published an illustration of a bas-relief from a tomb antedating 2000 B.C. that shows an Egyptian angling for *T. nilotica* from an artificial pond. Extensive modern use of *Tilapia* began in the Belgian Congo during the 1940s, using *T. melanopleura* and *T. macrochir*. The most popular species has been *T. mossambica*, widely introduced throughout east Asia and Oceania and in some West Indian islands. This species breeds readily, grows rapidly, tolerates salt water and low oxygen and includes much detritus and algae in its diet.

A rapidly developing branch of tropical and warm-temperate fish culture is the use of rice fields for growing fish. Most rice paddies produce a few wild fish, grown from fry brought in with the irrigation water. By suitable stocking and fertilizing large yields can be obtained from various carps or *Tilapia*, but some strengthening of the dikes and provision of channels in the fields is recommended. Effects on the rice crop are variously estimated from a small decrease to a slight gain in yield. The potential fish production of the world's rice fields is enormous, and it is available mostly in regions where fish are the accepted major protein of the human diet.

3. Brackish-Water Pond Culture.—River deltas and other marshy areas are sometimes developed into fish-rearing establishments; for example, in southern France, along the upper Adriatic coast of Italy, in India, Indonesia, Formosa, the Philippines, Japan and Hawaii. Most of the fishes used are of marine origin; they breed in the sea, but the young seek brackish or even fresh water. Mullets (*Mugil cephalus* and others) are widely used, eels are popular in southern Europe, as are the gilthead (*Sparus auratus*) and sea bass (*Morone labrax*). In tropical countries the milkfish (*Chanos chanos*), called *bandeng* or *bangos*, is most popular, along with mullets, the Javan tawes, the ten-pounder (*Elops saurus*) and *Tilapia*. Shrimps and prawns are frequently important by-products, as are adventitious fish such as the kakap (*Lates calcarifer*).

In a simple form of brackish-water culture, as, for example, in some of the Adriatic *valli*, the ponds are little more than natural salt marshes with channels to the sea closed off by a dike and gate. At appropriate seasons gates are opened and young fish are carried in by the tide. From this type of fishpond there are all gradations up to the extensive *tambaks* of Java, laboriously reclaimed from mangrove swamps and stocked with imported milkfish fingerlings. *Tambaks* are typically 1½ ft. deep; their salinity varies, with the site and season, down to almost completely fresh water. The principal food of milkfish in these ponds is algae, especially the blue-green *Oscillatoria*, giving a direct conversion from vegetable base to useful protein. Other species are used partly because the supply of milkfish is inadequate, partly for their own sake; tawes consume large amounts of vegetation and may improve milkfish production, while *Tilapia* helps to control malarial mosquitoes by removing floating algae. About 33,000,000 lb. yearly of fish and shrimps are produced from 200,000 ac. of ponds in Java; the Philippines have 175,000 ac.

The only example of brackish-water culture on a large scale in cool-temperate regions is carried out in Jutland, Den. Each year young plaice (*Pleuronectes platessa*) are caught at sea and transported to the inner expanses of the Limfiord, where they grow rapidly and provide a good harvest.

II. STOCKING OPEN WATERS

1. Release of Fry.—In the natural reproduction of salmonid fishes (salmon and trout), the eggs are buried by the female up to a foot or more deep in gravel nests or redds. During the 1850s it became a popular practice, in Europe, America and the Antipodes, to remove eggs and milt (sex glands containing semen) from mature trout and salmon and hatch them artificially. In the usual dry or Russian method, eggs and milt are squeezed into a pan, stirred gently and allowed to stand for several minutes, then washed. Rate of development depends on temperature. It is measured in degree-days, that is, the sum of successive days' water temperatures on the centigrade scale. After about 200 degree-days the embryo is recognizable inside the shell, and the eggs are said to be eyed. Three hundred degree-days or so later the eggs hatch, the released fry, or alevins, being delicate creatures with the large yolk sac of the egg still attached. Finally, 800 to 1,000 degree-days after fertilization, the remaining yolk is absorbed into the abdomen and the young fish are called fingerlings. In nature, they then emerge from the gravel and begin feeding.

In the early days of salmonid culture, eggs were held in perforated boxes floating in a stream until the fry were ready for liberation. Later, special troughs supplied with running water were built to hold the eggs, and these were soon installed indoors. To increase their holding capacity the troughs were deepened and provided with removable screen baskets to hold the eggs; double baffles divided the trough into compartments and directed the water from below upward through the eggs in each basket. A newer method is to stack perforated trays containing eggs vertically in layers three or four deep in a special frame so that the water is fed by gravity down the stack but up through each tray. This arrangement permits a great saving of floor space in the hatchery building. Care of the eggs has been simplified by the regular application of malachite green, a fungicide that controls the once-dreaded *Saprolegnia*. Previously this fungus, spreading from a few dead eggs, would quickly blanket and kill a whole basket unless checked by laborious picking.

In traditional salmonid culture the fry were hatched and held in the troughs, to be liberated in natural waters after the yolk sac was absorbed. The reasoning was that fertilization of fish eggs in nature must be extremely haphazard, scarcely exceeding 5% efficiency, whereas with artificial fertilization it commonly exceeds 95%. If the eggs were further protected from flood, drought and enemies during the incubation period, it was assumed that the greater part of the mortality of the normal life history would be circumvented. A very few spawners should suffice to maintain a very large body of fish, and all fears of overfishing could be set aside. So plausible did this seem that the various assumptions involved were not tested individually for many decades.

From its beginnings with salmon and trout (*Oncorhynchus* and *Salmo* species), artificial spawning and hatching were quickly extended to other fresh-water and anadromous fishes (sea dwellers who ascend rivers to spawn). Even ripe sturgeon eggs (*Acipenser* species), usually slated for processing to caviar, were cultured. The small eggs of whitefish (*Coregonus clupeaformis*), shad (*Alosa sapidissima*) or walleye (*Stizostedion vitreum*) were incubated in special glass jars of about 1½ gal. capacity, the water rising gently through the egg mass. Many hundreds of millions of eggs of these species were reared annually in hatcheries throughout the United States and Canada. Similar procedures were applied to marine fishes like cod (*Gadus morrhua*) and plaice, particularly in the North sea region, Maine and Newfoundland, though there was greater difficulty in handling their buoyant eggs.

These intensive efforts to increase natural fish stocks were on the whole extremely disappointing. The expected large increases in production simply were not realized and direct tests were undertaken to determine the cause of the low yield. For production of marine fishes the most conclusive tests were those of Gunder Dannevig in Norway, who compared a series of four fjords alternately stocked and not stocked with cod fry. The number of young cod produced in them was independent of whether they received hatchery fry or not. Similar results were obtained in experiments with plaice in Loch Fyne by Thomas Fulton, with whitefish in the

Great Lakes by John Van Oosten, and elsewhere. In other experiments some advantage of liberating fry was demonstrated, but at a level far below original expectations. For example, in a 12-year Canadian test with sockeye salmon (*Oncorhynchus nerka*), the fry-liberation technique approximately doubled the smolt (two-year-old salmon) production of a small stock, as compared with what a similar number of females produced by natural propagation. However, this was not considered enough gain to justify the expense involved and a computation showed that the country's total hatchery effort was producing only a small fraction of the commercial supply of sockeye.

The failure of fry liberation in open waters led to a reluctant but rather general abandoning of the technique. Most hatcheries for cod, plaice, lobsters (*Homarus* species), whitefish, ciscoes (*Leucichthys* species) and shad have been closed, as have the Alaskan and British Columbian salmon hatcheries, while in other places new techniques or new objectives have been introduced.

Later studies showed what was wrong with the original assumptions. Fertilization of fish eggs in nature is not haphazard, but highly efficient. Cod, for example, swim belly to belly, and the eggs are impregnated as they are extruded. Similarly, salmon eggs are laid in batches in the redd and are immediately smothered with milt. D. F. Hobbs in New Zealand finally showed, as late as 1937, that naturally spawned trout eggs are practically all fertile and that total mortality to emergence may be as little as 20% on good sites. Even temporary drying up of a stream does not necessarily kill the eggs, which are buried deep and stay moist.

Mortality is greatest after hatching; a young fish at the end of the fry stage (yolk sac just absorbed) has just begun its perilous existence. R. E. Foerster's experiments at Cultus lake, British Columbia, indicated that even such large fry as those of sockeye salmon suffer 95% loss during the first year of life and an additional 90% of the survivors perish before they return from the sea to the river estuary. The mortality among the tiny fry of cod, shad or whitefish is far greater. In this way the hundreds of millions of fry released dwindle to hundreds of thousands, to tens of thousands or to merely a few thousands of adult fish—depending on the species.

Finally, it appears that cultured salmon and trout fry are inferior to naturally hatched fry. Richard Vibert in France demonstrated and measured the greater hardiness of fry reared in gravel in terms of their resistance to extremes of temperature, current and predation. A clue to other harmful effects of life in hatchery troughs is afforded by the work of F. Neave and W. S. Hoar in British Columbia. Pink salmon (*Oncorhynchus gorbuscha*) reared in gravel will, at migration time, swim downstream rapidly at night and re-enter the gravel of the stream bed by day until they reach salt water. Thus they remain inconspicuous during a very vulnerable period of their life. However, once the advanced fry are regularly exposed to even weak daylight, as they are in normal hatchery practice, they lose this behaviour pattern. Instead, they school up and let themselves be carried leisurely downstream by day as well as by night, so that they are exposed to attack by a host of voracious fishes, mergansers, etc.

In spite of all this, fry release may not be completely outmoded. Attempts are being made to adjust hatchery procedures so that fry will be normally hardy, with their natural behaviour intact. An alternative course being tried is to move the hatchery outdoors again. New gravel spawning areas are being constructed and existing ones improved in order to obviate damage from predators, silting, floods and drought. In a large installation involving hundreds of thousands of spawners it is necessary to let the fish deposit their eggs themselves, and fish hatching thus becomes linked up with stream improvement. Such efforts are justified, however, only when there is no bottleneck to production at a later stage in the life history. This proviso is met by the pink salmon and the chum salmon (*Oncorhynchus keta*), which go directly to sea after emerging from the gravel.

2. Release of Fingerlings and Larger Fish.—Another reaction to the failure of fry liberation was the attempt to rear fry to a larger size before releasing them. This proved impractical with most of the small-egg species, but trout and salmon responded. Gradually the surviving hatcheries added rearing ponds and began to raise larger and larger fish. Beef liver was at first the standard diet, but the discovery of its effectiveness against human anemia sent its price skyrocketing and set off a protracted search for substitutes. Along with the search for suitable food, the quest for methods for combating diseases has been of major importance. Infections normally of low and unimportant incidence in the wild (endemic) often developed into epidemics in hatcheries, and many millions of young fish have succumbed to attacks by protozoa, fungi, bacteria and other parasites. Sulfa compounds, antibiotics and general sanitation work about as well with fish as with man, but there must be constant watchfulness for the signs of infection.

In Europe stocking streams with trout is for the most part a business. Typically, the owner of a stream purchases young trout (size and quantity based upon his previous experience) from a private hatchery and leases fishing rights by the day or by the season, expecting to make a profit. In North America fishing rights on most waters are still in the public domain, and responsibility for their stocking has been assumed by state or federal governments. It is impossible to make any over-all assessment of the success of their "maintenance" stocking with fingerling or larger trout. However, it is certainly true that many marginal trout streams, and many good trout streams in populous regions, would provide very little game fish without the "put-and-take" planting of large trout. Where hatchery trout are planted into waters containing a good population of native trout, R. B. Miller in Alberta found that the wild stock pre-empts favourable territories and the newcomers lose weight, and most die after a few weeks or months. Similarly, experiments in Michigan showed very little overwinter survival of planted trout when in competition with wild trout. The practical conclusion is that stocking is most successful, as well as most needed, where wild stock is sparse.

In stocking barren or reclaimed waters, of course, there can be good survival from liberations made at any stage from egg to adult. Often planting eyed eggs in gravel is most convenient, while for inaccessible lakes Gustave Prévost in Quebec showed that fingerlings can be dropped from an airplane without harm. A considerable portion of the production of trout hatcheries is now absorbed by lakes high in the mountains, lakes which lack spawning facilities, and lakes or streams cleared of fish by poisoning.

Anadromous fishes also have shared in the trend toward rearing fingerlings to larger sizes. In justification of this, it has been found that stocks of coho or silver salmon (*Oncorhynchus kisutch*) and Atlantic salmon (*Salmo salar*) are usually limited by the size of their river homes rather than by lack of fry. Hence rearing these fish to smolt size makes the hatchery product a clear net gain to the stock; in fact, that is the only way hatcheries can help in such a situation. The same is true for sockeye in some lakes.

Another powerful stimulus to salmon rearing has been the building of dams on salmon rivers. Some Swedish rivers are now dammed completely, from source to mouth, and their surviving runs of salmon and sea trout (*Salmo trutta*) are maintained entirely by rearing of smolts. Similarly, the progressive damming of western United States rivers has been accompanied by rapid expansion of rearing facilities for chinook (*Oncorhynchus tshawytscha*), coho and steelhead (*Salmo gairdneri*). Apart from their status as a (quite inadequate) compensation for lost nursery rivers, the average cost-to-benefit ratio for these installations seems to be close to marginal, if it is computed on the basis of the commercial value of the adult salmon produced and caught. However, most of the fish handled are also taken in large numbers by sport fishermen, and so are popularly assigned a value much greater than the fish buyer's price.

Fortunately, there is much scope for additional improvement in hatchery techniques. Evidence of this is found, for example, in experiments with cohoes at Minter creek in Washington state, in which native stream-reared smolts produced 5 to 15 times as many adult fish as pond-reared smolts of the same stock. Improved diets or other changes should gradually eliminate this differential. Experiments with chinook salmon by Lauren Donaldson in Seattle indicate possibilities of selecting fast-growing and

early-maturing stock for hatchery use. Transplanted fish commonly return to the stream where they were planted and very rarely return to their original stream unless it is close by. However, it has gradually become clear that in many instances transplanted fingerlings do not return to a stream nearly as successfully as fingerlings of the native stock, even when the two are similarly reared and similarly treated. The causes and full implications of this phenomenon have yet to be ascertained—in particular, have the missing fish gone somewhere else, or have they perished? Some of the evidence suggests the latter. Meantime, salmon hatcheries operated for maintenance should be wary of regular shipping of eggs or fingerlings from one watershed to another.

In the U.S.S.R., improved techniques of sturgeon culture are being used on the Volga, Don and Kura rivers, to compensate for the loss of spawning grounds cut off by dams and to increase their celebrated sturgeon fisheries.

3. Rearing Warm-Water Fishes for Distribution.—The general enthusiasm for fish culture in North America early spread from trout to warm-water species. It proved impractical to obtain live eggs by pressure from such "nesting" species as the black basses (*Micropterus* species), sunfishes (family Centrarchidae), crappies (*Pomoxis* species) and catfishes (family Ictaluridae), but these could readily be induced to spawn naturally in suitable ponds. In most species the eggs are guarded by the male parent. The basses require a sheltered gravel nest and the catfishes need a dark hole. Young bass are caught as they rise from the nest and are placed in rearing ponds previously fertilized with manure.

Other fish raised in the northern states and southern Canada include walleye, pike, chain pickerel (*Esox niger*) and occasionally the prized muskellunge (*E. masquinongy*). With any of these fish-eating species cannibalism is a major cultural problem, the control of which demands frequent sorting to even up the size classes, if major losses are to be avoided. For any considerable yield of fingerling walleye, pike or muskellunge, feeding large numbers of live minnows (small cyprinids) is necessary. These are usually seined from natural waters.

The original object of the bass and bluegill culture was to stock lakes and rivers—most of which, however, were supplied naturally with far more fingerlings than the hatcheries could hope to add. After the early 1930s the young fish were more and more used for the initial stocking of small ponds. Many thousands of ponds an acre or so in extent have been developed, and both federal and state governments encourage their use for fishing by supplying planting stock. The most popular initial combination is a mixture of largemouth bass and bluegill (*Lepomis macrochirus*) fingerlings; the ratios recommended vary from 1:1 to 1:15. With luck such a mixture may produce a "balanced" pond population: the young bluegills provide food for the bass, while the bass keep bluegill reproduction under control, and both species grow rapidly. In practice the bluegills sometimes overpopulate a pond and fill it with slow-growing useless stock. An equally common trouble is invasion of the pond by unwanted prolific species like golden shiners (*Notemigonus crysoleucas*), green sunfish (*Lepomis cyanellus*) or black bullheads (*Ameiurus melas*). Remedies include the removal of surplus small fish by seining, drawdown (partial draining), poisoning or "corrective" stocking with a voracious species such as the pike. If a pond is sufficiently isolated so that the accidental appearance of wild fish is very unlikely, the initial stocking can be done using species that reproduce poorly under pond conditions, and hence will not overstock the pond: rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieui*), channel catfish (*Ictalurus punctatus*) and hybrid sunfish have been used.

Other measures of control have also been recommended. For example, the experiments of H. S. Swingle and his colleagues in Alabama show that controlled applications of certain kinds of inorganic fertilizers induce phytoplankton blooms that indirectly promote rapid growth of bluegills (the bluegills chiefly eat the aquatic insects that are dependent on the phytoplankton) and also, by sheer density, control unwanted submerged weeds. Indeed, when pursued rationally, the whole procedure can develop into an intensive pond fish culture on the oriental pattern. However, in America the prime purpose is usually recreation, so harvesting of the crop is done by exciting but inefficient hook-and-line methods.

4. Introduction of New Species.—Much of the early fish-cultural work in North America was devoted to introducing foreign species or to spreading native fishes more widely over the continent. Carp, tench, brown trout and other fish were brought from Europe. Eastern American species were sent west to Colorado, California and Oregon: the shad, striped bass (*Roccus saxatilis*), Atlantic salmon, brook trout, lake trout (*Salvelinus* [*Cristivomer*] *namaycush*), channel and white catfishes, largemouth and smallmouth black bass, perch, bluegills and various other sunfishes, crappies, and several small catfishes or bullheads. Success has been varied. The shad and white catfish (*Ictalurus catus*) have established moderately important commercial fisheries, and the striped bass has become a very popular sport fish in waters near the Golden Gate. The black basses have become locally important for angling. Sunfishes, crappies, perch and bullheads have also proved locally useful, but they often become overabundant and stunted and are blamed for the scarcity of more useful species in many waters. Brook trout have thrived mainly in inaccessible waters not inhabited by native western trout, whereas lake trout have "taken" in a few deep lakes only. The Atlantic salmon could not compete with the very similar steelhead trout. Carp have become locally plentiful but do not tend to be overabundant as in eastern America, perhaps because they encounter in western waters an array of large cyprinids—the squawfish (*Ptychocheilus oregonense*) and its relatives—that eat similar foods and are warm-water predators capable of keeping carp fry at reasonable levels.

In exchange for this array of eastern species, the west had to offer principally its varied salmonids: five species of anadromous Pacific salmon (*Oncorhynchus* species), the lake-dwelling kokanee or fresh-water form of the sockeye salmon, the rainbow trout and its anadromous form the steelhead, two forms of the cutthroat trout (*Salmo clarki*), the Dolly Varden char (*Salvelinus malma*) and the beautiful golden trout of the southern Sierra Nevada (*Salmo agua-bonita*). Of these, only the rainbow trout has become extensively acclimatized in eastern North America, where it is still increasing in abundance and extending its range. As a stream fish it tends to displace the native brook trout except in the colder parts of trout streams. It has also produced some autumn-spawning runs of large fish in the Great Lakes, and true anadromous steelhead have appeared in Prince Edward Island. The European brown trout has also become widely distributed in the warmer trout streams, and has produced runs of sea trout in a few rivers of southeastern Newfoundland.

The most famous fish of western America is without question the chinook, king or quinnat salmon, which averages 20–25 lb. but often grows to 75 lb. and more. It has long been a principal sport and commercial fish from the Sacramento river to the Yukon. It was to obtain eggs of this salmon, specifically, that Livingston Stone established a fish-cultural station in 1874 on the McCloud river, at that time a remote tributary of the Sacramento. With makeshift equipment, and under the surveillance of the somewhat unfriendly Indians whose traditional fishing grounds had been pre-empted, eggs were eyed and shipped to eastern America and throughout the world. Coastal streams from the Mississippi river to the St. Lawrence received shipments, but unfortunately the great majority of the waters stocked were quite unsuitable, and in none was there any permanent success. The same was true in Europe. However, in the Waitaki river of New Zealand a run of chinooks became established, shortly after 1900, and maintained itself and spread naturally to most other major rivers of the east coast of the South Island. Although the McCloud river's salmon are now extinct and the very site of the early hatchery lies buried beneath the waters of Shasta reservoir, there is sentimental satisfaction in knowing that this historic stock still lives and is providing sport and food.

The success of introductions of new fish throughout the world is more or less inversely proportional to the variety and abundance of the native fish fauna. Australia and New Zealand, with a very

limited assortment of native fresh-water fishes, have readily acclimatized such foreign species as carp, tench, bream, perch, brown trout and (in one river) Atlantic salmon from Europe; and, from America, rainbow trout, the chinook salmon and some brook trout and kokanee. South Africa also has provided a home for brown and rainbow trout, largemouth and smallmouth bass and bluegill sunfish. European rivers, with a much more varied fish fauna, have yet found room for American smallmouth bass and the brown bullhead (*Ameiurus nebulosus*), the latter not a particularly welcome immigrant. Asia, richest of all in fresh-water fishes, has apparently not as yet accepted a newcomer, and indeed has felt no need to attempt transplantations.

The acclimatization of desirable new species is difficult and full of pitfalls. Even in success there may be failure. The carp, most prized of warm-water food fishes in Europe, was introduced in North America with high hope, but in most places it is now regarded as a nuisance. Indiscriminate stocking of sunfishes and minnows as "forage fish" has ruined many fine trout waters in western North America. The attempt to introduce a new sturgeon into the Aral sea (U.S.S.R.) in the early 1930s was followed by a massive (though not complete) mortality of the native sharp-nosed sturgeon (*Acipenser nudiventris*), which lacked resistance to a trematode (flatworm) parasite brought in with the transplants. In spite of such dangers, there is renewed interest in the introduction of new species almost everywhere in the world. Judicious selection of kinds that will not compete with useful native species, or that will substitute a more valuable for a less valuable species, offers a wide field for careful experimentation. For example, the very limited salmon stock and fishery of the North Atlantic suggests that a profitable industry could be built up around the Pacific pink, chum and sockeye salmon, species whose life history does not conflict with that of the native species (*Salmo salar*). Hence, renewed transplantation efforts are under way in Canada and the U.S.S.R. The tasty kokanee has been introduced in Oregon and California, and should be welcomed everywhere as a useful plankton-eating species, even if it were to supplant some of the less flavoursome and nonsporting ciscoes and small whitefishes. The Asiatic grass carp and fathead have been proposed for reservoirs of southern U.S.S.R. Greatest care should be taken with small omnivorous species such as the American sunfishes or the African *Tilapia*, which can so easily take over waters without producing a desirable crop.

III. IMPROVEMENT OF THE HABITAT

1. Changes in Lakes and Streams.—In Britain and continental Europe much effort is sometimes expended by an owner in improving his trout stream or other river by creating pools, riffles or covers that harbour fish or make fishing easy. In North America such efforts are largely co-ordinated by governmental agencies. During the business depression of the 1930s, when public works programs employed large bodies of labour for public projects, there was extensive activity in stream improvement in most states. Provision of shade and shelter, control of bank erosion, formation of pools, etc., were all undertaken—methods being developed and codified in the first instance by C. L. Hubbs and his colleagues in Michigan. Attempts were also made to extend these activities to lakes by making brush shelters where fish would accumulate, providing gravel nesting sites for bass and so on. Some of this effort has doubtless had permanent value, though this was rarely actually demonstrated. Generally speaking, there was no time to develop and test a program suited to the individual stream or lake, nor was there much follow-up work.

A more rewarding activity, which has continued unabated, has been the construction of new lakes and ponds for public fishing and other recreation. There are also indirect subsidies for private fishpond construction. By these means fish-producing waters have been increased by hundreds of thousands of acres—or millions of acres if large multiple-purpose reservoirs are included.

2. Fish Passes and Screens.—Obstructions to the migration of fishes occur in many rivers, either as natural falls or as dams of various sorts. When a dam is constructed it has been found feasible to build fish passes which many kinds of migratory fish will use—for example, salmon, trout, shad, carp, suckers (Catostomidae) and eels. Depending on the size of the river and the height of the dam, these passes range from a simple succession of small pools, each about a foot higher than the last, to multimillion-dollar installations with a complex collection system built across the face of the dam.

The most elaborate and expensive series of fishways are those around the main-stream dams on the Columbia river in Washington and Oregon, where chinook and other salmon are the species principally affected. While these structures allow a large fraction of the adult salmon to pass upstream, there is some delay at each, which eventually may become very serious as more and more dams are built.

Not only must adult fish be permitted to go upstream, but the young must get down safely. For dams up to about 100 ft. high, the spillway or the more slowly moving types of turbines usually offer reasonably good routes. Higher dams present problems that are only beginning to be approached seriously. A young fish can fall any distance through the air into water without harm, so experimental overpasses have been constructed on this principle: the water, containing fish, is broken into spray at some point clear of the dam and the excessive turbulence below it, and the fish can fall safely. However, the trouble lies in guiding the young fish to the point where the safe descent begins; almost every installation presents a different problem. One difficulty is a lack of basic information concerning behaviour patterns, muscular capacity, sensory acuity and physiological tolerance of young fish of different species and at different ages. Active research on this problem is in progress.

Sometimes fishways are built to provide a passage over natural or accidental obstructions, rather than dams. A celebrated example is the obstruction of the Fraser river at Hell's Gate in British Columbia, which dates from a series of slides caused by railway construction in 1913–14. Although the most serious damage was corrected by immediate removal of much of the rock, the Gate remained a complete obstacle to the ascent of pink salmon and a partial obstacle to the more vigorous sockeye and chinook salmon up to the time fishways were constructed in 1945–46.

Diversion of water for irrigation has also been a major hazard to anadromous fishes. It has affected particularly the salmon of the Sacramento and San Joaquin rivers of California, and the herringlike hilsa (*Hilsa ilisha*) in certain Indian rivers. Apart from reduced flow in the streams affected, there is direct loss of downstream-migrating young into the irrigation canals. In the United States, government intervention resulted in the installation of elaborate rotary screens on many intakes to prevent fish from entering the irrigation canals. Later, a series of louvers set at an angle down a concrete channel was constructed on a large Sacramento river diversion; the water flows between the louvers, but most of the fish do not pass.

3. Reduction of Mortality From Predation.—There are numerous kinds of animals that, in consuming useful fish, are in competition with man for what he claims as his own food. However, until man can actually use the fish that might be saved from predators, the latter do not cause any real loss. Thus, generalized complaints concerning the tremendous number of fish destroyed by seals, sharks, cormorants, gars, piranhas or snapping turtles—to mention a few popular culprits—may be true or false, but are of no particular interest. Quite different is the situation where predators attack usable fish concentrated in limited areas, or where they interfere with fishing operations. For example, sea lions may follow a troller and take salmon off the line; gray seals can very skillfully rob pound nets; an abundance of dogfish makes trawling difficult; kingfishers and herons gorge on trout from unprotected ponds; and so on. Here either control or evasive action is indicated, whichever is most feasible. Sometimes no action seems possible: Japanese long-liners lose 20% to 30% of their tuna catch to sharks in tropical waters.

In only a few situations has it been shown that a predator is actually involved in limiting useful fish and that control of the predator is feasible. H. C. White in New Brunswick showed that mergansers (goosanders) set a limit to Atlantic salmon production

at a level much below that which the streams could otherwise attain. Systematic control of these birds over a large area was begun and on some streams it increased smolt production fourfold. Similarly it was possible to increase sockeye salmon production threefold by control of squawfish in a British Columbia lake, at a cost amounting to approximately one-tenth of the commercial value of the increase in salmon caught. Local control of char, sculpins, etc., predators of salmon fry, has also been found effective, particularly in association with improvements in redds or water flow.

A spectacular attack on a predator, the sea lamprey, was begun in about 1945 in the Great Lakes. Lampreys are eel-shaped vertebrates that attach themselves to fish or mammals and suck their blood. The sea lamprey (*Petromyzon marinus*) probably became acclimatized in Lake Ontario during a late glacial stage when the lake was a brackish gulf of the Atlantic ocean, but Niagara falls prevented its ascent to the upper lakes. Lampreys frequently attach themselves to boats, so occasional individuals have probably entered Lake Erie since the construction of the first Welland canal. Eventually a pair was bound to breed successfully, but it was only after they had reached Lakes Huron and Michigan in the 1930s that they multiplied disastrously in the numerous suitable spawning tributaries of those lakes. Within a decade lake trout in those waters were commercially, and almost absolutely, extinct. To save the Lake Superior trout, and eventually to restock the other lakes, a system of electrical barriers was installed on all lamprey-spawning streams—some of them quite large rivers. In addition, their waters are being treated with a poison that in the correct concentration kills young lampreys without harming fish.

It is not yet known whether these heroic measures will successfully control or, as their more optimistic sponsors hope, actually eliminate sea lampreys in the Great Lakes. If not, there may be some hope in another direction. In Lake Ontario the lake trout has achieved an uneasy tolerance to lampreys. Many trout are attacked and survive, sometimes bearing more than a dozen healed scars; others seem to avoid attack. Whatever the reasons for this resistance, it may be something that their progeny will retain when transplanted to the upper lakes.

In practice it is difficult to make a clear distinction between predators and competitors; the term "coarse" fish embraces both. Coarse fish removal is sometimes undertaken to benefit the more valuable fish. Some states seine excess carp periodically from shallow lakes to keep in check their roiling (muddying) of the water and uprooting of vegetation. More spectacular is the poisoning of lakes to remove all fish in order to restock with more useful ones. The poison used is usually some form of rotenone, fatal to fish but, in the strength used, harmless to most other water animals and to all warm-blooded animals. As an example, Diamond lake in Oregon, just north of Crater lake, was poisoned in 1955 to remove an overabundant cyprinid (*Siphateles*) population that had been introduced accidentally from the Klamath watershed, probably as a bait minnow. The trout, of course, perished along with the rest, and had to be reintroduced.

IV. REGULATION OF FISHING FOR BEST YIELD

Fishing regulations may be designed simply to divide the available catch among different groups of fishermen or methods of fishing, or they may have as their primary purpose the exploitation of fish in the most rational manner. In pursuing the latter aim, two lines of attack may be distinguished. An attempt may be made (1) to make best use of a stock of fish already in existence or (2) to provide a maximum supply of future recruits.

1. Best Exploitation of Existing Stock.—Any brood or year class of fish decreases in numbers continuously from the time it is hatched. In the first year mortality is severe, but in spite of this the young fish grow so rapidly that the year class as a whole increases in bulk, and may continue to increase for a year or more—depending on the average life span and on feeding conditions. Sooner or later, however, a turning point is reached; losses from natural deaths overtake the rate of growth, the year class begins to decline, and it eventually disappears. For a small minnow this cycle is completed in 2 or 3 years; for the halibut it may take 40 or more. At some time during the cycle the individual fish become large enough to be useful to man. However, if the year class is still increasing in bulk (growth exceeding natural losses) it may be desirable to wait and begin harvesting when a larger total weight is available. But harvesting should not be delayed too long, or the year class will have passed into the declining phase.

More exactly, obtaining maximum yield depends jointly on intensity of fishing and on size at first capture. If fishing is light, greatest yield is obtained by having a small minimum size limit, or none at all, so that thinning out may occur. If fishing is heavy, it becomes important to spare the smaller fast-growing fish so they can be caught when they are larger.

In commercial fisheries the intensity of fishing is determined largely by economic factors: numbers of fishermen and boats tend to increase until catch per trip falls to a level that discourages new investment. Unfortunately, this may happen only after fishing has become so intensive that the stock is no longer yielding at maximum capacity. For example, Michael Graham calculated during the 1930s that North sea fishing grounds for bottom-dwelling species would yield about 13% more if fished 16% less. But to reduce fishing in a manner that makes sense economically, some boats and fishermen must stop fishing entirely. To decide who should stop fishing has so far proved an insoluble problem. However, the biological benefits of decreased fishing were obtained for eastern Pacific halibut stocks (*Hippoglossus stenolepis*), following studies by W. F. Thompson and colleagues, by setting a yearly catch quota.

The other approach, popularized by R. J. H. Beverton and S. J. Holt, is to adjust minimum size limits; it is applicable particularly to trawl and gill-net fisheries. An increase in minimum size by stipulating nets of larger mesh can be instituted without special hardship to the fisherman and even with some saving to him, for nets of larger mesh are usually cheaper and there is less sorting of the catch. Thus, international agreement on larger mesh sizes has been achieved for cod and haddock trawlers of the western North Atlantic; sustained yield increases of 10% to 25% have been predicted as a result—particularly as many of the young fish spared were formerly discarded at sea.

Among the many factors that can complicate this simple theory of exploitation, two important ones are mentioned here. An increase in growth rate sometimes compensates for thinning of the stock; this makes production more stable and also less susceptible to improvement by management regulations. Also, F. I. Baranov long ago showed that an unfished stock of a long-lived species resembles a virgin forest: there is a big crop of mature fish, accumulated and ready to be harvested once. After the first few years of fishing, yield must depend on the (much smaller) annual biological production. Failure to make this distinction has caused and still causes much concern about "depletion" of stocks that actually are only lightly fished.

2. Obtaining Maximum Recruitment.—The above analysis tells how to get the most out of a fishery stock once it is in existence. But in order to have adequate recruits year after year, the spawning stock must not be allowed to become too small. The question is, how small is too small? And can a spawning stock be too large?

Direct study of these questions is made difficult by the tremendous variability of success of reproduction in most fishes. For example, Johan Hjort showed that the 1904 year class of herring (*Clupea harengus*) in Norwegian waters contributed more to the fisheries of 1908 to 1918 than did all other year classes combined. Usually fluctuations are somewhat less extreme than this, but large enough to be of great practical importance.

In addition to these year-to-year fluctuations, there are long-term trends in ocean conditions that may augment the supply of one species, while another becomes depressed until fishing is no longer possible. The marked increase in cod along the southwest coast of Greenland after 1935 is associated with a small increase in sea temperature in this marginal area. Increases in sprats (*Clupea sprattus*), herring and cod in the Baltic sea seem to reflect an increase in salinity there. At other times there is no obvious reason for an observed change. For example, in the southern

North sea the supply of soles (*Solea vulgaris*) increased several-fold in spite of a regular and fairly intensive fishery.

In view of this large and little understood variability in survival of fish eggs, what should be done about maintaining a spawning stock? In the early 1900s there was widespread concern about a possible inadequate egg supply of both marine and fresh-water fishes, and a prevailing rule of thumb for size regulations was that each fish should be allowed to spawn at least once.

Later, fish tended to be divided up into two classes. For oceanic species such as cod, haddock (*Melanogrammus aeglefinus*), plaice and herring, the prevalent (but not unanimous) opinion is that recruitment is practically independent of the supply of spawn. Thus, fishing regulations should concentrate on the best utilization of whatever recruits are at hand, without worrying about the future supply.

For the various salmons, trouts, sturgeons and others the situation is quite different. Since these desirable fish are very easily caught as they crowd into estuaries and pass up narrow rivers, it is simple enough to deplete a spawning stock far below the most productive level. Indeed, if fish are caught only near the end of their lives, as is true of many American stocks of Pacific salmon, the only form that management can take is that of making provision for future supplies. Under these conditions what average fraction of a stock should be caught in order to give maximum sustained yield? Direct observation of certain stocks over a period of years indicates that from 50% to 90% should be caught. Thus, no single rate of exploitation can obtain best utilization of all stocks. Ideally each stock should be managed individually. Since this is difficult when species are mixed together in a common fishery, compromise is often necessary.

If numbers of fish caught can be accurately controlled, a better form of the management question is: what absolute number of spawners in each stock will give the best average yield? Already it is clear that too much spawning for best yield can occur, but too little is more common. Although success of reproduction varies, in fresh water as well as in the sea, this variability does not do away with the need for an adequate number of spawners.

See also FISH; FISHERIES; WILDLIFE CONSERVATION; FISHING VESSELS.

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(W. E. R.)

FISH CURING is the method by which fish is preserved in edible condition by drying, salting or smoking or by a combination of these. Fish decomposes rapidly, particularly in warm climates, as a result of the activities of the bacteria and molds that it harbours, and of enzymic self-digestion and atmospheric oxidation. From earliest times preservative processes have been developed and handed down, and these have permitted storage of day-to-day and seasonal surpluses until times of dearth.

Most methods of curing depend on dehydration, whether by evaporation, as in drying in the sun and wind or over smoky fires, or by extraction of fluid from the tissues by osmosis, in the case of treatment with salts. Common salt, which is chiefly used, and the chemicals absorbed from smoke also have specific bactericidal effects.

Drying alone is used in Norway and Iceland to produce stockfish (*stock*, a "stick") from nonfatty fish such as cod. Once a staple article of diet throughout Europe, it is now mostly eaten in Italy and Nigeria and by Scandinavian epicures in various countries. Hard drying is combined with heavy salting of split cod, etc., in making klipfish (*klipper*, rocks on which the fish was laid out to dry in Norway), an important export from North Atlantic countries to Iberia, the Caribbean and Latin America. French, Spanish, Portuguese and, occasionally, British vessels salt fish on the fishing grounds, usually for subsequent drying ashore. Certain bacteria, peculiarly resistant to salt, cause a form of spoilage known as "pink" from the colour produced.

Fatty fish, such as herring, pilchard and mackerel, are usually eviscerated and mixed with salt so that they become covered with a brine pickle. Packed tight with the pickle in barrels to minimize oxidation of the fat by atmospheric oxygen, this was formerly pre-eminent as an export. The Dutch fishery off the British coast salted and packed the fish on the fishing vessels (*busses*) at sea. In the 19th century the Scottish herring-curing industry was predominant and an extensive trade was built up, particularly with eastern Europe, but this declined after World War I.

"Red herrings" were ungutted herrings, hard salted and then hung in kilns for several weeks over smoldering sawdust fires, and were once popular in England but are now mainly exported to the Mediterranean and the Levant. Salmon, also a fatty fish, was similarly cured for long-term preservation by salting in barrels or salting and smoking. For shorter storage these fish were "potted" by heating in a pickle of salt, vinegar and herbs.

The changes in the fish during hard curing produced a characteristic flavour which added variety to otherwise drab diets and is still appreciated by gourmets. However, when the railways in the mid-19th century permitted for the first time rapid inland distribution of fresh sea fish, later chilled in ice, the taste for these rather tough, salty and highly flavoured hard-cured products declined in industrialized countries. Trade in them is therefore generally confined to countries, mostly with warm climates, that are not yet sufficiently advanced economically to rely on the distribution of fresh and frozen fish. Many such countries are also developing their own fisheries and therefore hard-curing methods, suited to the preservation of expected increases in supplies, may continue to be used for some time.

In the more advanced countries, particularly in northwest Europe and North America, during the period 1850–1950, much more lightly cured, mildly smoked products were developed that can be distributed satisfactorily but not stored without refrigeration. Typical of these are the kipper, which is made from split, gutted herring; the bloater, a whole, ungutted herring; the finnan haddie or haddock, which is cut open in a special way; and various types of smoked fillets. In Germany and Sweden hot-smoked products are preferred, such as buckling (from unsplit herring) and smoked eels, which are cooked in the smoke. All such products contain only sufficient salt and smoke to impart an attractive flavour (colour usually being supplied by harmless dyes), while the slight degree of drying avoids undue toughness. Furthermore, cold storage can be used partially or almost wholly for preserving.

From 1935 onward research workers and engineers investigated the traditional processes with a view to improvement. As a result mechanical dryers and smoking kilns that provide a better degree of control are becoming widely adopted both for the hard export cures and the milder ones for home consumption.

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FISHER, ANDREW (1862–1928), Australian statesman, prime minister in three of the commonwealth's early Labor governments, was born in Scotland, near Kilmarnock, on Aug. 29, 1862, and began life as a coal miner. He emigrated to Queensland at the age of 23 and was elected to the Queensland legislature in 1893. He became a pioneer member of the Labor party in the federal parliament (1901), a member of the first Labor government (1904) and prime minister (1908–09, 1910–13, 1914–15). His second term of office was particularly fruitful, especially in its moderate socialist policies, including the creation of the commonwealth bank, the imposition of a land tax, the introduction of maternity allowances and extension of the judicial arbitration system. In addition, a public works loan policy was formulated and the transcontinental railway begun. "Andy Fisher's golden days" have since become proverbial among Labor supporters. A man of simple, sincere personality, he was also a sound administrator. His governments developed Australia's armed forces, and he was quick to promise absolute support to Great Britain in World War I. This policy he carried through in 1914, but the strain imposed by the war caused Fisher to resign in 1915. He was high commissioner in London from 1916 to 1921 and died there on Oct. 22, 1928. (O. M. R.)

FISHER, HERBERT ALBERT LAURENS (1865–1940), English historian and statesman, chiefly remembered for his *History of Europe*, three volumes (1935), was born in London on March 21, 1865, and educated at Winchester and New college, Oxford. He became a fellow of New college in 1889, abandoned classics for history and studied in France and Germany, reacting strongly against German "scientific" history in favour of a more personal, elegant and liberal approach. He produced several works ranging from *Studies in Napoleonic Statesmanship: Germany* (1903) to *The Republican Tradition in Europe* (1911). His liberal sympathies led him to accept Lloyd George's invitation to become president of the board of education (1916) where he was responsible for the Education act of 1918 (*see* EDUCATION, HISTORY OF: *History of National Systems: England, 20th Century*). Fisher was later British delegate to the League of Nations assembly (1920–22) before returning to Oxford, where he was warden of New college from 1925 until his death in London on April 18, 1940. His defense of Macaulay and other writers of the same school in *The Whig Historians* appeared in 1928. The *History of Europe* showed Fisher's aims, sympathies and approach to large subjects and became a popular work, standing as his monument in the tradition of Macaulay and Lord Morley.

See D. Ogg, *Herbert Fisher 1865–1940* (1947).

FISHER, IRVING (1867–1947), U.S. political economist, who combined the talents of a scientist with the interests of a crusader, was born at Saugerties, N.Y., on Feb. 27, 1867. After taking a bachelor's degree (1888) and a Ph.D. degree (1891) in mathematics from Yale university, he taught mathematics before shifting to economics, becoming a full professor at Yale in 1898. Fisher used mathematical methods to discover original solutions to some of the fundamental problems of economics. His crusading spirit led him into many fields of reform, including economic stabilization, health, eugenics, conservation, prohibition and the League of Nations.

In *The Purchasing Power of Money* (1911) Fisher developed the modern version of the relation between changes in the quantity of money and changes in the general level of prices. In numerous writings he expounded his plan for the "compensated dollar," a dollar of constant purchasing power, sometimes referred to as the "commodity dollar." In place of the conventional gold standard, which defined the unit of money in terms of a given weight of gold, Fisher proposed to define the dollar in terms of a given value of gold. The constant value of gold was determined by an index number of commodity prices of a given basket of goods.

Among more than two dozen books, his most important were: *Mathematical Investigations in the Theory of Value and Prices* (1892); *The Nature of Capital and Income* (1906); *The Purchasing Power of Money* (1911); *The Making of Index Numbers* (1922); *The Theory of Interest* (1930); *Booms and Depressions* (1932). (D. Dd.)

FISHER, SAINT JOHN (1469–1535), English Roman Catholic bishop and cardinal, martyred for denying that Henry VIII was supreme head in earth of the Church of England, was born at Beverley, Yorkshire, and was ordained in 1491. His distinction as scholar, preacher and administrator brought him to the notice of Lady Margaret Beaufort, mother of Henry VII. He became her confessor (1497) and persuaded her to found readerships in divinity (1503) at the universities of Oxford and Cambridge and to found Christ's college (1505) and St. John's at Cambridge. She died in 1509 and Fisher became the effective founder of St. John's, which was finally established (1511) only through his persistence and generosity. In 1504 he was appointed chancellor of Cambridge university and bishop of Rochester, positions he held for 30 years. Through his influence his friend Desiderius Erasmus went to Cambridge (1511) as lecturer in Greek, a language that Fisher set himself to learn when nearly 50 years old. He also encouraged Hebrew studies. As a bishop he was unique in his day for his devotion to his diocese.

The series of sermons he preached in 1508 on the Penitential Psalms were printed by Wynkyn de Worde (1509); the book was in constant demand for many years. Much of Fisher's work at Cambridge was directed toward the training of scholarly priests and effective preachers, for he recognized the weaknesses from which the church was suffering; as he once said, "in the times of the apostles there were no chalices of gold, but there were many golden priests; now be many chalices of gold, and almost no golden priests." He offended Wolsey by preaching before him (1518) on this theme and on the need for setting the example of a simple and devout life. Two years later Fisher began his work as a controversialist; his books in Latin against Lutheranism and allied heresies gave him a European reputation as a theologian. He preached against the heresies of the day at St. Paul's cross in 1520 and 1526.

In convocation and in the house of lords he strongly opposed any interference by the state in church affairs, and urged that the church should reform itself. When the validity of the marriage between Henry VIII and Catherine of Aragon was first openly questioned (1527), both Henry and Wolsey consulted Fisher, who, after close study of the authorities, assured the king that there was no cause for his professed uneasiness of conscience. When the case was brought before Lorenzo Campeggio and Wolsey at Blackfriars in 1529, Fisher boldly defended Catherine; this defense was later published and Fisher also preached in London on the queen's behalf. By these actions he incurred the king's anger, which was further increased when Fisher vehemently opposed the granting to Henry (1531) of the title "Supreme Head of the Church and Clergy of England." The most he could achieve was the addition of the phrase "as far as the law of God permits," but this was omitted in the Supremacy act of 1534.

The first step in the king's attack upon Fisher came with the accusation that Fisher had not reported the subversive prophecies of Elizabeth Barton (*q.v.*). By an act of attainder (March 17, 1534) he was condemned for misprision (concealment) of treason, and a fine of £300 (a year's income from his diocese) was exacted in place of imprisonment during the king's pleasure. The Act of Succession (1534) required all subjects of full age to take an oath not only accepting the succession of Henry's issue by Anne Boleyn but also assenting to the whole act, which bastardized Princess Mary and repudiated the authority of the pope. Fisher and Sir Thomas More were called to take the oath (April 13, 1534); both refused on the grounds that, while willing to accept the succession as a proper matter for parliament, they could not accept the rest of the act. Four days later they were sent to the Tower of London. Fisher was then seriously enfeebled by illness, but his imprisonment became so harsh that he had to beg Thomas Cromwell (Dec. 22, 1534) to let him have warm clothing and suitable food.

The passing of the Supremacy and Treason acts at the end of 1534 tightened the hold of the law over Fisher and More, as denial of the royal titles was now made treason. Pope Paul III created

Fisher a cardinal (May 20, 1535); this inflamed the temper of the king so greatly that all hope vanished that he would show mercy to an aged man who had rendered such great services to religion and learning. Fisher was called several times before the appointed councilors, but refused to speak about the supremacy. It seems that at last the solicitor general, Sir Richard Rich, by a trick, in a conversation that he said was privileged, got Fisher to state his belief that the king was not and could not be supreme head of the Church of England. He was tried (June 17, 1535), was condemned for treason and was executed on Tower hill on June 22. His head was displayed on London bridge, and the stripped body was hastily buried in the churchyard of All Hallows, Barking. When, a fortnight later, Sir Thomas More was also martyred and was buried in St. Peter ad Vincula within the Tower, Fisher's body was reburied in the same church. He was canonized in 1935 and his feast day is June 22.

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FISHER, JOHN ARBUTHNOT FISHER, 1st Baron (1841–1920), British admiral, the first sea lord whose forceful and far-reaching policy of reform ensured the superiority of the Royal Navy during World War I. He was born in Ceylon on Jan. 25, 1841, and entered the navy at the early age of 13 "penniless, friendless and forlorn." He saw active service as a midshipman in the Crimean War, and also in China in 1859–60 when he took part in the capture of Canton and the attack on the Peiho forts. He specialized in gunnery and was employed for four years, while a commander, on experimental work with guns and torpedoes, being mainly responsible for the revision of *The Gunnery Manual.* Promoted to captain in 1874, he commanded various ships and the gunnery school. As captain of the new battleship "Inflexible," he took a prominent part in the bombardment of Alexandria (1882) and afterward commanded the naval brigade ashore.

After this campaign, Fisher held the post of director of naval ordnance and torpedoes for five years and reached flag rank on Aug. 2, 1890, serving for a year as admiral superintendent of Portsmouth dockyard. He was appointed to the board of admiralty in 1892 as third sea lord and controller of the navy, and for five years was responsible for the material efficiency of the fleet. He was knighted in 1894. He was commander in chief of the North America and West Indies station in 1897–99, and, after representing British naval interests at the Hague peace conference, became commander in chief of the Mediterranean fleet.

Fisher returned to the admiralty in 1902 as second sea lord. He was largely responsible for a revolutionary scheme for the entry and training of naval officers; in place of the old training ship "Britannia," cadets entered a new naval college at Osborne at the age of 12, whence after preliminary training they passed on to another college at Dartmouth. Engineers, executive officers and marines all received a common training and did not specialize until they reached the rank of lieutenant. Fisher became commander in chief, Portsmouth, in Aug. 1903. He went to the admiralty as first sea lord on Oct. 21 (Trafalgar day), 1904. He was created Baron Fisher, of Kilverstone, in 1909, and retired in Jan. 1910. During his time at the admiralty Fisher carried out some remarkable changes in the organization of the fleet, administration of dockyards, ship construction, development of submarines, conversion from coal to oil and gunnery development. To counter the rapid rise in strength of the German navy he reinforced British naval forces in home waters by reducing drastically the fleets on foreign stations—notably the Mediterranean. He scrapped obsolete ships, thus achieving a measure of economy while at the same time releasing men of high quality to provide the nucleus of crews for ships in reserve and bringing them to a higher degree of readiness for war.

At the same time Fisher was responsible for the creation of the battleship "Dreadnought" carrying ten 12-in. guns, the prototype of a design known as the "all-big-gun ship" which revolutionized naval construction and was immediately copied by Germany. As a result of his colossal drive, the ship was completed nine months after her keel was laid down, a record in battleship construction that has never been surpassed. Later, when German competition became acute, he got approval for his naval program with the slogan "We want eight and we won't wait." In addition he created the lightly armoured "Invincible" battle cruisers, carrying the same heavy armaments as the battleships but relying for their protection on high speed. In the test of war, however, the heavily armoured German battle cruisers proved more successful. Nevertheless, because of Fisher's foresight and creative genius, the Royal Navy entered the war with a fairly comfortable margin of strength. His autocratic methods were criticized by Lord Charles Beresford in 1909 and there was resentment in the fleet when it was revealed in the house of commons that Fisher had encouraged his friends to write to him about the capabilities of other officers. In consequence many officers felt that their chances of promotion were small unless they happened to be in the "fish pond."

Fisher left the admiralty in Jan. 1910 and remained in retirement until Oct. 1914 when he was recalled to be first sea lord on the resignation of Prince Louis of Battenberg. He was immediately confronted with the startling news of Adm. Sir Christopher Cradock's defeat by Graf von Spee at the battle of Coronel. With characteristic boldness Fisher detached the battle cruisers "Invincible" and "Inflexible" from the main concentration in the North sea and sent them to South American waters, where they met and destroyed Spee's squadron in the battle of the Falkland Islands. Fisher disliked the idea of a naval staff, preferring to do his own thinking on matters of strategy. A firm believer in British sea power, he supported amphibious operations, disapproving the army's involvement in France, and advocated striking at the heart of Germany from the Baltic in co-operation with the Russians. Yet in 1914 he opposed the Dardanelles expedition, which if properly planned held great possibilities for the use of sea power. Surprise was lost by an ill-timed attempt to force the straits by ships alone, and Fisher, feeling that any further reinforcement might imperil the naval position in the North sea, resigned on May 15, 1915. He published two volumes of memoirs, *Memories* and *Records,* in 1919, and he died in London on July 10, 1920.

Fisher was beyond question a genius and one of the greatest figures of his age. He had no fear of politicians, and, although not good in presenting his case logically, usually got his way by the strength of his personality, expressing himself in a series of verbal explosions often coloured with biblical analogy. His free use of slogans such as "Scrap the lot!" left no doubt in the public mind of the intentions of his policy. Ruthless to his enemies and charming to his friends, he favoured most those who had helped him with material development, but when war came he was quick to recognize qualities of leadership in others who were destined to command British naval forces at sea, and gave them his full support.

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FISHER (*Martes pennanti*), a North American carnivore of the weasel family (Mustelidae). It is brownish-black and about four feet long (including the bushy tail). The fisher, also called pekan, Pennant's marten and black "cat," is trapped for its valuable fur. A powerful little animal, it attacks its prey, largely rodents, with ferocity. In habits the fisher resembles its smaller relative, the marten (*q.v.*).

See also Carnivore; Fur.

FISHERIES. The term "fishery" embraces every method for pursuing and capturing aquatic animals, whether for profit or for sport. The term is usually meant to include whales and seals, even though they are mammals and not fish. Neither whaling nor sealing, however, comes within the scope of this article, which is concerned primarily with the historical, operational, research and conservation aspects of the commercial fisheries for both fresh- and salt-water fish and shellfish.

For discussions of whaling and sealing *see* the articles Whale Fisheries and Sealing. For information about sport fishing *see* Fishing.

HISTORICAL DEVELOPMENT

When man first ventured to sea he probably was pursuing fish. As fishing developed it prepared the way for sea trade and thus became a fundamental part of modern civilization. As nations organized large fishing fleets they became sea powers; the once-powerful Hanseatic league, for example, traced its beginnings to the herring fisheries. The rise of the Dutch as a sea power in the 17th century grew out of their dominance of the fisheries of the North sea. As early as the days of the Tudors the English were fishing not only in the North sea and other home waters but also off Iceland and Newfoundland to the west and as far as Vardö, Nor., to the east.

The fishing industry expanded and developed rapidly when improved means for taking fish became available. The introduction of steam vessels enabled fishing crews to travel faster and farther and in bigger ships. The development of diesel engines was a further improvement. The use of power equipment aboard ship made it possible to handle bigger nets and to take larger catches. The introduction of methods for icing or freezing the catch aboard ship improved the efficiency of the fishing fleet. The development of man-made fibres made it possible to use more efficient and bigger nets. The development of factory, or mother, ships on which filleting, freezing, canning and the manufacture of by-products could be conducted made it possible for large fleets of fishing vessels to operate thousands of miles from home ports. As the improvements were made, fishermen pushed farther and farther from their home ports until they covered most parts of the globe where fish were to be found in large enough quantities to make commercial fishing profitable.

Fish, beside being important as food, came to be a major raw material for several industries; *e.g.*, the manufacture of fish meal,

BY COURTESY OF MARINE RESOURCES OPERATIONS, SAN PEDRO, CALIF.; PHOTOGRAPH BY J. B. PHILLIPS

COMMERCIAL FISHING BOATS NETTING SQUID OFF MONTEREY, CALIF.

which is used as a feed for poultry and swine and as a fertilizer; the production of oils of various kinds, ranging from cod-liver oil to those used in tanning, soapmaking and the manufacture of margarine (*see* also OILS, FATS AND WAXES: *Uses*). Glue and isinglass are among the by-products of fisheries; fishskins can be converted into fine leather.

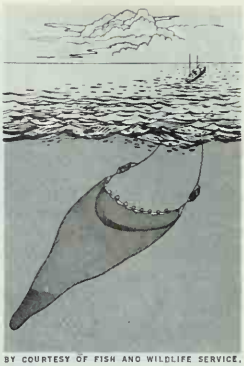
Although it was once thought that the supply of fish in the sea was inexhaustible, since about 1900 it has been recognized that man's activities may jeopardize the stability of the stock. It is important, with the growth of the world's population and the accompanying increase in demand for foods rich in protein, that nations co-operate in managing the world's fish supply in order to take full advantage of this resource.

The oceans and inshore coastal waters of the world provide most of the catch of fish and shellfish. Inland fisheries in fresh-water lakes, streams, farm ponds and rice paddies are estimated, however, to yield about 10,000,000,000 lb. of fish and shellfish annually.

FISHING METHODS

Perhaps the oldest method of catching fish is that of direct attack with a spear. Another ancient method involves the use of a trap, such as the weir, to intercept and capture roving fish. Fish-weirs admit fish at high tide and trap them when the tide ebbs. Expansion of the fishweir idea into a trap of wattle hedging and then into fixed nets is a logical evolution. Another form of trap is that into which fish are attracted by food; examples are the wickerwork traps for catching lobsters, prawns and crabs.

The baited line was probably first used without a hook, as it still is when eels are caught by "clotting," or "bobbing"; that is, by tying a bunch of worms at the end of a line and, when the bait has been taken by the eel, drawing the line in swiftly before the eel has disengaged its teeth. This method was improved upon by the introduction of a hook, the earliest form of which may have been a thorn. From these methods the more elaborate devices employed in modern commercial fishing were evolved, the most important being the system for bringing the trap, in the form of a net, to the fish instead of trusting to the natural movements of the fish or the lure of bait to bring the fish to a stationary trap.



BY COURTESY OF FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR

FIG. 1.—FISH OTTER TRAWL

In the fisheries of the North Atlantic and North Pacific, which are the most highly developed in the world, the chief methods of fishing are trawling, seining, gill netting (drifting) and lining. In trawling and seining a net is brought to the fish; in gill netting the fish approach the net; in lining, the line may be brought to the fish or the fish may approach the line.

Trawling.—In the case of the trawl, the trawler drags a bag-shaped net whose mouth (also called the wings) is kept open by one of three methods: by placing a beam across the head of the net; by towing the net with a pair of ships, one at each side of the net; or by attaching wooden kites, or otter boards, to the sides of the mouth. The beam trawl is used only on a few small fishing craft; the otter trawl, which is employed on almost all but the smallest trawlers, is the most effective device for taking demersal (*i.e.*, bottom-living) fish. Pair trawling is an efficient method for catching hake and herring off the bottom. The efficiency of the otter trawl has been improved by several modifications, one of which is the Vigneron-Dahl modification, a French invention in which the otter boards are attached to the wings of the net by wires up to 50 fathoms long.

Seining.—In seining, the fish are gradually encircled with a net in the centre of which is a bag similar to the one at the end (the "cod-end") of the trawl. Seines are used for catching both pelagic and demersal fish. (Pelagic fish are those caught in the upper layers of the sea.)

The types of seine used most frequently in pelagic fisheries are the lampara net, the purse seine and the rather similar ring net. When these nets are used, a shoal of fish is first surrounded with a curtain or wall of netting that is buoyed at the surface and weighted at the bottom. The lampara net has a large central bunt and short wings; the school of fish is worked into the bunt and captured. With the purse seine, once the school is surrounded, the bottom of the net is closed by drawing a line through purse rings attached to the lead line; the fish are then concentrated and removed by a brail

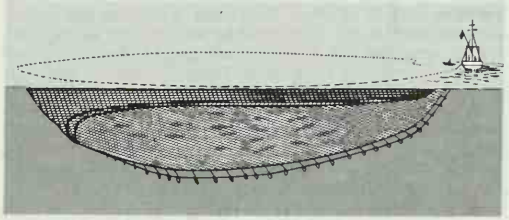


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FIG. 2.—SALMON PURSE SEINE

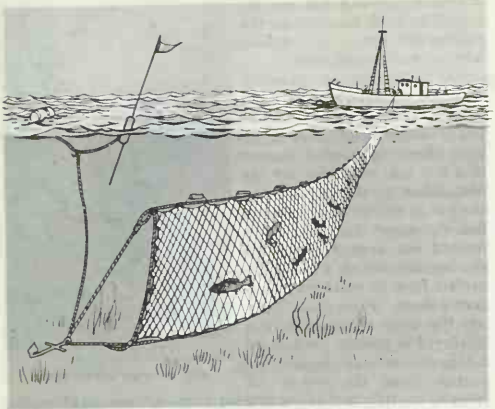

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FIG. 3.—ANCHOR GILL NET

or are pumped aboard the fishing vessel. The ring net resembles the lampara net in two ways: (1) it has two wings; and (2) the bottom of the central portion is closed with a purse line; it differs, however, in that it does not have a prominent bunt.

An efficient form of seine for catching demersal fish is the Danish seine, so-called because it was invented in Denmark where it is the principal means of catching demersal fish. It is widely used in other countries, particularly Scotland and England. With the Danish seine, an area of the sea bed is first encircled with two ropes of equal length of up to about one mile; to adjacent ends of the ropes is attached a trawl-shaped net. When the ropes and net have been placed in position, the free ends of the ropes are drawn to an anchored ship, thus gradually reducing the area of sea bed surrounded. Fish are driven before the moving ropes to the centre of the encircled area and are taken in the net, which is eventually drawn up to the ship.

Drifting.—The drift, or gill, net differs from the trawl and the seine in that it is not actively brought to the fish. On the other hand, it differs from the stationary trap and the many forms of stationary net in that it is attached either to a floating buoy or to a drifting ship (hence the name) and moves with the buoy or ship under the influence of wind and tide. It is lightweight but strong, being made of cotton, linen or man-made fibres; this net is the principal type used in the European herring fisheries. Each herring net is from 50 to 60 yd. long and about 14 yd. deep; fleets of as many as 85 nets may be placed in the water at a time from one vessel so as to form a wall of netting hanging perpendicularly in the water. The net is generally adjusted so that it floats with its top about 3 yd. below the surface of the water; it is kept at the desired level by a series of buoys, or "pellets," connected with the headline by strops. This net is devised to catch fish by the gills as they attempt to pass through the netting. Drift nets also are used for catching mackerel, pilchards, sprats and salmon.

Lining.—Fishing with lines and baited hooks was once of much greater commercial importance than it is in modern times. There are three methods of lining: hand-lining, long-lining and trolling. In hand-lining the line is drawn in by hand as soon as the fish is felt; in long-lining the line is shot out and left unattended until hauled in; in trolling the lines are towed through the water and hauled in when fish are caught.

Hand lines reached their greatest commercial importance in the Pacific tuna fisheries, but since the early 1960s most of the Pacific tuna catch has been taken with large purse seines. Hand lines are still used in taking many fish, such as cod, mackerel and snappers.

A long line is fitted with a great number of hooks (sometimes as many as 5,500) attached to the main line by thin lines of some strong material; the attaching materials vary with the fish sought. Long lines may be set on the sands at low tide but usually are worked from fishing vessels in deep water. When deepwater lines are used to catch demersal fish they are anchored and buoyed at each end and sometimes at intervals along their length; when used to catch pelagic fish, they are not anchored. Deep-sea long lines are chiefly used demersally for cod and halibut and pelagically for tuna. The baits, which vary according to local custom, include mussels, squid, octopus, herring and small pelagic fish.

Troll lines are long, single lines with one or more barbed hooks at the free end. They are baited with a natural or artificial lure and are drawn behind a moving boat. The baited hooks are held at the desired depth by the speed of the boat and by weights attached to the line. The lines require constant attention. Troll lines are used principally in the salmon and tuna fisheries.

Trends in Fishing Methods.—Since the beginning of the 20th century the world catch of fish has increased greatly because of increased demands for food and improved methods of capturing, processing, storing and transporting fish. The progress made in fishing methods since 1930 alone has been greater than that made in the previous 3,000 years. Until the late 19th century, methods for taking fish had not changed for centuries. Sails and oars were still used to propel fishing craft, and manpower alone was used to handle the gear. The first great improvement was the adoption of steam propulsion in fishing vessels, followed later by gasoline engines and still later by semidiesel and diesel engines, which have largely replaced steam power. Of equal and perhaps greater importance was the introduction of power equipment for handling fishing gear. Power winches were adapted to hauling large otter trawls, long lines, troll lines and gill nets. Mechanically driven turntables and rollers and the introduction of drum reels permitted the handling of large purse seines; adoption of a hydraulic power block further increased the ability of fishermen to handle this gear rapidly. (*See* also FISHING VESSELS.)

The development of electronic fishing aids after World War II also increased fishing efficiency. Use of loran, a system of long-range navigation with radio, permitted vessels to return to known fishing areas with greater precision than had previously been possible. Electronic depth sounders enabled fishermen to make a continuous record of water depths and to follow bottom contours. Echo sounders made it possible for fishermen to locate schools of fish that could not be detected by other means. Radar increased safety, and the general adoption of radio communication kept fishermen in touch with shore facilities and other fishing boats.

Use of man-made fibres that can be produced with the characteristics required for fishing gear greatly increased the efficiency of nets and resulted in increased catches. These characteristics in-

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FISHERMEN IN THE RACKS ON THE "HUGH M. SMITH" CATCHING (ONE-POLE) YELLOWFIN TUNA FROM A SURFACE SCHOOL

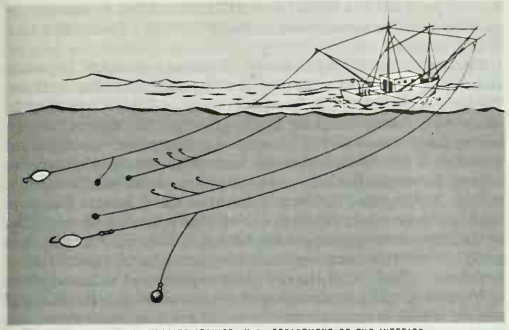

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FIG. 4.—SALMON TROLL LINES

cluded flexibility, resistance to rot and abrasion, high strength and low visibility in water.

Other major improvements included the use of airplanes to locate schools of pelagic fish and the development of powerful pumps to transfer fish from purse seines to the fishing boat and to unload the catch at processing plants.

FISHERIES PRODUCTION

Major Species of Fish.—Among the commercially important food fishes and the localities in which they are taken are the following: herring, in northern inshore water; pilchard, temperate inshore water; menhaden, temperate to subtropical inshore water; anchovies, tropical inshore; shad, temperate; Atlantic and Pacific salmon, northern temperate water of the two oceans; tuna, tropical offshore water; mackerel, temperate offshore; cod, northern water; haddock, northern water; whiting, temperate inshore; croakers, warm to temperate inshore; ocean perch, temperate; flounders, northern temperate. (*See* also FISH.) The principal species used in the manufacture of fish meal and oil are the menhaden and herring in the United States, the herring in Canada and in many northern European countries, anchovies in Peru and Chile and the pilchard and maasbanker (*Trachurus trachurus*) in southern Africa.

Shellfish.—The term "shellfish" embraces the edible species of both crustaceans (*e.g.*, crabs, lobsters, crayfish, prawns and shrimps) and mollusks (*e.g.*, oysters, mussels, cockles, scallops, clams, squids and whelks). Their economic importance varies from country to country but is usually less than that for fish because of smaller yield, although the average price per pound is usually much higher. The largest fisheries for shellfish include those for shrimp in the Gulf of Mexico; oysters, clams, crabs and scallops along the Atlantic and Gulf coasts of the United States; northern lobsters in the North Atlantic waters of the United States and Canada; the spiny (rock) lobster of the Republic of South Africa, Australia and New Zealand; and the king crab of the North Pacific.

Several of the shellfish, such as oysters, clams and mussels, can be and often are grown on privately owned grounds. Oyster farming in particular is highly developed in many areas. The similarity to agricultural farming is striking. First, the bottom ground is cleaned and planted with shells, gravel or other material on which the larval oysters can set when they end their free-swimming cycle. After the set of oysters is obtained and allowed to grow for a few weeks or months, it is transplanted to growing grounds. As the young oysters grow and require more space they are transferred one or more times to larger areas. Predators, principally starfish and oyster drills, are controlled. The stock, before being harvested, may be transplanted again to fattening grounds. The final operations consist of harvesting, shucking, grading and packing the oysters for shipment to market.

Small oysters used for seeding the oyster beds of the U.S. Pacific coast are obtained in Japan, where they are available in large quantities but where growing and fattening grounds are limited. (*See* also OYSTER: *Oyster Farming.*)

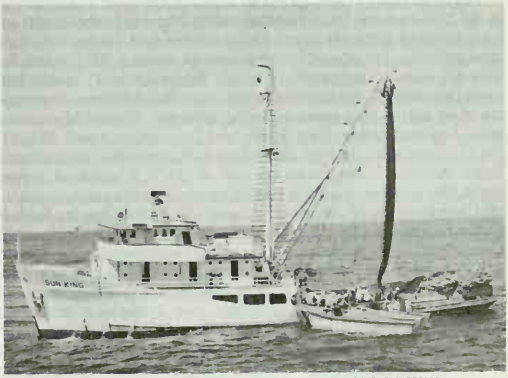
Leading Fishing Countries.—The output of the fisheries of the world cannot be estimated with accuracy because in many parts of the world no statistics are compiled. This applies particularly to inland fisheries, many of which are of great economic importance. However, the United States, the British Commonwealth, Japan and most countries of Europe publish statistics annually and sometimes more frequently. A comprehensive statistical account of most of the world fisheries is published in the *Yearbook of Fisheries Statistics* of the Food and Agriculture organization of the United Nations; statistics on the fisheries of Europe appear in the *Bulletin Statistique des Pêches Maritimes* of the International Council for the Exploration of the Sea; and figures on output of U.S. fisheries are published in the *Statistical Digest* of the fish and wildlife service of the U.S. department of the interior.

The fisheries in the cold and temperate waters of the northern hemisphere yield about 75% of the world catch, which totals about 41,000,000 metric tons. Asia, excluding the U.S.S.R., produces approximately 41% of the world catch; Europe, excluding the U.S.S.R., about 20%; North America 10%; South America 15%; U.S.S.R. 8%; Africa 6%; and Oceania, less than one-half of 1%. Nearly 38% of the world catch is marketed fresh; about 18% is cured; over 23% is reduced into oil and meal; 9% is canned; about 10% is frozen; and 2% is used for miscellaneous purposes. The marketing of frozen fish increased rapidly following the end of World War II.

Japan is by far the leading fishing country in the world, producing about 16% of the world catch. Other major fish producers are: Peru, Communist China, U.S.S.R., United States, Norway, Canada, Spain, India and the United Kingdom. These ten countries together produce nearly 70% of the world harvest of fish and shellfish.

Japan.—Japan markets about 14,000,000,000 lb. of fish, shellfish and other aquatic products annually. The development of Japan's fisheries, which are that nation's principal source of animal protein, is associated with the geographical position, the physiography and the large and dense population of the country. The proportion of coastal area to inland area is high; most of the coast is suitable for fishing, while much of the inland area is unsuitable for agriculture and cattle rearing. The fisheries are, in general, not centralized; there are many small coastal fishing villages and only a few large fishing ports. Japanese fishing is concentrated in the coastal waters of Japan proper but operations also are conducted in the Yellow, East and South China, Okhotsk and Bering seas; in the North, Central and South Pacific oceans; and in the South Atlantic ocean.

The principal kinds of fish taken by Japanese fishermen are sardines, herring, mackerel, cod, tuna, bonito, sea bream, salmon and flatfishes. Crustaceans, octopuses and seaweed also are important products of the Japanese fisheries. Aquiculture is important in Japan, as it is in most oriental countries; the main products are



BY COURTESY OF FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR

PACIFIC COAST PURSE SEINER LOADING A SEINE USING A HYDRAULIC POWER BLOCK

carp, eel, mullet, trout, oysters, clams and seaweed. The fisheries of Japan export large quantities of canned tuna, salmon and crab meat; fresh and frozen tuna and swordfish; fish-liver oils; and other fishery products.

China.—Accurate information about the size of the catch of the fisheries of Communist China is not available; estimates, however, range from 3,000,000 to 6,000,000 metric tons. Much of the catch is obtained through the cultivation of fish in interior waters. China is reported to have approximately 74,000,000 acres of fish ponds.

Peru.—The fisheries of Peru expanded their production rapidly after 1955 because a change in fishery regulations permitted the taking of anchovies for manufacture into meal and oil. Output of all species rose from 213,300 metric tons in 1955 to 5,243,100 metric tons in 1961; in that time Peru moved from 26th place in importance as a fishing nation to 2nd; it became the largest producer of fish meal, and Callao came to rank as the world's leading fishing port. Important fisheries are conducted for bonito and tuna, in addition to anchovies.

U.S.S.R.—The Soviet Union has long been noted for its catch of sturgeon from inland rivers and the production of sturgeon caviar; however, herring, cod, salmon, flatfish and fresh-water species other than sturgeon comprise the bulk of the nation's catch. The Soviet fisheries expanded rapidly after World War II. Many large factory ships, serviced by up to 50 to 60 fishing boats, were placed in operation in North Atlantic and North Pacific waters. In the Atlantic these ships fished as far west as the waters off Newfoundland and Massachusetts; in the Pacific they ranged as far east as the coast of Alaska. The Soviet Union occupies a leading position among fish cultivation nations; carp is the major product. Both the east and west ports in which Soviet vessels land their catch are located at great distances from large population centres. Preservation aboard the factory ships and in shore plants is necessary, therefore, and the distribution of fresh fish is limited. The preservation methods used are the conventional salting, canning and freezing processes.

United States.—Fisheries in the U.S. are located along the coasts of and in the Atlantic and Pacific oceans, Bering sea, Gulf of Mexico, Great Lakes and many rivers. In the Atlantic ocean U.S. fisheries are conducted from the Grand Banks of Newfoundland to northern South America. In the Pacific the range extends from the Bering sea to the coasts of Peru and Chile.

Although more than 200 species are taken commercially by U.S. fishermen, the menhaden, which is used almost entirely in the manufacture of fish meal and oil, accounts for more than 40% of the catch. Other leading species are tuna, salmon, shrimp, herring, crabs and ocean perch. These items, together with the menhaden, account for more than two-thirds of the U.S. catch. Details about the variety of fish, shellfish and other aquatic products taken in the U.S. are published in the reports of the fish and wildlife service of the U.S. department of the interior.

The importance of United States fisheries increased considerably in the 20th century, largely because of an increase in the output of manufactured products, particularly canned and frozen fish, fish meal and oil. The annual landings average about 5,000,000,000 lb. Fish are taken commercially by U.S. fishermen in 41 states but more than 60% of the catch is normally made by fishermen operating in or out of only seven states: California, Alaska, Massachusetts, Virginia, Maine, New Jersey and Louisiana. About 10% of the U.S. catch is taken off the coasts of Canada and Central and South America. The major portion of the U.S. catch of ocean perch, the principal food fish landed on the Atlantic coast, is taken off Canada; most of the catch of tuna, the leading species landed on the Pacific coast, is taken in international waters off Mexico and Central and South America. Other major food species in the North Atlantic catch are cod, herring, flounder, haddock, pollack and whiting. Other important Pacific species are salmon, herring, mackerel, sardines, halibut, flounder, and Dungeness and king crabs. Purse seines account for more than 45% of the tonnage of the U.S. catch, otter trawls 25% and lines 8%. An important trend in the fisheries of the U.S. was the decrease in the tonnage used for human food and the rapid increase in the catch used for industrial products and animal food. In 1958 the catch used for industrial products and animal food (2,750,000,000 lb.) exceeded the quantity used for human food (2,350,000,000 lb.) for the first time in U.S. history.

Norway.—The fishing industry of Norway is highly organized and employs the most modern processing and marketing facilities. The bulk of Norway's catch, which averages about 3,500,000,000 lb. annually, is taken on inshore fishing grounds. Because of this, the fishing fleet consists of small boats. A comparatively small part of the catch is disposed of fresh for immediate consumption because of such factors as the heavy concentration of landings in the first quarter of the year, the long distance to the principal European consumption markets for fresh fish and trade barriers abroad. Between 70%–80% of the herring landed is converted into oil and meal. Of the remaining portion a substantial part is canned, salted or frozen. The bulk of the cod catch is processed as salted, dried or frozen fish. The catches of such species as halibut, flounder and salmon, which are comparatively small, are consumed almost entirely as fresh or frozen fish. Much of the Norwegian catch is exported; *e.g.*, as canned sardines, frozen fillets, frozen round (whole) or dressed fish, salted cod, dried unsalted fish and fish meal and oil.

India.—The fishing industry in India suffers from lack of modern production and distribution facilities. The catch of fishery products is estimated at somewhat more than 1,000,000 metric tons annually, of which nearly three-fourths is obtained from the west coast of India, mostly within 10 miles of the shore although some fishermen work as far out as 25 miles.

Commercial fisheries play a relatively minor part in the Indian economy, accounting for only about one-half of one per cent of the national income and about one per cent (by value) of the country's food production. Fisheries are vital, however, to certain local economies, principally those in coastal regions but including some inland areas. Commercial fisheries that produce for immediate home consumption are conducted in small village ponds and other interior waters as well as along the coasts.

Spain.—The fisheries of Spain showed a steady upward trend after 1934, when the catch totaled 408,000 metric tons; by the 1960s the total had more than doubled. The chief fishing grounds of the Spanish fleet are in the Atlantic and the southern Mediterranean, with the former accounting for from 75% to 80% of the total landings. In addition to catches in coastal waters, significant quantities of fish are taken off the coast of Africa and in the northwest Atlantic, mainly on the Grand Banks off Newfoundland. Anchovies, hake, cod, horse mackerel, sardines and tuna are the principal species taken. Most of the catch is marketed fresh; however, large quantities are canned, salted and dried.

Canada.—Canada, with important fisheries in both the Pacific and Atlantic oceans, harvests about 2,000,000,000 lb. of fish annually. Cod and herring are the principal species taken; also important are haddock, pollack, redfish (ocean perch), halibut and lobsters. Much of the catch is exported. The principal exports consist of fresh and frozen fresh-water fish, cod, haddock, halibut, salmon and herring; live lobsters and fish meal; canned salmon; and salted cod.

United Kingdom.—For many centuries British deep-sea fisheries have been among the most highly organized in the world. (The inland fisheries of Great Britain are of little significance.) Fishing is conducted in three distinct areas comprising (1) "distant water" off Iceland, off the east and west coasts of Greenland, in the Barents sea and on the banks off Newfoundland and Labrador; (2) "middle water" (around the Faeroe Islands) and "near water" (fishing grounds in the North and Irish seas); and (3) "inshore water," which also yields considerable quantities of shellfish. The British fleet of "distant water" trawlers is one of the largest in the world.

More than 75% of the British catch, which averages slightly more than 2,000,000,000 lb. annually, consists of whitefish (fish with white, nonoily flesh). Cod and related species make up more than 80% and flounders about 10% of the whitefish caught. Herring account for about 15% of the total landings. Because of the nearness of the fishing ports to consuming centres, most of the catch is marketed fresh. There has, however, been a trend toward freezing the catch either at sea or on shore. (E. A. Pr.)

RESEARCH AND CONSERVATION

The progressive mechanization of fishing vessels, improved fishing gear and better methods of preservation that grew out of the Industrial Revolution enabled fishermen to fish more efficiently for longer periods of time and to extend their operations into international and distant waters. The much-increased and constantly increasing fishing intensity that developed soon posed a new problem. Some of the species in the sea that had been considered inexhaustible began to show signs of being overfished. The taking of fish on older and more readily accessible fishing grounds became more and more difficult, even with increased fishing effort, and in some instances the average size of the species decreased below desirable market sizes. This forced the more aggressive fishermen to move to new and more remote fishing grounds, while on the older and nearer fishing banks fewer and smaller fish had to be shared by an increasing number of fishermen entering the fishery from many countries.

The problem of overfishing first attracted attention about 1900 in the northeastern Atlantic (the North sea and adjacent waters), where fishing fleets were among the first to be mechanized and where intensive fishing had been carried on for many years. It was there that leading biologists of the day, such as Thomas Weymiss Fulton, D'Arcy W. Thompson, Johan Hjort and C. J. G. Petersen, first turned their attention to the problems of strictly marine fisheries. There too was organized the International Council for the Exploration of the Sea, the first international scientific organization devoted to the study of the sea and its fisheries. The formation of the council marked the beginning of effective organized sea fisheries research.

Sustaining the Yield.—Fish stocks belong to the group of resources that are renewable, in contrast with those resources, such as minerals or fossil fuels, that are irreplaceable within practical limits. To preserve a renewable resource it is not necessary to refrain from using it; but for maximum benefit it must be used in a way that permits the resource to regenerate itself rapidly enough to yield the maximum return on a continuing basis.

Populations of fish and other organisms tend to remain in balance with their environment. The losses in a population must in time be balanced by compensating accessions, otherwise the species will disappear. When losses are increased, accessions increase also, so that the population again tends to come into balance with its environment. It is this natural resiliency or ability to compensate for increased mortality that enables a population to survive an increase in mortality—either from increased predation, which includes fishing by man, or from disease and other natural calamities. The problem posed to the fisheries scientist is that of determining and recommending the fishing intensity, between zero and the economically practicable maximum, that will meet the two conditions of maximum value to mankind and production in perpetuity. This is often referred to as the maximum sustainable yield.

The general objective of maximum sustainable yield is subject to some modification in particular fisheries. For most species, one result of increased fishing is a decrease in the average size and age of individuals in the population, and thus in the catch. Increased total catch in such instances is often accompanied by a larger proportion of smaller fish. Since smaller fish are usually less desirable in the market place, a compromise must be reached between maximum total poundage and the most-desired sizes. In other cases economy of fishing effort may be of at least temporary importance even though total yield may be somewhat diminished. In most instances, however, the maximum sustainable yield is the primary objective of research and of conservation measures.

Population Characteristics.—In a typical sea fishery such as that for cod or for halibut, the response of the fish population to the development of the fishery can be measured by the changes in the amount of fish caught by each unit of fishing effort and by changes taking place in the size and age of the population. The most obvious biological index is the relative number of fish of different ages taken in the catches. The following changes can be expected in a new fishery as fishing effort is gradually increased: (1) the total yearly catch will increase for a time; (2) the catch per unit of fishing effort will begin to decrease as the fishing effort is progressively increased; and (3) the relative number of older and larger fish will steadily decrease. These changes, however, may be modified by an increase in growth rate at all ages, a greater survival rate of the young as result of less crowding and more food, and a decrease in natural losses through death brought about by less competition or reduced cannibalism.

If fishing intensity continues to increase, the genetic potential of the species for growth will soon be fully expressed and additional thinning of the stock will not increase the growth rate any further. Also, if the stock density is reduced too much, the capacity of the environment for producing fish food is no longer fully utilized.

To obtain the information needed to follow the course of a fishery several problems of considerable complexity are encountered. Variation in fishing intensity is only one of the causes of change in the magnitude of a population and in the size and age of its members. Variations in environment, as well as the availability of the fish to the fishermen, also affect population characteristics. How to separate the effects of fishing from effects of natural factors is one of the problems encountered by the fisheries scientist in obtaining a reliable estimate of the effects of fishing alone.

Ideally, to determine the standing crop of a fishery and its maximum sustainable yield, it would be necessary to have a full understanding of all environmental factors, both physical and biological, that affect the population. Full knowledge with which to achieve full understanding is not at hand for any major sea fishery, although the attainment of such knowledge is the ultimate goal of fisheries science. The three principal factors that determine population size, namely reproduction, growth and natural mortality, have been the subjects of study in many important fisheries as have been the relationships between the amount of fishing, the quantity of fish caught and the average size and age of individual fish in the catch. This type of information provides a satisfactory guide to the fundamental nature and current status of the fish population and affords a fairly accurate guide to the management of the fishery.

A feature of a fishery resource such as cod, halibut or herring that is fundamental to conservation is the division of the fishery into a number of natural biological units, usually referred to as stocks or populations. These biological units cannot always be defined precisely, since they are rarely completely or clearly separated. Such stocks have been described as groups of fish of the same species that intermix and interbreed freely with each other and occupy a continuous environment but do not mix freely with other stocks. As a result of inbreeding, the fish of a given stock are related more closely to each other (*i.e.*, are more genetically alike) than they are to members of other populations of the same species. Many stocks are inbred to the extent that they have developed minor morphological characteristics by which they can be distinguished from other stocks of the species. These distinguishing characteristics may express differences in genetic make-up or environment, or both. Such a stock has a tendency to respond as a unit independently of other stocks to factors affecting population size. For this reason the most efficient measures of fishery management should be those that could be applied to each population separately. Management measures cannot always be applied in this way, however, nor is it always desirable to do so. At times an aggregation of population units can be treated as a management unit.

Another important characteristic of a fishery resource is that the magnitude of the standing crop of commercial sizes of fish is distinct from the productivity of the fish population. If the species is long lived, slow growing and has a low fecundity, the productivity is small in relation to the standing crop. The soup-fin shark (*Galeorhinus zyopterus*), once harvested as a source of vitamin A (which is now produced synthetically), is an example. On the other hand a fast-growing species such as the tropical anchovy (*Cetengraulis mystecetis*), with a high rate of reproduction and a relatively short life, has a high rate of productivity.

Required Information.—In order to develop the minimum information needed for the management of a sea fishery, special bio-

logical information is required; *e.g.*, data concerning the age of the fish at various sizes and at sexual maturity, the migratory habits of the species, the rate and success of reproduction, and the fishery environment, as well as estimates of population magnitude, particularly of the commercially desirable sizes. Fundamental to all such information are complete records of the amount of the catch and the average size of the fish taken, including information concerning the area in which the catch was made and how much effort was expended.

Information on total catch is obtained mainly from government records of fish landings in the various fishing ports, but it is necessary to examine the logbooks of reliable fishing captains to obtain information about the area in which fishing was done and the amount of fishing effort expended as measured in hours of trawling time or the number of hooks fished. Also it is necessary to measure both at sea and in the fishing ports many thousands of fish from many areas to determine the size and age averages of the catch and to learn how these figures vary under different fishing intensities.

The age of a fish is determined principally by counting growth rings in its scales or other hard or bony structures. In fish such as salmon, trout and herring, scales are used for this purpose. Winter and summer growths are differentiated on the scale much like rings in the cross section of a tree. For species such as cod, plaice and halibut the ear bones, or otoliths, are used. Ages of many hundreds or thousands of fish are required, and the fish must have been captured in different places and under different conditions in order to adequately describe the age structure of the stocks.

Fish migration is usually studied by catching, marking (tagging), releasing and then recatching live fish. This procedure gives a clue to the extent of movement of the fish and its relationship to other members of the species. In addition, the growth of the fish during its period of liberty can be measured directly; also, the rate at which the marked specimens are returned by fishermen provides an estimate of the rate at which fish of marketable size are being removed by the fishery. Comparison of the proportions of marked and unmarked fish in the catch also gives a rough estimate of the size of the standing crop. Fish marking has proved an invaluable tool to the fisheries scientist; its importance is increasing as marking and recapture techniques and mathematical analysis of returns are improved. Over the years many tens of thousands of halibut, plaice, cod, haddock, herring, salmon and other species have been marked with numbered tags of various kinds.

Success of spawning in sea fisheries is measured by capturing the free floating eggs and larvae in fine-mesh nets towed behind a research vessel, and more particularly by capturing young fish with special gear before they are large enough to be caught in the usual way. The success of a fishery for some species, such as the haddock of the northwestern Atlantic, is determined by the success or failure of the newly hatched fish larvae to survive. Extremely large fluctuations in reproductive success occur; therefore it is necessary to investigate whether the survival from a particular season's spawning is good or bad since the success or failure of the spawning will determine the success or failure of the fishery during a specific season or specific seasons in the future.

The study of the environment in which the fish lives is also important in the collection of knowledge about a fishery resource and the dynamics of its populations. This branch of study, called oceanography, is frequently separated from the strictly biological studies. (*See* OCEAN AND OCEANOGRAPHY.) Oceanography deals with the properties of the ocean waters, their distribution and currents. The ocean "climate," or the average condition found in the sea, and the ocean "weather," or what is happening at the moment, are as important to fish as land climate and weather are to land animals. These factors affect the metabolism and distribution of fish, which, since they are cold-blooded (*i.e.*, their body temperature varies with and is almost equal to that of their environment), exhibit greater responses to small changes in environmental factors (*e.g.*, temperature) than do warm-blooded animals.

Fishery research also includes studies that lead to better and fuller use of fishery resources. This branch of research, which is usually referred to as fisheries technology, involves studies intended to improve fish processing, preservation and transportation methods; other studies aim at developing useful products from fish wastes. Basic research in this field includes studies of the structure and composition of fish muscle and fish oils, as well as studies of the metabolism of marine bacteria and their role in fish spoilage. Since protein from animal sources is an important component of balanced human nutrition, the full and efficient use of fish and fish products is of first importance.

Provisions for Research.—Most countries with a highly organized fishing industry have made some provision for resource study and management. The oldest organized government sea fisheries research units date from just before and soon after the turn of the 20th century.

In the United Kingdom the research station at Plymouth is perhaps the oldest and best known. Special government-supported research stations equipped with seagoing research vessels are located at Lowestoft and Aberdeen. Other European fishing countries have similar organizations. In the United States sea-fishery research is conducted jointly by the federal government and the maritime states. The U.S. bureau of commercial fisheries has special laboratories in Seattle, Wash., and Wood's Hole, Mass., as well as in other fishing areas, while some states (*e.g.*, California) have special sea-fisheries laboratories and research vessels of their own. In Canada the federal government founded and operates three marine fishery biological stations. Japan and the U.S.S.R. are rapidly expanding their already very substantial efforts. Additions of relatively large seagoing fishery research vessels such as the "G. O. Sars" and "Johan Hjort" in Norway, the "Africana" in South Africa, the "Ernest Holt" and "Clione" in the United Kingdom, the "Anton Dohrn" in Germany and the "A. T. Cameron" in Canada and many others indicated the serious intent of an increasing number of governments to participate in the exploration, research and harvest of sea fisheries.

Co-operative research by interested countries is almost a necessity where fisheries in international waters are prosecuted by two or more nations and where conservation or management measures, if they are to be effective, must be observed by all participants. The International Council for the Exploration of the Sea, the first organization of its kind, held its inaugural meeting in Copenhagen in 1902. Similar organizations to deal with research in the Mediterranean and North American areas were founded in 1919 and 1920 respectively. In 1948 a council for the Indo-Pacific area was formed by the fisheries division of the Food and Agriculture organization of the United Nations.

Parallel with the organization of the international fisheries councils ran another type of co-operative development that undertook management responsibilities as well as research. Terms of reference and objectives were more precise than for the councils and the agreements were in the form of formal treaties. The first such formal international convention was entered into by Canada, Japan, Russia and the United States in 1911 for the purpose of conserving the fur seals of the North Pacific. This convention was successful in restoring the fur seal populations and establishing methods of harvesting the animals. After a lapse of several years this convention was renegotiated by the four countries involved and took effect again in 1957. The second such fisheries agreement was the Pacific Halibut convention of 1924 between Canada and the United States, founded to deal with halibut in the northeastern Pacific. The commission established under this convention achieved a large measure of success. In 1937 the International Pacific Salmon Fisheries commission was formed by a convention between Canada and the United States to deal with the sockeye salmon and later the pink salmon of the Fraser river system, and an international convention for the regulation of whaling, to which all important whaling countries were party, was negotiated in 1946. The inaugural meeting of the new whaling commission was held in London in 1949. The Inter-American Tropical Tuna commission, with Costa Rica and the United States as the original members, and the International Commission for the Northwest Atlantic Fisheries, with members from Europe and North America, were established

by conventions in 1950. The International Convention for the High Seas Fisheries of the North Pacific Ocean, with Canada, Japan and the United States as members, came into force in 1953, and the Convention for the Regulation of the Meshes of Fishing Nets and Size Limits of Fish, made up of countries bordering the North sea, became effective in 1954. These and other international conventions and their commissions for carrying out the terms of the conventions have become effective instruments in dealing with regional problems of international fishery conservation and management.

See WILDLIFE CONSERVATION; WATERS, TERRITORIAL; and the sections on fisheries in the various country articles. Additional information about the species of fish mentioned appears in the articles on each species; *e.g.*, HERRING. *See* also references under "Fisheries" in the Index volume. (J. L. K.)

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FISHER OF LAMBETH, GEOFFREY FRANCIS FISHER, BARON (1887–), 99th archbishop of Canterbury (1945–61). Born at Nuneaton on May 5, 1887, of a clerical family, he enjoyed a brilliant career at Oxford, including three first classes, before entering upon a period of teaching at Marlborough college. He became at the age of 27 headmaster of Repton school, succeeding William Temple. After 18 years at Repton he became bishop of Chester. Translated to London in 1939, he served in that diocese during World War II until, on the death of William Temple, he was elevated to the see of Canterbury (1945). Under his guidance not only the Church of England but the whole Anglican communion surmounted the confusion of the postwar years. Most important was the church reunion question. The immediate issue was that of the United Church of South India, in which was seen the first example of a union between churches of the pre- and post-Reformation traditions. Fisher led the way forward while allaying the fears of those who thought that too much of the Anglican way of life might be surrendered. He also promoted closer fellowship among the Anglican churches. He formed four new provinces in Africa and Asia and furthered the unity of the member churches by securing the appointment of an American bishop as executive officer of the whole Anglican communion. At home he was instrumental in raising the stipends of the clergy to meet the rising inflation, furthering the preparation of a new body of canon law and maintaining the church's firm attitude on the sanctity of marriage. Almost his last act before resignation was to pay an official visit to Pope John XXIII in Rome, thus giving visible evidence of the Anglican desire to preserve friendship between the churches. On his retirement in 1961 he was created Lord Fisher of Lambeth. (J. W. C. W.)

FISH FLY, a name given to four-winged insects of the genus *Chauliodes* and allied genera. Fish flies and the related larger dobson flies comprise the family Corydalidae. The larvae are fresh-water inhabitants and the adults are usually found near water. *See* also DOBSON FLY; NEUROPTERA.

FISHGUARD AND GOODWICK (ABERGWAUN AND WDIG), a market town, seaport and urban district on the northern coast of Pembrokeshire, Wales, lies 13 mi. N. of Haverfordwest. It is a railhead and a yachting and tourist centre. Combined pop. (1961) 4,898. The town of Fishguard is perched high above the old harbour, known as Lower Town, at the mouth of the Gwaun river on the south side of Fishguard bay. On the west side of the bay are Goodwick town and the modern Fishguard harbour administered by British Railways and from where shipping services ply to Irish ports. The scenic high rocky coast is part of the Pembrokeshire national park.

The neighbourhood is historically interesting as the site of the "last invasion of Great Britain." General William Tate, an Irish-American adventurer in the service of the French government, with 1,400 French soldiers and convicts landed at Carreg-Gwastad point in 1797. His force soon capitulated to the local militia (who were accompanied according to legend by the women of the town, whose tall hats and cloaks caused them to be mistaken for soldiery). A memorial tablet on Goodwick beach marks the place where the invading force laid down their arms. The surrender document was signed at the Royal Oak inn on the Market square, Fishguard.

FISH HAWK, a common name in America for the osprey (*q.v.*).

FISHING. Primitive man fished to obtain food. Yet even when his very existence depended on success in catching fish and, of course, in hunting animals, he must have found pleasure and excitement in both pursuits. The desire to hunt and fish has remained a powerful force in man's nature; the excitement of the chase and the fascination of water are still strong.

This article deals with fishing as a sport: for commercial fishing *see* FISHERIES. For the various craft used in fresh-water and salt-water sport fishing *see* BOATING. *See* also HUNTING AND FISHING, PRIMITIVE. The main divisions of the article are as follows:

I. History
  1. Basic Methods
  2. Development of Equipment
  3. Developments After World War II
  4. Angling Literature
II. Fresh-Water Fishing
  1. Bait or Still Fishing
  2. Trolling
  3. Bait Casting or Spinning
  4. Fly-Fishing
  5. Tournament Casting
III. Salt-Water Fishing
  1. Fishing With Bait
  2. Float Fishing
  3. Trolling
  4. Bait Casting
  5. Fly-Fishing
  6. Big Game Fishing
IV. Fish and Fishing in the Principal Angling Countries of the World
  A. North America
    1. Fresh-Water Fish
    2. Salt-Water Fish
  B. Central and South America
    1. Mexico
    2. Bahamas
    3. Jamaica, Barbados, Trinidad and Tobago, and the Leeward Islands
    4. Cuba
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  C. Great Britain and Ireland
    1. Game Fish
    2. Coarse Fish
    3. Sea Fish
  D. Europe
    1. Northern Europe
    2. Central and Southern Europe
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  E. Africa
  F. Asia
    1. India and Pakistan
    2. Ceylon
    3. China and Southeast Asia
  G. Oceania
    1. New Zealand
    2. Australia

I. HISTORY

As fishing ceased to be a means of supporting life and became a sport, man gradually chose the more pleasurable means of catching fish. In the 20th century sport fishing, or angling, came to mean fishing with a rod, reel, line and hook. It is still a growing sport, above all in the more industrialized countries, and practised with pleasure by many nations and for many different sorts of fish. The basic methods of fishing are few in number and although anglers, fish and types of lake and river differ, the styles of fishing are all remarkably similar. These few basic methods, the equipment for them, the angling lore, and the ethics and customs they assume have all evolved by a slow process.

Fishing has been referred to in the literature and portrayed in the art of every civilization. Two thousand years B.C. an Egyptian angling scene was depicted with figures shown fishing with rod and line, with a hand line and with a net. There are references to fishing in ancient Greek, Roman, Assyrian, Jewish and Chinese writings.

Paleolithic man drew on the walls of his cave pictures of the fish he caught as well as of the animals he hunted. The Chinese were by far the most advanced, for somewhere between 1500 and 900 B.C. it was written "fishermen used the silk of cocoons for their lines, a piece of sharpened iron for their hooks, thorn sticks for their rods and split grain for their bait."

The hook must be one of the earliest tools on which man depended for his existence; the argument as to which came first, spear, net or hook, has not been resolved. Man first used sharp bones, thorns and pieces of wood as rudimentary hooks or "gorges" (pieces of flint, stone or bone the fish could swallow with bait but could not eject afterward). When he attained skill in working with wood, stone, shells and, much more important, with metal, fishhooks were among his first products.

The history of fishing as a sport had its starting point in modern Europe in 1496 when Wynkyn de Worde printed at Westminster the *Treatyse of Fysshynge With an Angle*, part of the second edition of *The Boke of St. Albans*. This, the first angling manual in any language, is generally thought to have been written by Dame Juliana Berners. This work lists 12 artificial flies and the method of making each. So little have the basic principles of fishing altered that six of these flies are still in use.

1. Basic Methods.—Angling gradually developed in technique, literature and equipment according to four basic methods—fishing with bait, trolling, bait casting and fly-fishing.

Bait Fishing.—Bait fishing is the oldest form of fishing. A bait, that is, something that a fish will eat, is impaled on or pressed round a hook. Common baits were and still are worms, larvae, insects (including flies), small fish or minnows, pieces of meat, shellfish and pastes made of flour. The hook is attached to a line. These two items composed the original equipment for bait fishing and are still used in the form of a hand line for sea fishing. Such tackle, however, is very limited in its use, for unless the bait is heavy, or unless some weight is used, it is difficult to cast far, it is impossible to fish over reeds and similar vegetation and it is troublesome to recover the bait or bring a fish to land unless the bank is very clear. The answer to these problems was a rod, a length of stick or cane to which the line was tied.

It is strange that in all the ancient illustrations a very short rod of only a few feet is shown, and man seems to have been very slow in seeing the advantages of a longer one. It is not known when or where a long rod, one as long as ten feet, was first used but there is strong evidence to suggest that the Romans saw the advantage of joining two or more pieces of cane together. This not only gave additional reach, but allowed the rod, when unjointed, to be carried about more easily. The reference is made by Martial (A.D. 40–*c.* 104), a poet who loved fishing and other country pursuits. Scholars have differed over the correct interpretation of the reference, but it seems reasonable to suppose that a nation as advanced as Rome, with different sorts of cane procurable in its colonies, hit upon the simple expedient of jointing two pieces together.

The bait fisherman, then, equipped with a rod, could reach out from the bank and over vegetation. He could thus let his bait lie on the bottom of river or lake if he wished, holding it there against the current if necessary by adding a weight or weights to his line; alternatively he could let his bait drift down with the current. By using a float or bobber, that is, a buoyant article like a piece of cork, he could suspend the bait at a desired depth. The float also acted as an indicator, its sudden movement or submersion warning him that a fish was nibbling his bait or taking it into its mouth.

Trolling.—By this method the bait is trailed behind a slowly moving boat. The bait is either a small fish or some lure which, when drawn through the water, spins, wobbles or vibrates. It is a very old method of catching fish, particularly large fish, and has been used, for example in the South seas, since earliest times. In the 19th century the term "trolling" was used in Great Britain to describe early forms of bait casting and the term "trailing" was used to describe trolling.

In South Africa still, what in the United States is called casting or bait casting and in Great Britain spinning is often referred to as trolling. This is, however, an exception and the term has come to be generally used to describe the trailing of a lure behind a boat.

Bait Casting and Spinning.—This is the casting of a lure or minnow, or a dead fish, which when drawn in by recovering line or when influenced by current imitates a small or wounded fish, frog or other bait. Of much later development than the other three methods, bait casting is linked in its growth with the invention and improvement of the fishing reel. In Great Britain all bait casting is called spinning; in North America the term "spinning" refers only to the casting of a lure using the fixed-spool or spinning reel, and spin casting designates the use of the enclosed fixed-spool reel.

Fly-Fishing.—Generally thought to be a modern development, fly-fishing is in fact a very old form. In the 3rd century A.D., the Roman poet Aelian described the way the Macedonians caught trout with an artificial fly and gave the "dressing," that is, the materials and method of making the fly they used. Dame Juliana also gave this dressing as did Izaak Walton in 1653, and this same fly is still used with only minor alterations.

In fly-fishing the angler seeks to imitate with silk, feathers, hair, wool and other materials the flies and insects that live in or near water and on which many fish feed. Artificial flies can also be lures which imitate small fish or other bait, or confections, which, for reasons only to be guessed at, arouse curiosity and rapacity in fish.

2. Development of Equipment.—The four basic methods of fishing outlined above have remained fundamentally unchanged, but gradual improvements in fishing tackle have allowed man to cast farther, to cast more accurately, to present his bait, fly or lure in a more natural and lifelike fashion and to handle hooked fish with greater certainty. The history of fishing as a sport is therefore largely the history of its equipment.

At the end of the 15th century, man fished, as he hunted, for pleasure and to obtain food. His tackle had progressed little in 3,000 years. His rod was a massive pole, about 15 ft. in length, made from local woods and hooped at both ends with iron. His line, probably of plaited horsehair, was tied to the end of his rod and his hook, bound to a strong single strand of horsehair, was attached to the end of the line. His effective casting range was the length of his rod plus the length of the line, so the greatest caution had to be exercised in approaching the water and every advantage of cover taken.

Even more difficult was the handling of a big fish after it had been hooked. The angler, having no running line, had to tire the fish within the limits of his rod and his short line. If a fish insisted in swimming away beyond these limits the fisherman had either to hold him with the risk of breaking his tackle or to throw his rod into the water, let the fish tow it round until it tired, and then recover his rod and renew the struggle.

This primitive and limited equipment was to endure for another 150 years, through a century and a half of constant and rapid progress in almost every other field. During this period of restless invention, no one offered the simplest idea to extend the range

of the fisherman; it was not until 1651 that Thomas Barker, in his *Art of Angling,* mentioned a ring of wire on the top of a rod and a simple form of winch which held, retrieved and released line to run through this ring. Four years later, in the second edition of *The Compleat Angler,* Izaak Walton mentioned the use of a reel to hold the line. He wrote, "Note also, that many use to fish for a salmon with a ring of wyre on the top of the rod, through which the line may run to as great a length as is needful when he is hooked. And to this end, some use a wheele about the middle of their rod, or nearer their hand, which are to be observed either by seeing them or a larger demonstration of words." Walton was obviously writing about a piece of equipment of which he had little knowledge and no practical experience. That so passionate an angler should not have used so fundamental an improvement shows that the use of reel and end ring was still exceptional.

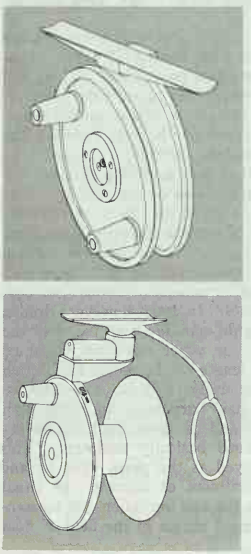
The angler, then, in Walton's day was just beginning to have an opportunity to extend the scope of his activities. A crude reel and running line permitted him to cast his bait or lure a little farther and to allow a fish to run well beyond the old limits of a line fixed to the end of the rod. He had other advantages too, for by 1655 Charles Kirby, a London hookmaker, had greatly improved the quality of the fishhook by using improved methods of tempering and hardening the metal. The hook, with an offset bend of the point, which he invented and which bears his name, is still in use all over the world. In 1613 there was mention of a landing net, although it is likely that this piece of equipment, which is used to lift a large fish out of the water, was in use a century or so before. In 1657 Barker mentioned the need to use a line 26 yd. in length (five times more line to play a fish with than was given by the old tight-line method) and a "landing hook," which is now called a gaff. This is a large hook attached to a shaft which is used to lift large fish ashore or into a boat. While the use of horsehair as a scarcely visible link between hook and line was to continue into the 20th century, experiments were made with other materials. In 1667 Pepys wrote of using a gut string with a minnow as a bait, while in 1676 Col. Robert Venables mentioned the use of a lute string. Of less use to the fisherman of those times was a patent made out to one Thomas Grant in 1632 for a "fish call or looking glass to lure fishes to net, spears, or hooks," one of the first 60 patents ever granted in Britain.

Despite much progress in the development of fishing tackle, however, the improvement of having wire rings, or guides, throughout the length of the rod and not only at the end is not mentioned until 1726. The nature of the reference in the *Gentleman Angler* makes it clear that such rings and the use of a "winch or wheel" were far from common.

About this time a transfer of the manufacture of fishhooks from London to the small Worcestershire town of Redditch was to have a far-reaching effect on the angler's equipment and thus indirectly on his methods and his sport. Until this period the fishhook trade had been centralized in London and to a much lesser degree in Yorkshire and Ireland. About 1730 the needle industry was establishing itself in Redditch and was quick to see, and seize, a kindred product. In the space of about 70 years the whole of the world trade in fishhooks had become centralized in this town. Not only was the making of hooks greatly improved, but the Redditch manufacturers progressed from these articles to other items of tackle, and gradually from what had been a cottage industry grew the first organized factories concentrating on all types of angling equipment.

Although it seems that relatively few fishermen took advantage of the increased scope given by a fishing reel, progress continued to be made. In 1770 a London tackle dealer was advertising "brass multiplying reels"—reels which were geared to give increased winding speed. Such reels never became popular in Great Britain, and although it seems certain they were first made in that country, they were developed in the United States, where George Snider of Kentucky pioneered this type of reel in 1810. Indeed from the beginning of the 19th century progress in equipment, and especially in fly-fishing equipment, ran on very parallel lines in both Great Britain and the United States. In North America, however, most of the fish are predaceous and the Americans therefore concentrated on bait-casting tackle; in Great Britain, where few fish are wholly predaceous, the emphasis was on bait fishing.

Another great step forward was taken between 1840 and 1850 with the development in the area of the river Trent of what became known as the "Nottingham" reel (fig. 1). This reel, made first in wood and later in metal, spun very freely on a spindle or "centre pin." It had an enormous effect on many sorts of bait fishing, for it allowed float and bait to proceed unchecked with the current and greatly increased the area that a river bait fisherman could cover efficiently. It also permitted a heavy lure or heavy tackle to be cast a long way and was therefore to lead to great progress in casting and in sea fishing, besides having considerable effect on the design of reels for fly-fishing.



T. B. THOMAS

FIG. 1.—(TOP) NOTTINGHAM CENTRE-PIN REEL, 1840–50; (BOTTOM) MALLOCH TURNTABLE REEL, 1884

Rods, too, were being improved, although the process was a slow one. Early in the 19th century the tips of rods were being made from several strips of cane glued together, and by 1847 tips made of six strips were known in Britain. There is divergency of opinion as to who made the first complete rod in the hexagonal form but it seems likely it was made in the United States between 1865 and 1870. About this same period, too, there were improvements in turning rods, particularly those in greenheart, a South American wood, and rods gradually started to become lighter and shorter.

Progress on lines was likewise slow and although silk, cotton and flax lines began to be used from about 1850, horsehair, sometimes mixed with silk, remained popular until almost the beginning of the 20th century. The period from 1870 until the beginning of the next century was the second great era of development in fishing methods and equipment.

Rods became still shorter and lighter, and anglers began to give up the heavy rods made from native woods like ash, and even the lighter woods like greenheart, in favour of the much lighter and more efficient rods built from strips of cane in hexagonal form and known as split, or built, cane. The wire rings through which the line ran, the fittings to hold reels in position and the ferrules used for joining the parts of the rod together were all lightened and improved. Silk lines came into general use and fly lines began to be "dressed"; that is, covered with coats of linseed oil which was then allowed to oxidize. These dressed lines were far heavier than the old horsehair lines, could be cast much farther, and most important, could be cast against a wind. The use of these lines altered the whole concept of fly-fishing and resulted in the use of the floating fly. Silkworm gut, first mentioned in 1722, at last began to supersede horsehair as the link between line and hook.

It was in the field of fishing reels, however, that the greatest progress was made, both in improved materials and improved design. The distance a lure could be cast was greatly increased, first by a method of coiling loose line in a basket and casting out these coils, and then, as the Nottingham reel was improved and became more and more free running, by actually casting from the reel.

In the United States, progress was made in the same way and in similar fields. The fly rod became even lighter and shorter than those in Great Britain and fly lines likewise were greatly improved.

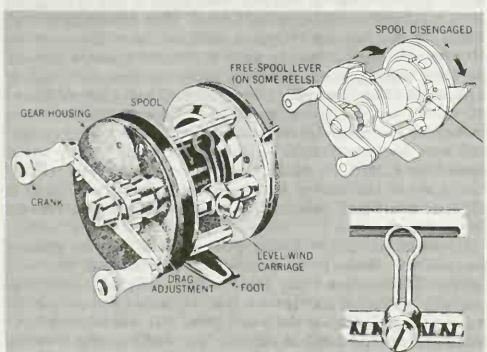
The multiplying reel (fig. 2) became a precision tool and, having much less spool inertia than the British Nottingham reel, became a much better casting instrument. This lack of inertia, coupled with the fact that bait casting was often practised from a boat, led to the short bait-casting rod of between four and six feet.

In 1896, William Shakepeare of Kalamazoo, Mich., invented the level-wind, a mechanism which traversed back and forth across the spool as the reel revolved and laid the line level upon it. About the same time wooden lures, called plugs, were also developed.

The difficulty of casting direct from a Nottingham reel and the skill required to control such a reel when casting led to the invention that was to have the greatest effect on angling. A long rod and a casting weight of at least one-quarter of an ounce were required to set the reel in motion and unless it was skilfully controlled throughout the cast the speed of the reel overtook the speed of the line and a tangle resulted. Between 1878 and 1884 reels were developed which operated on a turntable system. To cast, the reel was turned so that the axis of the reel lay along the rod instead of across it. This allowed the line to slip in coils over the edge of the spool instead of running out with its rotation, thus eliminating spool inertia. The line was recovered by turning the axis back to the normal position and winding in. These reels made casting easier, but they had certain disadvantages, in particular in the way they twisted lines. In 1905, however, Holden Illingworth, a Bradford, Eng., textile manufacturer, patented the first fixed-spool, or spinning, reel, on which the spool remained stationary with its axis along the length of the rod and on which the line was recovered by a bail, or flyer. Two years later he greatly improved this reel. The main purpose of the Illingworth reels was to cast very light baits, and the seven-foot rod he designed for use with them remained basically unaltered. This type of reel was gradually improved as the years went by and began also to be used on the continent of Europe. In Great Britain, however, the lack of game fish and limitations set on spinning for trout restricted development except in the field of float fishing.

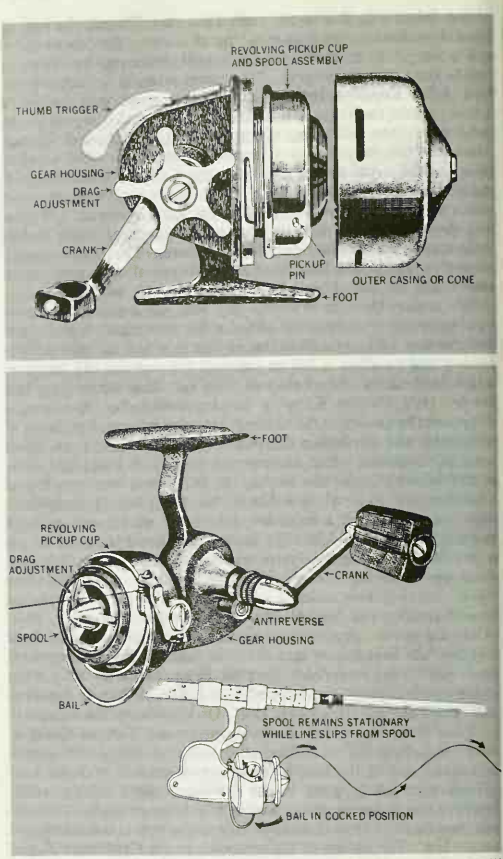
3. Developments After World War II.—Great improvements in fishing tackle were made after World War II. Fixed-spool reels (fig. 3) enjoyed wide popularity in Great Britain and on the European continent, where their manufacture was taken over and improved by specialist firms such as, for instance, French clockmakers. After the war they were also introduced with enormous success into the United States and other countries.

In the United States rods made of glass fibre are favoured over those of all other materials. In Great Britain and Europe, however, the split-cane rod still holds pride of place and the glass-fibre rod has not found great popularity. The fixed-spool reel has been further improved and the use of nylon monofilament lines with it has greatly increased its efficiency. In the United States a different type of fixed-spool reel, one with an enclosed spool, the closed-face or spin-casting reel, has been perfected and has won wide popularity (fig. 3). Paired with the flexible and highly active glass-fibre rod and using 6- to 10-lb. test lines and $\frac{1}{8}$- to 1-oz. lures, the spin-casting outfit is preferred in some areas. Lines are made from various man-made fibres and fly lines have been greatly improved by plastic dressings. The wide use of plastics has lightened and improved many other articles of fishing equipment.



BY COURTESY OF JAMES HEDDON'S SONS

FIG. 2.—MULTIPLYING OR BAIT-CASTING REEL SHOWING: (TOP RIGHT) TOTAL FREE SPOOL; (BOTTOM RIGHT) LEVEL-WIND CARRIAGE



(TOP) BY COURTESY OF THE GARCIA CORPORATION; (BOTTOM) FROM "THE WISE FISHERMEN'S ENCYCLOPEDIA," ED. BY A. J. MCCLANE. BY PERMISSION OF WM. H. WISE & CO., INC., PUBLISHERS

FIG. 3.—FIXED-SPOOL REELS: (TOP) CLOSED-FACE; (BOTTOM) OPEN-FACE

Equipment in the second half of the 20th century was further improved: tackle was made lighter and simpler to use; the effective casting and fishing range became almost unlimited. Yet with all these advantages, the angler still has to locate the fish and offer them the right sort of bait or lure in such a way that it appears natural and does not alarm them. He must still be able to read the weather and understand water. Angling, like other field sports, remains basically a matter of applied natural history.

4. Angling Literature.—Most of the best writing on fishing has been in English, for up until World War II nearly all the advances in all forms of fishing as a sport were made either in Great Britain or in North America. Izaak Walton set the standard with *The Compleat Angler*, the greatest of fishing books, and the works of Thomas Barker, Col. Robert Venables, W. C. Stewart, F. M.

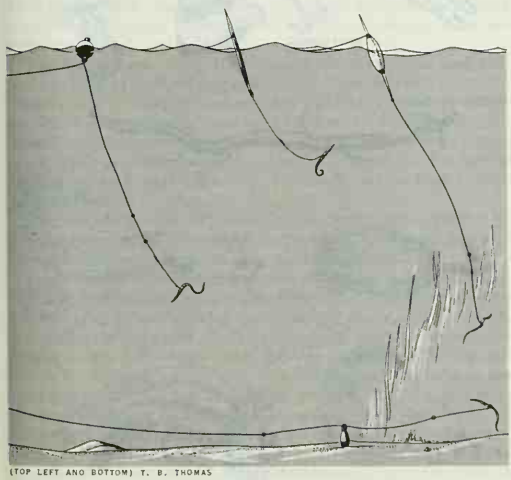
Halford, George La Branche, E. M. Hewitt, G. E. M. Skues, Robert Hartman and, more recently, A. J. McClane, Ted Trueblood, B. Venables and R. Walker, to mention very few, will long be read with both profit and enjoyment by fishermen everywhere. In France too, the writings of L. De Boisset and of Charles Ritz are more than worthy of what Walton called "the contemplative man's recreation."

II. FRESH-WATER FISHING

1. Bait or Still Fishing.—This term has been used in the most general sense to describe one of the four basic methods of fishing. There are, however, a large number of ways of still fishing with bait. All involve the use of hook and line and, for most sport fishing, a rod or pole. Fishing from the banks of a stream, a pond or a lake, from a pier or breakwater, or from an anchored or drifting boat are the most common methods. A large number of different baits are used, according to the species of fish sought and the type of water being fished. A float or bobber or some other signaling device, as a trip (see *Ice Fishing*, below), may be used but frequently is dispensed with in deep lakes or choppy water. The discussion of float fishing below indicates the basic techniques and tackle involved. (In the United States, especially in the Ozarks and the middle west, the term "float fishing" also refers specifically to a float trip in which the fishermen drift in a boat down a selected stretch of river, fishing as they go.) Float fishing and ledgering (using a sliding sinker to fish a bait on the bottom) are both known as coarse or bottom fishing in Great Britain (*see* under *Great Britain and Ireland*, below).

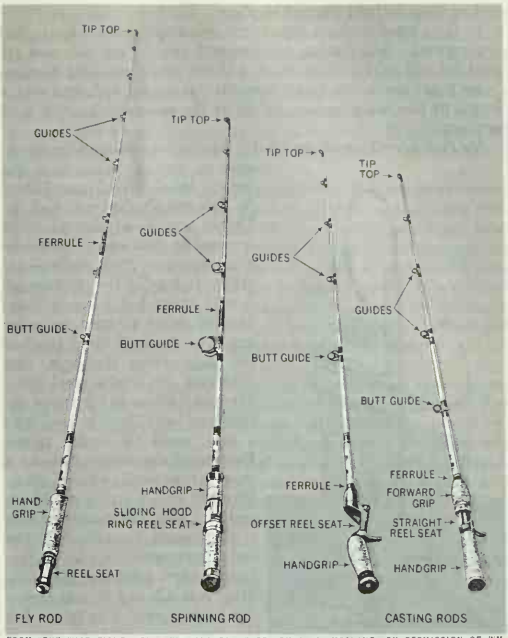
Float Fishing.—A float, or bobber, is a small buoyant object used to suspend the bait at a given depth, and to act as an indicator that a fish is taking or has taken the bait. It is also used as a means of conveying the bait to where the fish are known or suspected to be. Float fishing has been brought to a high degree of efficiency in England, where it is mostly employed to catch the species classed together as "coarse fish." The methods used in England will therefore be described, and other types of float fishing used elsewhere will be discussed as variations of these methods.

Tackle.—Float tackle consists of the line, the float and the equipment below it in the water (fig. 4). At the very bottom is the hook, which usually is attached to a length of nylon monofilament called a leader. The distance between float and hook depends on the type and depth of water being fished and the species of fish sought. A number of small lead weights, or sinkers, may be used. These are usually small lead shot, partially split so they



(TOP LEFT AND BOTTOM) T. B. THOMAS

FIG. 4.—FLOAT TACKLE: (TOP, LEFT TO RIGHT) BOBBER, PORCUPINE QUILL, ANTENNA; (BOTTOM) LEDGER



FROM "THE WISE FISHERMEN'S ENCYCLOPEOIA," ED. BY A. J. MCCLANE, BY PERMISSION OF WM. N. WISE & CO., INC., PUBLISHERS

FIG. 5.—BASIC TYPES OF RODS USED WITH DIFFERENT REELS

can be clamped on the line between float and hook. Their purpose is to give added casting weight; they "cock" the float, that is, cause it to ride upright in the water so that any indication of the bait being taken (a "bite") is seen. Sinkers also are used to suspend the bait at the right depth or, if there is any current, at the right depth and in the right position in the current, or to keep it on the bottom of the river or lake.

The question of depth is important for the float fisherman, for much of his art consists of presenting the right bait in a lifelike manner at the depth at which his quarry is feeding. Fish, according both to species and to prevailing conditions such as the water temperature, the strength of the current or the time of year, may be feeding just under the surface or at various depths right down to the bottom. The angler must first decide at what level he is going to fish. This he generally does by attaching a lead weight to his hook and taking soundings to determine the depth of the water. Then he adjusts his float, usually by means of metallic, rubber or plastic rings which hold it to the line, so that his bait "fishes" at the depth at which he reckons the fish to be.

The angler's line is attached to a leader and is usually between 25–100 yd. long, of nylon monofilament, braided nylon, Platyl or Terylene. This line is held on a reel which will either be of the Nottingham type or more likely a fixed-spool reel.

The float-fishing rod used in England is a long one, usually 10–15 ft. Such length is essential, for the waters fished often require 10–15 ft. of terminal tackle and without this length of rod it would be difficult to cast such tackle or land a fish. Because such rods are held for long periods, they must also be as light as possible. They are usually made in three pieces and at least two-thirds of such rods are made of light, "whole" bamboo cane. The best canes for this purpose are tonkin, from China, and Spanish reed from Spain and the south of France. Rods of this type have a number of wire rings (guides) along their length through which the line runs, with a big ring at the butt and a smaller one at the tip usually made of agate or some similar hard substance. The handles are made of cork and they have a simple system of two

sliding rings to hold the reel in place.

In the United States a lightweight telescopic rod made of glass is preferred. Bait-casting, spinning and spin-casting rods also are used for still fishing on occasion, and the traditional long bamboo "cane pole" prevails in many locations. It is used without a reel, a length of line being tied to the tip of the pole, which often is of one piece.

Ice Fishing.—This winter sport is especially popular in the northeastern United States and the upper Mississippi-Great Lakes-St. Lawrence valley region of the United States and Canada. The ice must be thick enough—usually a minimum of three inches—for safety and holes are cut through it with an ice bar, a heavy, long-handled chisel, or spud, or an ice auger; a dipper is used to clear the chips from the hole. One fisherman can tend several holes. Minnows, grubs and nymphs are favoured baits, usually used with a very small jig or ice spoon. Equipment commonly includes a short (three feet), whippy, glass-fibre rod with a simple centre-pin reel or a cleatlike device to hold a nonfreezing monofilament line and a tipup or tilt (*see* fig. 6) that signals when a fish has taken the bait; it is allowed to run before the hook is set. For larger fish the tipup may hold the reel, in some models below water to prevent freezing. Many pan fish (mostly crappies, bluegills and perch) are caught, but also northern pike, especially in the Great Lakes region, walleye, pickerel, bass and lake trout, with occasional catches of other species. Ice fishing usually is done with one or more companions and frequently large groups take part.

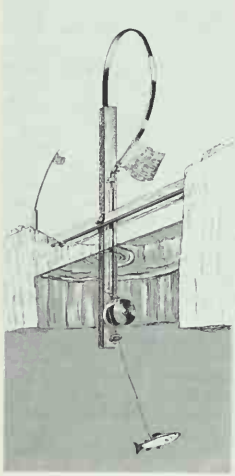


FIG. 6.—ONE TYPE OF TIPUP ASSEMBLY ICE FISHING

2. Trolling.—Trolling is generally used on waters where fish are hard to locate and in particular for fish that swim deep in the water. It is used all over the world but has been brought to its highest peak of efficiency in North America. There is considerable skill involved in trolling the right bait at the right speed and depth in the right places. Local knowledge is of particular importance in this type of angling.

Lures for trolling are numerous. Any of the lures described below (see *Bait Casting or Spinning*), or a live or dead fish or other bait mounted so that it spins or wobbles, may be used. These are trailed slowly behind a rowboat or one driven by a motor. The amount of line out controls the depth at which the lure is worked. In deep waters and for deep-swimming fish, metal lines are sometimes used.

The rod used is usually short, between five and seven feet, although longer rods are used in Great Britain and Europe. The rod is held or placed roughly at right angles to the direction in which the boat is moving so that the recovery (resiliance) of the rod tip helps to hook the fish.

A slightly different type of trolling is used in Britain and Norway for Atlantic salmon. This is known as harling and it is practised in rivers. The lure is fished from the stern of the boat in the usual manner, but instead of towing the bait, the boat is held by the oarsman in the current and the flow of the stream causes the bait to behave like a small fish. In this way the lure can be held over the parts of the river where fish are thought to be resting.

3. Bait Casting or Spinning.—Bait casting is the North American term for casting out a bait, plug or lure and recovering it with a multiplying reel. Spinning and spin casting refer to the use of fixed-spool spinning and spin-casting reels. In Great Britain, on the other hand, spinning refers to all of these methods.

Casting tackle consists of a rod, from 5 ft. up to about $10\frac{1}{2}$ ft. in length, a reel containing about 100 yd. of line, a leader, or trace, and the lure. The line is usually of either nylon monofilament, braided nylon, Dacron or Terylene. The leader, or trace, which is the scarcely visible link between line and lure, is usually of nylon monofilament or, if used for fish with sharp teeth, wire. It may be fitted with one or more swivels to prevent the line from becoming twisted. Leaders may be from nine inches to four feet long.

There are very many different sorts of lures. A small fish, mounted to spin or wobble through the water, is now little used.

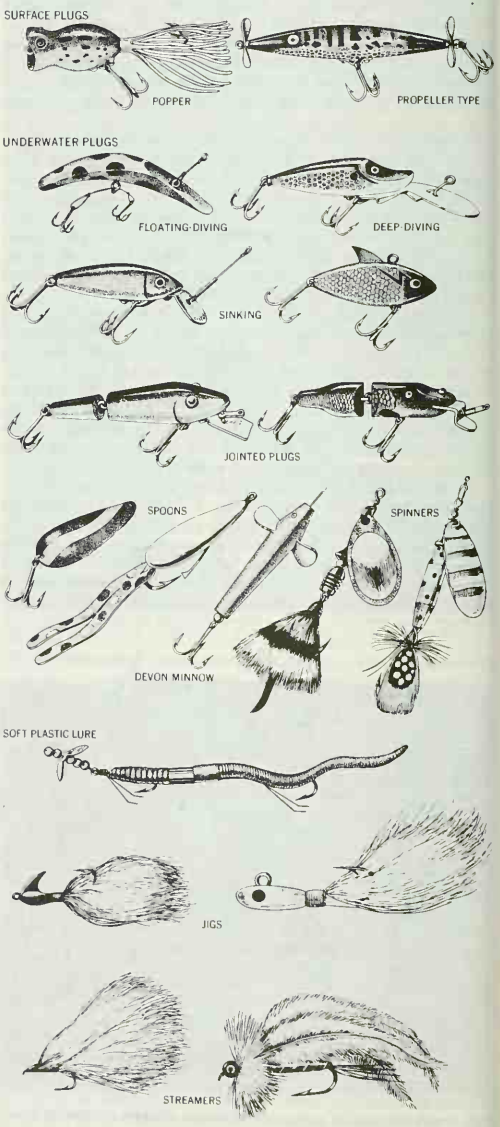


FIG. 7.—REPRESENTATIVE SELECTION OF FISHING LURES

In North America plugs, lures first made of wood but now mostly of pliable plastic in a vast variety of shapes, colours, sizes and weights, and behaving in a most lifelike way when drawn through the water, are used (fig. 7).

In Great Britain the most popular lure for many years has been the Devon minnow, a cylinder of wood, metal or plastic fitted with two fins which cause it to spin. Spoons, that is, spoon-shaped metal lures which spin, wobble or vibrate, are used all over the world.

Although the methods of fishing are similar, the methods of casting with the three different types of reel—the centre-pin, the multiplying and the fixed-spool—are very different.

The centre-pin reel is now little used. It is difficult to cast with because of the considerable inertia which must be overcome before the drum of the reel will start to spin. Once the drum does start to spin, however, it spins too fast for the bait, which decreases its speed as it travels through the air, and unless it is controlled the speed of the line being drawn off the reel becomes much slower than the speed at which the drum is revolving and a tangle of the line results.

The centre-pin reel is used with a rod 8½–10½ ft. long. The rod must be limber so that the build-up of casting power which causes the reel to start to revolve is gradual. The lure is swung back behind the angler and then forward and upward. The reel is prevented from spinning during the swing but this pressure is released early in the forward cast. As the lure flies out over the water the speed of the drum is controlled either by finger pressure or by some form of governor so that it does not exceed the speed at which the line is being drawn off. While these reels are difficult to cast with, and their rate of recovery, being ungeared, is slow, they are excellent reels with which to play fish.

The multiplying reel is less difficult to use, as its drum is much lighter than that of a centre-pin reel. A shorter rod and a shorter swing can be used. These reels are mounted on top of the rod, and the drum is controlled by pressure from the thumb so that its speed does not exceed that of the line. Numerous forms of governors are in use to control the drum speed automatically.

In North America and in parts of Scandinavia multiplying reels are mostly used with a short, single-handed rod of between 4½ and 6 ft. The lure is propelled with a short, snappy, overhead cast which gives great accuracy. In Great Britain these short rods are little used and, as the multiplying reel is there used for large fish like pike and salmon, a longer double-handed rod of eight to ten feet is generally employed; longer rods, usually about nine feet, are used likewise on the western coast of North America for steelhead (trout) and Pacific salmon. The gear ratio of multiplying reels normally is four to one; the rate of line recovery is therefore very fast.

The methods of fishing are the same the world over and irrespective of the species of fish sought. On rivers the cast is usually made across or slightly downstream. If the current is strong enough to impart fishlike motion to the lure by causing it to spin or wobble, the angler does not wind in. In slower water he assists the current by winding slowly. The depth at which his lure is "fishing" is again very important, and leads may be used to sink the lure down in the current.

Another effective way is to cast the lure upstream and to recover it downstream by winding very fast. In Great Britain this is a particularly effective way of catching salmon in the summer.

Probably the most interesting form of casting is that practised in North America, particularly for black bass. These fine sporting fish like to lie in weedy water in the vicinity of snags like old logs. The angler, approaching carefully in a boat, casts a floating lure from either a bait-casting or a spinning reel. Considerable accuracy is essential, for the lure must be dropped precisely in the right place. Having cast the lure to where he thinks a bass lies, the angler moves it gently so that it causes a slight commotion on the surface, as would a frog or a swimming mouse. The accuracy needed, the savage way in which a bass takes the lure and the excitement of being able to watch the lure working makes this as exciting a method of casting as the dry-fly is of fly-fishing.

When a fish is hooked, it is played by allowing it to pull against the spring of the rod and is allowed to swim away from the angler by being given line from the reel. With the revolving drum reels, that is, the multiplier and the centre-pin, line is given by allowing the reel drum to rotate backward, but with the fixed-spool reel this obviously cannot happen. These reels are therefore fitted with a slipping clutch, the tension of which is controllable. This tension is set so that when a fish exerts a certain amount of pull the spool is allowed to rotate and line given in this way. The rotation is also controllable by finger pressure.

With the centre-pin or "single action" reel, line can be recovered against the pull of the fish by winding, for the wind on these reels is direct and not through gears. With the other two types, however, the angler cannot exert enough pulling power through the gears and has therefore to use his rod as well, in a method known as pumping. The point of the rod is dropped and as it is lowered the angler winds in line. He then clamps his thumb on the multiplier or his finger on the fixed spool so that neither will rotate and raises his rod, thus recovering line, repeating the process until the fish is brought close to him.

The spinning, or fixed-spool, reel is initially much easier to use than the other two, although maximum efficiency requires considerable skill, practice and dexterity. As the line slips off the end of the spool, there is no inertia to overcome and as the drum does not revolve there is no problem of control to prevent line tangles.

There are two types of rod used with these reels—a single-handed one of from 4 to 8 ft. and a double-handed one of 8½–9½ ft. With both types the method of casting is similar. More importantly, there are two types of reel, the bail and the closed-face (spin-casting). With the bail type the right forefinger gathers and holds the line. The pickup mechanism or bail, that is, the mechanism which recovers the line on winding in, is lifted so that it no longer retains the line. The cast is then made, the forefinger releasing the line very late on the forward swing. To reel in the line, the pickup mechanism springs forward and as the handle is turned collects the line and distributes it onto the spool.

In the latter half of the 1950s spin-casting reels which were a combination of fixed-spool and multiplying reels were perfected in the United States: the line peels off the drum in the same way as with a stationary drum reel but the drum is enclosed in a bell-shaped cover. They are used on top of the rod like a multiplier and controlled in the same way by the thumb. These spin-casting reels are extensively used in North America and in Scandinavia.

The lack of inertia of these reels enables them to cast much lighter lures than the other two types. They are, however, intended for use with fine lines, and with lines of more than ten pounds breaking strain they progressively lose efficiency. This is because with thicker lines the gap between the top of the line on the spool and the lip of the spool widens rapidly, with consequent increase in friction.

Rods used with spinning reels require a large butt ring (the first ring up the rod). The line peels off these reels with a considerable cone and the large ring cuts down friction and prevents the cone from flapping against the rod. This is not the case with spin-casting reels so spin-casting rods do not have a large butt ring.

4. Fly-Fishing.—In this sport the angler uses a natural fly or, very much more commonly, an artificial fly made from silk, furs, feathers and other materials, so that it imitates one of a large number of flies which live in or near water. Flies are also made which imitate small fish, worms or other bait, while the flies used to catch salmon imitate nothing in nature. Sometimes flies that imitate frogs or mice are "tied" or "dressed" for black bass fishing. The original purpose of the artificial fly was to imitate some insect, however, and most 20th-century fly-fishing is with insect-imitating flies rather than with lures.

While fish feed on an enormous number of different flies, both aquatic and terrestrial, the basis of fly-fishing is the imitation of two insect groups found all over the world, Ephemeroptera and Trichoptera (caddis flies), in their various stages of development.

The first-named are known to fishermen as May flies, ephemerids or upwinged flies. Broadly speaking, their life cycle is in three stages—as nymph, subimago or dun, and imago or spinner—and each stage is imitated by fly-fishermen (*see* May Fly). Not dis-

similar to the life of the May flies is that of the very many species which make up the insect group Trichoptera—the flies the angler knows as caddis flies or sedges (*see* CADDIS FLY). Imitation of the different stages in the lives of these two groups of flies has developed the different methods of fly-fishing

Excluding salmon fishing, a totally different problem which will be dealt with separately, the various methods of catching trout with a fly can be applied, with perhaps slight local differences, to the catching of other fish. For this reason fly-fishing in general will be described on the basis of fly-fishing for trout.

The use of the natural fly is a style of angling little used but one no doubt of great antiquity. This method of fishing is known as dapping. One style of dapping is used with a very short line, using some insect such as a bluebottle, crane fly or grasshopper as bait. It is practised on bushed streams and the angler, concealing himself behind or in a tree, lowers the impaled insect to struggle on the water and thus attract trout. Another form of dapping developed on the Irish and Scottish lochs. The bait is generally either the May fly, the largest of the upwinged flies, or the crane fly or daddy longlegs. The rod is long, 14–15 ft. in length, and the line very light, with floss silk (embroidery floss) attached near its end. One or two flies are impaled on the hook and fly, and floss silk and line are allowed to blow out over the water with the wind, which is essential to this form of fishing. The fly is lowered onto the water well away from the boat and thus behaves in a very natural manner. Another form of fishing with a natural fly is practised in the maritime provinces of Canada in the spring. One or two of the ephemerids which hatch there in May are hooked onto a small hook called a midge hook and cast out onto the water. Such types of fishing obviously have many limitations, not least the difficulty of keeping the fly on the hook, and no doubt this prompted anglers to make imitation flies.

There are two main methods of fishing with the artificial fly—wet-fly fishing and dry-fly fishing. In the former the fly is used under the water, where it imitates a nymph, a drowned dun, some other water insect or a small fish. In the latter the fly floats on top of the water and represents a dun, spinner (spent spinner) or caddis fly (sedge), or some terrestrial insect blown onto the water.

Wet-fly fishing is by far the older of the two methods, for fishing with a floating fly was only developed toward the end of the 19th century. Originally men fished with a 12- to 14-ft. limber rod, a tapered line of horsehair, a leader or cast of horsehair and the fly. Fishing consisted almost entirely of casting across a stream and allowing the fly or flies (for with the wet fly several flies are often used) to swing round in the current. It was not until Stewart wrote *The Practical Angler* in 1857 that the advantages of fishing upstream were demonstrated. Trout and other fish swim with their heads facing upstream and Stewart showed that they could be approached much more simply and effectively from below and that the fly cast in this manner behaved in a more lifelike way. The method was easier to describe than to perform. The sport was dependent to a great extent on the wind, for it was impossible to cast against it, and, because long casting was not possible with so limited an outfit, a wind-ruffled surface allowed the angler to approach within range of the trout. It was not until the 1880s that rods and, above all, lines were improved enough to enable the angler to cast in any direction under most conditions of wind.

The development of the split-cane rod and the heavy, oil-dressed line brought about great changes in fly-fishing. The wet-fly fisherman was enabled to cast a much longer line, upstream or downstream. In Great Britain the concentration was first on the floating fly and then on improved ways of representing insect life just below the water's surface. In the United States progress was initially a little behind Great Britain in these two types of fishing, but similar styles were soon developed to suit the local conditions; the American angler also saw an advantage in the heavy line that his British counterpart overlooked. By its weight, and with a long cast, the heavy line enabled a fly, either one imitating some water creature or one representing a small fish, to be fished deep down in the water.

Methods using the sunk line have been used for many years in North America and, as a result, in many other countries. Such methods are still, however, little known or used in Great Britain.

Before examining in greater detail the individual methods of catching fish with an imitation fly, it is necessary to explain how the fly is cast and thus presented in different ways.

The only weight that assists the angler to cast a fly is the weight of his line. Until the 1880s lines were undressed—that is, they were not covered with the coats of oxidized oil and, later, plastic that now render the line relatively heavy. The modern line may be level (a line of between 20–30 yd. of the same diameter throughout), double tapered (tapering from a fine end up to a thick middle and back to a fine end), or forward tapered (tapering quickly to a thick portion and then quickly back to a long, fine back end).

This line is used with a limber, springlike rod. With some yards of line lying on the water in front of him, the fisherman lifts his rod sharply from a position roughly horizontal to a position just past the vertical. As the rod is moved to the rear, the weight of the line and the pull of the water cause it to bend. When a position of just past the vertical is reached the rod is stopped. As it recovers and straightens itself, it throws the line upward and backward in a loop. The caster allows this loop to straighten until the line is nearly straight out behind him. He then brings the rod forward through the same arc and the line follows, behaving in the same way as when it was thrown to the rear. To lengthen the line the caster holds a few yards in his left hand which he releases late in the forward stroke. The weight and impetus of the line going forward carries out this slack line. This lengthening of line is called shooting.

A leader or cast is tied to the end of the line. This is a two- to three-yard length of nylon monofilament or transparent silkworm gut. The fly is tied on the end; if more than one is used these are tied to short lengths of nylon or gut, called droppers, which are attached at intervals to the leader.

There are many styles of wet-fly fishing. The angler, wading in the water, may cast a short line upstream, pulling the flies toward him at a rate slightly quicker than that of the current by lifting his rod so that they represent the nymph just before emergence. He may imitate the same stage in the fly's life by casting a longer, floating line upstream, and letting his flies drift down with the current. He may cast a short line across the stream and allow his flies to swing with the current or, holding his rod high, allow the droppers to play on the surface of the water (dapping) like a dun struggling to leave the surface or a caddis fly dipping as it lays its eggs. He may cast a long, heavy line across and downstream and allow his fly to sink well down, imitating a small fish or a nymph swimming on the bottom. The skilled angler uses each method according to the prevailing conditions. If his fly is close to the surface the strike or "take" of a trout is revealed by a movement in the water which he calls a rise. If he is fishing deeper he feels a pull on his line. In either case he raises his rod and sets the hook.

In dry-fly fishing the lure is manipulated to imitate a fly floating on top of the water. While a wet fly is slim and sparsely dressed so that it sinks easily, the dry fly is fuzzy. When the fly becomes wet and sodden the dry-fly fisherman whisks it through the air a number of times to dry it.

There are two sorts of dry-fly fishing—fishing to the rise and "fishing the water." In the former the angler is casting his imitation to trout that are feeding during a hatch of fly. The correct choice of fly under these circumstances is crucial, as feeding trout become conditioned to eating just the one type of insect and will ignore every other sort which is brought down by the current. Fishing to the rise is a particularly interesting and exciting sport, for often the trout can be plainly seen in the water and the fisherman is trying to catch one individual fish.

In the other type of dry-fly fishing the trout are not actively feeding. Here the angler casts his fly, searching the water for a fish which can be tempted and paying particular attention to parts of the stream where his experience tells him a trout may be lying.

Both wet and dry flies are used on lakes as well as on rivers and streams, though the most common form of lake fishing is with wet flies from a boat. The boat is allowed to drift with the wind

and the angler casts in front and to the side. A dry fly is sometimes used, particularly when there is a hatch of fly. Lakes are also fished by wading, as in streams, in shallow waters along the shores, and from the bank; a particularly popular sport in Great Britain is fishing from the shores of reservoirs which have been stocked with trout. This type of fishing often requires very long casts, and specialized, powerful rods are needed.

The tackle used for these different types of fishing varies greatly. Rods run in length from about 7 ft., used on small streams, to 10½ ft., still used for boat fishing in Scotland; most rods run between 7 and 9 ft., being generally about 6 in. shorter in North America than in Europe. Rod actions, that is, the degree of stiffness, depend on the type of fishing and the weight of line it is necessary for them to cast. A rod for big migratory trout, such as the American steelhead or the European sea trout, obviously needs to be more powerful than a rod for trout of, say, a pound in weight.

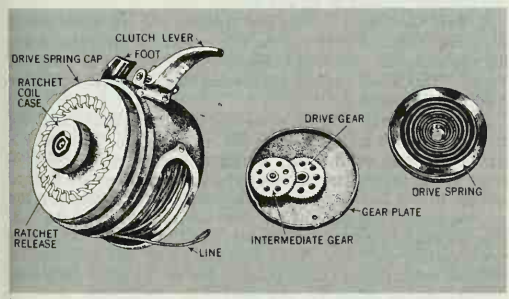
BY COURTESY OF THE GARCIA CORPORATION

FIG. 8.—SINGLE-ACTION FLY REEL

The line is the most important part of the fly-fisherman's equipment, and must be of the right weight to bring out the power of the rod. At the same time, for dry-fly fishing, it must not be too heavy, for it has to float. The reel is a simple, single-action type, often in North America with an automatic, spring-powered pickup that rewinds any free line, of the right weight to be in harmony with the rod and big enough to contain sufficient line for the type of fishing for which it is used.

There are many different types and patterns of artificial flies, usually named after the fly they imitate (*e.g.*, March brown), the materials from which they are made (*e.g.*, snipe and purple quill) or the inventor (*e.g.*, Greenwell's glory). Local conditions dictate the shape and nature of local flies, for a rough river will need a different type of fly from that used for a smooth stream or a lake. Thus there are the well-hackled dry flies of New York state, designed with a big tail to ride on rough water, and the spider flies of Yorkshire, sparsely dressed wet flies made of soft hackle, ideal when fished just under the water on a fast river. All over the world there are fly dressers who, working either in factories or individually, create flies of silk, fur and feather. Many anglers tie their own flies, finding both pleasure in making them and added interest in their use.

Salmon Fly-Fishing.—Salmon fly-fishing differs from other types



BY COURTESY OF THE ENTERPRISE MANUFACTURING COMPANY

FIG. 9.—AUTOMATIC FLY REEL SHOWING DRIVE MECHANISMS

because these fish, which enter the rivers from the sea to spawn, do not eat during their stay in fresh water. The angler, therefore, is not seeking to imitate some part of their immediate diet, although it is reasonable to suppose the lures which interest them remind them in some way of food they have eaten. Flies tied in a wide variety of sizes, colours and patterns, but not representing any particular insect, are used.

One of the methods of fly-fishing for salmon is known as sunk-line fishing. The sunken fly is principally used early in the year, that is, in North America in April, May and early June and in Great Britain in February and March. Salmon entering a cold river are interested in fairly large lures, fished well-sunken in the water and moved as slowly as possible. The size of fly varies from river to river, from very large flies three inches long down to smaller ones half an inch in length. For this style of fishing the angler uses a heavy line which takes his fly well down in the water, and casts rather more downstream than across, letting his fly swing slowly across the stream with the current.

Greased-line fishing was developed in the early days of the 20th century and was principally the invention of A. H. E. Wood of Glassel, Scot. Wood discovered that even in conditions of low water and warm weather salmon could be caught with a small, sparsely dressed fly fished just under the surface. The object of this style of fishing is to bring the fly across the current in a natural manner, and to keep the fly up in the water the line is greased. With this method salmon can be caught in the summer in low water under conditions which hitherto were regarded as hopeless. In addition, when taking the fly the salmon usually breaks the water in a "head and tail" rise, making this style a particularly exciting one.

It is most unusual for salmon in Britain and indeed in most parts of Europe to take a floating fly. In Canada and on some rivers in Iceland, however, the dry fly is most successful. A big, fuzzy fly is used and the technique is broadly the same as already described for trout.

In the United States and Canada short (8–11 ft.), single-handed rods are used except on one or two very rough rivers in the Gaspé area. In Europe, for the most part, long, double-handed rods of 11–15 ft. are best suited to the prevailing conditions.

5. Tournament Casting.—Competitions are held annually by member clubs of the American Casting association, Nashville, Tenn., and the International Casting federation, Vlaardingen, Neth. Highly specialized rods and reels are used to achieve maximum distance and accuracy in casting the fly and the plug.

Distance events are held for the trout fly, the salmon fly, the ⅜-oz. plug and the ⅝-oz. plug. Accuracy contests include both the wet and dry versions of the trout fly and both plugs. However, there is no accuracy event for the salmon fly. Few restrictions are imposed on tackle or techniques for attaining distance or hitting the target, a floating ring of 30 in. or less.

Skish is a refined version of tournament casting which limits the bait casting line to not less than 9 lb. test and the reel to standard design although not the rod and not the fly rod, reel or line. However, all casting for distance and accuracy must be performed as in fishing and without exaggerated wind-up. In addition to trout fly and plug, there is a bass bug accuracy event.

III. SALT-WATER FISHING

The four basic methods of fishing are likewise used in salt water. Bait fishing and trolling are widely used; casting and spinning are used much less but are rapidly growing in popularity, especially in U.S. waters; and fly-fishing, although also growing in popularity, is practised only in a few areas and for a few species of fish. While the methods are basically the same as those used in fresh water, the tackle used is often very different due to the conditions of greater depths, wider areas, rocks, tides and currents.

1. Fishing With Bait.—The various methods of bait fishing are commonly used for sea fish, irrespective of whether the angler is fishing from a beach, off rocks, from a pier or from a boat. The baits used are those which form a normal part of the diet of sea fish—worms which live in sand or mud, marine shellfish and small sea fish either whole or cut up. Ground baiting, while not so frequently and extensively used as by the fresh-water bait fisherman, is still used in many parts of the world. Called chum in the United States, and "rubby-dubby" in Great Britain, ground bait consists mostly of pulped-up oily fish, like the North American menhaden or the Cornish pilchard. Bags containing crushed fish are either

trailed behind a boat or placed so that the tide carries out a slick to draw fish to the bait on the angler's hook. Sometimes the chum is spooned over to drift down tide.

The most commonly used methods are those greatly similar to the fresh-water methods of bait fishing. A lead sinker, sometimes one pound in weight, though more normally four to eight ounces, is used. Shapes and weights vary greatly according to the type of bottom, the depth of the water and the number of hooks, which may be held away from the line and leader by wire or plastic booms.

Such tackle can be cast out from beach or rocks, cast or lowered into the water from a pier or jetty or lowered from a boat to where the fish are known or suspected to be.

Surf fishing, casting from the shore, has long been a popular form of sea fishing in, for example, South Africa and the United States, and this style of angling is probably the one growing most rapidly all over the world. It is a highly skilled form of fishing, for great knowledge is often necessary to locate the fish and very considerable skill is needed to make long casts with heavy weights and to handle big fish in heavy surf.

A long rod, 9–11 ft., is ordinarily used in surf fishing. All three types of reel are used and at one time the centre-pin reel was used a great deal, particularly and with exceptional skill in South Africa. Because such reels are so difficult to control, the multiplying reel, designed for surf casting, is being used by more and more fishermen. The fixed-spool (spinning) reel, used with light tackle, gained greatly in popularity after World War II, especially in North America.

Surf fishing has probably reached its highest degree of skill and the highest degree of organization along the Massachusetts coast. Some surf fishermen camp out on the beach in "beach buggies," vehicles equipped with oversized balloon tires to enable them to give high performance on sand, as well as with bunks and cooking equipment. Small aircraft are used as spotters on occasion to locate a shoal of fish and radio the information to the buggies, which race to the reported area. Surf fishing is sometimes very effective at night.

The British sea angler, less fortunate in the fish around the coast and fishing often in very heavy currents, which demand heavy leads and shorter, stouter rods, nevertheless fishes in a very similar way. Because conditions vary so greatly even within a small area, tackle likewise varies and rods run from 7 ft. up to 12 ft. In many other parts of the world, where conditions are rather more similar to those in North America, surf casting in the American style is becoming increasingly popular, even in countries like New Zealand and parts of South America, so well blessed with fine trout fishing.

Many forms of bait fishing can be practised from a boat. The most common is again a form of bait fishing using a sinker. As always the fish must first be located, and a knowledge of the "marks," that is, the exact location of their feeding grounds and thus of navigation, is essential. The boat angler must also find out at what depth the fish are feeding. The usual method is to lower the sinker until it touches bottom and then to wind in line until a bite is received. The angler notes how many turns of his reel he has made from the bottom to the depth at which the fish are feeding and is thus able to ensure that his bait is fishing at the right depth. Usually the sinker is left on the bottom and the hooks are adjusted to the right depths.

The one disadvantage of such fishing is that heavy leads have to be used. Other methods using lighter and more sporting tackle can also be used from a boat. For fish which sometimes swim high in the water, fish like the sea basses and the mackerels, an unleaded line and tackle can be allowed to run out with the tide or current or can be trailed behind a slowly moving boat. Another form of bait fishing is used on the west coast of Canada and the United States for coho and spring or Tyee salmon. The bait is a strip of herring, cut so that when drawn through the water or when influenced by current it moves in a lifelike manner. A small lead of about an ounce is fixed a yard or so above the bait, and bait and lead are either cast and retrieved, trolled, or allowed to hang in the current. These methods are called "strip casting" or "mooching." Caught on light tackle, the Pacific salmon is a very sporting fish

Not dissimilar is the method developed in the 1940s and 1950s for catching blue and mako sharks off the Cornish coast of England. The ideal conditions occur when the wind is blowing against the tide. The boat is allowed to drift, putting out a trail of "rubby-dubby" which runs off with the tide and attracts the sharks to the angler's bait. This bait, usually a whole herring or pilchard, is allowed to trail behind the drifting boat, suspended at the required depth by a cork float. Sharks caught in this way give a very good fight, and although these British fish are not as large as those in many other parts of the world, they do run to more than 300 lb. and provide a sporting method of fishing.

2. Float Fishing.—This is practised all over the world for fish that can be caught close to the surface, and because very light tackle can be employed it is a particularly sporting way of catching salt-water fish. Fresh-water tackle is often used and a very popular outfit is a seven-foot, light spinning rod and a fixed-spool reel. Very many species of fish are caught by such means and members of the bass, mullet and mackerel families are taken on float tackle all over the world.

A particularly interesting and unusual form of float fishing is practised in the southern states of the United States, generally for speckled weakfish (*Cynoscion nebulosus*). The bait is a shrimp fished a yard or so below an egg-shaped float with a concave top. These are cast out either from a bait-casting or spinning outfit and then retrieved in a series of jerks. These jerks cause the float to be pulled under the water, and the air escapes from the concave top causing a very audible pop which attracts the weakfish to the bait. In this way the float acts both as a bite indicator and as a means of attraction.

3. Trolling.—This style of fishing is greatly practised for sea fish, for it is the best way of locating fish in great expanses of water, often of considerable depth. With the exception of trolling for what are known as big game fish, a specialized technique which will be dealt with separately, the methods of fishing are very similar to those used for fresh-water fish.

Typical of salt-water trolling is the method used on the west coast of North America to catch the large Pacific salmon (*Oncorhynchus tshawytscha*). All types of craft are used, from rowboats to special power-driven ships designed for this sport. Behind such crafts are trailed spoons, plugs and dead fish, either whole or cut up. A very popular method is to use a dead herring preceded by a large spoon called a "herring dodger." The dodger acts both as an attractor and to cause the herring to move in a lifelike manner. Basing itself on this sport of trolling for Pacific salmon is the famed Tyee club of Campbell River, British Columbia. This club lays down rules as to tackle that may be used, and presents buttons to anglers who catch large specimens of these salmon—bronze for 30-lb. fish, silver for 40-lb. fish, gold for 50-lb. fish and diamond for those of 60 lb. and above.

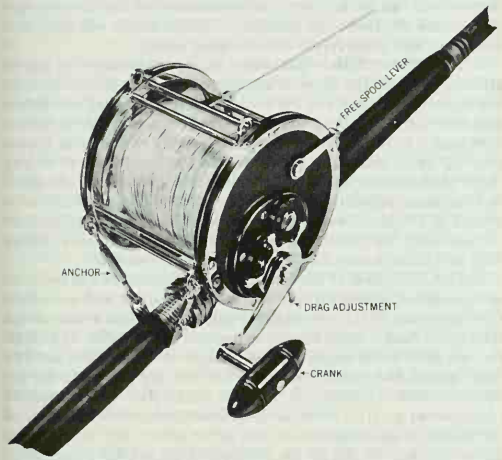
4. Bait Casting.—Casting and spinning for salt-water fish is becoming more and more popular everywhere, in particular where big predatory fish are found close to the shore and in sheltered waters. Tackle and methods are in many cases identical with those used in fresh water.

5. Fly-Fishing.—The flies used in this particularly sporting method are lures imitating small fish, shrimps, etc. Generally a strong, nine-foot rod is used, for long casts have to be made and many of the fish caught are relatively big and powerful. Europe and the British Isles have few places suitable for fly-fishing in the sea, but Florida and some of the other southern states of the U.S. offer splendid fly-fishing for bonefish, small tarpon and other species. Farther north the striped bass takes a fly well in places on both the Atlantic and Pacific coasts while on the latter fly-fishing for coho salmon offers splendid sport.

6. Big Game Fishing.—The fish sought in this form of angling are the big fish of the world, principally the members of the tuna, shark and swordfish or billfish families which may run from 100 lb. in weight to well over 2,000 lb. Although such trophies are caught on heavy bait fishing tackle, the most popular, effective and sporting method is trolling. Deep-sea trolling is a highly specialized form of fishing requiring a boat designed for the purpose and heavy-duty tackle designed for handling very big fish.

The craft for big game fishing must be capable of withstanding heavy seas and is equipped with a "fighting seat," a turntable chair from which the angler can exert the maximum pressure on a fish many times his own weight. The rod, a massive one of glass fibre or laminated wood, has a butt that fits into a socket in the chair. The reel is usually a very large multiplying reel, although some British big game fishermen prefer a centre-pin reel, and is usually designed so that a harness that fits over the angler's shoulders or around the small of his back can be connected to it, thus allowing the fisherman to use all his strength against the fish. The reels have a throwout lever or other device to release the spool and allow it to run free, and usually a braking device or drag to regulate line tension. The line is made of Dacron or Terylene and the leader of wire.

Craft designed for such fishing generally have outriggers—long poles to which the lines are attached by what Americans call clothespins and the British clothes pegs, which hold the lines well clear of the boat, thus allowing more than one line to be used. The age-old problem of locating fish and determining the depth at which they are feeding has been solved in part by the use of echo sounders and other electronic aids.



BY COURTESY OF PENN FISHING TACKLE MFG. CO.

FIG. 10.—BIG GAME REEL BUCKLED TO HEAVY-DUTY ROD

Big game fish are sought throughout the world and since, as with other sports, the establishing of records is no small part of the interest, the International Game Fish association was formed in 1939. Having its headquarters in Miami, Fla., with a committee of experts in the sport, the I.G.F.A. acts as a clearinghouse for information, as arbiter in disputes and as the awarding authority for world records of big game fish, according to species and the type of tackle, classed by strength, on which each record was made.

IV. FISH AND FISHING IN THE PRINCIPAL ANGLING COUNTRIES OF THE WORLD

A. North America

U.S. and Canadian anglers are extremely fortunate in their native fishing for, although in so vast an area fish and types of fishing vary, and, as always in a society becoming increasingly industrialized, the town-dwelling angler needs to travel a long way to obtain good sport, wonderful lake, river and sea fishing exists in North America. Furthermore, in most U.S. states and Canadian provinces fishing is not private but is open to all who hold the necessary licence. Licence fees (and nonresident licence fees) vary widely from state to state as do regulations covering, species by species, size limits and catch or creel limits and establishing open and closed seasons. Fees are used to help finance hatcheries and other fishery management and conservation programs. (*See* Fish Culture; Wildlife Conservation.) Especially after World War II, new highway construction and increasing use of light airplanes made many previously hard-to-reach fishing waters—particularly in northern Wisconsin and Minnesota and the remoter regions of the western United States and of Canada—more easily accessible. (*See* also Boating.)

In North America as elsewhere various fishes are known by many local names. The following discussion is based on the more generally accepted common names; the scientific nomenclature follows that of the American Fisheries society. Some fish caught in more than one country are separately dealt with only under the country in which they are most important to fishermen, for example, *Carp* under *Great Britain and Ireland.*

1. Fresh-Water Fish.—*Atlantic Salmon* (*Salmo salar*).—The Atlantic salmon, sometimes known as the Kennebec salmon, is found in North America from northern Maine, its last stronghold in the United States, to northern Canada. The same fish is found in northern Europe and the British Isles.

Salmon ascend from the sea to the headwaters of the rivers in which they were born to spawn. When the eggs hatch in the early spring the tiny fish, which are known as alevins, live upon the contents of a yolk sac until they grow into what are called salmon parr or pink. The immature salmon spends from one to three or more years in the river until, usually when two years old, and in the spring or early summer, it descends the river and migrates to the sea. At this stage, when it is known as a smolt, it is about six inches long and weighs only a few ounces. A fish that has spent one year in the sea is known as a grilse. The salmon increases very rapidly in size and the average run of fish returning for the first time to fresh water weighs between 8 and 20 lb. After spawning, individuals that do not die return to the sea but they invariably lose condition in fresh water, becoming thin and often suffering from fungus diseases. In this state they are known as kelts. (For details of the life cycle of the salmon *see* Salmon.)

For the angler the one notable difference between the North American and the European salmon is that the former will take a dry fly. Fly-fishing only is the rule in North America and no bait casting or live bait fishing for these fish is allowed. Some of the best rivers in Quebec and New Brunswick, like the Miramichi and the Restigouche, are wholly or partly in private hands but many other salmon rivers including all those in Nova Scotia are open to everyone.

Landlocked Salmon (*Salmo salar sebago* and *Salmo salar ouananiche*).—These two fish are Atlantic salmon which do not migrate to the sea, the difference being that the former, originally only found in Maine, lives in lakes with no access to the sea while the latter lives in rivers in the Lake St. John area in Quebec which have access to salt water. Neither run as big as the migratory fish but both are very fine sporting fish which take fly and spinner very well. An eight-pound landlocked salmon is a big one.

King Salmon (*Oncorhynchus tshawytscha*).—The largest of the Pacific salmon, known also as Tyee, Chinook and spring, these huge fish are found from California as far north as Alaska. They are usually caught by trolling in the river estuaries but at times can be caught by strip casting and "mooching," by fly-fishing and by bait or plug casting. Many west coast rivers have a run of small male grilse, known as "jack springs," which give great sport on a fly rod. In certain rivers very big fish run—for instance at River's inlet on the mainland of British Columbia, fish of between 40 and 60 lb. are common.

Coho Salmon (*Oncorhynchus kisutch*).—Known also as the silver salmon, the coho is a great sport fish, being principally caught in the sea, in estuaries and low down in rivers. Its distribution is similar to the king and like all Pacific salmon its condition deteriorates rapidly in fresh water. It can be caught trolling, strip casting, bait casting and on a fly. Generally the fly, a long lure made from deer or polar bear hair, is trolled, but on occasions coho will take a fly cast to them. A very game fish, it jumps repeatedly when hooked. It is not as large as the king, averaging about nine to ten pounds.

Lake Trout (*Salvelinus* [*Cristivomer*] *namaycush*).—The largest of the North American char (*q.v.*) and a very fine table fish,

the lake trout, also known as Great Lakes trout, is found only in the northern states of the United States and across Canada, in deep lakes. Though it can be caught on the surface on fly and casting and spinning tackle in the spring when the ice melts, it is usually caught by very deep trolling. It reaches a weight of 50 to 100 lb.

Brook Trout, or Speckled Trout (Salvelinus fontinalis).—Originally native to the northeastern states of the U.S. and to eastern Canada, this beautiful fish has been widely planted all over North America. Being a char it requires cold water, and although it will feed on the surface in the spring it prefers deep water. Very voracious, it will take most baits and lures and takes a well-sunken fly very well. The brook trout is excellent eating. It runs to the sea in the maritime provinces and Maine. Depending on the food supply weights range from less than one to more than ten pounds.

Dolly Varden Trout (Salvelinus malma).—A voracious, bottom-feeding char, this fish is found in British Columbia and the western states. It will take any bait or lure and will run to the sea if it has access to it. A good table fish, it weighs up to 30 lb.

Arctic Char (Salvelinus alpinus).—The same migratory char that runs up the Icelandic rivers also ascends the rivers of northern Canada. Little is known about its distribution but fish over 15 lb. in weight are not uncommon.

Cutthroat Trout (Salmo clarki).—This is a true trout and a native of the Pacific drainage from California to Alaska. It is a voracious fish which will take fly, bait or lure. It runs to the sea when it has access. Excellent for eating, the record is more than 40 lb., though a four-pounder is a good fish in most waters.

Rainbow Trout (Salmo gairdneri).—Rainbow trout is the other of the North American true trout and a wonderful sporting fish; it has been transplanted from the Pacific drainage to many other areas of North America and to many other countries. A very strong fighter which takes fly, lure and bait, it weighs from 1 to more than 30 lb. The extremely large rainbow caught in Lake Pend Oreille, Ida., are locally called Kamloops (because the lake was stocked with trout from the Kamloops area of British Columbia) or Kootenay. The rainbow trout has strong migratory tendencies and when it has access to the sea or a large lake, as one of the Great Lakes, becomes sea-run and is known as a steelhead. Steelhead trout are caught on bait, fly and spinner.

Brown Trout (Salmo trutta).—Introduced into North America from Europe, the brown trout gives the same excellent sport there as it gives in the lands where it is native (see *Great Britain and Ireland*, below).

Arctic Grayling (Thymallus arcticus or signifer).—The grayling is native to Montana (a subspecies, *tricolor*) and to Alaska and northern Canada. It is a splendid sporting fish which takes fly, spinner and bait.

Smallmouth Black Bass (Micropterus dolomieui).—A fish of extraordinary strength for its size, the smallmouth black bass is one of the world's great sporting fish. Originally native to the northern states and northeastern Canada, it has been transplanted to many other areas. Excellent eating, these fish will take fly, spinner, plug and bait. Fish between four and five pounds are not unusual.

Largemouth Black Bass (Micropterus salmoides).—Though bigger than the smallmouth, it is not quite so game but will take fly, spinner, plug and bait.

Yellow Perch (Perca flavescens).—The yellow perch, also known as the ringed perch, is one of the most popular North American pan fish. It is a close relative of the European perch (*Perca fluviatilis*). It is caught on live bait (minnows, crayfish and worms are popular) and on flies. The average weight is less than one pound but many lakes have larger perch and catches may average two pounds and over.

Northern Pike (Esox lucius).—The northern pike is common to northern states of the U.S. and across Canada. Although it will take worms and other bait, its main food is fish of all species. For this purpose the pike has a large mouth equipped with hundreds of teeth. It is a long, streamlined fish with great power of propulsion at its tail giving high speed in swimming over a short distance. Its eyes are placed well forward so that its vision is likewise forward and its green, dappled body is perfectly camouflaged for the ambushing of smaller fish. At times a voracious feeder, it takes bait, live or dead fish and lures. Northern pike of 10 to 15 lb. are not rare and some weigh more than 40 lb.

Muskellunge (Esox masquinongy).—A very large member of the pike family, the muskellunge is native to the northeastern and north central states of the U.S. and to eastern Canada. It takes dead or live fish and large lures. Muskellunge weigh up to about 70 lb.

Walleye (Stizostedion vitreum vitreum).—This game fish is known by many names including walleyed pike, pike perch, walleyed perch and, in Canada, *doré*. Its original range was in Canada west to Alberta and southward in the Great Lakes-Mississippi valley region; it is now found all over the United States and Canada. It is excellent eating. Mostly it takes bait, live and dead fish and lures. Weights average 2 to 5 lb. and go up to more than 20 lb.

Pan-fish.—In many parts of the United States the fishes known as pan-fishes give sport to many anglers. This group includes, in addition to yellow perch, the white crappie (*Pomoxis annularis*), the black crappie (*Pomoxis nigromaculatus*), the bluegill (*Lepomis macrochirus*) and a number of other members of the *Lepomis* species usually referred to as sunfishes. All the above will take bait, small flies and small lures. All are good eating.

2. Salt-Water Fish.—Salt-water fishing is probably the fastest growing phase of the sport of angling, not only in North America but in many other parts of the world, with thousands of new fishermen and boatmen joining the quest for the sporting fish of the sea each year. In the following discussion several of the more important big game and other salt-water fish, and methods of fishing them, are described briefly to illustrate various aspects of the sport, and the more popular quarry are identified. The range of many species is, of course, world-wide and major occurrences of interest to sportsmen are mentioned below as well as in sections dealing with particular waters, as *Central and South America*.

Sailfish.—Noblest of the salt-water species must be the billfishes or spearfishes, which include the sailfish, marlins and swordfish. Certainly none of the true finfishes approaches them in size except the bluefin tuna. Most numerous member of the tribe, or at least the one most often caught, is the sailfish, of which there are two valid species and possibly others. The two are known as the Atlantic sailfish (*Istiophorus albicans*) and the Pacific sailfish (*Istiophorus greyi*). As in all spearfishes, the cylindrical spear of the sailfish is an elongation of the upper jaw. But the sailfish is unique in that its dorsal fin is enlarged to saillike proportions. When the fish swims deep the great fin is lowered and folded into a groove on its back. However, when it feeds on the surface the sail is often partly raised as it pursues bait fish or bait. Sailfish are coveted as trophies, and no fish is more widely sought by neophyte big game anglers. In the Atlantic ocean, the average fish caught runs 6 or 7 ft. in length and ranges in weight between 40 and 50 lb.; some weigh up to about 100 lb.

The Pacific sailfish is a heavyweight by contrast, with average weight of 100 lb. A Pacific sailfish caught with hook and line off Galapagos Islands in 1947 weighed 221 lb. The range extends from California to Ecuador, Japan, the Marianas and the Philippines, into the Red sea and Persian gulf and off the east African coast. Acapulco, Mex., was developed as a tourist area largely as a result of its excellent sailfishing. The centre of fishing activity for the Atlantic sail is off the seaboard coast of Florida and the Gulf of Mexico, but the fish are also taken in many other areas including the Bahamas, Cuba, Puerto Rico, Jamaica, Venezuela, British Honduras and Brazil.

Sailfish are occasionally caught by drifting a deep bait, but most often they are sought on the surface and usually seen before the strike. Baits of balao, needlefish, flying fish or mullet or strips of large fish smoothly filleted and shaped are favourites. They are trolled behind a slowly moving boat, preferably from outriggers which, together with the rolling of the boat, cause the baits to skip and swim over the wave tops. The sailfish may rush and strike a bait or it may rise up under it. In any event, the fisherman in the fighting chair takes the rod and puts his reel into free-spool. Should

the fish strike, a sharp rap will be felt by the fisherman who then takes his fingers off the spool and gives line freely until, gauging by the speed of the reel, he feels certain the fish has the bait. The brake is then applied, and the hook is driven home. The sailfish, as all spearfish, is believed to first strike a bait with its bill to stun it. The theory is that it then circles and takes the bait as it drifts down from the free-running reel.

A hooked sailfish provides a spectacle which lures the fisherman again and again to the sport. Suddenly the blue water seems to explode, and the huge fish, sail erect, surges upward. It "walks" the waves momentarily. Then it plunges, "greyhounding" in a series of cascading leaps. It yields only when exhausted. The mate on the boat, with gloved hands, seizes the wire leader as it emerges from the water, reaches down and grabs the fish by the bill. A sailfish or small marlin is never gaffed. At the angler's command the mate either slides the fish into the boat or snips the leader and lets it go free. Most sailfish, unless they are wanted for mounting, are released to fight another day. The flesh is palatable only when smoked.

Marlins.—Similar in many ways to the sailfish, except for its lack of an enlarged dorsal fin, is the white marlin (*Makaira albida*). This billfish grows somewhat heavier than the Atlantic sail and somewhat smaller than the Pacific sail. Average weight may be 60 to 70 lb, although 100-pounders are frequently taken. A fish of 161 lb. was caught with rod and reel off Miami Beach, Fla., in 1938. Dark blue, and silver underneath, the white marlin is distinguished from the blue marlin, which is found in the same waters, by its rounded first dorsal and pectoral fins. The blue marlin has sharply pointed dorsal and pectoral fins. It is also much darker than the white and much heavier. Surface feeding, a white marlin shows the top section of its tail, or caudal fin, in the northern part of its range. Off Bimini, the same fish usually shows no fins until it moves in on the bait, when the raised dorsal fin is seen cutting the water. White marlin strike baits similar to the kind used for sailfish although off Long Island and New England whole squid or a rigged eel is used rather than bait fish. Once they rap the bait they must be given the "drop-back" with a free-spooled reel. They prove just as spunky as the sails when hooked, rearing and plunging to rid themselves of the hook. The range of the white marlin pretty much overlaps that of the Atlantic sailfish except that it extends northward into chilly New England waters as well. When the July run of whites is on at Ocean City, Md., some boats may catch and release a dozen of these game fish.

The huge blue marlin (*Makaira nigricans*) is often a running mate of the white. In the Atlantic ocean, big game anglers troll for the smaller white marlin or for sailfish and hope to spot the sharp, triangular dorsal fin of the cruising blue. The boat may troll a strip bait or a small bait fish. At the same time it may have a sewn mackerel (with backbone removed to give added "life" to the bait) bouncing along from an outrigger. Many captains who fish for the big marlins and swordfish keep the best bait aboard and wait for sight of the quarry before presenting it, as baits are torn up from too much trolling. In the Bahamas a fair-sized bonefish is considered an excellent marlin bait. Once the fish is sighted the bait is put over and is drawn past the blue. Should the fish rap the bait with his bill, the angler free-spools the reel and gives the familiar drop-back. Blue marlin are powerful fish. They leap and "greyhound" but they also dive very deep. At times they will dive and then die from exhaustion many fathoms beneath the boat. Unless the angler has heavy tackle he will be unable to pump the fish to the surface. Blues are caught along the eastern Atlantic coast as far north as New England but they are more plentiful in the warm tropical waters of the Bahamas, Cuba and Puerto Rico. They are also taken in Venezuela and Barbados. Average weight of blue marlin is between 200 and 300 lb. The record is over 800 lb.

There are two other marlins, less fished for because of their remote habitat but in the same class with the blue. One of them, the black marlin (*Istiompax indicus* or *marlina*), is considered the greatest of the finfishes. It is a native of the Pacific, ranging from the Gulf of California south to Peru. It is known off many of the Pacific islands including Hawaii and the Philippines, and in waters off Australia and New Zealand. But the black made its mark with anglers off Peru; big game fishermen from many lands visit the Cabo Blanco club to fish for 1,000 lb. specimens. The fishing for it is typical of all marlin trolling.

The striped marlin (*Makaira audax*) grows almost to the size of the blue. Its range is largely that of the Pacific black marlin but it is more abundant. Average fish run from 250 to 350 lb. A fish weighing 692 lb. was caught with rod and reel off Balboa, Calif., in 1931.

Swordfish.—Most striking of the billfishes is the broadbill swordfish (*Xiphias gladius*), distinguished by the prolongation of its upper jaw into a long, flattened, sharp-edged and pointed sword which is nearly one-third the total length of the fish. Swordfish are especially prized among big game fishermen. To begin with they cannot be fished for until they are seen on the surface. And when they are on the surface they are often surfeited with food and not interested in the angler's offering of a whole fish or a squid. Again, when they do rush the bait they are not easily hooked, and when they are hooked their relatively soft mouths leave room for the familiar mishap of the pulled-out hook. The fish average from 250 to 350 lb. but 500-pounders are common. Exceptional was the 1,182-lb. swordfish caught off the famed grounds at Iquique, Chile, in 1953, by big game angler Lou Marron of New Jersey.

Swordfish are from common to rare over much of the world. They are a valuable market fish and because of their habit of lolling on the surface and their fearlessness of boats, they are easily harpooned for the commercial market.

Tuna.—While there are several species of tuna and all of them are eagerly sought by fishermen, none approaches the magnificent bluefin (*Thunnus thynnus*) for sheer size or abundance. The bluefin has been reported in most of the warm or temperate seas of the world. Young fish of the species—fish of 8 to 15 lb. or more—are often found with false albacore and the bonitos, cousins in the family tree. Fishermen trolling feather or nylon lures in the wakes of fast cruisers may catch one or the other. If a watch is kept on the boat's wake, the fish may be seen to snatch the lures within 20 ft. of the stern. This is particularly true in the Atlantic ocean. In some Pacific fishing areas, among them California, the small bluefins are more readily taken with live bait after having been chummed to the boat with live sardines. Even in such miniature sizes the bluefins recklessly strip line from the reels in their steep dives. Tuna of 75 lb. have been known to completely empty reels of 500 yd. of 15-thread line.

But while the peppery little tuna provide great sport for legions of sport fishermen and a summertime charter boat business on both coasts of the United States, it is the giant bluefins that fascinate one coterie of anglers to the extent that they spend small fortunes to catch just one. Records of giant tuna being taken by nets or harpoon are centuries old. Not until 1898, however, when Charles A. Holder succeeded in boating a 183-lb. bluefin with rod and reel off Catalina, Calif., did anglers everywhere raise their sights on these leviathans of the deep. Holder organized the Catalina Tuna club the day after his catch. The fish were caught without benefit of the friction brakes which are built into modern reels. Improvement of equipment was accompanied by a comparable increase in the size of the fish caught. Bluefin tuna are rumoured to grow as large as 1,600 lb A specimen harpooned off Rhode Island in 1913 weighed 1,225 lb. One weighing 977 lb. was caught on rod and reel at St. Ann's bay, Nova Scotia, in 1950.

Giant tuna are fished for in several different ways, of which the chumming method is the most frequently used in the United States and Canada, and off the Scandinavian coast. Whole or large chunks of herring or menhaden are used to lure the fish. A similar fish or chunk of fish is drifted or floated out on a large hook which is twisted to a steel leader. Chum is used to lure the huge fish to the baits in the tide rips off Nova Scotia. The same method is used at Montauk point, Block Island, and along the New England coast. A system of slowly swimming a live mackerel or whiting is also successful when the tuna are seen on the surface.

During the May run of giant tuna off Bimini and Cat cay in the Bahamas, the schools of northbound fish are spotted from lookout perches on fast cruisers. The boat races ahead to in-

tercept the school. Near the point of interception a whole mullet is sent overboard and jigged rapidly. If the maneuver has been correctly timed, one of the tuna may break away from the school and seize the bait.

The torpedo-shaped tuna, with body grooved to receive certain of the fins for streamlined speed swimming, is among the fastest fish in the sea (estimated 40 m.p.h.). A giant hooked on a line is almost tireless in its deep-boring rushes. However, skilled anglers have brought 500- and 600-lb. tuna to the boat in as little as 20 minutes. The average fight may last two hours. Should the fight go to five and six hours, the odds are with the tuna. The tuna is still fresh or "green" and the angler is exhausted. Once the tuna has been brought alongside the boat, the mate grabs the leader with a gloved hand and sinks a "flying gaff" into the fish. The flying gaff has a detachable head which is fastened with heavy manila hemp to a cleat on the boat. After the death flurry, a noose is swung over the tuna's mackerellike tail and it is pulled aboard with the hoist.

Other tuna prominent in the angler's book are the yellowfin or Allison's tuna (*Thunnus albacares*) and the bigeye tuna (*Thunnus obesus*). Neither approaches the size of the bluefin tuna although they may reach several hundred pounds. Smaller still is the albacore (*Thunnus alalunga*) which averages from 15 to 50 lb.

Tarpon.—Trophy of the brackish waters, the rivers, inlets and back bays of tropical climates, the tarpon (*Megalops atlanticus*) also is often referred to as the silver king, *grande écaille*, sábalo, and by many other names. It sometimes reaches a weight of nearly 300 lb. and is highly prized for its spectacular, leaping fight. A fish of 283 lb. was taken with rod and reel from Lake Maracaibo, Venez., in 1956. When a school is rolling on the surface each tarpon breaks the surface with its snout, and the dorsal fin with its whiplike appendage comes into view. Finally the broad tail sweeps up, and the fish is gone to repeat the roll in another moment. Tarpon gulp air during their rolling to augment gill breathing. Scientists believe this direct absorption of air explains their ability to thrive in stagnant pools and poorly oxygenated water.

Excellent baits for tarpon are live pinfish or mullet. Most tarpon fishermen, however, prefer to use artificial lures. Sometimes the fish will strike at slow-moving, deep-running plugs. Other times they will engulf noisy surface plugs. Fly-fishermen catch baby tarpon on white and silver flies. These restless fish may be taken on spinning rod and bait-casting tackle as well as strong deep-sea rod and reel. As a rule the light tackle is most effective when the fish are in shallow water or narrow drains. Their fight then consists of leaptrogging and tail-walking rather than long, swift runs. Under such conditions tarpon as large as 160 lb. have been caught on 14-lb. test lines. When tarpon are swimming in strong currents, however, they will rush down tide, and heavy tackle is needed. Most important in tarpon fishing are needle-sharp hooks to penetrate the bony plates of the jaws. Even more horny than the mouth surfaces are the great silver scales of the fish. Gaffs will hardly penetrate the scales, and as a result tarpon are always gaffed in the mouth. The same bright scales, larger than silver dollars on 100-lb. fish, are the souvenirs of the tarpon fishing trip. As food the tarpon is worthless. Therefore, unless the fisherman wants the fish for a mount, he pulls a scale from the exhausted quarry and then sends the tarpon back to the school.

Bonefish.—Few fish have been so widely acclaimed for their swiftness as the bonefish (*Albula vulpes*). Although a relatively small fish, with average weight running from four to six pounds and only rarely caught over ten pounds, the silvery bonefish can flee at sizzling speed when hooked or alarmed. A favourite of the light-tackle fishermen, the bonefish will often strip a reel and break free in the first surging run to escape into deep water. This first flight invariably is in a straight line and sometimes will continue for 100 yd. or more before the nervous energy that made it possible is spent. If the fisherman stops the first run, the fight is half won. Barring accidents with sharp coral which could cut the line, the tiring quarry eventually will be brought alongside the boat and netted. Bonefish prefer to feed on shallow, grassy flats, or banks, following the incoming tide into only a foot or two of crystal-clear water. They have piglike snouts, ideal for rooting in the bottom and digging out small shellfish and crustaceans which are then crushed between a rock-hard tongue and an equally hard palate. Often when rooting up the bottom their tails break the surface. Fishermen poling the flats in shallow-draft skiffs look for these signs of "tailing fish." Another clue to the presence of fish are little puffs of mud stirred up by the feeding. Fishermen hastily, although stealthily, intercept the feeding fish and cast to them with baits of shrimp, hermit crab, conch or crayfish.

Light bait-casting rods and reels once were the favourite for bonefish. They have been largely replaced by spinning tackle. Fly-fishermen, using a heavy salmon-type rod and a forward-tapered fly line with plenty of backing and special streamer flies, also catch them. These fish may also be chummed to an anchored boat with bits of shrimp. Bonefish are native to many areas of the world including the Florida keys, Bermuda, the Bahamas, Cuba, Puerto Rico, Venezuela, California, Mexico, Hawaii, Australia, Japan and India. Some of the best bonefish flats are at Andros Island in the Bahamas. A bonefish taken in Hawaii in 1954 weighed 18 lb. 2 oz. Sometimes confused with bonefish and also eagerly sought are ladyfish, or chiro (*Elops saurus* in the Atlantic, *Elops affinis* in the Pacific). The permit (*Trachinotus falcatus*) is a swift but scarce fish of the Florida keys and Bahama flats and may be taken while bonefishing. It has been caught at over 40 lb.

Striped Bass.—The striped bass (*Roccus saxatilis*), a member of the perchlike fishes of the sea bass family Serranidae, is said to be the most popular inshore fish of the United States. At least this is true along much of the east coast where the striped bass, also called striper, rockfish, greenhead or lineside, is sought throughout much of the year, from South Carolina to Maine. It is equally popular in parts of California and in Coos bay, Oregon, where the fish now flourishes as a result of being transplanted in San Francisco bay from New Jersey in 1877 and 1882. The original stock of 434 small fish multiplied until striped bass became important as a recreational fish in California second only to the salmon. Commercial fishing for stripers was permitted in California until 1935 when a law was passed making it a game fish, setting fishing limits on size and numbers, and forbidding its sale. California authorities estimated that by the second half of the 20th century 200,000 anglers fished for stripers in the state's waters and spent $10,000,000 annually in pursuit of their sport. Striped bass are fish of brackish and fresh water as well as the salt sea. They spawn in swift currents of rivers several miles inland. The young fish may spend a year or two in fresh water before descending to the ocean. Adult bass are known for their extended migrations. On the Atlantic coast the principal spawning area of the striper is Chesapeake bay. During the spring movement Chesapeake bay bass, or "rocks" as they are known in that area, travel northward to populate hundreds of miles of surf and bays. In California waters and in such Oregon waters as Coos river, bait fishing for the species has been brought to a fine art. Favourite baits are chunks of pilchard or other herringlike fishes. Live bullheads up to six inches in size are used, as well as clams and worms.

Throughout much of the east coast range of the striper, most fish, particularly the larger ones, are caught on artificial lures—plugs of various shapes and sizes, bucktail jigs and lures shaped of tin or chrome-finished lead. However, eels of a foot or so in length, killed and carefully rigged with hooks, prove excellent lures for night casting. Striped bass are most often sought at night in the boiling surf by casters or "squidders" who wear wading boots of armpit height. Less hardy anglers charter fishing boats and troll lures along the edge of the surf or over rocks and wrecks. Striped bass generally attain greater size on east coast grounds of their origin. Fish of 20 and 25 lb. are common. During the fall run in New England, scores of 35- to 45-lb. fish are taken daily, with occasional 50- and 60-lb. fish.

Bluefish.—The hard-fighting bluefish (*Pomatomus saltatrix*) best illustrates the phenomenon of cyclic abundance and scarcity among the pelagic fish of the sea. Bluefish have always been an important food species. Over the years, catch records show the bluefish has repeatedly gone from peak periods to poor periods and back again. Basis for an intensive sport fishery along the east coast of the United States, the bluefish, sometimes described as elft,

tailor, snapper, or greenfish, is spread through many of the warm seas of the world. Some of the largest specimens have been reported from Africa although a hook and line record of 24 lb. 3 oz. was established in the Azores in 1953. A savage predator of the ocean, a school of bluefish will chop shoals of bait fish to fragments, providing a feast for the sea gulls and food for creatures of the ocean's bottom. Bluefish are taken from the surf by casters who use lures and plugs. Immature blues, or snappers, are a favourite of the cane-pole fishermen of the bays. Most bluefish, however, are caught by trolling metal or feathered jigs from slow-moving boats. The troller "follows the gulls" to find feeding bluefish. Bluefish when they are in teeming numbers respond quickly to chum of ground menhaden. A piece of fish on a hook with a wire leader as protection against the sharp teeth of the blue is the bait.

Yellowtail.—The Pacific yellowtail (*Seriola dorsalis*) is beautifully streamlined and solidly muscular. Anglers seek it in many waters for the fish is abundant in Australia, New Zealand, and off South Africa, as well as along the Pacific shores of California, Mexico, and throughout the range to Chile. In California, at least, the fish supports a large party boat business. The Pacific yellowtail is a surface feeder, rising from kelp beds to take chum of live sardines tossed overboard by slowly cruising boats. Once the fish have found the chum, a live sardine is baited on a hook and allowed to drift back to the fish.

Yellowtails are strong fighters and delicious eating. Average size may run from 5 to 20 lb. but specimens up to more than 100 lb. have been caught.

Flatfish.—There are said to be over 50 genera and 500 species of flatfish starting with the giant Atlantic halibut (*Hippoglossus hippoglossus*) and ranging down to the tiny hogchoker (*Trinectes maculatus*). The Atlantic halibut is rarely found by the angler, but the California halibut (*Paralichthys californicus*) which grows to about 60 lb., in contrast with more than 600 lb. reported for the Atlantic halibut, is caught by sport fishermen. Flatfish have colour and both eyes on one side only, right or left. When very young they have normally placed eyes but with growth one eye migrates over the top of the head and settles beside the other. Other names in general usage for the various flatfishes are flounder, fluke, dab, sole and plaice. Some species cling to the deep offshore grounds and are never taken by angling. But in inshore waters, whether warm or cold, there is almost always one member of the huge family which will take the fisherman's baited hooks. Some species such as the winter flounder (*Pseudopleuronectes americanus*) spend their lives within an inch or two of the bottom where they feed by digging out worms and small crustacea from the mud. Other flatfish such as the summer flounder, or fluke (*Paralichthys dentatus*) will even break the surface in pursuit of bait fish. The summer flounder, which may weigh up to 20 lb., is most often taken with a live minnow on a hook that is dragged with the tide along the bottom. Less active members of the family such as the winter flounder are usually caught with bits of sea worms or clams on small hooks fished right on the bottom.

Channel Bass, Snook, Bonito and Others.—The channel bass or red drum (*Sciaenops ocellata*) is found on the Atlantic coast south of New England and caught on lures and bait, particularly by surf casting. A large fish, it weighs up to 80 lb. A number of species of snook (*Centropomus undecimalis*) are found in both the Atlantic and Pacific oceans. It is a very game fish which can be caught by most fishing methods and it takes a fly well. Average weight is 4 to 9 lb. but the record is more than 50 lb. The common Atlantic bonito (*Sarda sarda*) is a fish of the mackerel family, found in the Atlantic and the Mediterranean, similar in form to but smaller than the tuna; the striped bonito (*S. orientalis*), which is world-wide, and the Pacific bonito or Chilean bonito (*S. chiliensis*) of the Pacific also are caught as bonito (*q.v.*). These very fast fish give great sport, although the average weight is well under 15 lb.

Among other salt-water quarry the crevallé, jack crevallé or common jack (*Caranx hippos*), a very strong fish found on both coasts, can be caught on bait and by casting or trolling. It may weigh from 2 or 3 lb. to about 30 lb. The genus includes the blue runner, the skipjack, yellow jack and other crevallés. The dolphin (*Coryphaena hippurus*), a very beautiful fish (not to be confused with the aquatic mammal of the same name) and excellent eating, is found on both coasts and off Hawaii. Its principal food is the flying fish and it is generally caught by trolling. The average weight is under 25 lb.; some weigh more than 80 lb.

The weakfish or sea trout (*Cynoscion regalis*) and the spotted weakfish or spotted sea trout (*Cynoscion nebulosus*) are found south of New York state on the Atlantic coast. They take various baits, especially shrimps, and can be caught on a fly and on lures. They make excellent eating. A large one weighs ten pounds.

A great many other salt-water fish are sought by U.S. and Canadian fishermen. Among the more popular are pompano, barracuda (or barracouta), amber jack, grouper, coney, snapper, cod, mackerel, pollack, sea bass, shark and flounder.

B. Central and South America

1. Mexico.—Though there is good river fishing in Mexico, particularly for rainbow trout, it is for the superb fishing off its coasts that this country is renowned among anglers. The world's biggest tarpon are caught in the mouth of the Panuco at Tampico, Acapulco is famed for Pacific sailfish, while Veracruz offers a wide variety of sporting sea fish—bass, marlin, grouper and many others. All three are well-known angling resorts and all three have famous "rodeos"—competitions among anglers for the largest fish of a species caught during the period of the event.

2. Bahamas.—This group of islands offers some of the finest sea and big game fishing in the world and Bimini and Cat cay are as famed among salt-water anglers as the Restigouche, the Spey or the Aaro are famed among salmon fishermen. Giant tuna and marlin offer sport to the big game enthusiasts while tarpon, barracuda, kingfish, wahoo, bonefish and many other species can be caught on lighter tackle.

3. Jamaica, Barbados, Trinidad and Tobago, and the Leeward Islands.—These are similar to the Bahamas in the sport they offer: big game fish, barracuda or great barracuda, tarpon and kingfish. In Jamaica there is a fresh-water fish, the mountain mullet (*Agonostomus monticola*), which gives good sport on light tackle.

4. Cuba.—Highly famed for its sea and big game fishing which is similar to that of the Bahamas, Cuba also has fine fresh-water angling. Large tarpon are caught in some of the fresh-water lakes and there is splendid fishing for largemouth black bass and bonefish.

5. South America.—The great native sporting fish of this vast subcontinent is the dorado (*Salminus maxilosus*), a very strong fish which runs to more than 40 lb. Usually it is caught on heavy bait-casting tackle in the Orinoco, Uruguay, Paraguay and Paraná rivers, in the Amazon and its tributaries and in Bolivia. One of the world's largest fresh-water fish, the pirarucu, or arapaima (*Arapaima gigas*), is caught in the Amazon and its tributaries and in British Guiana. It runs up to several hundred pounds in weight. It is usually caught on live bait. Other good native sporting fish are the tucunare (*Cichla ocellaris*) of British Guiana, a perchlike fish which takes a big fly well; the boga, a characid, and the pacú, also a characid of Argentina, which are caught on bait; and the trucha of Chile, which will take fly or spinner.

Of greatest importance perhaps to the fresh-water angler is the fact that brown and rainbow trout, char and Atlantic salmon have been introduced with great success into many of the rivers and lakes of Colombia, Peru, Chile and Argentina. Particularly in the latter two cases, brown and rainbows grow to a very large size in the glacier-fed rivers of the southern Andes and Patagonia and the trout fishing in these areas is probably unequaled in the world.

Off Cabo Blanco in Peru is some of the finest big game fishing in the world. Here the cold Humboldt current meets the equatorial current and in this area there is an enormous concentration of all big game fish. Most sought of these is the giant black marlin (*Makaira indica*) which runs over 1,500 lb.

All round the coast of South and Central America there is good fishing. Surf casting is growing in popularity, particularly in Ar-

gentina, and a small band of enthusiasts enjoys excellent sport.

C. Great Britain and Ireland

Fishing in this area is divided into game fishing, that is, fishing for salmon, trout and sea trout, coarse fishing, which includes all the other fresh-water species, and sea fishing. The salmon season, varying according to river, runs roughly from January to October, the trout season, likewise variable, from March to September and the statutory coarse fish season runs from June 16 to March 14.

1. Game Fish.—*Salmon* (*Salmo salar*).—This is the Atlantic salmon described under *North America*, above, and its life history is the same, the chief difference being that in Great Britain and Europe the salmon rarely will rise to a dry fly. The salmon do not feed in fresh water but will take a large wet fly and are also caught on spinning lures and on worms and prawns. Salmon run up most rivers in the British Isles except those of northeastern, eastern and southeastern England. Some of the best rivers are the Wye and the Eden (England), the Usk, Teifi and Dee (Wales), the Dee, Tweed, Tay and Spey (Scotland), and the Blackwater, Lee and Boyne (Ireland). The record British salmon was caught in the Tay and weighed more than 60 lb.

Trout (*Salmo trutta*).—There is one native species of trout in the British Isles, the brown trout, and apart from some rivers in eastern and southeastern England, these fine fish are widely distributed. They do, however, vary greatly in size and colour, the latter depending greatly on the colour of their background. In the chalk streams of Hampshire a two-pound trout is common, due to the vast amount of food obtainable in these alkaline rivers. A trout the same age from the acid rivers of Devonshire would probably weigh between four and six ounces.

Trout live on insects in their various stages, small fish including their own species, worms and most small forms of life living in the water. They are caught on artificial flies and on spinning lures and will take most forms of bait. The principal English trout rivers are the Test and Itchen in Hampshire, the Kennet in Berkshire, the Dove in Derbyshire, the Wharfe and Ure in Yorkshire and the Eden in Cumberland. The Usk is the best trout stream in Wales while Scotland and Ireland both have great numbers of fine trout streams, the best in Scotland probably being the Don while the Suir and Maigue in Ireland would be hard to beat. Trout, too, thrive in lakes and reservoirs like the Irish limestone lochs, Loch Leven in Scotland and many man-made reservoirs throughout the British Isles. The largest trout weigh up to about 40 lb. This is most exceptional and a four-pound trout is a big one anywhere. The American rainbow trout has been introduced into Britain but only with success in certain reservoirs and in the river Wye in Derbyshire. Both brown and rainbow trout are excellent table fish.

Sea Trout (*Salmo trutta*).—This fish, one of the great sporting fishes of the world, is the same species as the brown trout but has seagoing habits like the North American rainbow steelhead. The sea trout is spawned in November at the same time as the brown trout and spends about two years in the river before migrating to the sea. Unlike the salmon it remains close to the shore during its salt-water life and a great deal is known about its existence in the sea. After several months in salt water the young sea trout will probably return to the river for the first time and thereafter will return each year of its life to spawn.

Sea trout are caught on wet and dry flies, on spinning lures and on bait. They are very strong fish and are great leapers, jumping clear of the water many times in their efforts to escape the hook. Although much of their life is spent away from man, they are very shy and are generally best caught at night.

Sea trout run up most of the unpolluted rivers of the British Isles and are known by many local names. In Scotland the small fish returning for the first time are called finnock or harling. In Ireland sea trout are called white trout, in Wales sewin and in many other parts they are referred to as salmon trout. Weights of more than 20 lb. have been recorded but any fish over 6 lb. can be accounted a good one. They are particularly good table fish.

The west country is well blessed with good runs in streams like the Tavy, Taw and Torridge. In Wales the Dovey holds very big fish and both Scotland and Ireland have an embarrassment of riches in this regard, with Loch Maree in the former particularly worthy of note.

2. Coarse Fish.—Besides casting or floating his bait to the fish, the skilled coarse fisherman brings the fish to his bait and holds them in the vicinity by the use of ground bait. This usually consists of bread or poultry meal, soaked to varying consistencies. For heavy water a solid, doughy ground bait is needed to sink down in the current. For still waters, ground bait that acts like a cloud is used. A certain quantity of the bait the angler is using on his hook is mixed in the ground bait so that the fish are conditioned to feeding on it.

The diverse character of rivers and lakes, and the differing species in them, have led to the development of a number of fishing "styles." The Hampshire Avon in England, for example, is a deep, fast and very clear stream; the normal method of float fishing there is long trotting. A big float and heavily weighted terminal tackle are allowed to drift away with the current to perhaps 30 yd. below the angler. The rod used is limber, between 10–11 ft. in length, and the reel, usually a Nottingham reel, is very free running. The Thames, England, style on the other hand requires a very light, stiff, 14-ft. rod. The float is fished very close to the rod tip with a very short length of line between them. The float travels along with the current as far as the length of rod allows it, and then is lifted and cast into the water again. Indeed there are still Thames fishermen who use a "roach pole"—a light rod about 20 ft. long, with no rings, and the line tied to its end. In Europe, a somewhat similar long rod with tight line is still widely used for float fishing.

Another method of float fishing is float ledgering. The terminal tackle is heavily leaded, particularly close to the hook, and the distance between hook and float is greater than the depth of the water. Some of the lead thus rests on the river bed, anchoring the bait in a current, and allowing it to lie on the bottom. (*See* also *Ledgering*, below.)

The following method is typical of float fishing. A float fisherman seated at the head of a fast stream about six feet deep, with maggots as bait, will adjust his tackle so that the bait is just tripping the bottom of the stream. He throws in a handful of maggots as ground bait and then follows them down the stream with his hook bait. As his bait is carried down with the current, the angler watches his float. Should a fish take it, the float will stop, or dip, or be pulled under the water. At this indication the angler sets the hook by jerking his rod sharply, thus pulling his hook home in the fish. If the fish is of any size it has to be "played" by keeping pressure on it with the flexible rod and allowing it to swim away by giving it line off the reel. When the fish has been tired in this way, it is brought back close to the angler and lifted out by means of the landing net, a small hoop net on the end of a shaft.

Ledgering.—A basic method of angling all over the world, ledgering is closely allied to float fishing, but no float is used. Although there are many differing applications, the idea is to anchor the bait on the river or lake bottom by means of a sliding weight, or sinker, in Great Britain called a ledger. These vary in design, but it is essential that the weight hold the bottom and allow the line to pass freely when a fish takes the bait so that no resistance is felt. Various lengths of rod are used, probably the most popular being one of about seven feet in length, used with a fixed-spool reel. Ground bait is used in the same way as for float fishing.

As no float is used other methods of detecting a "bite" must be employed. Some watch the tip of the rod which is pulled down when a fish takes the bait. Indicators of various simple types are used which are attached to the line. When the indicator moves the angler sets the hook. A form of ledgering has been devised to catch carp, a very shy fish, at night, and for this purpose a simple electrical buzzer is used which sounds when the line is pulled out.

Fishing Matches.—Match fishing for coarse fish is a sport of enormous popularity on the continent of Europe and in England.

The match organized by the Birmingham Anglers' association, for instance, draws 4,000 competitors, all fishing in one afternoon on one stretch of river. As can be imagined the organization of such an event is a considerable undertaking.

Matches usually last four or five hours. The river is divided into the required number of "swims," each marked with a numbered peg. The competitors draw for peg numbers and the purpose of the match is to catch the heaviest weight of fish. As each fish is landed it is placed in a "keep net" (a large, sack-shaped net) and thus kept alive until the end of the competition. At the end of the allotted time each angler's catch is weighed and the fish are then returned to the river.

Considerable sums of money are won in such contests, in prize money, in sweepstakes and in betting. It is not unusual for the winner of a big match to leave the waterside several hundred pounds the richer.

Pike (*Esox lucius*).—The largest purely fresh-water fish in Britain, the pike is the only fish of this type common to both Europe and North America.

Pike are caught on spinning (bait-casting) tackle, by trolling and by live baiting with a small fish. Despite their size they are not strong fighters, although in some of the cold-water Irish lochs their performance in this regard is more spectacular. They vary a good deal in size—in some parts of England a ten-pounder would be thought a good fish while in Ireland anything under 20 lb. would be considered of no account.

Many are the stories of the pike's rapacity though, like all predators, it ignores the smaller fish around it when not hungry.

Perch (*Perca fluviatilis*).—Olive green in colour, with dark bars down its side and red fins, the perch, a relative of the North American yellow perch, is a very handsome fish and, although troublesome to prepare, a fine table fish. It is most voracious and can be caught with a fly, by casting and trolling and by all types of bait fishing. Gregarious in habit, like all shoal fish it becomes more solitary as it becomes older and bigger.

Perch are caught all over the British Isles and weigh up to about six pounds. When unhooking a perch the angler must watch out for the spines in its front dorsal fin.

Roach (*Rutilus rutilus*).—In England the roach is to the coarse fisherman what the trout is to the game angler: there are hundreds of thousands of men whose ambition is to catch a "two-pounder." The roach is a silvery fish with a dark back and red fins, very timid and invariably the member of a shoal. Its diet mainly is composed of insects, fresh-water shrimps and weed, although after spawning big roach will feed on very small fish and can be caught on small spinners. Roach will take an artificial fly but for the most part they are caught on the very many different styles of bait fishing. They are common in nearly all English counties, in eastern Wales and southern Scotland, but are not native to northern Scotland or Ireland. In North America the name has been applied to several fish.

Rudd (*Scardinius erythrophthalmus*).—Looking like a roach but more golden in colour, the rudd is more localized in distribution, although unlike the roach it is common in Ireland. The rudd is a surface feeder, will take a fly well and can be caught by many of the different forms of bait fishing. Weights of more than four pounds have been recorded. It has been introduced to the United States where it is sometimes known as the pearl roach.

Chub (*Leuciscus cephalus*).—Big (up to about ten pounds), voracious, gregarious except when very large, and extremely shy, chub are greatly prized by coarse fishermen. They are widely distributed throughout England, eastern Wales and southern Scotland and can be caught by all means of angling provided due caution is employed. They take a fly well in summer. Famous chub rivers are the Hampshire Avon, the Herefordshire Wye and the Annan in Dumfriesshire. (For North American chub *see* CHUB.)

Dace (*Leuciscus leuciscus*).—Looking rather like a small chub, the dace never grows to a large size (under two pounds). It is nevertheless a good sporting fish and is usually caught on light float tackle. It takes the fly well, with a very fast rise. (For North American dace *see* DACE.)

Carp (*Cyprinus carpio*).—An exceedingly powerful and shy fish, the carp was considered almost impossible to catch except under exceptional circumstances and with the lightest of tackle. After World War II a means of capturing these fish was found. The method of fishing has already been described under *Ledgering*. Carp weighing 25 to 30 lb. are not rare. The carp, originating in Asia, is also found in Europe and North America, where fly-fishing tackle often is preferred. (*See* also CARP.)

Barbel (*Barbus barbus*).—Originally native only to the Thames, the Trent and rivers of Yorkshire in Great Britain (but also found in central Europe), the barbel has been introduced into others, notably the Hampshire Avon via the Dorset Stour. It is an exceedingly powerful fish, beautifully shaped for living in very fast, strong water on clean gravel. A bottom feeder, the barbel is usually caught by deep-bait fishing although after spawning it will take a spinning bait. It is a very powerful fish running to a good size, up to 14 lb. and more.

Tench (*Tinca tinca*).—A handsome greenish fish, the tench feeds entirely on the bottom and is generally caught in the summer months at dawn or dusk. Living mostly in slow rivers and in lakes and ponds, the tench is usually caught on float tackle and is a powerful fish to handle. Tench are big at five pounds. Although they are little eaten in Britain, tench are excellent table fish.

Bream (*Abramis brama*).—A flat-sided fish, living mostly in slow muddy rivers and in lakes, the bream is another bottom feeder. It is caught by most forms of bottom fishing, is common to most of the English counties and is caught in quantity in Ireland. Weights of more than 13 lb. have been reported. In North America the name sometimes is given to a number of fish including bluegills and pinfish.

Eel (*Anguilla anguilla*).—Born in the Sargasso sea, the European fresh-water eel runs up most British rivers as an elver, a tiny, wriggling, wormlike creature two or three inches long. It spends several years in fresh water, during this time feeding voraciously. Having the ability to cross wet grass, it is found in landlocked ponds. It returns to the sea to spawn and die. The eel is mostly regarded as a nuisance by British anglers but big eels, those weighing several pounds, are powerful fish and the flesh is delicious. The eel of eastern North America is the *Anguilla rostrata;* that of Japan the *Anguilla japonica*. (*See* also EEL.)

Grayling (*Thymallus thymallus*).—The grayling is a beautiful silvery fish with a large, often deep purple, dorsal fin. It is of the same family as the highly prized North American game fish, the Montana grayling (*Thymallus signifer tricolor*) and the arctic grayling (*Thymallus arcticus* or *signifer*). It is closely related to the salmon and the trout and indeed behaves very much like the latter. These fine sporting fish are at their best from October to December, take both wet and dry flies well, and are also caught on float tackle. They are river fish and are only found in the cleanest of streams. Being by origin arctic fish, they will feed in the coldest of weather. They are much more prized on the European continent than in Britain both for the sport they offer and for their excellence as table fish. A two-pounder is a good fish anywhere.

3. Sea Fish.—The following are the most common sea fish sought by anglers in the British Isles:

European Sea Bass (*Morone labrax*).—The sea bass, a member of the sea perch family (Serranidae), is to the sea fisherman what the salmon is to the fresh-water angler. These fine predatory fish are found everywhere in British water and indeed members of the bass family are found all over the world. Silver, with a blue back and a spined dorsal fin, the bass is particularly fond of river estuaries. It is caught by every method of fishing and can at times be taken on the fly. An eight-pounder is a big fish. (*See* also BASS.)

Mackerel (*Scomber scombrus*).—The Atlantic mackerel, a widely distributed fish, is the strongest fish ounce for ounce in British waters. Like the sea bass it is predaceous and can be caught by most angling methods. On light tackle mackerel give wonderful sport and can sometimes be taken on a fly. It weighs up to four pounds. (*See* also MACKEREL.)

Gray Mullet.—There are a number of gray mullets, forming the family Mugilidae, the commonest British species being *Mugil*

cephalus, known in North America as the striped or black mullet. Generally very difficult fish to catch, on occasions they lose all caution. Like the European sea bass they are fond of estuaries and will swim up into fresh water. They are usually caught by float or bottom fishing. Weights run up to about ten pounds.

Skate (*Raja batis*).—A very large member of the ray (*q.v.*) family, the skate is caught by fishing with heavy tackle on the bottom. It uses its flat body to obtain maximum resistance from the water and thus puts a very great strain on the rod and tackle. Excellent eating, the skate runs up to several hundred pounds in weight, particularly off the Irish coast.

Plaice (*Pleuronectes platessa*).—The plaice (*q.v.*) is a flatfish which is excellent eating. It is caught in a variety of ways, the most interesting being drifting with a worm as bait with a small spoon above the worm. It is thought that the spoon revolving suggests to the plaice that another fish is about to take the bait. The common European flounder (*q.v.*) (*Platichthys flesus*) is caught in the same way.

Pollack (*Gadus pollachius*).—A very strong and sporting fish, the European pollack, or pollock, is caught in a variety of ways. When hooked, it dives with great force for the bottom. It reaches a weight of more than 20 lb.

Blue Shark (*Prionace glauca*).—The sport of fishing for these large fish was unknown before the 1950s. They are principally caught off the Cornish coast by the methods already described. A large blue weighs up to 180 lb.

Mako Shark (*Isurus oxyrhynchus*).—This very large shark is caught in the same way as the blue shark and in the same waters. It weighs up to 350 lb. in British waters.

Tope (*Eugaleus* or *Galeus galeus*).—A small but very game member of the shark family, tope are caught in a variety of ways. The females are always bigger than the males and weigh up to about 70 lb.

Conger (*Conger oceanicus* or *conger*).—A very large and fierce eel, the conger is usually caught on bait of fresh fish. Fishing over a wreck is generally the best way of taking conger, which may weigh more than 80 lb.

D. Europe

The fish, both sea and fresh-water, just described are likewise common to European waters. Their distribution of course depends on geographical factors. There are, however, several fish not native to British waters which afford sport to anglers of the European continent. Principal among these is the European pike perch (*Lucioperca lucioperca*), a close relative of the American walleyed pike and a good sporting and table fish which can be caught on casting or spinning tackle and by bait fishing, and the huchen (*Salmo hucho*), a salmon found only in the Danube and its tributaries. The huchen runs as big as the Atlantic salmon and is usually caught in winter by casting with a mounted dead fish. In eastern Europe and in Russia there are several fish, particularly members of the chub family, which are not found farther west. Little is known about them from a fishing point of view and they have no common English names. Members of the char family (*Salvelinus* species), a troutlike fish found in some of the deep British lakes, are much more common in some of the more northerly countries and run to a good size. They do, however, vary greatly in size and colour from one locality to another and again have no common names in English.

1. Northern Europe.—Iceland has wonderful trout, sea trout and salmon fishing and also has a run of migratory arctic char (*Salvelinus alpinus*), the fish which runs into northern Canadian waters. Pike and perch are common in Norway but so are the even more sporting salmon, sea trout, trout, char and grayling. Salmon run very big (to more than 75 lb.) on some of the Norwegian rivers, notably rivers like the Namsen and the Aaro. Sea trout also run big and on rivers like the Aurland and the Laerdal take the dry fly well. There is excellent salt-water fishing for most of the sea fish already mentioned. There are good salmon rivers in Sweden, too, although not as good as those in Norway. The Em is without doubt the best sea trout river in the world. There is also excellent fishing for pike and perch both in the lakes and, most unusually, in the Baltic where both fish are sea-run. Denmark has only one salmon river but does have excellent trout and sea trout fishing. The Danes have developed a technique for catching sea trout in the sea on spinning lures. There is also excellent sea fishing off the Danish coast and big game fishing for bluefin tuna, or tunny (*Thunnus thynnus*), running up to near the 1,000-lb. mark in the waters between Denmark and Sweden. There is salmon fishing in northern Finland and excellent fishing for trout, sea trout, char, grayling, pike and perch all over the country. The trout run big, particularly those which go up the streams from the larger lakes in order to spawn.

2. Central and Southern Europe.—All the fish so far mentioned are found in Germany, although pollution has killed off the salmon run in rivers like the Rhine. There is particularly good trout and grayling fishing in southern Germany and wonderful carp fishing in Schleswig-Holstein. Excellent trout and particularly fine grayling fishing is found in most parts of Austria as well as good fishing for pike and perch, char and huchen. The Traun is one of the best rivers in the world for trout and big grayling. The rivers of Czechoslovakia offer good trout and grayling fishing; there is an abundance of splendid pike, perch, pike perch and particularly carp. There is also good huchen fishing. In Switzerland there is very good fishing for most of the fish found in Europe, and trout and pike run very big in some of the lakes.

Good coarse fishing is to be found in some of the slower rivers of France and still excellent trout fishing in the more mountainous regions and in Normandy where there are chalk streams of the type found in southern England. The North American black bass has been introduced into some French waters and there are some good salmon rivers in Brittany. The sea fishing in the Mediterranean is very good. There is very good trout fishing in the Ardennes, good coarse fishing in the slower rivers and also plenty of sea fishing. The Netherlands has no trout fishing to speak of, but offers much water containing pike, perch, pike perch, roach, bream and carp. Sea fishing resembles that of Great Britain. Most of the European fish can be caught in Luxembourg and there is good trout fishing in the mountain streams.

Trout and grayling are fished in the mountain rivers of Italy and there are pike, perch, tench, carp, roach and chub in the slower rivers and lakes. The sea fishing is excellent. Spain has very fine salmon fishing in the Eo and Narcea and plenty of good trout fishing in mountain streams. There is very good trout and sea trout fishing and some salmon fishing in Portugal, which also has some of the best sea bass fishing in river estuaries. Swordfish and tuna can also be caught off the coast. Yugoslavia probably has the best trout fishing in Europe and every year trout up to ten pounds and more are taken on the dry fly. There is also excellent grayling fishing, huchen fishing in the Danube tributaries, and good fishing for carp, perch and pike.

3. U.S.S.R.—Angling is a very popular sport in the U.S.S.R. where there are many species of sporting fish, some of which are not known elsewhere. In the western part of the Soviet Union most of the European fish already described are found—Atlantic salmon in the north, trout, char and grayling well distributed, and in the slower rivers pike, perch, pike perch, roach, chub, carp and bream. There are several members of the chub family not found farther west, the taimen, a close relative of the Danube huchen, a landlocked Atlantic salmon (*Salmo relictus*) found in the northern lakes, and a number of members of the whitefish family (Coregonidae). The Pacific salmon which ascend the rivers of Canada and the United States also run in the Soviet rivers.

E. Africa

In the vast territory of Africa there are countless fresh-water and salt-water fish which have no common names in English. Certain of the native species give good sport and are thus sought by the angler, while trout, black bass and carp have been introduced into many parts.

Trout, both brown and rainbow, have been introduced into most of the mountain rivers in Cape Province, Natal and the Transvaal in South Africa, and on some of these rivers the fishing can be very good by any standards. The North American black bass, both

the smallmouth and the largemouth, have also been successfully transplanted, and while they do not fight with quite the vigour they display in their native, colder waters, they are a very welcome addition to the fish available to anglers. The carp has also been introduced and runs to weights over 40 lb., particularly in the Transvaal. Of the native fresh-water fish a barbel called the yellowfish (*Barbus carpensis*) is a good fighter and will sometimes take a fly, and various members of the cichlid (*q.v.*) family (genus *Tilapia*), known locally as kurper, give good sport. The sea fishing off the coast of South Africa is magnificent, including big game fish like sharks, tuna and swordfish and smaller fish like elft (the North American bluefish), kabeljau, snapper and countless others.

There is very fine trout fishing for both brown and rainbow trout in Kenya, particularly in the Nyeri district, and the largemouth black bass has been introduced. There are also native fish of the *Barbus* genus. Off the coast sailfish, marlin, swordfish, tuna and barracuda are very numerous.

The great sporting fish of central Africa is the tiger fish (*Hydrocyon*) and this provides the best sport in that territory, including Northern Rhodesia. There are several species of tiger fish, the smaller ones running up to about 6 lb. and the larger ones to more than 20 lb. They are beautifully coloured fish with huge, dangerous teeth and can be taken on bait-casting lures with a steel leader. The giant Nile perch (*Lates niloticus*) runs up to hundreds of pounds in weight. There is good trout fishing in Southern Rhodesia, and the American black bass has also been introduced there. Of the native fish both the tiger fish and *Tilapia*, known locally as bream, are much sought after. In Uganda, trout have been introduced, both brown and rainbow. There are also Nile perch, members of the *Barbus* genus, tiger fish and a sporting fish called locally a barbel, which takes a casting lure well.

Tiger fish provide the best sport in west Africa, particularly in the Niger and its tributaries, although huge Nile perch and a fish called pella are fished for. There is excellent sea fishing, particularly for barracuda and also for tarpon.

F. Asia

1. India and Pakistan.—During the long British rule in India, brown and rainbow trout were introduced into the rivers of Kashmir and into some other mountain rivers. The principal native sporting fish of India and indeed of other parts of Asia is the mahseer (*Barbus tor*). A large fish running up to 200 lb. and more and with extremely powerful jaws, the mahseer thrives best in cold, fast rivers. Small fish will take a wet fly but the bigger ones are usually caught on bait or on spoons. Very strong hooks are required.

Other sporting fish are the carnatic carp (*Barbus carnaticus*), the baril (*Barilius bola*), which take a fly well, the rohu or labeo (*Labeo rohita*), and a predatory fish, the murral, which is widely distributed. There is also good fishing in the river estuaries for fish called bahmin, nair and seer.

2. Ceylon.—Rainbow trout have been introduced with success into some of the rivers of Ceylon, particularly into the streams in the Nuwara Eliya district. European carp have also been planted in some of the lakes and run to a good size. There are mahseer in some of the rivers but they run very small. A predatory fish called a walliya can be caught on bait-casting or spinning tackle.

3. China and Southeast Asia.—Sport fishing has flourished in the countries where British or American influence has been strong; although there are many species of fish in the vast area of China and southeast Asia, and fish represent a major item of diet, sport fishing with western equipment is little practised. There is, however, no keener angler anywhere than the Chinese and in Malaya, due to both British and Chinese enthusiasm, angling has grown in popularity. The local fish have no English names but in the rivers members of the mahseer family (*Barbus*) and off the coast many different kinds of sea fish, including sharks and swordfish, are caught in large numbers.

Pacific salmon run in the waters of Japan but although the Japanese are first-class commercial fishermen, fishing is not generally popular as a sport.

G. Oceania

1. New Zealand.—All the fresh-water sporting fish of New Zealand have been introduced and no finer trout fishing, both for brown and rainbow trout, but particularly for the latter, exists. The trout run very big, particularly in the North Island. Salmon, both the Pacific and Atlantic species, have been introduced to the South Island. The Atlantic salmon has become landlocked but the quinnat salmon (the Chinook or Tyee salmon of North America) remains seagoing and is taken in the rivers on spoons and similar baits.

The big game fishing, particularly in the Bay of Islands and the Bay of Plenty, is first class, swordfish and sharks being the principal quarry. Since World War II sea fishing, particularly surf casting, has become increasingly popular in New Zealand.

2. Australia.—A number of native fish of high edible and sporting value are found in the Australian rivers, the principal ones being the Murray cod (*Maccullochelia macquariensis*), the perch (*Prectoplites fluviatilis*) and the golden perch (*Prectoplites ambiguus*). Brown and rainbow trout have been introduced with success on a very wide scale. Australia is blessed with splendid sea fishing, both for big game fish—swordfish, tuna, shark—and for smaller fish like jewfish, kingfish, barracuda, grouper and yellowtail. Some of the world's finest trout fishing is found in Tasmania.

See also references under "Fishing" in the Index volume.

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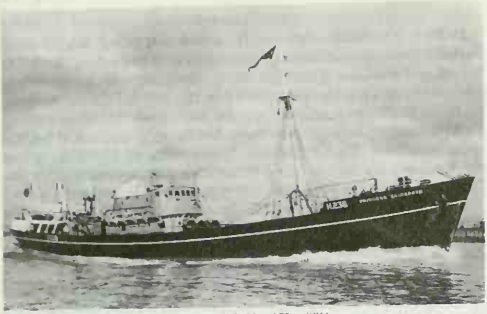
(T. B. T.; F. E. Ke.)

FISHING FROG: *see* Angler (Angler Fish).

FISHING VESSELS. As shipbuilding technology developed, so did the techniques of catching fish, and the character of fishing vessels changed to suit the methods employed. Three basic types of fishing evolved: fishing with a spear or harpoon; fishing with a hook and line; and fishing with a net. Vessels for spear fishing developed from the primitive canoe to the modern whale-killer ships that catch whales with explosive harpoons. Hook-and-line vessels developed in a wide range of types and sizes up to the modern tuna clipper or long-liner. Net-fishing vessels developed an equal range of varieties extending in size up to the 200-ft. trawlers used on the Atlantic codfish banks.

Vessels used for fishing in the protected waters of rivers, lakes and sounds are small and are nearly always open vessels without closed decks. Although subject to many variations in shape and in materials of construction, they are essentially the same the world over. While the open boat is still widely used for commercial fishing in many parts of Africa, Asia and South America, in Europe and the United States most such craft are used by fishermen who fish for sport only.

Short-range boats designed to fish in exposed bays or to make short runs out into the ocean are by far the most numerous of



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BRITISH LONG-RANGE DEEP-SEA TRAWLER, OPERATED IN THE NORTH ATLANTIC TO CATCH COD AND OTHER BOTTOM FISH BY MEANS OF TRAWL NETS

commercial fishing vessels and are used throughout the maritime world. Generally about 20 to 45 ft. in length, they are either partly or totally enclosed; they always have partial decks over the bow and stern and quite often have full decks broken only by fish holds or hatches. There is an infinite variety of craft of this kind. Sails are still used to a limited extent in some areas, but the internal-combustion engine is now practically the universal source of power.

Intermediate-range boats can go out into the open sea and stay for several days. They range from 45 to 80 ft. in length and use various types of fishing gear. With fully enclosed decks, mechanical propulsion and living accommodations, they can fish in relatively exposed waters a considerable distance from their home port. They operate mainly out of ports in the more highly industrialized countries.

Long-range vessels range from 80 to 200 ft. in length. Among the various types are the trawlers that operate from both sides of the Atlantic into the Atlantic fishing grounds; the tuna clippers that operate off the western coasts of the Americas; the tuna handliners and bait boats operated by the Japanese; and the whalekiller ships operated by Japanese and European interests in the antarctic. All such craft are highly mechanized and expensive.

Means of preserving a catch of fish is a necessity for intermediate-range and long-range fishing vessels. Salt was the first medium but it was largely replaced in the 20th century by ice. Modern vessels, particularly the long-range type, use mechanical refrigeration extensively. In such fisheries as the Pacific tuna, fish are held for three or four months before the vessel returns to port.

Mother ships that accompany smaller fishing vessels to distant fishing grounds form a special category. These ships are equipped to supply, feed and maintain large numbers of men for a long period of time and to process the fish on board. The codfishing schooners of the North Atlantic were probably the first mother ships. They remained at sea for long periods while individual fishermen in dories brought the fish aboard to be salted down. Many types of mother ships have been tried and many are still operating. The whale factory ships are the largest. Salmon, tuna, cod and crab canneries and freezer ships of various kinds operate in different parts of the world.

BY COURTESY OF FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

JAPANESE LONG-RANGE TUNA VESSEL THAT USES LONG LINES SPREAD BETWEEN BUOYS WITH BAITED HOOKS SUSPENDED FROM SHORT VERTICAL LINES

In early times, as distinctive types of vessels were developed in different areas, they generally were named for the area plus an additional name, the derivation of which has often been lost in time. The Yorkshire coble, Hastings lugger and Chesapeake sharpie are examples.

As communications developed and fishing spread throughout the world, the old names and place designations have been dropped and they are now generally named for the type of fishing gear they use. Vessels fishing with nets are called trawlers, draggers, seiners, gill netters and driftters. Vessels using hooks and lines are called long-liners, hand-liners, trollers, pole boats and bait boats. *See* also FISHERIES. (G. C. NM.)

FISH LOUSE, small Crustacea, viz., members of the orders Eucopepoda, Branchiura, Isopoda and Amphipoda which are external and gill parasites of fishes and other marine animals. *See* CRUSTACEA; COPEPODA; MALACOSTRACA.

FISK, JAMES (1834–1872), U.S. financier whose flamboyant techniques in promoting securities earned for him the name "Barnum of Wall Street," was born April 1, 1834, at Bennington, Vt. He was successively a circus hand, waiter, peddler, dry-goods salesman, stockbroker and corporate official. In 1864 he formed the brokerage firm later known as Fisk and Belden and became a stock market operator for Daniel Drew. In 1867 Fisk joined Drew and Jay Gould in wresting control of the Erie railroad from Cornelius Vanderbilt. As vice president and comptroller of the road, Fisk used corporate funds to corrupt public officials, produce Broadway shows and support Broadway beauties, including the well-known Josie Mansfield, to such an extent that he was also called "The Prince of the Erie." Fisk was Gould's lieutenant in the attempted corner of the gold market which led to the fateful "Black Friday" of Sept. 24, 1869. Fisk was shot by E. S. Stokes, a former business associate, on Jan. 6, 1872, and died the following day in New York.

See W. A. Swanberg, *Jim Fisk: the Career of an Improbable Rascal* (1959). (J. R. LT.)

FISK, WILBUR (1792–1839), U.S. educator and Methodist clergyman, was born at Brattleboro, Vt., on Aug. 31, 1792, the son of Isaiah and Hannah (Bacon) Fisk. He studied at Peacham academy and the University of Vermont, and graduated from Brown university in 1815 (A.M., 1818). Licensed as a local preacher at Lyndon, Vt., in 1818, he was received into the New England Conference of the Methodist Church in June of that year. While stationed at Charlestown, Mass. (1819–20), Fisk attended a camp meeting, where—according to his statement—he experienced "a supernatural work of grace leading him into a higher Christian life." In 1823 he married Ruth Beck of Providence, R.I., and for three years thereafter was presiding elder of the Vermont district, becoming chaplain of the Vermont legislature in 1826. While in Europe (1835–36) he was elected bishop of the Methodist Episcopal Church (May 1836) but declined consecration. His high repute as an educator did much to raise the estimate of Methodism in New England, where before his time it had suffered because of its indifference to learning. He was a founder and principal of Wesleyan academy, Wilbrahm, Mass. (1825–30); a founder and first president of Wesleyan university, Middletown, Conn. (1831–39); and a member of the Connecticut board of education (1838). Pulmonary hemorrhages, from which he had suffered since childhood, resulted in his death on Feb. 22, 1839, at the height of his career.

See J. Holdick, *The Life of Wilbur Fisk, D.D.;* J. H. Brown (ed.), *Lamb's Biographical Dictionary of the United States.* (W. C. B.)

FISKE, BRADLEY ALLEN (1854–1942), U.S. naval officer who invented a number of instruments that revolutionized

naval warfare, was born in Lyons, N.Y., June 13, 1854. He graduated from the United States Naval academy in 1874. At the battle of Manila bay (1898) he was navigator of the gunboat "Petrel," and was cited by Adm. George Dewey for heroic action in inaugurating fire control from a fighting top. During the Philippine insurrection, Fiske commanded the monitor "Monodnock."

His fame rests, however, upon his inventive genius. Chief among his inventions were the electric range finder, an electric ammunition hoist, a naval telescope mount and sight, and the torpedoplane (*q.v.*). Bluff and outspoken, Fiske was in controversy with secretaries of the navy through several administrations. He was one of the ablest exponents of adequate naval preparation, and his enthusiasm frequently ran afoul of a conservative navy department. His resignation, in May 1915, was the outcome of a long dispute on naval policy. Fiske saw many of his inventions developed and used successfully in World Wars I and II. He wrote *From Midshipman to Rear Admiral* (1919), an account of his experiences in the U.S. navy.

He died in New York city on April 6, 1942.

See D. W. Knox, *A History of the United States Navy* (1936).
(W. B. Ck.)

FISKE, JOHN (1842–1901), U.S. historical writer and popular lecturer, was born in Hartford, Conn., March 30, 1842. His name, originally Edmund Fisk Green, was legally changed to that of a great-grandfather, John Fisk, in 1855; he later adopted the spelling Fiske. Graduated from Harvard in 1863, Fiske practised law for a short time, delivered two series of lectures at Harvard in 1869 and 1871, was assistant librarian from 1872 to 1879, and thereafter devoted himself to writing and lecturing.

In his best known philosophical work, *Outlines of Cosmic Philosophy* (1874), Fiske undertook to demonstrate the compatibility of science and religion by maintaining that both could be comprehended under the generalizations of the then vigorously disputed concept of evolution.

Fiske wrote 13 volumes of United States history, 10 of them dealing with the colonial period and all of them based on his public lectures. Fiske's historical writing, although concerned largely with the development of governmental institutions, also contained material on social life and economic interests. One of his last works, *The Mississippi Valley in the Civil War* (1900), reflected the newer interest of historians in sectional influences in political life. He died at Gloucester, Mass., on July 4, 1901.

Bibliography.—Josiah Royce, "Introduction," *Miscellaneous Writings of John Fiske,* 12 vol. (1902) is the best analysis of Fiske's thought; John S. Clark, *The Life and Letters of John Fiske,* 2 vol. (1917), furnishes personal data; Edward Arthur White, *Science and Religion in American Thought* (1952), provides interpretation and context. (E. A. We.)

FISKE, MINNIE MADDERN (Marie Augusta Davey) (1865–1932), U.S. actress whose career in the theatre was long and distinguished, was born in New Orleans, La., Dec. 19, 1865. Her father, Thomas W. Davey, was a theatrical manager. Mrs. Fiske first appeared on the stage at the age of three under her mother's maiden name as "Little Minnie Maddern." At five she made her New York debut in *A Sheep in Wolf's Clothing* and later the same year performed as Eva in *Uncle Tom's Cabin.* The next several years were spent as a child actress; she made her first appearance as an adult star in 1882. In 1890 she married Harrison Grey Fiske, a playwright and theatrical manager. In 1893 she enjoyed a modest success in *Hester Crewe,* a play written by her husband, but *Tess of the D'Urbervilles* (1897) was her first truly great success. At about this time also, she began to specialize in the plays of Ibsen and Shakespeare, and her interpretations of Ibsen's heroines were especially acclaimed.

In 1901 Fiske opened the Manhattan theatre in New York to oppose Charles Frohman's Theatrical Syndicate, which then dominated the U.S. theatre. Although Fiske lost a great deal of money during the six years this theatre was in operation, he and his wife gave New York some of its greatest theatre. The most important plays in which Mrs. Fiske starred during this period were Paul Heyse's *Mary of Magdala* (1902), *Hedda Gabler* (1903), *Becky Sharp* and *Leah Kleschna* (1904), Langdon Mitchell's *The New York Idea* (1906) and Ibsen's *Rosmersholm* (1907). After the closing of the Manhattan, Mrs. Fiske appeared in Edward Sheldon's *Salvation Nell* and in several Ibsen plays. On Feb. 15, 1932, she died of a heart ailment.

Bibliography.—William Winter, *The Wallet of Time* (1913); Walter Pritchard Eaton, "The Theatre Mrs. Fiske Knew," *Theatre Arts Monthly* (May 1932); F. C. Griffith, *Mrs. Fiske* (1912). (S. W. H.)

FISK UNIVERSITY, an institution of higher education in Nashville, Tenn., named for Gen. Clinton B. Fisk of the Freedmen's bureau, was established in 1865 and opened in Jan. 1866 as the Fisk school to provide for the education of southern Negroes. In 1867 it secured a charter as Fisk university under the auspices of the American Missionary association to educate young people "irrespective of color." Shortly thereafter, a Tennessee statute restricted attendance to Negroes, but later the college again admitted foreign and U.S. students of all races and creeds.

FISTULA, a term used in surgery to designate an abnormal communication leading either from the surface of the body to a normal cavity or canal, or from one normal cavity or canal to another. These communications are the result of disease or may be congenital. Fistulas between arteries and veins also may occur, usually as the result of injury. (F. L. A.)

FIT, in medicine, is an episode in which the patient exhibits violent, inappropriate and involuntary activity, either muscular or emotional.

The term also is used to describe convulsions. *See* Convulsions; Epilepsy.

FITCH, (WILLIAM) CLYDE (1865–1909), U.S. playwright, whose best-known play *Beau Brummel* was produced in 1890, was born on May 2, 1865, in Elmira, N.Y., and graduated from Amherst college, Amherst, Mass., in 1886. An interest in literature led him to establish himself in New York city, where he began writing short stories for various magazines. He was a prolific writer, producing 33 original plays and 22 adaptations. His best plays were social satires and character studies focusing on some human strength or weakness. Among the more important, in addition to *Beau Brummel,* were *The Climbers* (1901), *The Girl With the Green Eyes* (1902), *The Truth* (1907) and *The City* (1909). He also wrote a large number of frank melodramas and historical plays. Fitch excelled in comedy, realistic dialogue and theatre technique, but in general his plays lack strength and universality.

Fitch died in France on Sept. 4, 1909.

See M. J. Moses and V. Gerson (eds.), *Plays by Clyde Fitch* (1915) and *Clyde Fitch and His Letters* (1924).

FITCH, JOHN (1743–1798), U.S. metal craftsman and one of the earliest builders of steamboats, designed and built a steamboat which operated successfully in 1787.

Fitch built steamboats propelled by oars, paddle wheels and a crude type of screw propeller. These vessels operated reliably, but he did not give thought to building and operating costs and so failed to demonstrate the economic value of steam propulsion. As a result, the use of steam power was not continuous following his early efforts, and Robert Fulton, who did not launch a boat until after Fitch's death, is given more credit for the origin of this type of transportation.

Born Jan. 21, 1743, in Windsor, Conn., Fitch had but six years of common schooling. He was then put to work on a farm and later apprenticed to a brass founder and clockmaker. He set up his own business but did not succeed financially, and in all his later efforts he was always short of funds.

Settling in Bucks county, Pa., in 1785, Fitch became interested in propelling boats by steam power, an interest that continued until his death. He failed to obtain subsidies from the continental congress and applied to the state governments, who refused funds but granted him exclusive rights to operate steamboats on their waters. He built several models of steamboats and with these persuaded some Philadelphians to form a company which furnished money to build a 45-ft. boat. On Aug. 22, 1787, in the presence of members of the Constitutional Convention, this vessel was successfully operated on the Delaware river. He built a larger boat propelled by steam-powered paddle wheels, which made regularly

scheduled trips, carrying passengers and freight, between Philadelphia, Pa., and Trenton, N.J. The schedule was maintained and published in the Philadelphia daily papers.

Fitch's claims to invention of the steamboat were challenged by James Rumsey, and this controversy resulted in the issuance of pamphlets in 1787–88 in which both men set forth their claims.

Fitch was granted a U.S. patent for steamboats on Aug. 26, 1791, and a French patent in the same year.

He started construction of another steamboat but it was wrecked by a storm. This so discouraged the members of his company that they declined to advance any more money. He went to France in 1793 but failed in his attempts to interest that country in steam navigation. He returned to the U.S. despondent and in poor health. He died at Bardstown, Ky., on July 2, 1798. (M. R. D.)

FITCH, RALPH (fl. 1583–1606), London merchant, was one of the earliest English travelers and traders in Mesopotamia, the Persian gulf and Indian ocean, India proper and Indochina. In Feb. 1583 he embarked in the "Tiger" for Tripoli in Syria and traveled thence to Aleppo together with J. Newberry, J. Eldred, W. Leedes and J. Story of the Levant company; his trip there is alluded to by one of the witches in Shakespeare's *Macbeth*, act i, sc. iii. From Aleppo he reached the Euphrates, descended the river to Fallujah, crossed southern Mesopotamia to Baghdad and sailed down the Tigris to Basra (May to July 1583). There Eldred stayed behind to trade while Fitch and the rest sailed down the Persian gulf to Ormuz, where they were arrested as spies and sent as prisoners to the Portuguese viceroy at Goa (September to December). Through the sureties procured by two Jesuits (one being Thomas Stevens, formerly of New college, Oxford, the first Englishman known to have reached India by the Cape route, in 1579) Fitch and his friends regained their liberty and, escaping from Goa in April 1584, traveled through the heart of India to the court of the great Mogul Akbar, then probably at Agra. Leedes stayed there, while Story had remained in Goa and Newberry was lost while returning through the Punjab.

Fitch, now alone, descended the Jumna and the Ganges, visiting Benares, Patna, Kuch Behar and Hugli. After traveling through east Bengal, he sailed for Burma (Nov. 1586). He visited the Rangoon region, ascended the Irrawaddy some distance, acquired a remarkable acquaintance with inland Pegu and even penetrated to the Siamese Shan states (1586–87). Early in 1588 he visited Malacca and in the spring of that year he began his homeward travels. He went first to Pegu and next to Bengal, then round the Indian coast, touching at Cochin and Goa, to Ormuz; next up the Persian gulf to Basra and up the Tigris to Mosul; finally via Urfa, Bir on the Euphrates and Aleppo to Tripoli on the Mediterranean. He reappeared in London on April 29, 1591. His experience was greatly valued by the founders of the East India company, who consulted him on Indian affairs. He died about Oct. 5, 1611.

BIBLIOGRAPHY.—R. Hakluyt, *Principal Navigations*, vol. ii, pt. i, pp. 245–271, especially pp. 250–268 (1599); J. Horton Ryley, *Ralph Fitch, England's Pioneer to India* . . . (1899). (WM. C. B.)

FITCH (FITCHET, FITCHEW), names applied to the domesticated ferret and also to its wild relative the polecat (*qq.v.*). Earlier names were ficheux, fecheu and fitcholl.

FITCHBURG, a city of Massachusetts, U.S., located on the Mohawk trail about 45 mi. W.N.W. of Boston, was named for John Fitch, who did much to secure incorporation. It is one of the seats of Worcester county. Originally known as Turkey Hills, Fitchburg was first settled in 1740 and was essentially an agricultural community until the first decade of the 19th century. It was established as a town Feb. 3, 1764, and incorporated as a city March 8, 1872. Pop. (1960) 43,021; Fitchburg-Leominster standard metropolitan statistical area (Fitchburg, Leominster and Lunenburg town in Worcester county and Shirley town in Middlesex county), 82,486. In 1963 Westminster town (Worcester) and Townsend town (Middlesex) were added to the SMSA, making its population (1960 census figures) 90,158. (For comparative population figures *see* table in MASSACHUSETTS: *Population.*)

For years Fitchburg's principal industries were the manufacture of machinery, paper and textiles. After mid-20th century the leading industries were the manufacture of metal products, paper and allied products, and machinery. Firearms, leather goods, wheel goods, toys, locksmith supplies, saws, shoes and slippers, and man-made yarns are other major products. A state teachers' college was established there in 1894. (J. F. Z.)

FITTIG, RUDOLF (1835–1910), German organic chemist, known for the reaction by which aryl hydrocarbons may be synthesized, was born on Dec. 6, 1835, in Hamburg. After studying for his Ph.D. (1856–58) under Friedrich Wöhler at Göttingen, he was assistant to Wöhler, then became professor at Tübingen in 1869, and successor to Adolf von Baeyer at Strasbourg in 1876. He helped to edit *Annalen der Chemie* from 1895 to 1910. The Wurtz-Fittig reaction, first used by Fittig in 1864 to prepare toluene from bromobenzene, methyl iodide and sodium, is a general method by which aryl halides react in ether with sodium to produce hydrocarbons. Fittig and his students published approximately 400 papers which contributed much to synthetic organic chemistry. Among the subjects treated in the papers were the discovery of pinacone reaction (1859); diphenyl (1862); isophthallic acid (1869); complex potassium manganese cyanides (1868); and the synthesis of mesitylene (1869). In the course of later research diacetyl and phenanthrene were produced; piperine and unsaturated acids were studied; the diketone formula for quinone was proposed; alpha-naphthol was synthesized; and the relationship between gamma-hydroxy acids and lactones was clarified. Fittig had tremendous influence on organic chemistry. He died on Nov. 19, 1910, in Strasbourg. (V. Bw.)

FITTON, MARY (*c.* 1578–*c.* 1647), identified by some writers with the "dark lady" of Shakespeare's sonnets although there is no hint in her authenticated biography that she was acquainted with Shakespeare. The daughter of Sir Edward Fitton of Gawsworth, Cheshire, she was baptized there on June 24, 1578. She became maid of honour to Elizabeth I *c.* 1595. She was the mistress of William Herbert, later earl of Pembroke; she married Capt. William Polwhele and, on his death, a Captain Logher. She died *c.* 1647 and is represented, apparently as dark in colouring, on the Fitton monument in Gawsworth church.

FITTON, WILLIAM HENRY (1780–1861), British geologist, the author of the classic memoir known as "Fitton's strata below the chalk," was born in Dublin, Ire., in Jan. 1780. Educated at Trinity college, in that city, and at Edinburgh university, he took a medical practice at Northampton in 1812 but moved to London in 1820 and devoted himself to the science of geology. His "Observations on some of the Strata between the Chalk and the Oxford Oolite, in the South-east of England" in the *Transactions* of the Geological society (ser. 2, vol. iv, 1834–35), embodied a series of researches, extending from 1824 to 1836, in which he established the true succession and relations of the Upper and Lower Greensand, and of the Wealden and Purbeck formations, and elaborated their detailed structure. He was elected a fellow of the Royal society in 1815, was president of the Geological society 1827–29 and was awarded the Wollaston medal by the Geological society in 1852. He died in London on May 13, 1861.

See the obituary notice by R. I. Murchison in *Quart. J. Geol. Soc. Lond.*, vol. xviii, p. xxx (1862).

FITZGERALD, the name of a historic Irish house, which descends from Walter, son of Other, who at the time of the Domesday survey (1086) was castellan of Windsor and a tenant-in-chief in five counties. From his eldest son, William, known as "de Windsor," descended the Windsors of Stanwell, of whom Andrew Windsor was created Lord Windsor of Stanwell by Henry VIII; the barony is now vested in the earl of Plymouth, his descendant in the female line. Of Walter's younger sons, Robert was given by Henry I the barony of Little Easton, Essex; Maurice obtained the stewardship (*dapiferatus*) of the great Suffolk abbey of Bury St. Edmunds; Reinald the stewardship to Henry I's queen, Adelaide; Gerald (also a dapifer) became the ancestor of the FitzGeralds.

As constable and captain of the castle that Arnulf de Montgomery raised at Pembroke, Gerald strengthened his position in Wales by marrying Nesta, sister of Griffith, prince of south Wales, who bore to him famous children, "by whom the southern coast of Wales was saved for the English and the bulwarks of Ireland

stormed." Of these sons William, the eldest, was succeeded by his son Odo, who was known as "de Carew," from the fortress of that name at the neck of the Pembroke peninsula; William's eldest son, Gerald, had been slain by the Welsh. The descendants of Odo held Carew and the manor of Moulsford, Berks, and some of them acquired lands in Ireland. But the wild claims of Sir Peter Carew, under Queen Elizabeth I, to vast Irish estates, including half of "the kingdom of Cork," were based on a fictitious pedigree. Odo de Carew's brothers, Raymond Fitzgerald (*q.v.*) and Griffin, took an active part in the conquest of Ireland.

Returning to Gerald and Nesta, their son David "Fitz Gerald" became bishop of St. David's (1147–76), and their daughter Angharat mother of Gerald de Barri (Giraldus Cambrensis; *q.v.*). A third son, Maurice, obtained from his brother the stewardship of St. David's, *c.* 1174, and having landed in Ireland in 1169, on the invitation of King Dermod, founded the fortunes of his house there, receiving lands at Wexford, where he died and was buried in 1176. His eventual territory, however, was the great barony of the Naas (in Kildare), which Richard Strongbow, earl of Pembroke, granted him with Wicklow castle; but his sons were forced to give up the latter. His eldest son, William, succeeded him as baron of the Naas and steward of St. David's, but William's granddaughter carried the Naas to the Butlers and so to the Loundreses. Gerald, a younger son of Maurice, who obtained lands in Offaly, was father of Maurice "Fitz Gerald," who was justiciar of Ireland from 1232 to 1245. In 1234 he fought and defeated his overlord, the earl marshal, Richard, earl of Pembroke, and he also fought for his king against the Irish, the Welsh and in Gascony, dying in 1257. He held Maynooth castle, the seat of his descendants.

Earls of Kildare.—The justiciar left a grandson Maurice (son of his eldest son Gerald) and a younger son Maurice; the latter was justiciar for a year in 1272, while the former, as heir male and head of the race, inherited the Offaly lands, which he is said to have bequeathed at his death (1287) to John "Fitz Thomas," whose military life was crowned by a grant of the castle and town of Kildare, and of the earldom of Kildare to him and the heirs male of his body (May 14, 1316). Dying shortly after, he was succeeded by his son Thomas, son-in-law of Richard de Burgh, the "red earl" of Ulster, who received the hereditary shrievalty of Kildare in 1317, and was deputy justiciar in 1320 and justiciar of Ireland in 1327–28. His younger son Maurice "Fitz Thomas" (1331–90), 4th earl, was frequently appointed justiciar, and was great-grandfather of Thomas (1427–77), 7th earl, who between 1455 and 1475 was repeatedly in charge of the government of Ireland as "deputy," and who founded the "brotherhood of St. George" for the defense of the English Pale. His son Gerald (*c.* 1456–1513), 8th earl, called Mór ("the Great"), was deputy governor of Ireland from 1481 for most of the rest of his life, though imprisoned in the Tower of London two years (1494–96) on suspicion as a Yorkist. He was mortally wounded while fighting the Irish as "deputy." Gerald (d. 1534), 9th earl, followed in his father's steps as deputy, fighting the Irish, till the enmity of the earl of Ormonde, the hereditary rival of his house, brought about his deposition in 1520. In spite of temporary restorations he died a prisoner in the Tower.

In his anger at his rival's successes the 9th earl had been led, it was suspected, into treason, and while he was a prisoner in England his son Lord Thomas Fitzgerald (*q.v.*) broke out into open revolt (1534). He and his five uncles were hanged as traitors in Feb. 1537, and acts of attainder completed the ruin of the family.

But the earl's half-brother Gerald, a mere boy, had been carried off and, after many adventures at home and abroad, returned to England after Henry VIII's death, and to propitiate the Irish was restored to his estates by Edward VI (1552). Having served Mary I in Wyat's rebellion, he was created by her earl of Kildare and Lord Offaly on May 13, 1554, but the old earldom (though the contrary is alleged) remained under attainder. Although he conformed to the Protestant religion under Elizabeth I and served against the Munster rebels and their Spanish allies, he was imprisoned in the Tower on suspicion of treason in 1582. But the acts attainting his family had been repealed in 1569, and the old earldom was thus regained. In 1585 he was succeeded by his son Henry ("of the Battleaxes"), who was mortally wounded when fighting the Tyrone rebels in 1597. On the death of his brother in 1599 the earldom passed to their cousin Gerald, whose claim to the estates was opposed by Lettice, Lady Digby, the heir-general. She obtained the ancestral manor of Geashill with its territory and was recognized in 1620 as Lady Offaly for life. George (1611–60), 16th earl, had his castle of Maynooth pillaged by the insurgents in 1642, and after its subsequent occupation by them in 1646 it was finally abandoned by the family.

The history of the earls of Kildare after the Restoration was uneventful save for the reacquisition in 1739 of Carton, which thenceforth became the country seat of the family. James (1722–73), 20th earl, who obtained a viscounty of Great Britain in 1747, built Leinster house (now the place of assembly of the *oireachtas*, "national parliament") in Dublin, and formed a powerful party in the Irish parliament. In 1756 he was made lord deputy; in 1760 he raised the Royal Irish regiment of artillery; and in 1766 he received the dukedom of Leinster, which remained the only Irish dukedom till that of Abercorn was created in 1868. His wealth and connections secured him a commanding position. Of his younger children, one son was created Lord Lecale; another was the well-known rebel, Lord Edward Fitzgerald; another was the ancestor of Lord De Ros; and a daughter was created Baroness Rayleigh. William Robert (1749–1804), 2nd duke, was a cordial supporter of the Union, and received nearly £30,000 for the loss of his borough influence. In 1883 the family was still holding more than 70,000 ac. in County Kildare; but, after a tenure of nearly 750 years, arrangements were made to sell the land to the tenants under the land purchase acts. In 1893 Maurice Fitzgerald (1887–1922) succeeded his father, Gerald (1851–93), 5th duke; Maurice's brother Edward (1892–) succeeded as 7th duke in 1922.

Earls of Desmond.—The other great Fitzgerald line was that of the earls of Desmond, who were undoubtedly of the same stock and claimed descent from Maurice, the founder of the family in Ireland, through a younger son Thomas. Thomas "Fitz Maurice" Nappagh ("of the ape"; 1261–98), justiciar of Ireland in 1295, obtained a grant of the territory of "Decies and Desmond" in 1292. His son Maurice Fitz Thomas or Fitzgerald (d. 1356), inheriting vast estates in Munster, and strengthening his position by marrying a daughter of Richard de Burgh, earl of Ulster, was created earl of Desmond (*i.e.*, south Munster) on Aug. 22, 1329. The greatest Irish noble of his day, he led the Anglo-Irish party against the English. He surrendered in England to the king and was imprisoned, but eventually regained favour, and was even made deputy in 1355. Two of his sons succeeded in turn, Gerald (1359–98), 3rd earl, being appointed deputy in 1367, despite his adopting his father's policy which the crown still wished to thwart. But he was superseded two years later, and defeated and captured by the native king of Thomond shortly after. Yet his sympathies were distinctly Irish. The remote position of Desmond in the southwest of Ireland tended to make the succession irregular on native lines, and a younger son succeeded as 6th earl in 1420. His son Thomas, earl from 1462 to 1467, governed Ireland as deputy from 1463 to 1467, and upheld the endangered English rule by stubborn conflict with the Irish. Yet John Tiptoft, earl of Worcester, who superseded him, procured his attainder with that of the earl of Kildare, on the charge of alliance with the Irish, and he was beheaded on Feb. 15, 1468, his followers in Munster avenging his death by invading the Pale. His younger son Maurice, earl from 1487 to 1520, was one of Perkin Warbeck's Irish supporters, and besieged Waterford on his behalf. Maurice's son James, earl from 1520 to 1529, was proclaimed a rebel and traitor for conspiring with the French king and with the emperor. At his death the succession reverted to his uncle Thomas (1454–1534), at whose death there was a contest between his younger brother Sir John "of Desmond" and his grandson James, a court page of Henry VIII. Sir John secured possession till his death (1536), when his own son James succeeded *de facto*, and *de jure* on the rightful earl's being murdered by the usurper's younger brother in 1540. Intermarriage with Irish chieftains had by this time classed the earls

among them, but although this James looked to their support before 1540, he thenceforth played so prudent a part that in spite of the efforts of the Butlers, the hereditary foes of his house, he escaped the fate of the Kildare branch and kept Munster quiet and in order for the English till his death in 1558. His four marriages produced a disputed succession and a break-up of the family. His eldest son, Thomas "Roe" (the Red) was disinherited, and failed to obtain the earldom, which was conferred by Elizabeth I on his half-brother Gerald, "the rebel earl" (*c.* 1533–83) (*see* DESMOND, GERALD FITZGERALD).

But the influence of the Fitzgeralds remained powerful even after the forfeiture of their estates following the murder of the 15th earl. The disinherited Thomas "Roe" left a son, James "Fitz Thomas," who, succeeding him in 1595 and finding that the territory of the earls would never be restored, assumed the earldom and joined O'Neill's rebellion in 1598, at the head of 8,000 of his men. He was eventually seized (1601) by his kinsman the White Knight, Edmund Fitz Gibbon, whose sister-in-law he had married, and was sent to the Tower. The *sugan* ("man of straw") earl lingered there obscurely as "James M'Thomas" till his death in 1607. In consequence of his rebellion and the devotion of the Irish to his house, James, "the queen's earl," son of Gerald, "the rebel earl," who had remained in the Tower since his father's death (1583), was restored as earl of Desmond and sent to Munster in 1600, but as a Protestant he achieved nothing, and he died the following year. Later claimants to the title lived abroad, taking service under the Habsburgs until the last, the condé de Desmond, was killed in 1632.

The Fitzmaurices.—There can be no doubt that the house of Fitzmaurice was also of this stock, although their actual origin, in the 12th century, is doubtful. From a very early date they were feudal lords of Kerry, and their dignity was recognized as a peerage by Henry VII in 1489. The isolated position of their territory (Clanmaurice) threw them even more among the Irish than the earls of Desmond, and they often adopted the native form of their name, "MacMorrish." Under Elizabeth I the lords of Kerry narrowly escaped sharing the ruin of the earls. The conduct of Thomas (*c.* 1520–90) in the rebellion of James "Fitzmaurice" Fitzgerald (*q.v.*) was suspicious, and his sons joined in that of the earl of Desmond, while he himself was a rebel in 1582. Patrick, his successor (*c.* 1541–1600), was captured in rebellion (1587), and when free, joined the revolt of 1598, as did his son and heir Thomas, who continued in the field till he obtained pardon and restoration in 1604, though suspect till his death in 1630. His grandson withdrew to France with James II, but the next peer became a supporter of the Whig cause, married the eventual heiress of Sir William Petty, and was created earl of Kerry in 1723. From him descended the family of Petty-Fitzmaurice, who obtained the marquessate of Lansdowne (*q.v.*) in 1784, and still hold among their titles the feudal barony of Kerry together with vast estates in that county.

From the three sons by a second wife of one of the earls of Desmond's ancestors descended the hereditary White Knights, knights of Glin and knights of Kerry, these feudal dignities having, it is said, been bestowed upon them by their father, as lord of Decies and Desmond. Glin castle, County Limerick, is still the seat of the (Fitzgerald) knight of Glin. The knights of Kerry received a baronetcy in 1880. (J. H. R.; E. A. MacL.)

FITZGERALD, LORD EDWARD (1763–1798), one of the most attractive and gallant of Irish rebels, was the fifth son of James, 1st duke of Leinster, and Emilia Mary, daughter of the 2nd duke of Richmond. Born at Carton house, County Kildare, on Oct. 15, 1763, he was brought up in France, where his mother lived, after his father's death, in the duke of Richmond's house at Aubigny. Returning to England in 1779, he joined the Sussex militia and went on active service in America in 1781 on the staff of Lord Rawdon. He was severely wounded at the battle of Eutaw Springs (1781). He returned to Ireland in 1783 and was elected to the Irish parliament as member for Athy. He voted with the opposition minority, led by Henry Grattan and J. P. Curran, but took no active part in public affairs. He toured Spain in 1787, and then sailed for New Brunswick as a major in the 54th regiment. He showed his high sense of adventure by traveling (1789) across Canada through unexplored territory, from Fredericton to Quebec. The Bear tribe of Hurons made him one of their chiefs, and he went on down the Mississippi to New Orleans, before returning to England.

Elected member for Kildare, Fitzgerald refused Pitt's offer to command an expedition against Cádiz. In London he associated with the Whigs who followed Charles James Fox and R. B. Sheridan, and joined the Society of the Friends of the People. Visiting Paris in Oct. 1792, he lodged with Thomas Paine and attended the debates of the convention. On Nov. 18 he attended a British banquet in Paris, where he joined in the toast to "the speedy abolition of all hereditary titles and feudal distinctions." He also repudiated his own title, and for these actions he was cashiered from the army. On Dec. 27, 1792, he married Pamela, a protégé of Madame de Genlis. It was commonly believed that Madame de Genlis was Pamela's mother; the father was claimed to be Philippe Égalité, duc d'Orléans.

Fitzgerald and his young wife returned to Dublin in Jan. 1793. There the United Irishmen society was rapidly expanding and Wolfe Tone, as secretary of the Catholic committee, was preparing a popular agitation under the inspiration of the French Revolution. Fitzgerald at once resumed his seat in the Irish parliament and within a few weeks was ordered to apologize for his defiance of the government. Wolfe Tone was actively engaged in Paris by May 1796, trying to obtain French military aid for an Irish insurrection. Fitzgerald had already joined the United Irishmen, who were openly advocating an independent Irish republic. In the same month he and his friend Arthur O'Connor went to Hamburg to negotiate for French assistance in an Irish rising. They contacted Gen. Lazare Hoche in Basel, but the Directory would not negotiate with Fitzgerald because of his wife's connection with the Orléans family. Fitzgerald therefore left O'Connor to continue the mission which resulted in Hoche's abortive expedition to Bantry bay in Dec. 1796. After his return to Ireland Fitzgerald became increasingly involved with the United Irishmen.

In July 1797 Fitzgerald declined to stand again as member for Kildare because free elections were impossible under martial law. A military committee was formed, under Fitzgerald, to prepare for co-operation with a French landing, or, if necessary, to organize an Irish insurrection, for which they claimed that 280,000 men were now ready to rise. Delays on the French side decided the committee to prepare for a general rebellion on May 23, 1798. Informers had revealed all the main plans to the English authorities, and on March 12 the members of the Leinster provincial committee were arrested while meeting at Oliver Bond's house. Fitzgerald was not present, since he had been warned to keep away; but he refused to escape and leave his friends. On May 11 a reward of £1,000 was offered for his capture; he was betrayed by an informer and arrested, after a fierce struggle, in a house in Thomas street, Dublin, on May 19. He mortally wounded one of his captors and was himself shot in one arm and disabled. Fitzgerald was removed to Newgate jail and there died of his wounds on June 4, 1798. Lord Edward—gay, humorous, entirely unselfish and courageous—lacked the qualities that were needed either for international conspiracy or political leadership in his own country.

Fitzgerald's widow had to leave Ireland before he died. She went to Hamburg and there later married the American consul, J. Pitcairn, but remained devoted to Fitzgerald's memory. She died in Paris in Nov. 1831.

See Thomas Moore, *Memoirs of Lord Edward Fitzgerald*, rev. ed. (1897). (D. G.)

FITZGERALD, EDWARD (1809–1883), English writer, translator of Omar Khayyám (*q.v.*), was born at Bredfield, near Woodbridge, Suffolk, on March 31, 1809. His father, John Purcell, who had married a Miss FitzGerald, assumed in 1818 the name and arms of his wife's family. From 1816 to 1821 the FitzGeralds lived at St. Germain and at Paris, but Edward was educated at Bury St. Edmunds and at Trinity college, Cambridge, where he got to know Thackeray and W. H. Thompson (later master of Trinity). After taking his degree in 1830 he returned to Paris but soon chose to settle in Woodbridge where he passed a secluded leisurely life

devoted to flowers, music and books. His intimacy with Tennyson began about 1835 and that with Carlyle about 1842. In 1851 FitzGerald published *Euphranor*, a Platonic dialogue on youth, born of memories of his happy life at Cambridge. In 1852 appeared *Polonius*, a collection of aphorisms, several original, the rest borrowed from English classics. Both were anonymous. In the following year he published *Six Dramas of Calderón*, freely translated, and, having turned to oriental studies under the guidance of his friend E. B. Cowell, later professor of Sanskrit at Cambridge, in 1856 he published a version of the *Salámán and Absál* of Jami in Miltonic verse. In the same year he married Lucy Barton, but they soon separated. She was the daughter of the Quaker poet Bernard Barton, and when she edited her father's poems and letters in 1849 FitzGerald added a memoir of the author.

In March 1859 a little anonymous pamphlet was published as *The Rubáiyát of Omar Khayyám*. The poem seems at first to have attracted no attention, but in 1860 Rossetti discovered it, and Swinburne and Lord Houghton quickly followed. The expression which it gave to the perplexity of the times led to the demand for a second edition in 1868. The new edition was enlarged by the addition of 35 quatrains, and FitzGerald continued to modify the poem until 1879. Meanwhile FitzGerald had produced in 1865 a version of the *Agamemnon* and two more plays from Calderón. In 1880–81 he issued privately translations of the two Oedipus tragedies; his last publication was *Readings in Crabbe*, 1882. His *Bird-Parliament*, an abridged version of the *Mantiq at-Tair* of 'Attár, appeared posthumously.

After 1861 FitzGerald's greatest interest centred in the sea, and for several years, till 1871, he spent the months from June to October mainly in "knocking about somewhere outside of Lowestoft." He died, suddenly and in his sleep, at Merton, Norfolk, on June 14, 1883. He was "an idle fellow, but one whose friendships were more like loves"; his wit and human side are displayed in his inimitable letters. Tennyson's dedication of his *Tiresias* to FitzGerald's memory, in some touching reminiscent verses to "Old Fitz" (1885), was the signal for the universal appreciation of Omar Khayyám in his English dress. The exquisite melody of FitzGerald's verse has made the poem probably better known than any single poem of its class.

Bibliography.—FitzGerald's works appeared in 2 vol. (1887); his *Letters and Literary Remains* were ed. by W. Aldis Wright, 7 vol. (1902–03); other *Letters* were ed. by F. R. Barton (1923), those to Bernard Quaritch by C. Quaritch Wrentmore (1926) and those to W. B. Donne by N. C. Hannay (1932). His *Dictionary of Mme. de Sévigné* was ed. by his great-niece, M. E. FitzGerald Kerrich, 2 vol. (1914). *See* also T. Wright, *Life of E. FitzGerald*, 2 vol. (1904); A. C. Benson, *E. FitzGerald* (1905); Morley Adams, *Omar's Interpreter, a New Life of E. FitzGerald* (1910); A. M. Terhune, *Life of E. FitzGerald* (1947); P. de Polnay, *Into an Old Room: the Paradox of E. FitzGerald* (1950); A. J. Arberry, *The Romance of the Rubáiyát* (1959). (E. G.; A. J. Ay.)

FITZGERALD, F. SCOTT (Francis Scott Key Fitzgerald) (1896–1940), U.S. novelist famous for his depictions of the "jazz age" (the 1920s), was born in St. Paul, Minn., Sept. 24, 1896. He attended a series of schools—St. Paul academy, Newman, Princeton—which tended to confirm his feelings that he was always tantalizingly near, but never endowed with, great wealth, an emotion explored fully in some of his finest fiction. Princeton, which he left without finishing in 1917, and the army, in which he served, 1917–19, disappointed him profoundly as he later confessed: Princeton did not put him on its football team and the army did not send him overseas. He began *This Side of Paradise* (1920) in the army and rewrote it on the advice of Maxwell Perkins at Scribner's. Largely autobiographical, it sounded the rallying cry of the rebellious youth of the decade of revolt just beginning. Two volumes of short stories, *Flappers and Philosophers* (1920) and *Tales of the Jazz Age* (1922), were followed by a second novel, *The Beautiful and Damned* (1922), which purported to treat the exciting revolt of sophisticated youth while affirming the meaninglessness of life. Fitzgerald's real genius was revealed with the appearance of *The Great Gatsby* (1925), a story about Jay Gatsby's pursuit of an immense but elusive dream and the resulting destruction of both Gatsby and dream through the casual cruelty of fabulous wealth—a story of the fantastic '20s but also a story which probes deeply the American character. Some of Fitzgerald's finest stories appeared in *All the Sad Young Men* (1926), but it was not until 1934 that another novel appeared—*Tender Is the Night*, a frightening story of Dick Diver's spiritual bankruptcy and disintegration of character. A final volume of short stories followed—*Taps at Reveille* (1935). Fitzgerald himself, like Diver, was discovering that his moral resources were disappearing—a process he described with agonizing vividness in a series of essays, "The Crack-Up" (1936). He was attempting to recapture his lost talent in a novel about Hollywood when he died in 1940. The unfinished novel together with Fitzgerald's notes was published in 1941 as *The Last Tycoon*.

Bibliography.—Arthur Mizener, *The Far Side of Paradise* (1951); Alfred Kazin, *F. Scott Fitzgerald: The Man and His Work* (1951); James E. Miller, Jr., *The Fictional Technique of Scott Fitzgerald* (1957). (J. E. Mr.)

FITZGERALD, GEORGE FRANCIS (1851–1901), Irish physicist, whose researches were mainly concerned with electromagnetism, radiation and electrolysis. He was born in Dublin on Aug. 3, 1851, and educated at Trinity college there, where he spent the rest of his life, becoming fellow in 1877, tutor in 1879, and professor of natural and experimental philosophy in 1881. He was elected a fellow of the Royal society in 1883 and was awarded the society's Royal medal in 1899. FitzGerald was renowned for his extensive knowledge of physics, his critical powers and his brilliant speculations. His studies on radiation led him to the conclusion, shortly afterward established experimentally by H. R. Hertz (*q.v.*), that the oscillatory discharge of an electric condenser might produce electric waves, the basic discovery in wireless telegraphy. In his study of the negative result of the Michelson-Morley experiment he formulated the hypothesis that the length of a body in motion through the ether is contracted in the direction of the motion, an assumption since known as the FitzGerald-Lorentz contraction because of the independent derivation and considerable development of it made by H. A. Lorentz (*q.v.*). FitzGerald's papers, edited by J. Larmor, were published as *The Scientific Writings of the Late George Francis FitzGerald* (1902). In addition to his scientific work, FitzGerald was interested in education and it was largely through his efforts that technical education was established in Ireland. He died in Dublin on Feb. 22, 1901. (D. McK.)

FITZGERALD, JAMES (called Fitzmaurice) (d. 1579), Irish leader and Catholic rebel, was the son of Maurice (d. 1564), brother of the 14th earl of Desmond. In 1568, after the arrest of his cousin Gerald, 15th earl of Desmond (*q.v.*), and of his brother Sir John Fitzgerald, Fitzmaurice, as he was generally called, was appointed "captain of Desmond." His interest in the earldom of Desmond led him into battle and defeat by Thomas Fitzmaurice, lord of Lixnaw. In 1569 he tried to prevent the Protestant church expanding into Munster. The aggressive and exploiting policy of the English government led to the temporary reconciliation and joint rebellion of the Butlers and Fitzgeralds; Fitzmaurice's appeal to Spain for help in 1569 failed and he was further isolated by the return of the earl of Desmond to Ireland in 1573. He decided to leave Ireland in 1575 to gain foreign support, having rejected overtures from the English government. Henry III of France, anxious for peace with England, declined to help, but Philip II of Spain and the pope both encouraged the plan for a Catholic invasion of Ireland, which was to be a second front in the Catholic attack on England. Pope Gregory XIII issued a brief (Feb. 25, 1577) granting conditional plenary indulgence to all rebels. Philip II was encouraging but fully occupied elsewhere; the death of Don John of Austria (1578), who had been chosen as a figurehead, and the diversion of supplies to Morocco delayed matters further. Even the Jesuits were reluctant to jeopardize their English projects by blatant support of Fitzmaurice. This bleak outlook was softened by the adhesion of an English exile, Nicholas Sander.

Fitzmaurice landed at Dingle in southwest Ireland on July 18, 1579. His cry of revolt was received sympathetically but passively by the earls of Desmond and Kildare. The English government had been kept well posted on all these developments by Sir William Drury, who now arranged for Fitzmaurice to be betrayed by his

former supporters. The plan was successful. Fitzmaurice was slain in a skirmish with Tibbot Burke of Castleconnel (Aug. 18, 1579), and Drury claimed the credit for the action. Desmond, encouraged by Sander, now entered the war hoping for continental support, but the English commanders crushed the rebellion ferociously and by 1583 Munster was quelled and devastated.

In the following century, Thomas Russell, while blaming Fitzmaurice for the fall of the house of Desmond and not denying that he was a traitor to Elizabeth, described him as a "brave and gallant gentleman, witty, learned . . . of a high adventurous polliticke and dissembling mind." (R. D. Es.)

FITZGERALD, RAYMOND (d. *c.* 1185), surnamed Le Gros, one of the adventurers who took part in the Anglo-Norman conquest of Ireland under Richard Strongbow, earl of Pembroke, was son of William FitzGerald and brother of Odo de Carew. He was sent to Ireland by Strongbow in May 1170, and was largely responsible for the capture of Waterford and Dublin. He was sent to Aquitaine to hand over Strongbow's conquests to Henry II, but was back in Dublin by July 1171, when he led a sortie from the town. He subsequently retired to Wales, resentful because Strongbow forbade his marriage with his sister Basilia; however, he returned with his kinsman Meiler FitzHenry to help quell the rebellion of 1174. He was then allowed to marry Basilia and was reinstated as constable of Leinster, an office he had held briefly before going to Wales. He achieved a series of military successes and after the fall of Limerick to his forces (Oct. 1175) order was restored. On the death of Strongbow (1176) he became acting governor until the arrival in Ireland of William FitzAldhelm. He was then deprived of his estates near Dublin and Wexford, but his family secured the recall of FitzAldhelm in 1177. Raymond relieved his uncle, Robert FitzStephen, who was besieged in Cork (1182), and died some time after 1185.

See G. H. Orpen, *Ireland Under the Normans,* vol. i, ii (1911). (A. Gw.)

FITZGERALD, LORD THOMAS, 10th Earl of Kildare (1513–1537), known as "Silken Thomas," was the leader of a serious rebellion in Ireland against the authority of Henry VIII. He was born in London in 1513, the eldest son of Gerald, the 9th earl, and his first wife Elizabeth. Both father and son spent some years in London for political reasons, since the 8th earl was hostile to the Tudors and Fitzgerald loyalty was doubtful. Lord Thomas married (*c.* 1529) Frances, daughter of Sir Adrian Fortescue, cousin of Anne Boleyn and the earls of Ormonde.

The 9th earl, summoned to London in Feb. 1534 to answer charges of disloyalty, left his son as deputy in Ireland. Lord Thomas renounced his allegiance to Henry VIII on June 11, possibly on account of rumours of his father's death in the Tower of London, which did not in fact take place until Sept. or Dec. 1534. Lord Thomas hoped to establish himself with help from the pope and the emperor Charles V. This help never came, but he had considerable initial success, although the Butlers, earls of Ormonde, did not support him. Dublin was taken, all but the castle, and Archbishop John Allen was executed, after attempting flight to England, on July 28. Henry VIII appointed Sir William Skeffington on July 30 as lord deputy, with the aim of suppressing Fitzgerald. After a slow start Skeffington retook Dublin and then stormed the Fitzgerald stronghold, Maynooth castle, in March 1535. Pope Paul III's excommunication of Henry VIII in July did not effectively advance the continental plans against England, nor did the Irish receive the expected help from Spain. Events in Ireland stagnated. In August Kildare (as Lord Thomas had become, although he never used the title) was captured but escaped. Later the same month (about Aug. 23) he offered to surrender on terms, the nature of which is uncertain and which, when he did surrender, were not kept. Removed to England, Kildare was not imprisoned (possibly to preserve the illusion that forgiveness might follow) until Ireland was pacified. In May 1536 an act of attainder in the Irish parliament echoed the terms of the English act of the previous year. The government still delayed, fearing repercussions and support for Kildare, but on Feb. 3, 1537, with his five uncles he was hanged, drawn and quartered at Tyburn.

Kildare left no children and the title passed to his stepbrother Gerald. As a personality little is known of the 10th earl, except the traditional stories of impulsiveness, dash, bravery, thoughtlessness and pride. Kildare's rebellion ended his family's hereditary viceroyalty of Ireland and for a time threatened to be a serious, concerted, European and Catholic attack on Henry VIII. (R. D. Es.)

FITZHERBERT, SIR ANTHONY (1470–1538), English judge and legal systematizer, was born at Norbury, Derbyshire, and from 1523 until shortly before his death in 1538 was justice of the court of common pleas. He was the author of *La Graunde Abridgement* (1516), a digest of important legal cases written in Old French; *The Office and Authority of Justices of the Peace,* first printed in 1538 (last ed. 1794); and *New Natura Brevium* (1534, last ed. 1794), with a commentary ascribed to Sir Matthew Hale.

FITZNEALE (Fitznigel), **RICHARD** (*c.* 1130–1198), author of the *Dialogus de scaccario* ("Dialogue of the Exchequer"), bishop of London and treasurer of England under Henry II and Richard I, was the son of Nigel, bishop of Ely (1133), and the great-nephew of Roger, bishop of Salisbury. Roger had organized the exchequer under Henry I, and Nigel, who was treasurer under Henry I and Stephen, purchased the office (*c.* 1158) for his son Richard, who retained it until his death. Richard's name appears in the lists of itinerant justices for 1179 and 1194; he was also a judge of common pleas. He became archdeacon of Ely (*c.* 1160) and a canon of St. Paul's; he became dean of Lincoln not later than 1184 and bishop of London in 1189. He died on Sept. 10, 1198.

Richard FitzNeale's *De necessariis observantiis scaccarii dialogus,* commonly called the *Dialogus de scaccario,* is an account in two books of the procedure followed by the exchequer in the author's time, a procedure which was largely the creation of his own family. The speakers in the dialogue are Richard himself and an anonymous pupil. In the prologue the conversation is said to have taken place in the 23rd year (1176–77) of Henry II's reign. This probably marks the date at which the book was begun but it was not completed before *c.* 1179. Soon after the author's death it was already recognized as the standard manual for exchequer officials. It was frequently transcribed and has been used by English antiquarians of every period. The *Dialogus* describes contemporary exchequer practice with detail and accuracy, except where the author occasionally oversimplifies his account of a particular procedure; and on historical points he is sometimes misinformed. The text of the *Dialogus* shows that its author also composed a chronicle of the reign of Henry II, arranged in three columns and thus named the *Liber tricolumnis.* This work is not extant; William Stubbs's identification of it with the *Gesta Henrici* formerly attributed to Benedictus Abbas, abbot of Peterborough, has not been upheld. The *Dialogus* was attributed to Gervase of Tilbury by Thomas Madox and other 18th-century antiquarians, possibly because his *Otia Imperialia* was written in three parts.

Bibliography.—F. Liebermann, *Enleitung in der Dialogus de Scaccario* (1875); C. Johnson (ed. and trans.), *Dialogus de Scaccario* (1950); D. C. Douglas and G. W. Greenaway (eds.), *English Historical Documents,* vol. ii (1953).

FITZOSBERN, ROGER (fl. *c.* 1070), known as Roger de Bréteuil, inherited (1071) the earldom of Hereford, the Isle of Wight and the English estates of his father, William FitzOsbern (*q.v.*), his elder brother William obtaining the Norman lands of Bréteuil and Pacy. At the wedding (1075) at Exning, Cambridgeshire, of Roger's sister Emma and Ralph de Gael, earl of Norfolk, Roger and Ralph, together with Waltheof, earl of Huntingdon, plotted rebellion against William I. They were prevented from joining forces by the bishop and sheriff of Worcester and the abbot of Evesham, whose troops stopped Roger crossing the river Severn. He was tried in the king's court, deprived of his lands and title and put in prison, where he behaved so insolently that he was never released. (G. W. S. B.)

FITZOSBERN, WILLIAM (d. 1071), earl of Hereford, one of William I's closest supporters, was the son of Osbern de Crépon, seneschal of Normandy. FitzOsbern himself became seneschal of Normandy and in 1060 was given the lordship and castle of Bréteuil. He took a leading part both in the preparations for the Norman invasion of England and in the battle of Hastings, and was

rewarded with a grant of the Isle of Wight and the earldom of Hereford, both vitally important for the defense of England. After the Conquest FitzOsbern held a position of the highest responsibility. In 1067 he commanded the army in the king's absence, was put in charge of a new castle at Norwich and was made the king's special representative in the north. In the critical rebellion of 1068–69 he was governor of York. In 1071, having been sent to Normandy to help Queen Matilda, he became involved in the Flemish succession dispute and was killed at the battle of Cassel in Flanders on Feb. 20, 1071. He founded the abbeys of Cormeilles and Lire in Normandy and introduced the "laws of Bréteuil" to Hereford, whence they became a model for many western English, Welsh and Irish boroughs.

See M. Bateson, "The Laws of Bréteuil," *English Historical Review*, vol. xv and xvi (1900–01). (G. W. S. B.)

FITZOSBERT, WILLIAM (d. 1196), nicknamed WILLIAM THE BEARDED, crusader and demagogue, was a London citizen of good family, who took part in the English expedition against the Moors in Portugal (1190). On his return he made himself leader of the common people of London against the mayor and aldermen, rousing the mob by fiery speeches at St. Paul's, and especially protesting against the assessment of the "aid" to pay Richard I's ransom (1194). Though for a time a member of the city council and claiming acquaintance with the king, he was regarded by his fellow magistrates as a dangerous demagogue, and they persuaded the justiciar Hubert Walter to seize him before he led an armed revolt in the city. He was taken from the sanctuary of St. Mary-le-Bow, Cheapside, to the Tower, sentenced to death, and hanged in chains at Smithfield on April 6, 1196, with nine followers, being at once revered as a martyr by the poorer classes. (G. W. S. B.)

FITZPETER, GEOFFREY (d. 1213), justiciar of England under Richard I and John, was a son of Peter of Ludgershall. By his marriage with Beatrice de Say, great-niece of the first earl of Essex, Geoffrey established a claim to succeed William de Mandeville (d. 1189) in the earldom. He received the third penny of the county (signifying acknowledgment of him as earl) from Easter 1190 and obtained a ratification of his claim by Richard I (Jan. 23, 1191) but was not formally recognized as earl until the coronation of King John on May 27, 1199. Geoffrey had gained administrative experience as justice of the forest and as sheriff under Henry II. He was one of the council of regency appointed to assist the justiciar during Richard's absence on crusade and as such had a seat on the bench at Westminster. He continued to sit there, apparently as senior justice, working in harmony with Archbishop Hubert Walter until he succeeded him as justiciar (July 11, 1198). He was the first justiciar whose writs survive in any number; they show him incessantly traversing the country when he was not sitting at Westminster. It is evident from his long tenure of office, which ended only with his death, that Geoffrey enjoyed John's confidence; however, toward the end there seems to have been a coolness between them, which can probably be explained by the king's quarrel with the justiciar's son, Geoffrey de Mandeville, whose wife John coveted. The king's alleged expression of relief on Geoffrey's death was a fiction of the chronicler Matthew Paris. The contemporary and sober chronicle of Walden abbey, describing Geoffrey's dealings with the abbey, gives a dark picture of his violence and lawlessness where his own interests were concerned. But he undoubtedly had considerable cause for complaint against the abbot, and the episode does not seem to have been typical of Geoffrey's behaviour. He died on Oct. 14, 1213.

See D. M. Stenton, *Pleas Before the King or His Justices, 1198–1202*, vol. i (1948); *The Book of the Foundation of Walden Abbey*, ed. by H. Collar, trans. by C. Emson, in *Essex Review*, vol. lxv–lxvii (1936–38). (H. G. RI.)

FITZROY, ROBERT (1805–1865), English vice-admiral, hydrographer and meteorologist, who commanded the "Beagle" on its famous voyage of circumnavigation, was born at Ampton Hall, Suffolk, on July 5, 1805, a grandson on his father's side of the third duke of Grafton and, on his mother's, of the first marquis of Londonderry. He entered the navy in 1819. After service in the Mediterranean and on the South American station he was promoted in 1828 to the command of the "Beagle," a brig of 240 tons, which was employed on the survey of the coasts of Patagonia and Tierra del Fuego.

She returned in 1830, and Fitzroy brought with him four Fuegians. Three survived and were taken back the next year, when he was reappointed to the "Beagle" to continue the survey. She sailed on Dec. 27, 1831, carrying, as a supernumerary, Charles Darwin. On Oct. 2, 1836, she returned, having surveyed the Strait of Magellan and part of the coast of South America and run a chronometric line around the world. In 1839 Fitzroy published in two volumes *Narrative of the Surveying Voyages of H.M.S.S. Adventure and Beagle . . .*, with a third volume by Darwin.

In 1842 he became a member of parliament for Durham and was appointed conservator of the Mersey. Early in 1843 he was appointed governor and commander in chief of New Zealand. His policy favoured the Maoris, and the settlers secured his recall in Nov. 1845. After serving as superintendent of the Woolwich dockyard and as commander of the "Arrogant," an experimental screw frigate fitted out under his supervision, he retired in 1850. In 1854 he was appointed chief of the newly formed meteorological department of the board of trade, and henceforward his career was devoted to practical meteorology.

In 1863 he published his *Weather Book;* the views in it were far in advance of his time. His last years were devoted to the Lifeboat association. He committed suicide on April 30, 1865.

Fitzroy's other publications included *Remarks on New Zealand* (1846), *Sailing Directions for South America* (1848) and occasional papers in the *Journal of the Royal Geographical Society.*

See *Symons's Met. Mag.*, no. 33, pp. 161–164 (1898), and *Mar. Obs.*, vol. i, pp. 50–52 (1924). (G. MY.)

FITZSTEPHEN, WILLIAM (d. *c.* 1190), English author of the first biography of Thomas Becket, was born in London. He entered Becket's service between 1154 and 1162, and described himself as *dictator* in Becket's chancery, *lector* in the hearing of cases and, in chapel, as Becket's subdeacon. He appeared with Becket at the council of Northampton (1164) when Becket's disgrace was made public. In 1170, when Becket returned to England Fitzstephen rejoined his household and witnessed his murder in Canterbury cathedral. His life of Becket is the most valuable we have, for though he writes as a partisan he gives a precise account of the differences between Becket and the king. He held various judicial appointments between 1170 and 1190.

BIBLIOGRAPHY.—His "Vita S. Thomae," which begins with his famous and valuable description of London ("Descriptio nobilissimae civitatis Londinae"), is in *Materials for the History of Thomas Becket*, ed. by J. C. Robertson, vol. iii, pp. 1–154 (1877); his description of London appears separately in the later *Liber Custumarum*, reprinted in *Munimenta Gildhallae Londoniensis*, ed. by H. T. Riley, vol. ii, pt. 1, pp. 1–15 (1860). *See* also Sir T. D. Hardy, *Descriptive Catalogue of Materials*, vol. ii, pp. 330–33 (1865); *English Historical Documents*, ed. by D. C. Douglas, vol. ii, pt. 3, p. 702 *et seq.*, pt. 4, p. 956 *et seq.* (1953).

FITZTHEDMAR, ARNOLD (1201–*c.* 1275), London chronicler and merchant, was born there on Aug. 9, 1201, the son of German parents from Bremen and Cologne, who had become London citizens. He was well educated, connected by marriage with several wealthy London families, and inherited great wealth and standing in the City. He became an alderman, but in Feb. 1258, with many others, was convicted of fraud, amerced and banned from office; in Nov. 1259 he was declared innocent and reinstated. At first critical of Henry III's misrule and sympathetic toward the baronial reformers of 1258–59, he was alienated when they allied in June 1263 with the "popular" mayor Thomas FitzThomas and the middle-class revolutionaries. These, with mob support, overthrew the merchant oligarchy that had monopolized power in London. Fitzthedmar probably was implicated in the royalist plot to trap Simon de Montfort at Southwark in Dec. 1263, and was one of 40 leading citizens who were saved from execution by the arrival, on the morning of their trial, of the news of the victory of Edward (later Edward I) at Evesham (Aug. 1265). As one of the delegation that went, under safe-conduct, to negotiate with Edward at Windsor in Oct. 1265, he was imprisoned for a few days. As custodian of the city muniments from 1270, he compiled,

in the miscellaneous *De antiquis legibus liber,* in addition to an account of his own ancestry and birth, the invaluable *Chronicle of the Mayors and Sheriffs of London, 1188–1274,* the chief authority on the government and politics of London after 1239 and on London's relations with the crown and with the baronial reformers. He died about 1275.

See *De antiquis legibus liber: Cronica majorum et vicecomitum Londoniarum,* ed. by T. Stapleton (1846), ed. and trans. by H. T. Riley (1863). (R. F. T.)

FITZWALTER, ROBERT (d. 1235), English baronial leader against King John. He first came into prominence as joint constable, with his cousin Saher de Quency (later earl of Winchester), of the castle of Vaudreuil, which, in mysterious circumstances, they surrendered to the French king Philip II in 1203. They were popularly accused of cowardice; but John issued a written statement that they acted under his instructions. By 1212, however, Robert was in opposition to John and fled to France. Sentenced to outlawry, his lands were seized and his castles razed. As part of the king's reconciliation settlement with the papacy, Robert's estates were restored in the following year. But he remained active in his opposition to the king, his animosity quickened, if it had not been caused, by John's quarrel with Robert's son-in-law, Geoffrey de Mandeville, son of Geoffrey FitzPeter, earl of Essex, and by John's designs upon De Mandeville's wife, Robert's daughter Maud. Robert took part in the demonstrations of baronial strength and the negotiations which led to the sealing of Magna Carta in June 1215, and was one of the 25 barons named to see that the king obeyed its provisions. On the outbreak of war, Robert was placed in command of the baronial forces. Again acting with Saher de Quency, he negotiated the intervention of Philip II's son Louis, to whom the barons offered the English throne. At the battle of Lincoln (May 20, 1217) Robert was taken prisoner, but was released in October after the conclusion of peace. In 1219, in company with Saher de Quency, he departed on crusade, returning sick, apparently early in 1221. He died on Nov. 9, 1235. His memory long survived in the legend of King John and the fair Matilda (Maud), which became a popular subject of romance. (H. G. Ri.)

FITZWILLIAM, a family with English and Irish branches, important in English history. The alleged descent of the Fitzwilliams from an illegitimate son of William the Conqueror is almost certainly fictitious. The fortunes of the English branch of the family really began with Sir William Fitzwilliam (1460–1534), sheriff of London, who acquired the future family seat at Milton, Northamptonshire, in 1506. His grandson, also Sir William Fitzwilliam (*q.v.*), was thrice deputy of Ireland. The latter Fitzwilliam's grandson took the Irish title of Baron Fitzwilliam of Lifford in 1620. In later generations the Irish titles of Viscount Milton and Earl Fitzwilliam (1716) and the English titles of Baron Milton (1742) and Viscount Milton and Earl Fitzwilliam (1746) were added.

William Wentworth Fitzwilliam (1748–1833), 2nd earl (English peerage), was an active Whig and inherited the large Wentworth estates in Yorkshire on the death in 1782 of his uncle the marquess of Rockingham, thus becoming one of the richest members of the nobility. He was lord lieutenant of Ireland (1794–95) and, in opposition to Pitt, strongly supported Grattan's Catholic emancipation campaign. He was president of the council in 1806 and thereafter mainly in opposition. He died at Milton in 1833.

Fitzwilliam's son, Charles (1786–1857), 3rd earl, officially adopted the surname Wentworth-Fitzwilliam. William Thomas George Wentworth-Fitzwilliam (1904–), 8th earl, succeeded to the title in 1952.

An Irish branch of the family, the Fitzwilliams of Meryon, were descended from a 12th-century member of the family who went to Ireland under Prince John. The titles of Baron and Viscount Fitzwilliam died out with the 8th viscount in 1833. The most celebrated member of this branch was Richard (1745–1816), 7th viscount, who left his library to Cambridge university and also a fund for creating the Fitzwilliam museum at Cambridge.

FITZWILLIAM, SIR WILLIAM (1526–1599), English royal servant, whose career was spent mainly in Ireland, of which he was twice lord deputy, was born at Milton, Northamptonshire, the eldest son of Sir William Fitzwilliam (d. 1552). His first recorded connection with Ireland was in a grant of land there from Edward VI. Fitzwilliam's career was doubtless aided by his relationship by marriage to both Sir Henry Sidney and William Cecil, later Lord Burghley, although at a later stage relations between Fitzwilliam and Sidney were strained. Appointed temporarily as keeper of the great seal in Ireland in 1555, he became vice-treasurer for Ireland and treasurer at war in 1559. Between 1559 and 1571 he was five times lord justice of Ireland in the absence of his patrons, the earl of Sussex and Sir Henry Sidney, and in this office he survived the first of what was to prove a long series of charges of corruption and maladministration. As lord deputy (1572–75) Fitzwilliam was also involved in various disputes with the English government; at first over the return of the earl of Desmond which he had opposed and whom he was finally bullied into seizing in 1574, over the Ulster plantation project, and with Sir Edward Fitton who replaced him as vice-treasurer in 1573. Furthermore he had strong suspicions that Sir Henry Sidney was intriguing against him at court.

In England, from 1575 to 1588, he was governor of Fotheringhay castle when Mary Stuart was executed there. Fitzwilliam was restored to Ireland as lord deputy in 1588 and his energetic measures during the Armada crisis and its aftermath were effective and, some said, remunerative. But such charges, which, with his chronic ill-health, were constant features of his career, were largely unproved; even so, his personal expenditure was extravagant, and he felt it necessary to leave (after his death) a vindication of his Irish activities.

Fitzwilliam succeeded in quelling a mutiny among Sir Thomas Norris' troops in 1590, settled the Macmahons in County Monaghan in 1591, and also acted as mediator between the O'Neill family and the earl of Tyrone. When Maguire rebelled in 1593 he acted promptly by taking Enniskillen castle. But his health was failing and he retired in 1594, "blind, lame, burst and full of dropsy." An attempt was made to bring him to trial but failed, perhaps through the good offices of Burghley. He died in 1599 and was treated unfavourably by subsequent historians. (R. D. Es.)

FIUME: *see* RIJEKA.

FIVE CIVILIZED TRIBES, a term that has been used officially and unofficially since at least 1866 to designate the Cherokee, Choctaw, Chickasaw, Creek and Seminole Indians (*qq.v.*) in Oklahoma (former Indian Territory). Since 1874 they have been dealt with through one centralized agency of the bureau of Indian affairs of the U.S. department of interior, but there has never been any unification or over-all organization of these tribes. They were the major tribes of the southeastern states, from which they were forcibly removed by the U.S. government during the 1830s to large adjoining tracts in the eastern part of Indian Territory. Here they maintained almost complete independent control over their internal affairs until 1907. Each organized as a "nation," with a written constitution and laws, and a republican government modeled on that of the U.S., consisting of an executive department (headed by an elected "principal chief" or "governor"), a bicameral legislature and a judiciary department with elected judges and police and jury trial. Public-school systems were instituted, in part supported by tribal funds and in part provided by Christian church missionaries. During the American Civil War most tribes were divided between supporters of the Union and the Confederacy, providing soldiers for each army, and their territories were depopulated and devastated. Before this time, and especially following the reorganization of each nation after the war, economic and educational progress was rapid and distinctive fusions of Indian and Anglo-American cultures developed.

When transcontinental railroads were built through Indian Territory and the settlement of adjoining states increased, the Five Civilized Tribes lost their independence. Between 1893 and 1907 (when Oklahoma became a state) the U.S. government forced the allotment of the tribal lands to individual, enrolled tribal members (including "freedmen," former Negro slaves of the Indians) and abrogated the national governments. Former tribal land was opened to white settlement and many Indian allottees lost their

land through unscrupulous practices. The tribal governments have continued in modified form to the present, but with little or no authority; the councils have largely only advisory functions. All tribal members are full citizens of Oklahoma and the United States. The bureau of Indian affairs provides some services for enrolled tribal members but no reservation system is in effect.

See also OKLAHOMA: *History.*

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(W. C. ST.)

FIVE NATIONS: *see* IROQUOIS.

FIVES, a ball game played by two or four players in a court enclosed on three or four sides, the ball being struck with the hand protected by a glove. Certain forms of the game in the United States and in Ireland are known as handball (*q.v.*). The etymology of fives is uncertain. Nevertheless, since fives has been used to describe handball play and boxing it is reasonable to conclude that the word is associated with the five fingers of the hand acting in unison. Long before the present games of fives were known, Samuel Johnson defined the word as "a kind of play with a bowl" and later a bunch of fives was a familiar expression for the closed fist. Games using hand, ball and wall were various and without set rules or carefully defined areas until late in the 19th century. They were played in the tennis courts from medieval times to at least the end of the 18th century, in the Fleet prison and against any straight wall or angle of walls which presented itself to child or man. Most of these games could also be played with the racket. As Nicholas says in the *Familiarum Colloquiorum Opus* (1526) of Erasmus: "We shall sweat less if we play with a racket." And Jerome replies: "Let us leave nets to fishermen; the game is prettier if played with the hands."

The three versions of the modern game are named after well-known English schools. (J. AE.)

Eton Fives.—The peculiar features of the Eton fives court arose from the game's being first played at Eton college against the chapel wall with buttresses forming the side walls and with the balustrade of the chapel steps projecting into the left-hand side of the court, which was divided latitudinally by a step.

The modern standard court has retained all these characteristics, being enclosed on three sides and open at the back, with a shallow "step" dividing the upper or top portion from the lower or bottom portion. The buttress which projects from the left-hand wall is now called the "pepperbox" which, with the step, encloses a small square section of the floor called "Dead Man's Hole." The "line" of the court is the lower angle of a sloping ledge running across the front wall at the height of 4 ft. 6 in. Items of equipment required are padded gloves and special balls about $1\frac{3}{4}$ in. in diameter and $1\frac{3}{4}$ oz. weight, covered in white kid.

The game is played by four persons, two against two, the server standing in the upper court; the taker of service stands in the lower court ready to return the service. The partners of both server and taker of service also stand in the lower court, the server's partner having choice of position. To start the game the server must throw the ball above the line on to the front wall so that it then hits the right-hand wall before dropping into the lower court to suit the taker of service, who is said to be "cutting." The rally is not started until the "cutter" has received a service to his liking and returned it above the line; thereafter the ball is returned alternately by either side, the rally ending when the ball is hit either below the line or out of court. Only the side serving may score, game being 12 points. The Eton Fives association, to which schools and clubs are affiliated, regulates the game and is responsible for the organization of the amateur championship for the Kinnaird trophy, presented by Lord Kinnaird in 1926, and the Public Schools competition for the challenge cup, presented by the association in 1949. (P. C. C.)

Rugby Fives.—This is played in a four-walled court with no form of hazard. The dimensions of the standard court are length 28 ft., width 18 ft., height of front wall 15 ft., height of back wall 6 ft. The front wall is distinguished by a wooden board running horizontally across it at an even height of 2 ft. 6 in. from the floor. A few courts have no back wall and others have a lower one. The ball is hard and solid, approximately 2 in. in diameter and weighing about $1\frac{1}{4}$ oz. Specially padded gloves are worn. The game may be played by two or four players and is won by the first side to win 15 points or the first player to score 2 points after each has 14. Only the receiver can score points and when he wins a rally he scores one point, but should his opponent (the server) win it, he becomes receiver. The server starts a rally by throwing the ball up so that it first hits the front wall and then the nearest side wall; he must strike it after the first bounce and before the second so that it hits first the side wall and then the front wall. The opponent must return the service, before the second bounce, on to the front wall above the board, either directly or after it has hit any of the other walls. The players then hit the ball alternately.

The game is regulated by the Rugby Fives association. Open singles and doubles championships, schools' singles and doubles competitions and Scottish and north of England championships are held. Most courts are owned by schools and universities.

Winchester Fives.—This is similar to Rugby fives except that the court has a "buttress" on the left-hand side wall about 10 ft. from the front wall, which means that the rest of the court is that much narrower. There are fewer courts of this type. (R. A. C.)

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FIZEAU, ARMAND HIPPOLYTE LOUIS (1819–1896), French physicist best known for his experiments in light, particularly the speed of light, was born at Paris, Sept. 23, 1819. As he was wealthy, he was able to follow his inclinations and devote himself to experimental work in physics. Between 1845 and 1849 he worked in conjunction with Foucault (*q.v.*). They investigated the infrared portion of the solar spectrum and made other observations in heat and light. In 1849 Fizeau published the results of his experiments on the velocity of light; he also gave the first reliable value of this velocity by a terrestrial method, as well as the correct explanation of the Doppler effect (*see* LIGHT: *Waves and Interference*) as applied to the light coming from a star, and showed how it could be used to measure the relative velocities of stars in the line of sight.

In 1851 he carried out a series of experiments on the velocity of light in a moving medium, and measured the shift of interference fringes resulting from light passing through a column of moving water. These experiments were designed to see if any relative motion of ether and matter could be detected (*see* ETHER [IN PHYSICS]). Later experiments describe the use of a condenser for increasing the efficiency of an induction coil and the application of interference methods for measuring the expansion of crystals. He became a member of the French Academy in 1860 and of the Bureau des Longitudes in 1878; in 1863 he was appointed *inspecteur de physique* at the École Polytechnique Paris. Fizeau died at Venteuil, Sept. 18, 1896.

FJORD (FIORD), a long narrow arm of the sea commonly extending far inland, resulting from the inundation by the sea of a severely glaciated valley. Many fjords are astonishingly deep; Sogne fjord in Norway is 4,078 ft. deep and Messier channel in Chile is 4,167 ft. It is the great depth of these submerged valleys, extending thousands of feet below sea level, that necessitates their glacial origin. It is assumed that the huge, thick glaciers formed in these valleys were so heavy that they could erode the bottom of the valley far below sea level before they floated in the ocean water. After the glaciers melted, the waters of the sea invaded the valleys and formed the fjords.

Glacial erosion produces U-shaped valleys and fjords are characteristically so shaped. Since the lower, slanting part of the U is underwater, the walls of fjords may rise vertically for hundreds of feet from the water's edge. Similarly, just a few yards from the shore the water may be several hundred or even thousands of feet deep. In some fjords small streams in tributary valleys plunge hundreds of feet over the steepened edge of the fjord; some of the world's highest waterfalls are of this type. Valleys are normally winding and twisting, and so fjords commonly have the same attributes—winding channels and occasional sharp

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SOGNE FJORD, NORWAY

corners. The U-shaped valley floored with glacial debris in many cases extends inland back into the mountains and in a few cases still has a small glacier at the head of the valley. The river that formed the original valley commonly re-establishes itself on the upper valley floor after the disappearance of the ice and begins to build a delta (*q.v.*) where it enters the sea at the head of the fjord. In many cases this delta is the only place on the fjord where villages and farms are located. Fjords commonly are deeper in the middle and upper reaches than at the seaward end. This results from the greater erosive power of the glaciers closer to their source where they are moving most actively and vigorously. All such valleys are not the result of glacial erosion, however.

See D. W. Johnson, *Shore Processes and Shoreline Development* (1919); Andre Guilcher, *Coastal and Submarine Morphology* (1958). (W. C. C.)

FLACH, JACQUES GEOFFROI (1846–1919), French jurist, the author of several works on the history of medieval France, was born at Strasbourg on Feb. 16, 1846. He settled in Paris after the war of 1870. From 1884 he was professor of comparative legislation at the Collège de France, and he also held posts at the École des Sciences Politiques and at the École d'Architecture in Paris. He died in Paris on Dec. 5, 1919.

Flach's great work, *Les Origines de l'ancienne France*, was produced in four volumes—*Le Régime seigneurial* (1886); *Les Origines communales, la féodalité et la chevalerie* (1893); *Le Renaissance de l'état. La Royauté et le principat* (1904); and *Les Nationalités régionales. Leurs Rapports avec la couronne de France* (1917)—which, although not always consistent, were characterized by originality and vigour and were based on a wide use of manuscript sources.

Flach also wrote *Études critiques sur l'histoire du droit romain au moyen âge* (1890) and *L'Origine historique de l'habitation et des lieux habités en France* (1899).

FLACIUS ILLYRICUS, MATTHIAS (1520–1575), Lutheran reformer and a pioneer in the study of church history, was born at Albona, in Illyria, on March 3, 1520. He studied under the humanist Baptista Egnatius in Venice, and from 1539 onward at Basel, Tübingen and Wittenberg, where he was welcomed (1541) by Philipp Melanchthon and came under the influence of Luther. In 1544 he was appointed professor of Hebrew at Wittenberg. He opposed the Augsburg Interim and the compromise of Melanchthon known as the Leipzig Interim (*see* ADIAPHORISM). Melanchthon wrote of him with venom as a renegade. He moved to Magdeburg (1549) where his feud with Melanchthon was patched up, and continued in the controversy with Georg Major, who thought good works necessary for salvation. In the controversy with Andreas Osiander over the meaning of justification Flacius took the side of Melanchthon and his disciples.

From 1552 he was occupied with the *Magdeburg Centuries*, a church history treating the centuries mechanically as historical units but using a great number of manuscripts, which were collected under his supervision from all accessible libraries throughout Europe. The idea was to refute the Roman claims by history. In 1557 he was appointed professor of New Testament at Jena; but he was soon involved in controversy with V. Strigel, his colleague, on synergism (Melanchthon's theory of the function of man's free will in conversion). In 1566 he became Lutheran pastor at Antwerp, where he published his *Clavis scripturae*, a dictionary of biblical language and tracts concerning biblical hermeneutics. There he developed his famous thesis, set forth previously in his disputation with Strigel at Weimar (1560), that original sin is not an *accidens* but *forma substantialis* of man, the intention of which was radically to exclude free will in man. On this ground he was bitterly opposed by Protestants as a Manichaean heretic.

Flacius had to leave Antwerp when the government, at the eve of revolution, forbade Protestant services. In 1567–73 he sought asylum both in Frankfurt and Strasbourg but in both cases was compelled to leave. Then the prioress of the White Ladies at Frankfurt harboured him and his family until his death there on March 11, 1575.

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FLAG, a word of Teutonic (Germanic) origin used from the 15th and 16th centuries in various northern European languages to signify a piece of cloth, bunting or similar material displaying the insignia of a community, an armed force, an office or an individual. A flag is usually, but not always, oblong and attached by one edge to a staff or halyard. The part nearest the staff is called the hoist, the outer part is called the fly. The length (also called the fly) usually exceeds the width (hoist). Flags of various forms and purpose are known as colours, standards, banners, ensigns, pendants (or pennants), pennons, guidons and burgees. Originally used mainly in warfare, flags were, and to some extent remain, insignia of leadership, serving for identification of friend and foe and as rallying points. They are now also extensively used for signaling, for decoration and for display. As the usefulness of a flag for purposes of identification depends on its blowing out freely in the wind, the material preferred is usually light and bears a device or pattern identical on both sides. Wording therefore tends to be excluded and the simpler patterns are favoured. Any colours or devices may be used, but European usage normally follows the practice of heraldry in discouraging the juxtaposition of "metal" and "metal" (*i.e.*, of yellow and white) or of colour and colour without "metal" interposed. The flag of the Vatican City state is an exception to this rule.

HISTORY

Origins.—The earliest insignia used in battle were not flags at all, and are usually described as standards. They are not to be confused with the later flags (serving the same purpose and carried by mounted military units) to which the term standard is now applied. The ancient standard consisted of some solid object fixed on a bracket at the top of a pole, sometimes with streamers attached. The object displayed was a sacred symbol; of the four standards carried before the kings of ancient Egypt, for example, one is claimed to have represented the king's placenta. Monuments dating from the reign of Rameses II show these sacred standards "as the actual agents of the enemies' discomforture." A similar standard is shown on an early tomb at Ur of the Chaldees; and there is abundant evidence of such standards being borne in Assyria from the 9th century B.C. They are shown as associated with such kings as Ashurnasirpal II (in 885 B.C.), Sargon and Sennacherib; and they were evidently used not only in battle but in hunting.

While these especially sacred emblems were carried before kings, other similar insignia were borne by military units and ships. An Assyrian statue of 671 B.C. shows a soldier with the standard of

his unit; and Egyptian ships are shown on pottery as bearing signs of the harpoon or fish, probably associated with their ports of origin. In some instances the streamers may have become more prominent than the standard itself, and a lance with a pennon is shown in Assyrian sculpture of 885–860 B.C.; but the standard in its solid form remained normal and was evidently transmitted via Crete to the Aegean. An occasional variant may have been the display (as in China) of the head of some discomfited enemy. This might be the origin of the Greek custom of bearing a helmet or other piece of armour on a spear point. The various Greek cities, however, had more distinctive signs, such as a sphinx or a Pegasus, and the Romans followed suit, using the effigies of gods, of generals or of animals (wolves, horses and bears). According to Pliny, it was G. Marius who, in his second consulship, ordered that the Roman legions should have only the eagle as standard. This eagle effigy was revived in France by Napoleon I and, later, in Fascist Italy. It has otherwise fallen into disuse.

The vexillum, or Roman cavalry flag, was nearer to a flag in the modern sense and is still used in ecclesiastical ceremony. It is described by Livy as a square piece of cloth fastened to a bar fixed crosswise on a spearhead. This description is confirmed by reference to Roman coins, medals and sculpture. The labarum, the imperial standard of the later Roman emperors, was of similar pattern but larger, of purple silk and embroidered in gold. The vexillum may have had special appeal for Christians because it was cruciform. It gained in importance from the time of Constantine's conversion and bore thereafter the monogram of Christ or some other religious emblem. Used in both Latin and Byzantine religious processions, the ecclesiastical banner has thus an unbroken continuity with ancient Rome. Its attachment to a horizontal bar makes it suitable for the display of elaborate embroidered scenes and figures, visible only from the one direction, a second motif being often depicted on the reverse side; and the foot of the banner often ends with a gold fringe coming to two or more points, which may be tasseled. This form of banner was also used in the middle ages on warlike expeditions, more particularly perhaps on those which had some religious significance. The banner bearing the device of St. Martin's hood, originally kept by the monks of the abbey of Marmoutier and used in battle by the counts of Anjou, was presumably of this pattern. It was said to have been taken into battle by Clovis in 507, and Charlemagne fought under it at the battle of Narbonne. It was used by the kings of France, but was replaced by the oriflamme of St. Denis, first taken into battle by Louis VI in 1124 and last seen on the battlefield at Agincourt in 1415. By one account the oriflamme would seem to have been a plain red square, but it is also said to have had three points with tassels of green silk. Similar in form may have been the banner entrusted to William the Conqueror by Pope Alexander II, and similar again the English standard which gave its name to the battle of the Standard in 1138. The latter, however, was a ship's mast on wheels and carried, as well as a silver pyx, three banners dedicated respectively to St. Peter of York, St. John of Beverley and St. Wilfrid of Ripon. A banner of this ecclesiastical pattern was known in the middle ages as a gonfalon or gonfanon; it was borne by the chief magistrates of certain Italian cities and also used at sea. Banners of this type are still sometimes hoisted on the masts which front the cathedral church of St. Mark at Venice.

Oriental Flags.—The examples so far given illustrate the use made in ancient and medieval times of insignia which, while serving the same purpose as flags, were essentially different in form. Flags recognizable as such were the invention, almost certainly, of the Indians or the Chinese. It is said that the founder of the Chou dynasty in China (*c.* 1122 B.C.) had a white flag carried before him; and it is known that in A.D. 660 a minor prince was punished for failing to lower his standard before his superior. Chinese flags had devices such as a red bird, a white tiger or a blue dragon. They were carried on chariots and planted upon the walls of captured cities. The royal flag had, however, all the attributes of kingship, being identified with the ruler himself and treated with a similar respect. It was thus a crime even to touch the flag-bearer. The fall of the flag meant defeat; and the king would rarely expose his flag and his person together, the flag being normally entrusted to a general.

Flags had equal importance in ancient India, being carried on chariots and elephants. The flag was the first object of attack in battle, and its fall would mean confusion if not defeat. Indian flags were often triangular in shape and scarlet or green in colour, with a figure embroidered in gold and a gold fringe. If these and the Chinese flags had a common origin in the standards of ancient Egypt and Assyria, they might have developed from the streamers attached to the pole. This possibility gains some likelihood from the fact that some Indian flagstaffs were surmounted by a figure similar to that displayed on the flag itself. Mogul royal insignia included, however, other things besides the flag, more especially yaks' tails and the state umbrella. Flags seem also to have been used, in India as in China, for signaling, and there is an instance of a white flag being used as a signal for a truce as early as A.D. 1542. Indian and Chinese usage spread to Burma, Siam and southeastern Asia. Flags with a background of white, yellow or black silk are mentioned, with devices (an elephant, a bull or a water hen, for example) embroidered on them in gold. A Siamese treatise on war gives the impression that the flags were unfurled as the march began.

Flags were probably transmitted to Europe by the Saracens. But Islam's prohibition of the use of any identifiable image as idolatrous influenced their design. They are often mentioned in the early history of Islam and may have been copied from India. But Islamic flags are greatly simplified and appear to have been plain black or white or red. Black was supposed to have been the colour of Mohammed's banner: the colour of vengeance. A black flag was used by the Abbasids in A.D. 746 (A.H. 129), the Omayyads and 'Alids choosing white by contrast and the Khawarij (Kharijites) red. A plain red flag is therefore retained by the sultanate of Muscat and Oman. Green was the colour of the Fatimid dynasty and eventually became the colour of Islam. In adopting the crescent sign, however, *c.* 1250, the Osmanli Turks were reverting to an Assyrian sacred symbol of the 9th century B.C. and probably of greater antiquity than that. The crescent moon, with or without an additional star or stars, has since become the accepted symbol of Islam. It has appeared, usually white, in the flags of Egypt, Turkey, Tunisia, Libya, Madagascar, Pakistan and some of the Malay states, against a background of green, red or black.

The Use of the Cross.—The use of the flag and the pennon was probably copied by the Europeans from their Saracen opponents during the third crusade (1189–92), or perhaps slightly earlier. It was the assembly, in one army, of knights from almost every nation in Christendom that necessitated their differentiation from the enemy and from one another. Heraldry first appeared in England in the first half of the 12th century, but was firmly established during the decade 1190–1200, influenced both by the crusade and by the adoption of closed helmets, which prevented the recognition of their wearers. Closely connected with heraldry was the adoption of the flag. Thus, the Knights of St. John adopted as their standard a white cross on a red field; this was confirmed to them by a papal bull of 1259 which enjoined them to wear surcoats of the same pattern. This wearing of some form of cross had considerable significance. In assuming it, the crusader at once proclaimed his vow and demanded the aid of all Christians toward its fulfillment. It partly superseded his own personal device—associated as that may have been with local quarrels and feuds—and marked him out as a man with a mission approved by the church. Once he arrived in the Holy Land, it showed on which side he was fighting and tended to show further, by the variation in its form, from what part of Christendom he came, so stimulating the beginnings of national consciousness. (Knights of the religious orders displayed no such local affinities.) The French adopted a scarlet flag with a white cross, the English and Germans a white flag with a scarlet cross. It is not clear to what extent other variants were adopted by other national groups; but it is known that the crusaders retained their uniform after their return to Europe and with it the "national" flag associated with their respective patron saints. This was certainly the case in England, where

the cross of St. George was firmly established in the 13th century. It contrasted with the flags used by the king and the nobility to symbolize more personal and local loyalties. It was not entirely peculiar to England and was known as the cross of St. George also in 13th-century Germany. The French cross in white on scarlet also remained in use and was revived on a national basis by Louis XI in 1479. In general, these flags rose or fell in esteem with the idea of nationalism which they symbolized. They were not so much in evidence in periods when the conflict was less between France and England than between Burgundy and Valois or between Lancaster and York.

Other national flags with the cross device either developed during the third and later crusades or were imitated by nations that had not been strongly represented in the Holy Land. Thus, the flag of Denmark (a white cross on a red field, called the *Danebrog*) was certainly used from 1308 and may date from 1219, the year indicated by tradition and well supported by probability. The Norwegian flag was similar, but the Swedish flag developed as a yellow cross on a blue field. The Swiss flag, a white cross on red, first appears in 1339 in a context that shows a significant identification of a national with a holy cause. The Scottish flag of St. Andrew, a diagonal white cross on a blue ground, is of uncertain but clearly medieval origin, and the same is true of the Irish flag of St. Patrick, with the cross borne diagonally red on white, and perhaps as old as the 12th century. Many European nations thus adopted and still use the cross in some form. At an international conference held at Geneva in 1864 representatives of 12 nations signed a treaty providing that hospitals, ambulances and medical personnel of all armed forces should bear a red cross on white, the Swiss flag with reversed colours. This has since remained the symbol of the International Red Cross organization.

Tricolour Flags.—The French Revolution began a new phase in flag design. The Revolutionary tricolour was to invade the rest of Europe and to spread by example to other parts of the world. But if the tricolour was revolutionary in intent, it was not wholly novel in design. Austria had a flag with horizontal stripes of red, white and red in 1200 or earlier; and a previous revolution, that of the Dutch against Spain, had left the Netherlands with a flag (from 1574) of orange, white and blue in horizontal stripes of equal width. Orange was gradually replaced by red in the 17th century, leaving the Dutch flag exactly as it is now, although the use of the orange colour was not actually prohibited until 1795. The tricolour thus stood for revolution, and it is important to remember, in this connection, that the revolutionary movement which transformed France did not wholly originate there, but derived something from the revolt of the Austrian Netherlands in 1787–89. This revolt centred at first in Brabant, where a tricolour in black, yellow and red vertical stripes, these being the Belgian colours, appeared as early as 1790. This gave the French revolutionaries a good precedent for hoisting their vertical tricolour, which also first appeared officially in 1790, with the red stripe in the hoist and the blue in the fly. In 1794 this order was reversed so as to have the blue in the hoist, the red in the fly and the white in the middle. It was eventually found more pleasing to the eye to vary the width of the stripes in the proportion of blue 30%, white 33% and red 37%. This French tricolour replaced the Bourbon device of the fleur-de-lis (used since 1589) and, with one short interruption from 1815–30, has remained the French flag ever since, being used for almost every purpose. From 1946 the merchant and naval flag remained unchanged but the stripes in the national flag were again of equal width. During the 19th and 20th centuries, as monarchies were replaced in most countries by republics, a tricolour was usually taken as the proper symbol of republicanism and even copied, perhaps largely for considerations of legibility and economy of manufacture, by countries still monarchical.

Other National Flags.—Flags not based on the cross, a combination of stars and stripes or the tricolour are either heraldic or oriental. The heraldic flags, embodying part or the whole of a coat of arms, include the flags of Portugal, Vatican City, San Marino and Albania. Oriental flags vary greatly in pattern: some, like that of Saudi Arabia, are open to criticism as being illegible at a distance; others, like that of Japan, are simple and effective.

Forms and Functions.—It has been shown that many of the flags of Christendom date from the period of the third crusade or have developed since by imitation. There were always certain countries whose flags were exceptions to this rule, Spain being one; but the use of flags was widespread, and the cross occurred in most of those that could be called national. But these flags were subdivided according to their shape and purpose into standards, banners, guidons, pennons and streamers. There were also many flags of a personal, family or local significance that were of a different, and usually more complex, pattern. Of the main types, the standard was the largest and intended, from its size, to be stationary. It marked the position of an individual before a battle, during a siege, throughout a ceremony or at a tournament. For the monarch it marked the palace, castle, saluting base, tent or ship where he was actually present. Standards were also used at first by the greater nobles, whose personal insignia they bore. They were originally long and tapering toward the fly, ending in two points. Banners were square or oblong and were borne in action (as the standard was not) before royal and noble warriors down to the rank of knight banneret. These again bore the personal or family device. The guidon, a word derived from the French *guyd-homme*, was similar to the standard but rounded in the fly or with two swallow tails, both rounded. Guidons were borne by leaders in battle who were of no more than knightly rank and so not entitled to display a banner. (In the British army guidons have thus come to be borne by dragoon regiments of cavalry. The household cavalry regiments and dragoon guards, by contrast, have standards; and the hussars and lancers have no flags at all.) The pennon, a small triangular flag, was carried by each knight on his lance. One purpose of the pennon was to obviate accidents in much the same way as does a red flag tied to a long pole or rod which extends beyond the tailboard of a truck. But the pennon served also to strike terror into the enemy and to denote rank. To create a knight banneret, the king or his representative might tear off the fly of the knight's pennon and so turn it into a small banner, which would serve at least until a proper banner was made. The streamer (now known as a pendant or pennant) was a long, tapering flag from 20 to 60 yd. long and about 8 yd. broad at the hoist, ending in two points. Because of its shape almost its only use was at sea. In the 15th century it was flown from a pole rising above the fighting top, and later from the yardarm or topmast. It came eventually to distinguish the warship from the merchantman and, more specifically, the warship in commission from the warship laid up in harbour. The pennant is now white in the Royal Navy, with a St. George's cross near the hoist, and denotes a warship in commission, being hoisted when the captain assumes his command.

As the oblong flag or banner might be used in a variety of ways, it came to have different names according to its exact use. In Great Britain these names included ensign (*q.v.*), jack and colour, all of which are still current.

BRITISH AND COMMONWEALTH FLAGS

The first of these is the royal standard, about the exact origin of which there is some doubt. The three lions of England would seem, however, to date from the period when other flags and heraldic devices first appeared; that is, the end of the 12th century. Originally described as "leopards," they seem to have been used as a personal device by Richard I, *c.* 1195. They appeared on the standards of John, Henry III, Edward I and Edward II, and at first of Edward III. But this last king claimed in 1340 to be king of France as well as of England, and therefore quartered the English lions with the French lilies, giving the lilies the place of honour. The French lilies of that period were scattered over the whole field as if taken from a piece of patterned cloth, with incomplete lilies round the edge. This type of royal standard was used with only temporary variation until 1405, when Henry IV followed the French procedure of 1365 and reduced the lilies to three, two above and one below. The standard thus revised was used without modification until 1603, when James VI of Scotland came to the English throne as James I. James's standard displayed the quartered

arms of France and England in the first and fourth quarters, the Scottish lion (in its border, or tressure) in the second quarter and the Irish harp in the third. This standard remained in use until the reign of William III, when the arms of Nassau were embodied. Fresh complications were introduced by George I and George II, who placed the arms of Hanover in the fourth quarter. After the French Revolution, however, by the treaty of Amiens in 1802, George III renounced the title of king of France and removed the lilies from his standard. The arms of Hanover, borne in pretense over those of England, Scotland and Ireland, were dropped in 1837, and the royal standard thereafter appeared in its present form, with the lions of England in the first and fourth quarters, the lion of Scotland in the second and the harp of Ireland in the third. The royal standard in one or other of its forms has always been displayed by the heads of state in England and Great Britain and, generally speaking, by them alone. To this rule, however, there are two exceptions. In the first place, the royal standard went out of use during the period of the Commonwealth, its place being taken by a special flag devised by the protector, Oliver Cromwell, for himself—the cross of St. George in the first and fourth quarters, the cross of St. Andrew in the second and the Irish harp in the third, with his own arms in pretense. In the second place, the royal standard used to be displayed by the lord high admiral when in command of the fleet and was thus used by Lord Howard of Effingham in 1588, by the duke of Buckingham in the reign of Charles I and by the duke of York during the Dutch Wars. This usage died out with the office of lord high admiral itself, the royal standard now being flown only by the sovereign.

The union flag of Great Britain appeared in its earliest form at the accession of James I. It displayed the red cross of England superimposed on the white cross of Scotland, with the blue field of the latter. As red on blue is not permissible, the red cross had to be bordered with white, its own correct field. It is clear from James I's proclamation that this flag was primarily intended for use at sea, to be hoisted on the maintop. Ships from English ports would hoist St. George's cross at the foretop while those from Scottish ports would hoist St. Andrew's flag. Charles I, however, in 1634 restricted the use of the union flag at sea to the Royal Navy. This usage was interrupted during the Commonwealth period and complicated for a time under Cromwell by the addition of an Irish harp, but the flag was resumed in its original form on the restoration of Charles II in 1660. So the old flag, the Great Union, continued in use until 1800, the date of the legislative union with Ireland. The need then was to incorporate the cross of St. Patrick (diagonal, red on white) with the existing union flag. To combine the three crosses without losing their identity was no easy task. Each had to be distinct and each had to retain the fimbriation, or bordering, which denoted its original ground. In the first union flag, the red cross of St. George with the white fimbriation that represented the original white field was simply imposed upon the white saltire of St. Andrew with its blue field. However, to place the red saltire of St. Patrick on the white saltire of St. Andrew would have been to obliterate the latter; nor would the red saltire have its proper bordering denoting its original white field. Even were the red saltire narrowed in width, the portion of the white saltire that would appear would be not the St. Andrew's saltire but only the fimbriation appertaining to the saltire of St. Patrick. The difficulty was resolved by making the white broader on one side of the red than on the other. In fact, the continuity of direction of the arms of the red St. Patrick's saltire was broken by portions of it being removed from the centre of the oblique points that form the St. Andrew's saltire. Thus the Irish and the Scottish saltires can be distinguished easily from each other, while the Irish (red) saltire has its proper white fimbriation.

The union flag, in both its old and new forms, is used in two ways. It can be flown by itself or it can be incorporated into another flag (an ensign or military colour, for example). When it is flown by itself, its use afloat is very different from its use ashore. At sea when hoisted at the mainmast of a king's ship, it is the flag of an admiral of the fleet. Hoisted at the jack staff in the bows of a ship, it indicates a man-of-war and is properly called the union jack (a jack being any flag flown from the jack staff). The union flag must be used at sea in no other way, and its misuse can involve, for the offender, a heavy fine. On shore it is flown over fortresses and military headquarters, but is also used indiscriminately by all British subjects for merely decorative purposes. They have come to call it the union jack in all circumstances; and this usage, inaccurate though it is, would now be difficult to change.

Ensigns.—The ensign is the flag flown at a ship's stern. The word "ensign" means "insignia," and an ensign was originally the banner of the highest-ranking person on board a medieval ship equipped for war. It is thus strictly comparable with the ensign of a company of infantry formerly borne by a young officer, the ensign-bearer or simply ensign. The conversion of a sailing ship for warlike purposes involved the construction of a wooden castle in bows and stern, and it was the sterncastle that housed the steering gear. The senior military officer on board needed to be near the helmsman, and his banner would be flown near his own station in battle; that is, in the stern. By Tudor times the national ensign was tending to supersede personal insignia as part of a general process which might be called the nationalization of war: the process by which the hereditary military ranks of earl, baron, banneret and knight were replaced by the commissioned ranks of general, captain, lieutenant and ensign. Pictures of English ships in the reign of Henry VIII show the St. George's cross at all mastheads, and also on the ensign poles. After 1603 the union flag seems to have been as universally used, but with the streamer or pennant of the older St. George's pattern. The "Prince Royal" is shown wearing these flags in 1610, with the royal standard at the main topgallant masthead to show the king's presence on board.

Even in the Elizabethan period it was the custom to divide a fleet (like an army) into three divisions; the centre, the van and the rear. These came to be known, respectively, as the red, the white and the blue squadrons. They were distinguished by ensigns of the appropriate colour with the St. George's cross in their upper canton. An ensign of this pattern is shown in a picture of the "Sovereign of the Seas" in 1637, showing that the canton with the union flag pattern did not immediately replace the St. George's cross. The Royal Navy was reorganized during the second and third Dutch Wars, after 1660. The main fleet of about 100 ships, with merchantmen now excluded from battle, continued at this period to fight in a strict formation first introduced *c.* 1652. Each of the three main squadrons was commanded by an admiral and subdivided into three divisions; a centre division directly commanded by the admiral, a van division commanded by a vice-admiral and a rear division commanded by a rear admiral. As the admiral of the red squadron was also in supreme command (and might in fact be the lord high admiral in person), he flew the union flag at the main. He was not designated admiral of the red squadron until 1805. The flag officers (or flagmen as they were sometimes called) numbered nine in all, with the admiral of the fleet as the senior and the rear admiral of the blue squadron as the junior of all. All the ships flew their appropriate ensign but changed it on transfer to a different squadron. When the legislative union of England and Scotland took place in 1707, the cross of St. George was replaced in the ensign by the union flag pattern. At the same time merchantmen were instructed to fly the red ensign, being later forbidden to use either of the other ensigns or the pennant or the jack. In the 18th century the concentration of the entire battle fleet under one flag officer became unusual. Smaller fleets, of 30 ships at most, could be commanded as a single squadron without rigid subdivision, and it became the custom for all ships to fly the ensign of the commander in chief. The system of red and white and blue became a mere system of seniority among flag officers, whose number now far exceeded the original nine. An admiral of the blue squadron flew his flag at the main topgallant mast and all his ships, the flagship included, bore the blue ensign. A vice-admiral of the red flew his flag at the fore topgallant mast, his ships hoisting the red ensign. A rear admiral of the white flew his flag at the mizzen, his ships following suit with white ensigns. The system was unsatisfactory in that the ensigns varied in colour without differing much in significance. They were altered in 1801, insofar as the present union flag took the place of

the old; but otherwise remained in simultaneous use in the fighting fleet until 1864, when the Royal Navy adopted the white ensign as its own (influenced, perhaps, by the fact that Lord Nelson had been vice-admiral of the white when he died, so that all the ships at Trafalgar had flown that ensign during the battle). The red ensign was now restricted to the mercantile marine, and the blue ensign was assigned to the royal naval reserve and to ships not of the Royal Navy but nevertheless in the public service.

The white ensign is therefore essentially the flag of the Royal Navy. It should not be flown anywhere or on any occasion except by a ship (or shore establishment) of the Royal Navy, with but one exception: by a grant of William IV dating from 1829, vessels belonging to the Royal Yacht squadron, the chief of all yacht clubs, are allowed to fly the white ensign. From 1821 to 1829, ships of this squadron flew the red ensign as that of highest dignity; but as that ensign was also used by merchant ships, they obtained the grant of the white as being more distinctive. Some few other yacht clubs flew the white ensign until 1842, when the privilege was withdrawn by an admiralty minute. By some oversight this order was not conveyed to the Royal Western club of Ireland, whose ships flew the white ensign until stopped in 1858. Since that date the Royal Yacht squadron alone has had the privilege. Any vessel of any sort flying the white ensign, or pennant, of the Royal Navy is committing a grave offense; and the ship can be boarded by any officer of Her Majesty's service, the colours seized, the vessel reported to the authorities and a penalty inflicted on the owners or the captain or both. The penalty incurred is £500 fine for each offense, as laid down in section 73 of the Merchant Shipping act, 1894.

The blue ensign is the flag of the public service other than the Royal Navy and is also the flag of the royal naval reserve. It is flown in addition by certain authorized vessels of the British mercantile marine, the conditions governing this privilege being that the captain and a certain specified portion of the officers and crew shall belong to the ranks of the royal naval reserve. When the blue ensign is flown by ships belonging to British government offices the seal or badge of the office is displayed in the fly: for example, hired transports fly it with the yellow anchor in the fly; the marine department of the board of trade has in the fly the device of a ship under sail; the telegraph branch of the post office shows in the fly a device representing Father Time with his hourglass shattered by lightning; the ordnance department displays upon the fly a shield with a cannon and cannon balls upon it. Certain yacht clubs also are authorized by special admiralty warrant to fly the blue ensign. Some of these display it plain; others show in the fly the distinctive badge of the club. Consuls general, consuls and consular agents may also fly the blue ensign, the distinguishing badge in their case being the royal arms.

The Royal Air Force uses, as its distinctive flag, an ensign of the colour known as R.A.F. blue with the union device in the upper canton and the R.A.F. aircraft distinguishing mark (a target of red, white and blue, with red in the centre and blue for the outer ring) in the fly. This ensign is hoisted at R.A.F. establishments and is also seen afloat on the launches of the Air-Sea Rescue service. Another ensign variant is flown by vessels belonging to the war department and navigated by men of the British army service corps fleet.

Until the later years of the 18th century the ensign was always flown from a flagpole in the stern of the ship called the ensign staff. As the old type of latcen mizzen sail came to be replaced, however, by the new fore-and-aft rigged mizzen, the ensign staff was found to be in the way of the new spanker boom and was therefore removed. The ensign was henceforward hoisted on a halyard that led to the spanker gaff. This arrangement has since been faithfully observed in shore establishments of the Royal Navy and also by the Royal Air Force, the flagpole being a miniature version of a mizzenmast complete with gaff. The hoisting and lowering of the ensign is usually made a ceremony each morning and night, with the appropriate bugle calls and with all present at attention.

Commonwealth Flags.—Various countries of the Commonwealth of Nations have national flags which are based upon the British ensigns or which otherwise incorporate the union flag pattern. Canada flies as its national flag a red ensign with the arms of the dominion in the fly, the red ensign being similarly used as the merchant flag. Australia uses the blue ensign with the addition of six white stars of which five are arranged as in the constellation of the Southern Cross. New Zealand has the blue ensign, but with four red stars outlined in white, also suggesting the Southern Cross as a symbol of the Antipodes. The colonies in the commonwealth mostly use the union flag with a badge or shield placed in a white disk covering the centre. Their ships mostly use the ordinary red ensign. Jamaica, which became an independent nation within the commonwealth in Aug. 1962, adopted a gold saltire, green triangles between upper and lower limbs and black between left and right. (For descriptions of the flags of the Asian countries of the Commonwealth of Nations, see *Flags of Other Countries*, below.)

The Admiralty and Trinity House.—There are two other British sea flags that are worthy of brief notice. These are the admiralty flag and the flag of the master of Trinity house. The admiralty flag is a plain red flag with a clear anchor in the centre in yellow. In a sense it is a national flag, for the sovereign hoists it when afloat in conjunction with the royal standard and the union jack. It would appear to have been first used by James, duke of York, as lord high admiral, who flew it when the sovereign was afloat and had the royal standard flying in another ship. When a board of commissioners was appointed to execute the office of lord high admiral, this was the flag adopted, and in 1691 the admiralty ordered the navy board, then a subordinate department, "requiring and directing it to cause a fitting red silk flag, with the anchor and cable therein, to be provided against Tuesday morning next, for the barge belonging to this board." In 1725, presumably to make the device more artistic, the cable was twisted round the stock of the anchor. It was thus made into a foul anchor, the thing that a sailor most hates; and this despite the fact that the first lord at the time, the earl of Berkeley, was himself a sailor. The anchor retained its unseamanlike appearance until cleared in 1815, and even to this day the buttons of the naval uniform bear a foul anchor. The anchor flag is solely the emblem of an administrative board; it does not indicate the executive or combatant functions that are vested in those entitled to the royal standard, the union or an admiral's flag. But on two occasions it has been made use of as an executive flag. In 1719 the earl of Berkeley, who at the time was not only first lord of the admiralty but also vice-admiral of England, obtained the special permission of George I to hoist it at the main instead of the union flag; and in 1869, when H. C. E. Childers, then first lord, accompanied by some members of his board, went on board the "Agincourt," he hoisted the admiralty flag and took command of the combined Mediterranean and channel squadrons, thus superseding the flags of the two officers then in command of these squadrons. When the admiralty flag is flown by the sovereign it is hoisted at the fore, his own standard being of course at the main and the union at the mizzen.

The flag of the master of Trinity house is the red cross of St. George on its white ground, but with an ancient ship on the waves in each quarter; in the centre is a shield with a precisely similar device surmounted by a lion.

The sign of a British admiral's command afloat is always the same; *i.e.*, St. George's cross. Formerly it was borne on the main, the fore or the mizzen, according to whether the officer to whom it pertained was admiral, vice-admiral or rear admiral; but, as ironclads superseded wooden ships and a single pole mast took the place of the old three masts, a different method of indicating rank was necessitated. Today the flag of an admiral is a square one, the plain St. George cross. When flown by a vice-admiral, it bears a red ball on the white ground in the upper canton next to the staff; when flown by a rear admiral it has a red ball in both the upper and lower cantons. As most modern flagships have two masts, the admiral's flag is hoisted at the one which has no masthead semaphore. The admiral's flag is always a square one, but that of a commodore is a broad white pennant with the St. George cross. If the commodore is of the first class, the flag is

AFGHANISTAN

ALBANIA

ALGERIA

ANDORRA

ARGENTINA

AUSTRALIA

AUSTRIA

BAHRAIN

BELGIUM

BHUTAN

BOLIVIA

BRAZIL

BULGARIA

BURMA

BURUNDI

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF NATIONS

FLAG

CAMBODIA

CAMEROON

CANADA

CENTRAL AFRICAN REPUBLIC

CEYLON

CHAD

CHILE

CHINA, REPUBLIC OF (FORMOSA)

CHINA, PEOPLE'S REPUBLIC OF

COLOMBIA

CONGO, REPUBLIC OF (BRAZZAVILLE)

CONGO, REPUBLIC OF THE (LEOPOLDVILLE)

COSTA RICA

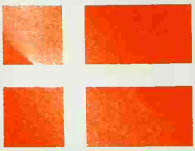
CUBA

CYPRUS

DRAWN BY GEORGE AND [illegible]

CZECHOSLOVAKIA

DAHOMEY



DENMARK

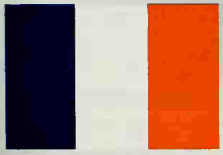
DOMINICAN REPUBLIC

ECUADOR

EL SALVADOR

ETHIOPIA

FINLAND



FRANCE

GABON

GAMBIA

GERMANY, FEDERAL REPUBLIC OF (WEST)

GERMANY, DEMOCRATIC REPUBLIC OF (EAST)

GHANA

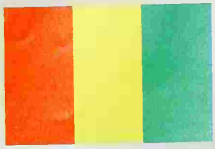
GREECE

GUATEMALA

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF NATIONS

FLAG



GUINEA

HAITI

HONDURAS

HUNGARY

ICELAND

INDIA

INDONESIA

IRAN

IRAQ

IRELAND (EIRE)

ISRAEL

ITALY

IVORY COAST

JAMAICA

DRAWN BY GEORGE ARM[illegible]

JAPAN

JORDAN

KENYA

KOREA, REPUBLIC OF (SOUTH)

KOREA, DEMOCRATIC PEOPLE'S REPUBLIC OF (NORTH)

KUWAIT

LAOS

LEBANON

LIBERIA

LIBYA

LIECHTENSTEIN

LUXEMBOURG

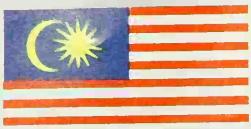
MALAWI

MALAGASY REPUBLIC

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

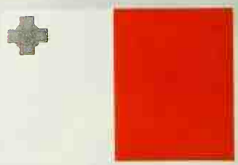
FLAGS OF NATIONS

FLAG



MALAYSIA

MALI



MALTA

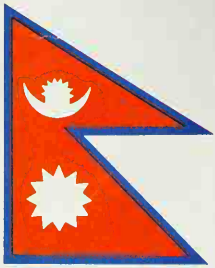
MAURITANIA

MEXICO

MONACO

MONGOLIA

MOROCCO



NEPAL

NETHERLANDS

NEW ZEALAND

NICARAGUA

NIGER

NIGERIA

NORWAY

DRAWN BY GEORGE ARM

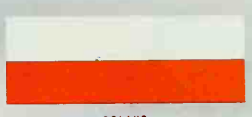
PAKISTAN

PANAMA

PARAGUAY

PERU

PHILIPPINES



POLAND

PORTUGAL

QATAR

RUMANIA

RWANDA

SAN MARINO

SAUDI ARABIA

SENEGAL

SIERRA LEONE

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF NATIONS

FLAG

SOMALI REPUBLIC

SOUTH AFRICA

SOUTH ARABIA, FEDERATION OF

SPAIN

SUDAN

SWEDEN

SWITZERLAND

SYRIA

TANZANIA

THAILAND

TOGO

TONGA

TRINIDAD

TUNISIA

DRAWN BY GEORGE ARMSTRONG AND [illegible]

TURKEY

UGANDA

UNION OF SOVIET SOCIALIST REPUBLICS

UNITED ARAB REPUBLIC

UNITED NATIONS

UPPER VOLTA

URUGUAY

VATICAN (PAPAL STATE)

VENEZUELA

VIETNAM, DEMOCRATIC PEOPLE'S REPUBLIC OF (NORTH)

VIETNAM, REPUBLIC OF (SOUTH)

WESTERN SAMOA

YEMEN

YUGOSLAVIA

ZAMBIA

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF NATIONS

FLAG

VIKING FLAG (A.D. 1000)

FLAG OF SPAIN (1492)

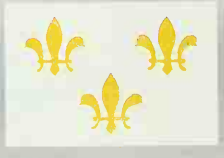
BANNER OF COLUMBUS (1492)

FLAG OF CHAMPLAIN

FLAG OF JOHN CABOT (1497)

FLAG OF HENRY HUDSON (1609)

ANDROS FLAG



BOURBON FLAG OF FRANCE

BRITISH RED ENSIGN (METEOR FLAG)

LIBERTY TREE FLAG (1775)

GADSDEN FLAG (1775)

CONTINENTAL FLAG (1775-77)

PINE TREE FLAG (1775)
(FIRST NAVAL ENSIGN)

FIRST NAVY JACK (1775)

FLAG OF GREEN MOUNTAIN BOYS (1775)

DRAWN BY GEORGE [illegible]

FLAGS IN UNITED STATES HISTORY

GRAND UNION FLAG (1776)

BENNINGTON FLAG (1777)

NORTH CAROLINA MILITIA FLAG (1781)

FIRST NATIONAL FLAG (1777-1795)

NATIONAL FLAG (1795-1818)

NATIONAL FLAG (1818)

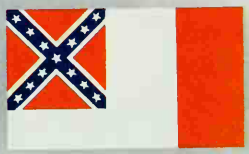
ALAMO FLAG

NATIONAL FLAG (MEXICAN WAR-1846)

NATIONAL FLAG (APRIL 12, 1861)

"STARS AND BARS" OF THE CONFEDERACY (1861)

BATTLE FLAG OF THE CONFEDERACY



LAST CONFEDERATE FLAG (1865)

NATIONAL FLAG (1912-1959)

NATIONAL FLAG (1959-1960)

NATIONAL FLAG (FROM JULY 4, 1960)

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS IN UNITED STATES HISTORY

FLAG

ALABAMA

ALASKA

ARIZONA

ARKANSAS

CALIFORNIA

COLORADO

CONNECTICUT

DELAWARE

FLORIDA

GEORGIA

HAWAII

IDAHO

INDIANA

ILLINOIS

DRAWN BY GEORGE ARMITAGE AND ENGRAVED BY A. BRITANNICA

FLAGS OF THE STATES OF THE UNITED STATES

IOWA

KANSAS

KENTUCKY

LOUISIANA

MAINE

MARYLAND

MASSACHUSETTS

MICHIGAN

MINNESOTA

MISSISSIPPI

MISSOURI

MONTANA

NEBRASKA

NEVADA

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF THE STATES OF THE UNITED STATES

FLAG

NEW HAMPSHIRE

NEW JERSEY

NEW YORK

NEW MEXICO

NORTH CAROLINA

OHIO

NORTH DAKOTA

OKLAHOMA

OREGON

PENNSYLVANIA

RHODE ISLAND

SOUTH CAROLINA

SOUTH DAKOTA

TENNESSEE

DRAWN BY GEORGE ARM.

FLAGS OF THE STATES OF THE UNITED STATES

TEXAS

UTAH

VERMONT

VIRGINIA

WASHINGTON

WEST VIRGINIA

WISCONSIN

WYOMING

DISTRICT OF COLUMBIA

PUERTO RICO

VIRGIN ISLANDS

AMERICAN SAMOA

GUAM

DRAWN BY GEORGE ARMSTRONG AND ENCYCLOPÆDIA BRITANNICA

FLAGS OF THE STATES OF THE UNITED STATES AND ASSOCIATED AREAS

FLAG

CROSS OF ST. GEORGE
(ENGLAND-12TH)

CROSS OF ST. ANDREW
(SCOTLAND-EIGHTH CENTURY)

GRAND UNION FLAG (1606)

"UNION JACK" (SINCE 1801)

CROSS OF ST. PATRICK
(IRELAND-FIFTH CENTURY)

EVOLUTION OF THE UNION JACK

RED CROSS

RED CRESCENT

CHINA, REPUBLIC (1912)

AUSTRIA-HUNGARY, ENSIGN (1869-1923)

ITALY (1861-1944)

UNITED EUROPE FLAG
(COUNCIL OF EUROPE)

GERMANY, WAR FLAG (1871-1918)

GERMANY, SWASTIKA (1935-1945)

JAPAN ENSIGN

DRAWN BY GEORGE ARMITAGE FOR ENCYCLOPAEDIA BRITANNICA

HISTORIC FLAGS OF THE GENEVA CONVENTION AND THE 19TH AND 20TH CENTURIES

plain; if of the second class, the flag has a red ball in the upper canton next to the staff. The same system of differentiating rank prevails in most navies, though very often a star takes the place of the ball. In some cases the indications of rank are differently shown; for instance, in the Japanese navy the distinction is made by a line of colour on the upper or lower edges of the flag.

(C. N. P.)

FLAGS OF THE UNITED STATES

The first flag flown in the British colonies in America was a square of white bunting or silk adorned with a large red cross of St. George, the arms of which extended to its full length and breadth. It was carried by John Cabot when he discovered the North American continent in 1497, and the ships that brought the colonists to Jamestown, Va., in 1607, and to Plymouth, Mass., in 1620, displayed it from the foretop as the English flag along with the union flag at the maintop.

The Puritans of New England objected to the cross and in 1634 John Endecott, who was to become governor of Massachusetts ten years later, cut part of the cross from the flag at Salem. Formal complaint was entered that the flag had been defaced by Endecott, and it was charged that the mutilation might be construed as an act of rebellion against England. When the case was tried, it was testified that the mutilation had been done not as an act of disloyalty but from the conscientious conviction that, as the cross had been given to England by the pope, it was a relic of Antichrist and that to allow it to remain was an act of idolatry. Endecott was found guilty of "a great offence" for which he was worthy of admonition, and he was barred from holding public office for a year.

When Sir Edmund Andros was commissioned as governor of New England in 1686, he designed a flag showing the cross of St. George on a white ground with the monogram "J. R." signifying "Jacobus Rex" in the centre of the cross surmounted by a crown. New England flags from *c.* 1700 to the end of the colonial period often displayed a tree, usually thought to be a pine but sometimes described as an oak.

Banners of many different designs were used by the colonies. In the early days of the Revolution each state adopted a flag of its own. That of Massachusetts bore a pine tree. South Carolina had a naval flag of red and blue stripes adorned with a rattlesnake (although the official state flag was blue with a white crescent and palmetto). The rattlesnake with 13 rattles was a common decoration, usually accompanied by the inscription, "Don't tread on me." The snake and the motto appeared on the banner of John Proctor's battalion raised in Westmoreland county, Pa., and was carried by this battalion in the American Revolution. The New York flag was white with a black beaver on it, and the Rhode Island flag also was white adorned with a blue anchor and with 13 white stars in its blue canton. The colours carried by different regiments differed with the taste of their commanders.

The first flag containing the stars of which there is any record was hoisted in 1775 in the armed schooner "Lee," captain, John Manley of Massachusetts. The flag was white with a blue canton containing 13 five-pointed stars. In the centre of the flag was a blue anchor at the top of which was a scroll bearing the word "Hope." Virtually this was Rhode Island's flag.

The importance of a flag for the ships which congress had ordered to be outfitted in 1775 was recognized; a letter from Col. Joseph Reed, Washington's military secretary, dated Oct. 20, 1775, recommended that a flag be adopted "by which our vessels may know one another" and suggested the pine tree flag, then in use on floating batteries around Boston. Primarily, flags were designed for naval ships. Differing from various regimental banners carried by individual units, the Stars and Stripes was not carried by any U.S. army land forces until 1834 (by the artillery). It was not carried as the national colour by the infantry until 1841, and was not authorized as a cavalry standard until 1887 and not carried until 1895. In the navy the Stars and Stripes is called the ensign.

On Jan. 1, 1776, the day the new continental army "came into being," to use Washington's own words, a new flag was displayed on Prospect hill, in the American lines besieging Boston. It had 13 red and white stripes and the British union jack, with its crosses of St. George and St. Andrew, on a canton. This showed loyalty to the crown, as the colonists were not then planning independence. This flag, which closely resembled that flown by the British East India company, was merely the British red ensign, modified by placing six horizontal white stripes on the red field. It was known contemporaneously as the continental flag or congress colours, in later years as the Grand or Great Union or Cambridge flag.

This flag was flown from the ships of the new continental navy when it sailed from Philadelphia three days later. As that interval of time was too limited for information to have arrived from Boston, it is evident that some prior arrangement had been made. That this was the work of a committee of congress that conferred with Washington in Oct. 1775 has been suggested, but this is unlikely as there is no mention of it in the report of the committee.

The continental flag continued to be used even after the Declaration of Independence had made the crosses of England and Scotland inappropriate. Congress even tacitly approved it in the following September by directing that it be used on privateers. That the inappropriateness was recognized is shown by a letter written by William Richards, a navy quartermaster, in Oct. 1776, complaining of the lack of a suitable flag and that one could not be obtained until a design was fixed, so the navy continued to use the continental flag.

It was not until June 14, 1777, almost a year after the adoption of the Declaration of Independence, that the continental congress adopted a design for the national flag. It resolved that "The flag of the United States shall be thirteen stripes, alternate red and white, with a union of thirteen stars of white on a blue field, representing a new constellation." A comparison of this design with that of the continental flag shows that the only change was a union of stars to replace the union of the crosses of England and Scotland, using the same blue field. Hence the Stars and Stripes evolved in two stages from the British red ensign.

Although the 13 stars are usually pictured as being arranged in a circle, no rule had been made and there was thus no uniformity. Some flags were made with 12 stars in a circle and 1 in the centre, others with three horizontal rows of 4, 5 and 4. In others the stars were arranged as if they had been placed on the arms of the combined crosses of St. George and St. Andrew.

The first record of the Grand Union flag being hoisted in a naval ship is that of Lieut. John Paul Jones on board the "Alfred," at which time he wrote: "I had the honor to hoist with my own hands the flag of Freedom, the first time it was displayed on the Delaware." Although his appointment was dated Dec. 22, 1775, the squadron did not sail until Feb. 17, 1776. That Jones hoisted the Stars and Stripes in the "Ranger" July 4, 1777, is in error, for he then had not taken command, and there can be found no printed official announcement of the new flag (adopted June 14, 1777) until Sept. 3, 1777. Later, however, Jones flew the Stars and Stripes in both the "Ranger" and the "Bon Homme Richard," and on Feb. 14, 1778, received the first foreign salute to the new flag in Quiberon bay, France.

The belief that the flag raised at Ft. Stanwix (Ft. Schuyler) near what is now Rome, N.Y., was the first Stars and Stripes in battle is incorrect, because that flag had no stars. William Colbreath, a soldier at the fort, wrote in his diary (still extant): "Aug. 3d. Early this Morning a Continental Flagg made by the Officers of Col. Gansevoorts Regiment was hoisted and a Cannon Levelled at the Enemies Camp was fired on the Occasion."

Col. Marinus Willett's report, Aug. 21, 1777, to Gov. Jonathan Trumbull, reads: "Aug. 8 brought off 5 of the enemies' colours and displayed them on the flagstaff of the impromptu made continental flag." John McGraw, also a soldier there, carved on his powder horn a plan of the fort with a continental flag of the Grand Union design flying.

The first Stars and Stripes flown in battle by land forces was probably the famous 76 flag (still preserved in the North Bennington, Vt., museum), its outer stripes white, flown in the battle of Bennington, Aug. 16, 1777.

The theory that Washington's coat of arms, which contained mullets and bars (similar to stars and stripes), suggested the new flag has no supporting evidence, nor was a suggestion from such a source necessary as there were several striped flags in existence at the time, and mention has already been made of flags in America with stars.

Later investigators leaned to the conclusion that the design was drawn by Francis Hopkinson, a member of the naval committee and a signer of the Declaration of Independence. He was an artist, and there are extant bills which he presented to congress for artistic work.

The first public assertion that Elizabeth, or Betsy, Ross made the first Stars and Stripes appeared in a paper read before the historical society of Pennsylvania on March 14, 1870, by William J. Canby, a grandson of Betsy Ross. In 1857 his aunt, a daughter of Betsy by her third husband, asked him to write from her dictation the story of the making of the flag she had heard her mother tell many times. The story was that in June 1776, before the adoption of the Declaration of Independence, General Washington, Robert Morris and George Ross, representing a committee of the congress, came to her upholstery shop in Arch street, Philadelphia, Pa., showed her a rough draft of a flag with stars and stripes and asked if she could make such a flag. She did, and it was taken to the state house, where the congress was in session, and shown to the members; they adopted it as the flag of the United States and ordered her to make many of them.

This story was long regarded as authentic, but nowhere can there be found any record of the appointment of a committee to design a flag in June 1776 and no record of the adoption of any flag by the congress prior to June a year later. The only record of any flags made by Betsy Ross is at Harrisburg, Pa., a voucher dated May 29, 1777, for £14 and some shillings for making flags for the Pennsylvania navy.

There was no change in the number of stars or stripes from the adoption of the design until Jan. 13, 1794, when congress, in recognition of the admission of Vermont and Kentucky, voted to add two stripes and two stars, one for each of the new states, to take effect May 1, 1795. This new flag, with 15 stripes and 15 stars, remained unchanged until 1818, when there were 20 states in the union, Tennessee, Ohio, Louisiana, Indiana and Mississippi having been admitted, and so congress on April 4 of that year voted that the flag should contain 13 alternate red and white stripes, representing the original 13 states, and that a star for each new state should be added on the July 4 following its admission to the union.

Display of the U.S. Flag.—The national flag of the United States has 13 horizontal stripes, 7 red and 6 white, with a red stripe at the top and bottom, and a union or canton of blue in the upper quarter next to the staff and extending down to the bottom of the fourth red stripe. As of July 4, 1960, the union contained 50 five-pointed stars, arranged in nine horizontal rows of, alternately, six and five stars. This arrangement was fixed by the executive order of Pres. Dwight D. Eisenhower of Aug. 21, 1959, which also fixed the proportions of the flag: hoist (width) of the flag, 1; fly (length) of the flag, 1.9; hoist (width) of the union, $\frac{7}{13}$; fly (length) of the union, 0.76; width of each stripe, $\frac{1}{13}$; diameter of each star, .0616.

U.S. military forces display the flag during daylight hours. Aboard navy ships there are occasions when the flag is also displayed at other times. When a ship is at anchor, the ensign is normally displayed on the flagstaff at the stern. When the ship is under way, the ensign is usually hoisted to the gaff, a spar on the aftermast. Whenever the flag, or ensign, is hoisted or lowered, the national anthem is played. On Memorial day the army half-staffs the flag only until noon. On that day the navy's ensign is half-staffed only during the few minutes of firing the salute.

Although the flag is normally flown only during daylight hours specific authority is given to fly the flag day and night in Baltimore, Md., over Ft. McHenry, whose flag inspired Francis Scott Key to write the "Star Spangled Banner," and over Flag House, where the famous colour was made. Other locations where, by custom, the flag is flown 24 hours a day include the national capitol; the grave of Francis Scott Key, Frederick, Md.; Municipal War Memorial, Worcester, Mass.; Pike's Peak, Colo.; and Mt. Suribachi on the island of Iwo Jima in the Pacific ocean.

Nearly every state has its own criminal codes prohibiting misuse of the flag, or any pictures of it, in connection with advertising. Most of the states direct that the flag shall be displayed at all schoolhouses while the school is in session and also that pupils shall pledge allegiance to the flag. Some states forbid the display of any red or black flag along with the national flag in any procession or public hall.

Lack of uniformity in the matter of displaying the flag by civilians led to the adoption of a flag code. The National Americanism committee of the American Legion called a conference in Washington, Flag day, June 14, 1923, and delegates from 72 patriotic organizations there assembled adopted a universal flag code. Although that code lacked any federal authority, it was generally followed. When World War II came, congress was asked to enact a federal flag code. This was done, and on June 22, 1942, the president signed the joint resolution, known as public law 623. The first section declares the codification of existing rules and customs for the guidance of civilians not required to conform to the regulations issued by the different official branches of the government. The remainder of the law, as subsequently amended, consists of the following:

SEC. 2. (a) It is the universal custom to display the flag only from sunrise to sunset on buildings and on stationary flagstaffs in the open. However, the flag may be displayed at night upon special occasions when it is desired to produce a patriotic effect.

(b) The flag should be hoisted briskly and lowered ceremoniously.

(c) The flag should not be displayed on days when the weather is inclement.

(d) The flag should be displayed on all days when the weather permits, especially on New Year's Day, January 1; Inauguration Day, January 20; Lincoln's Birthday, February 12; Washington's Birthday, February 22; Army Day,[1] April 6; Easter Sunday (variable); Mother's Day, second Sunday in May; Memorial Day (half staff until noon), May 30; Flag Day, June 14; Independence Day, July 4; Labor Day, first Monday in September; Constitution Day, September 17; Columbus Day, October 12; Navy Day,[1] October 27; Armistice Day,[2] November 11; Thanksgiving Day, fourth Thursday in November; Christmas Day, December 25; such other days as may be proclaimed by the President of the United States; the birthdays of States (dates of admission); and on State holidays.

(e) The flag should be displayed daily, weather permitting, on or near the main administration building of every public institution.

(f) The flag should be displayed in or near every polling place on election days.

(g) The flag should be displayed during school days in or near every schoolhouse.

SEC. 3. That the flag, when carried in a procession with another flag or flags, should be either on the marching right; that is, the flag's own right, or, if there is a line of other flags, in front of the center of that line [figs. 1 and 4].

(a) The flag should not be displayed on a float in a parade except from a staff, or as provided in subsection (i).

(b) The flag should not be draped over the hood, top, sides, or back of a vehicle or of a railroad train or a boat. When the flag is displayed on a motorcar, the staff shall be fixed firmly to the chassis or clamped to the radiator cap.

(c) No other flag or pennant should be placed above or, if on the same level, to the right of the flag of the United States of America, except during church services conducted by naval chaplains at sea, when the church pennant may be flown above the flag during church services for the personnel of the Navy.

No person shall display the flag of the United Nations or any other national or international flag equal, above, or in a position of superior prominence or honor to, or in place of, the flag of the United States at any place within the United States or any Territory or possession thereof: *Provided*, That nothing in this section shall make unlawful the continuance of the practice heretofore followed of displaying the flag of the United Nations in a position of superior prominence or honor, and other national flags in positions of equal prominence or honor, with that of the flag of the United States at the headquarters of the United Nations.

(d) The flag of the United States of America, when it is displayed with another flag against a wall from crossed staffs, should be on the right, the flag's own right, and its staff should be in front of the staff of the other flag [fig. 3].

(e) The flag of the United States of America should be at the center

[1]When Armed Forces day (third Saturday in May) was established in 1948, following the establishment of the department of defense in 1947, its celebration, to a large extent, superseded those of Army day and Navy day.
[2]Armistice day was renamed Veterans day in 1954.

FIG. 1. IN PROCESSION WITH ANOTHER FLAG. U.S. FLAG ON MILITARY (FLAG'S OWN) RIGHT

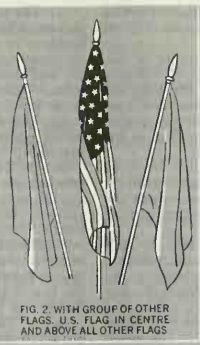


FIG. 2. WITH GROUP OF OTHER FLAGS. U.S. FLAG IN CENTRE AND ABOVE ALL OTHER FLAGS

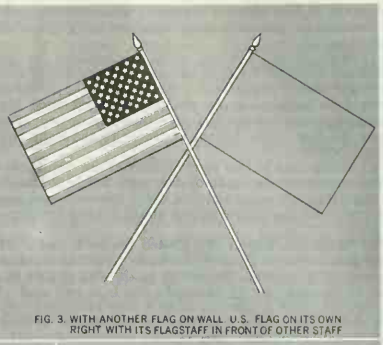


FIG. 3. WITH ANOTHER FLAG ON WALL. U.S. FLAG ON ITS OWN RIGHT WITH ITS FLAGSTAFF IN FRONT OF OTHER STAFF

FIG. 4. IN PROCESSION WITH LINE OF OTHER FLAGS. U.S. FLAG IN FRONT OF THE CENTRE OF THE LINE

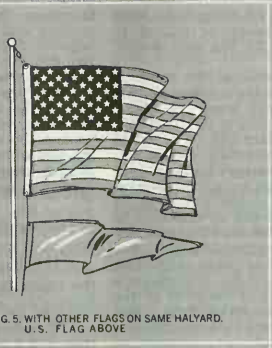


FIG. 5. WITH OTHER FLAGS ON SAME HALYARD. U.S. FLAG ABOVE

FIG. 6. WITH ONE OR MORE FLAGS OF OTHER NATIONS. STAFFS OF EQUAL HEIGHT: FLAGS OF APPROXIMATELY EQUAL SIZE

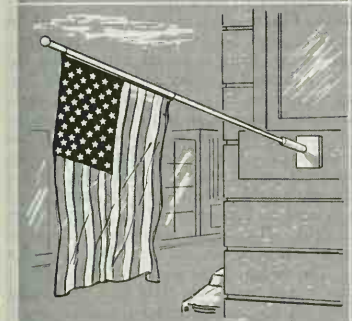


FIG. 7. ON STAFF PROJECTING FROM BUILDING

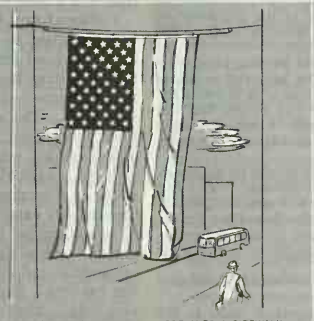


FIG. 8. SUSPENDED FROM A ROPE OVER A SIDEWALK

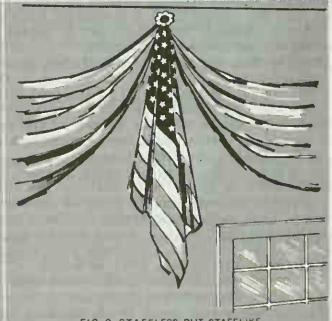


FIG. 9 STAFFLESS BUT STAFFLIKE

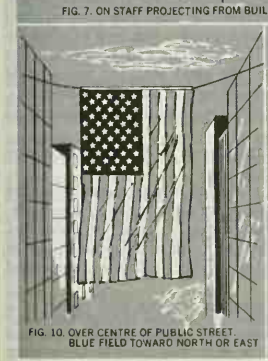


FIG. 10. OVER CENTRE OF PUBLIC STREET. BLUE FIELD TOWARD NORTH OR EAST

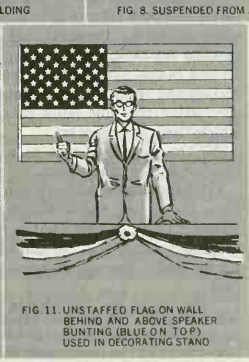


FIG 11. UNSTAFFED FLAG ON WALL BEHIND AND ABOVE SPEAKER BUNTING (BLUE ON TOP) USED IN DECORATING STAND

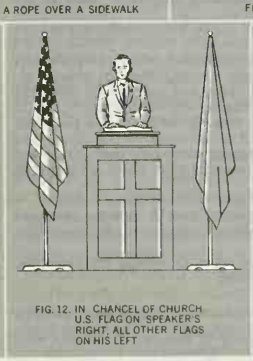


FIG. 12. IN CHANCEL OF CHURCH U.S. FLAG ON SPEAKER'S RIGHT, ALL OTHER FLAGS ON HIS LEFT

FIG. 13. PROPER SALUTES

PROPER METHODS OF DISPLAYING AND SALUTING THE FLAG OF THE U.S.

and at the highest point of the group when a number of flags of States or localities or pennants of societies are grouped and displayed from staffs [fig. 2].

(f) When flags of States, cities, or localities, or pennants of societies are flown on the same halyard with the flag of the United States, the latter should always be at the peak [fig. 5]. When the flags are flown from adjacent staffs, the flag of the United States should be hoisted first and lowered last. No such flag or pennant may be placed above the flag of the United States or to the right of the flag of the United States.

(g) When flags of two or more nations are displayed, they are to be flown from separate staffs of the same height. The flags should be of approximately equal size [fig. 6]. International usage forbids the display of the flag of one nation above that of another nation in time of peace.

(h) When the flag of the United States is displayed from a staff projecting horizontally or at an angle from the window sill, balcony, or front of a building, the union of the flag should be placed at the peak of the staff [fig. 7] unless the flag is at half staff. When the flag is suspended over a sidewalk from a rope extending from a house to a pole at the edge of the sidewalk, the flag should be hoisted out, union first, from the building [fig. 8].

(i) When the flag is displayed otherwise than by being flown from a staff, it should be displayed flat, whether indoors or out, or so suspended that its folds fall as free as though the flag were staffed[1] [fig. 9].

(j) When the flag is displayed over the middle of the street, it should be suspended vertically with the union to the north in an east and west street or to the east in a north and south street [fig. 10].

(k) When used on a speaker's platform, the flag, if displayed flat, should be displayed above and behind the speaker [fig. 11]. When displayed from a staff in a church or public auditorium, if it is displayed in the chancel of a church, or on the speaker's platform in a public auditorium [or on the floor], the flag should occupy the position of honor and be placed at the clergyman's or speaker's right as he faces the congregation or audience. Any other flag so displayed in the chancel or on the platform should be placed at the clergyman's or speaker's left as he faces the congregation or audience [fig. 12]. But when the flag is displayed from a staff in a church or public auditorium elsewhere than in the chancel or on the platform [as the congregation's flag] it shall be placed in the position of honor at the right of the congregation or audience as they face the chancel or platform. Any other flag so displayed should be placed on the left of the congregation or audience as they face the chancel or platform.[2]

(l) The flag should form a distinctive feature of the ceremony of unveiling a statue or monument, but it should never be used as the covering for the statue or monument.

(m) The flag, when flown at half staff, should be first hoisted to the peak for an instant and then lowered to the half-staff position. The flag should be again raised to the peak before it is lowered for the day. By "half staff" is meant lowering the flag to one-half the distance between the top and bottom of the staff. Crepe streamers may be affixed to spear heads or flagstaffs in a parade only by order of the President of the United States.

(n) When the flag is used to cover a casket, it should be so placed that the union is at the head and over the left shoulder. The flag should not be lowered into the grave or allowed to touch the ground.

Sec. 4. That no disrespect should be shown to the flag of the United States of America; the flag should not be dipped to any person or thing. Regimental colors, State flags, and organization or institutional flags are to be dipped as a mark of honor.

(a) The flag should never be displayed with the union down save as a signal of dire distress.

(b) The flag should never touch anything beneath it, such as the ground, the floor, water, or merchandise.

(c) The flag should never be carried flat or horizontally, but always aloft and free.

(d) The flag should never be used as drapery of any sort whatsoever, never festooned, drawn back, nor up, in folds, but always allowed to fall free. Bunting of blue, white, and red, always arranged with the blue above, the white in the middle, and the red below, should be used for covering a speaker's desk, draping the front of a platform, and for decoration in general.

(e) The flag should never be fastened, displayed, used, or stored in such a manner as will permit it to be easily torn, soiled, or damaged in any way.

(f) The flag should never be used as a covering for a ceiling.

(g) The flag should never have placed upon it, nor on any part of it, nor attached to it any mark, insignia, letter, word, figure, design, picture, or drawing of any nature.

(h) The flag should never be used as a receptacle for receiving, holding, carrying, or delivering anything.

(i) The flag should never be used for advertising purposes in any manner whatsoever. It should not be embroidered on such articles as cushions or handkerchiefs and the like, printed or otherwise impressed on paper napkins or boxes or anything that is designed for temporary use and discard; or used as any portion of a costume or athletic uniform. Advertising signs should not be fastened to a staff or halyard from which the flag is flown.

(j) The flag, when it is in such condition that it is no longer a fitting emblem for display, should be destroyed in a dignified way, preferably by burning.

Sec. 5. That during the ceremony of hoisting or lowering the flag or when the flag is passing in a parade or in a review, all persons present should face the flag, stand at attention, and salute. Those present in uniform should render the military salute. When not in uniform, men should remove the headdress with the right hand holding it at the left shoulder, the hand being over the beart. Men without hats should salute in the same manner. Aliens should stand at attention. Women should salute by placing the right hand over the heart. The salute to the flag in the moving column should be rendered at the moment the flag passes [fig. 13].

Sec. 6. That when the national anthem is played and the flag is not displayed, all present should stand and face toward the music. Those in uniform should salute at the first note of the anthem, retaining this position until the last note. All others should stand at attention, men removing the headdress. When the flag is displayed, all present should face the flag and salute.

Sec. 7. The following is designated as the pledge of allegiance to the flag: "I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible, with liberty and justice for all." Such pledge should be rendered by standing with the right hand over the heart. However, civilians will always show full respect to the flag when the pledge is given by merely standing at attention, men removing the headdress. Persons in uniform shall render the military salute.

The eighth section empowers the commander in chief of the army and navy to change or add to the rules whenever desirable.

A U.S. flag painted on the side of a ship or aircraft should have the union toward the bow or nose of the craft and the stripes flowing aft, as if flying in the wind.

The U.S. jack is taken from the union of the national flag in that it is a blue field containing 50 white stars.

Personal and Official Flags.—As it is the prerogative of the U.S. president to design his own flag (though not all presidents have exercised this privilege), there is no set pattern, but the field is always blue. The flagstaff is ebony and is the only flagstaff authorized (army regulations, 1917) to bear the "eagle, alert" staff head. The correct staff head of all other U.S. flags is the spear (or "acorn, ball"; navy staffs may bear the star, lance, ball or flat truck), never the eagle. The vice-president's flag design includes a part of the great seal in colour, encircled by 13 blue stars, on a rectangular white field. The flag of the secretary of the treasury exhibits crossed anchors encircled by 13 white stars on a rectangular blue field. That of the secretary of the army includes part of the great seal in colour, and four white stars on a rectangular red field. The design of the secretary of the navy's flag exhibits a foul anchor and four white stars on a rectangular blue field. Other cabinet officers, undersecretaries, assistant secretaries and staff officers have distinguishing flags indicative of their office and rank. Personal flags, with varying numbers of stars depending on rank, are flown by U.S. generals and admirals. The United States shield, taken from the great seal, has seven white and six red vertical stripes (representing the original 13 colonies), supporting the blue band or chief (representing the nation) in which there are no stars.

All the states, as well as a number of U.S. cities, have distinctive flags of their own.

Confederate Flags.—When a bloc of southern states seceded from the union, the selection of a suitable flag was much discussed. Early in Feb. 1861, a convention of six of the states met in Montgomery, Ala., to consider the form of government to be set up, and a committee, appointed to select a flag, recommended that

> . . . the flag of the Confederate States of America shall consist of a red field with a white space extending horizontally through the center equal to one-third the width of the flag, the red spaces above and below to be of the same width as the white; the union blue, extending down through the white space and stopping at the lower space; in the center of the union a circle of white stars corresponding to the number of States of the Confederacy.

[1] When displayed either horizontally or vertically against a wall, the union should be uppermost and to the flag's own right; that is, to the observer's left. When displayed in a window, the flag should be displayed in the same way; that is, with the union or blue field to the left of the observer in the street.

[2] Subsection (k) is often read too literally. The flag always holds the position of honour, the "military right of line." This is at the right of a person or persons facing people who are facing them, whether the staffed flag is in chancel, on platform or on the floor. Honour is a matter of position, not altitude.

This report was adopted on March 4, 1861. The flag thus approved came to be known as the Stars and Bars. It was first displayed over the state house in Montgomery.

At the battle of Bull Run, or Manassas as the Confederates called it, the similarity in colours of the flags of the Northern and Southern armies led to confusion, and at the suggestion of Gen. G. T. Beauregard a battle flag was devised and used (but never officially adopted) by the Southern armies throughout the war. It was based on a design suggested by Col. William Porcher Miles and Col. Walton, and consisted of a red field, usually square, on which was placed a blue St. Andrew's cross separated from the field by a white fillet, and adorned with 13 white stars (although there were only 11 Confederate states). The Stars and Bars having proved to be unsatisfactory, demand was frequently made for the adoption of a flag of different design. Finally, in May 1863, the Confederate congress, in session in Richmond, Va., adopted a new design.

The resolution recommending it set forth that the flag should be white with a red canton containing the battle flag designed by General Beauregard. Objections arose that this second flag resembled the British white ensign and might be mistaken for a flag of truce, and so on March 4, 1865, a broad vertical strip of red was added to the fly. (Gy. A.; G. W. Do.; X.)

FLAGS OF OTHER COUNTRIES

Europe.—*France.*—The St. Martin's hood (*see* above) and the oriflamme were succeeded by the *cornette blanche* of the Bourbons when Henry IV came to the throne in 1589. This was a white flag, sometimes carrying the fleur-de-lis arms of royalty, and it was used until the Revolution. The origin of the well-known French tricolour, which was then adopted, is clear from a perusal of contemporary papers. When the Bastille was taken and destroyed on July 14, 1789, the Parisians wore cockades of red and blue, the colours of the coat of arms of the city, in conformity with instructions from the national assembly the preceding day. Three days later the king went to the Hôtel de Ville and the newspaper *Le Moniteur*, in its issue of July 20, in describing the incident, related that the mayor of Paris "presented to the king a cockade, the same as that which the citizens had adopted. His majesty received it and put it on his hat," where the white cockade of the Bourbons was already placed. Red, white and blue were thenceforth known as "the national colours," symbolizing the unity of king and people. The white flag flown by the navy was not changed until the following year. On Oct. 24, 1790, the assembly passed a law providing for a flag of three vertical stripes of red, white and blue to be flown from the jack staff on the bowsprit of ships, and the ensign had the same device as a canton on the white flag. On Feb. 15, 1794, the ensign was denounced in the assembly as "an outrageous caricature" inasmuch as "the republican colours are relegated to a corner of the flag." The white ensign was thereupon abolished and the tricolour jack substituted for it. The law provided that the colour be reversed so that the blue stripe would be next to the staff.

The Netherlands.—The flag of this country had its origin in the colours of the prince of Orange, the leader of the Dutch in their War of Independence. His colours were orange, white and blue, and two flags used in 1574 are still preserved. Just how or why the top stripe was changed from orange to red, as it is today, is not clear, but the instability of the colour orange or the higher visibility of red may have been reasons. As early as 1597 the use of red is recorded, and in 1634 the governor general of the Dutch East Indies, in placing an order for bunting for the manufacture of flags, requested either orange or red. This indicates that the two colours were considered interchangeable. Orange remained the official colour, however, and in at least four flag books published in the first half of the 18th century the Dutch flag is described as orange, white and blue, although the accompanying illustrations show a red stripe, not an orange one. It was not until Feb. 17, 1795, that the estates-general prohibited the use of orange and on the following Sept. 25 described the red, white and blue emblem as the national flag.

Belgium.—The Belgian flag has three vertical stripes of black, yellow and red. These colours were first used by the Brabançons in 1790 and were probably taken because they are the colours of the coat of arms of Brabant. However, it should be noted that they are also the same as the colours of the arms of all the principal provinces of Belgium. In 1830, when the Belgians revolted against the Netherlanders, the French tricolour, as the symbol of liberty, was flown. When success was achieved and the kingdom of Belgium established, the Brabançon colours were taken for the national flag.

Germany.—Each kingdom and principality had its own local flag and coat of arms, and there never was a flag common to all of Germany until the establishment of the empire in 1871. Then the flag that had been adopted four years before by the North German confederation—black, white and red in three horizontal stripes—was taken for the national flag of Germany. These colours came from the black and white arms of Prussia and the red and white colours of the Hanseatic league. When the republic was inaugurated in 1918, the colours were changed to black, red and gold, a flag which had been flown during the revolutions of 1848. The *hakenkreuz* (swastika) flag of the National Socialist regime having been dropped after World War II, both the Federal Republic of Germany and the German Democratic Republic adopted the black, red and gold flag; the German Democratic Republic superimposing in the centre a hammer and compass surrounded by a wreath of grain with a black, red and golden ribbon twisted in it.

Austria.—The Austrian flag dates from early in the 13th century when Duke Frederick II of Austria adopted a horizontal white stripe on a red field for his coat of arms and banner. The earliest authentic date for this is 1232, and it continued to be the flag of Austria with no intermission until the *Anschluss* of 1938, thus becoming probably the oldest flag in continuous use. It was restored after World War II.

Czechoslovakia.—When Czechoslovakia was formed after World War I, it adopted a flag of red, white and blue, the colours of the coats of arms of Bohemia, Moravia and Slovakia. The flag had two horizontal stripes of red and white with a blue triangle at the hoist. After the occupation of Czechoslovakia by Germany in 1939 the colours were retained, but in Bohemia and Moravia they were arranged in three horizontal stripes, with white at the top and blue at the bottom.

Switzerland.—The origin of the Swiss flag, a white couped cross on a red field, is usually ascribed to the year 1339, but the only authority for that date is an account written 100 years later. The first historical mention of the white cross emblem occurs in 1444, when the Swiss were charged with having worn red crosses on their military tunics, instead of the customary white, to deceive the enemy. However, this shows that the white cross was already the established Swiss device, although not on a flag. Apparently its use was by custom only; not until May 16, 1814, was it officially recognized as "the military emblem of the ancient Swiss."

Spain.—In medieval times and until 1785 the royal armorial banner was the only flag in Spain which could be considered as national. In that year it became a *cornette blanche*. A Bourbon was on the throne and he used the white flag of that family charged with the royal arms. In order to differentiate clearly between the ships of Spain and those of other countries ruled by Bourbons, all of whom used the white flag, a new national flag of red and yellow was adopted, taken from the Spanish coat of arms. A central horizontal stripe, comprising half the area, was yellow; on each side was a strip of red. This flag lasted until the overthrow of the monarchy in 1931, when a tricolour of red, yellow and purple was adopted. The Nationalists under Gen. Francisco Franco used the flag of the monarchy in the civil war and restored it as the national flag when they became victorious in 1939. The coat of arms is sometimes displayed on the yellow stripe.

Portugal.—Armorial banners were used in Portugal until well into the 19th century. In 1821 the *cortes* approved a resolution which provided that the national cockade be blue and white, "the colours used on the shield of Alfonso Henriquez," the first king of Portugal, in the 12th century. In 1830 a flag was adopted of those two colours, blue occupying two-fifths of the flag next to the staff, white the remainder. The coat of arms was centred on the line

dividing the two colours. In 1910 the monarchy was overthrown and green and red replaced the blue and white.

Italy.—The flag of Italy is green, white and red in three vertical stripes. This flag first appeared on May 14, 1795, at Bologna in a student demonstration. These three colours, however, had been favourites in northern Italy for several hundred years, ever since Dante used them as symbols of the three cardinal virtues of faith, hope and charity. In Sept. 1797 the newly formed Cisalpine republic adopted the flag for its troops taking part in the Napoleonic campaigns in Lombardy. When Napoleon was crowned king of Italy in 1805, he took the flag for his new kingdom, but with his downfall Italy again disintegrated and the flag ceased to exist. On March 4, 1848, Charles Albert, king of Sardinia, resurrected the flag, and when Italy was again united under his son Victor Emmanuel II in 1861 it became the emblem of the entire country.

Scandinavia.—The flag of Denmark has a white cross on a red field and is known as the *Danebrog*. This flag is first known to have been used on the seal of Waldemar, duke of South Jutland, on a document of 1308. The merchant flag is of the usual rectangular shape; the naval ensign is swallow-tailed.

The flags of the other Scandinavian countries are all based on the *Danebrog*. Sweden uses a yellow cross on a blue field; yellow and blue are also the colours of its national coat of arms, which consists of three gold crowns on blue. The flag dates from the reign of Gustavus I Vasa, who was crowned in 1528. The naval ensign is swallow-tailed with a tongue; *i.e.*, it has three points.

Norway was united to Denmark for 400 years until 1814, when it came under the Swedish crown. It retained the Danish flag, but with the addition of the lion of Norway in the upper corner. Because of the difficulty of distinguishing this from the flag of Denmark itself, a change was made in 1821, the lion being eliminated and a blue cross superimposed on the white cross of the Danish flag. Norway was completely independent after 1905, but continued to use the same flag. The naval ensign has three points.

The national flag of Finland has a blue cross on a white field, "the blue for the colour of the lakes, the white as the emblem of the snow-fields," as a member of the Finnish diet said when the flag was first suggested in the 1860s. The coat of arms is placed on the cross on the state flag and other variations.

The flag of Iceland is the reverse of that of Norway, a red cross bordered with white on a blue field.

Hungary.—The Hungarian flag has three horizontal stripes of red, white and green. In the early middle ages the royal banner had red and white horizontal stripes; in some way green came to be associated with these, and a coat of arms was developed in the 14th century with all three colours. During the reign of Maria Theresa (1740–80) a national flag of red, white and green made its appearance, but it does not seem to have come into general use. It was not until 1848 that the diet prescribed that "the ancient flag shall again be used." This definitely established the national flag of Hungary. After the establishment of the Communist government the new national emblem—a rising star, above a hammer crossed with an ear of wheat, the whole encircled by sheaves of wheat—was placed on the tricolour flag. In 1957 the emblem was removed.

Poland.—The national flag was flown after 1919, but was not officially adopted until 1927. The colours, a white and a red horizontal band, go back to the old Polish banner of Lech, a white eagle on a field of solid red. According to legend the brothers Czech and Lech set out from Yugoslavia to find a new home for their people; Czech stopped and founded Prague; Lech kept on to found Warsaw, and seeing on his journey a white eagle in a tree chose it as part of his emblem.

U.S.S.R.—The flag of the Russian empire was white, blue and red in three horizontal stripes and was first displayed in the reign of the tsar Aleksei Mikhailovich in 1667. His son Peter the Great founded the Russian navy, and about the year 1712 a blue X-shaped cross on a white field was taken for the naval flag. With the fall of the empire in 1917 and the establishment of the Soviet government all imperial emblems were abolished and the red flag of revolution became the national flag. A crossed hammer and sickle in yellow in the upper corner symbolize the artisan and the husbandman, and above them is a five-pointed star outlined in yellow. This star is said to represent the five continents which, according to Soviet belief, are eventually to embrace the doctrines of Marx.

It is strange that the red flag, symbolical of revolution, originally had precisely the opposite connotation. After the fall of the Bastille in 1789 rioting became frequent in Paris, so that the assembly passed an act providing for martial law; and the hoisting of the red flag was to be the signal that this had been declared. The red flag was so displayed several times during the ensuing two years; then came the fateful day of July 17, 1791, when it was raised and the troops, under the marquis de La Fayette, fired on a riotous mob on the Champ de Mars, killing several hundred. Popular indignation at this act strengthened the extreme radical elements, and the next year the mob used a red flag inscribed "Martial law of the people against the revolt of the court," on the principle that the people constitute the sovereign power, and that whenever a government opposes the people it is the government that is in revolt and the people are justified in declaring martial law against it. Several similar incidents occurring in the next few years, both in France and in other countries, firmly established the red flag as the symbol of opposition to government.

Yugoslavia.—Yugoslavia has three horizontal stripes of blue, white and red for its national flag, with a red star outlined in yellow on the centre. The flag of Serbia until the close of World War I had the same three colours, but the top stripe was red, the bottom one white. The flag originated in the uniform worn by the Serbs during their insurrection against the Turks. They wore white shirts, which hung to the knees, under a blue coat and red caps. A company of soldiers thus garbed presented three lines of red, blue and white.

Rumania.—The flag of Rumania, adopted in 1859, has three vertical stripes of blue, yellow and red. The colours are taken from the coat of arms. The emblem of the republic is superimposed on the centre band.

Bulgaria.—The Bulgarian flag has three horizontal stripes of white, green and red, with the national coat of arms centred in the white stripe near the hoist.

Albania.—The flag of Albania is a resurrection of the banner of the national hero Skanderbeg, who successfully fought the Turks for 24 years in the 15th century. It has a black double-headed eagle on a red field. During the occupation of the country by the Italians (1939–40) a gold fasces was superimposed on the eagle. After World War II a red star, outlined in yellow, was placed above the eagle.

Greece.—The Greek War of Independence started on March 25, 1821, when Bishop Germanos raised a banner of blue, surmounted by a white cross, at Hagia Lavra. In the following January a flag of five blue and four white stripes, with a white cross on a blue canton, was adopted by the revolutionary assembly at Epidaurus.

Ireland.—The national flag of Ireland, adopted in 1921, has three vertical stripes: green, the old colour of the Irish clans; white, for peace; and orange, the colour of the Orangemen.

Asia and Africa.—*Turkey.*—The Turkish flag has a white star and crescent on a red field. The story usually told is that the star and crescent was the emblem of Constantinople and that the sultan Mohammed II appropriated it when he captured the city in 1453. In fact, however, the crescent became the symbol of the followers of Mohammed the Prophet very early in the spread of Islam, and it was on the red flag of the Osmanli Turks 200 years before the capture of Constantinople. The Osmanlis were then a small tribe in the sultanate of Roum in Asia Minor, but they expanded rapidly, overrunning eastern Asia and the Balkans and establishing the country that came to be Turkey. On the other hand, the star was not added to the crescent on the flag until about 1798.

Egypt and Syria.—After proclamation of the United Arab Republic of Egypt and Syria in Cairo in 1958, a national flag of red, white and black horizontal stripes with two green stars on the white stripe was adopted. On the dissolution of the republic in 1961, Syria returned to its former national flag, *i.e.*, horizontal stripes of green, white and black (for the significance of the colours, see *Jordan and Iraq*, below), with three red stars on the white.

South Africa.—The flag of the Republic (formerly Union) of South Africa is basically the old Netherlands flag of orange, white and blue. The white centre stripe contains a device consisting of three flags—the British union jack and the flags of the two former Boer republics, Orange Free State and Transvaal.

Jordan and Iraq.—The two Muslim countries Jordan (formerly Trans-Jordan) and Iraq, formed after World War I, had nearly identical flags. Both were based on one adopted by King Husain of the Hejaz, which had three horizontal stripes of black, white and green, with a triangle of red next to the staff. Green was the colour of the Fatimid dynasty, and became the colour of Islam. The symbolism of green has already been explained (*see* above, *History: Oriental Flags*). White and black were the colours of the first two dynasties of caliphs, the Omayyads and the Abbasids, respectively, and red was the colour used by Husain's ancestors. Arabia was conquered by Ibn Saud, who introduced his own green flag, but in the meantime Husain's two sons, Abdullah and Faisal, had become kings of Trans-Jordan and Iraq respectively and they preserved his flag. In Jordan a white star is placed on the red triangle; Iraq used two white stars and the point of the triangle was cut off, forming a red trapezoid. The Iraq flag was changed to a black, white and green tricolour following the establishment of a republic in 1958. In the centre is a sun emblem in yellow and red.

Iran.—The flag of Iran is a horizontal tricolour of green, white and red, with an ancient device, the lion and sun, on the centre. The lion and sun device is omitted when the flag is flown by the people and on the merchant flag.

Israel.—The national flag of the state of Israel is white with two Yale-blue bands extending the full length of the flag. In the centre of the flag is a shield of David, made of six Yale-blue bands, forming two equilateral triangles with their bases parallel to the two blue bands.

Japan.—The naval ensign of Japan has a red rising sun with 16 rays on a white field; the national flag has a red ball on white. These flags were adopted in the later 19th century, although the sun banner had long been an emblem of the emperor.

China.—The flag of China in the days of the Manchu emperors was the imperial dragon. The republic established in 1912 adopted a flag having five horizontal stripes of red, yellow, blue, white and black, representing the five races, or clans, of China. This lasted until 1928 when the banner of the Kuomintang party replaced it. This flag has a red field with a canton of blue charged with a white sun having 12 rays, and is used by the Republic of China. The flag of the People's Republic of China is red, with one large and four small gold stars.

India.—The national flag has three horizontal stripes: deep saffron, symbolizing the spirit of renunciation and humility; white, the path of light, truth, simplicity; bottle green, relation with the soil. In the centre of the white stripe, in dark blue, is the wheel of Asoka, the Buddhist ruler of the 3rd century B.C.

Ceylon.—The national flag is known as the lion flag. It has two vertical stripes, green and saffron, next to the hoist; the balance is a red field in which is shown a lion holding a sword. The whole has a border of yellow. This flag was first hoisted on the morning of Feb. 4, 1948, and proclaimed a new era in the history of Ceylon, when it became a self-governing dominion of the Commonwealth of Nations.

Pakistan.—The national flag has one vertical white stripe one-quarter the flag's width, the remaining three-quarters being a field of solid bottle green in which is shown a white crescent and one white star.

Burma.—The national flag has a solid red field, with a dark-blue canton in which is one large white star surrounded by five smaller white stars.

Siam.—The flag of Siam (Thailand) has five horizontal stripes of red, white, blue, white and red. The naval ensign has the Siamese badge, a white elephant on a red disk, placed on the centre of the flag.

Latin America.—*Mexico.*—The flag of Mexico, three vertical stripes of green, white and red, was adopted in 1821, when Mexico gained its independence. The Mexican device—an eagle with a serpent in its beak, standing on a cactus—is on the centre stripe of the naval and state flags.

Argentina and Uruguay.—The flag of Argentina is a white stripe placed horizontally on a light-blue field, with a golden sun, taken from the coat of arms, on the centre. It originated in the colours of the uniforms worn by the Argentinians when they repulsed a British invasion in 1806. The flag was adopted Feb. 13, 1813. Uruguay, which co-operated with Argentina in the early wars, uses the same colours in horizontal stripes, five white and four blue, with the same golden sun on a white canton.

Venezuela, Colombia and Ecuador.—The flags of these countries —three horizontal stripes of yellow, blue and red—are all taken from the ensign hoisted by Gen. Francisco Miranda over his expedition of 1806, when the revolutions in South America against Spain commenced. Venezuela has seven white stars in an arch on the blue stripe; the national coat of arms is sometimes placed on the yellow stripe, near the hoist. The yellow stripe occupies the upper half of the Colombian and Ecuadorian flags, as it did on Miranda's ensign. Colombia has a white star on the centre of the merchant flag, and the coat of arms on the naval ensign. The coat of arms is placed in the centre of the Ecuadorian flag; the merchant marine flag is plain.

Peru.—The Peruvian flag has a white vertical stripe on a red field, with the coat of arms on the centre. It is said that these colours were suggested by a dream that José de San Martín, the Argentinian, had the night after he landed in Peru with an army to assist in the Peruvian war for independence. The flag as now designed was adopted Feb. 25, 1825.

Brazil.—The flag of Brazil is green with a celestial globe in blue on a yellow lozenge. The day Dom Pedro proclaimed the independence of the country, Sept. 7, 1882, he wore an arm band of green and gold.

Paraguay.—The flag of Paraguay is red, white and blue in three horizontal stripes, with national badges on the centre, a different badge on each side. In its present form it dates from Nov. 17, 1842.

Bolivia.—The flag of Bolivia was adopted July 14, 1888. It is a tricolour of red, yellow and green, representing the country's animal, mineral and vegetable riches. The coat of arms appears on the yellow stripe of the flag used on public buildings and by official institutions.

Chile.—The flag of Chile dates from Oct. 18, 1817. It is divided horizontally into white and red, and has a blue canton on which is a white star of five points, one point for each letter of the name Chile.

(R. E. Wy.; Gy. A.)

OTHER FLAGS

International and Supranational Flags.—Besides the flags flown by separate nation-states there are now several flags, apart from the red cross already mentioned, which are used internationally. The flag of the United Nations is blue, with the globe (as seen from the north pole) surrounded by a wreath all in white. Then there is the flag of the European union, in green and white; and the flag of the Americas, a white flag with three blue Maltese crosses, which offends the laws of heraldry by placing yellow (of the sun's rays) on white. The flag used at the Olympic games is white with five interlaced circles in blue, yellow, black, green and red. The flags of the Geneva convention include the red cross on a white field in most countries, but Muslim nations, such as Turkey, have replaced the cross with a red crescent while others, like Iran, have adopted a red lion. Other international flags are the flag indicating condition of health aboard ship, plain yellow, and the pilot flag, yellow and blue vertical stripes. But these, which are flags of the international code for the letters Q and G, respectively, and the white flag indicating surrender or truce, are really signals (*see* SIGNAL COMMUNICATION). All flags, it should be noted, however, can be used to some extent as signals. Striking the flag denotes surrender. Dipping the flag (lowering it slowly and re-hoisting it smartly) is a form of salute. A flag flown at half staff is a sign of mourning. A flag hoisted upside down is a signal of distress. In a ship that has surrendered, the captors may hoist their own ensign above the ensign of their opponents, primarily to

persuade their own side to cease fire. In World War II, submarines re-entering their base would sometimes hoist a black flag with some symbol to indicate a recent success.

Yachting Flags.—In Great Britain yachts may fly on occasion an ensign, a racing flag and a burgee. Ensigns may be white, blue, blue with a badge, red with a badge or plain red. The white ensign has been confined since 1858 to yachts of the Royal Yacht squadron. The blue ensign may be flown by any yacht that is entitled to a royal naval reserve warrant on the conditions applicable to any merchantman. The blue ensign with a club badge in the fly is flown by yachts belonging to clubs that have the prefix "Royal" and an admiralty warrant. The red ensign with a club badge is flown by yachts belonging to clubs that have only a royal and not an admiralty warrant. The red ensign may be flown by any yacht, whether belonging to a club or not. The burgee is essentially a club flag, being triangular, and is more often seen than the ensign. Burgees are numerous in Great Britain and still more numerous in the United States; that of the Royal Thames dates from 1775, others from the period 1820–50. The racing flag is flown only during a race to indicate which yachts are competing. It may be hauled down as a signal that a yacht has given up the race. The racing flag is intended to distinguish one yacht from another and may be of any design the owner pleases. A white-bordered union flag may also be carried, to use as a protest or as a pilot signal.

House Flags.—Merchantmen in British registry fly certain flags in addition to the blue or red ensign. Although they may not fly the union jack, they may fly at the jack staff a white-bordered union jack as a sign of nationality. They may fly from their foremast, when leaving port, the flag of the country for which they are bound. They may also fly their house flag, indicating the shipping line to which they belong. House flags originate, it has been claimed, from the flags hoisted on Bidston hill (overlooking the old entrance to the Mersey) to inform the owners in Liverpool of their ships' arrival or departure from the Hoyle lake, which was invisible from their office windows. But the ownership of 18th-century ships was complex, and the permanently established shipping lines appeared more after 1815. Earliest of these was, of course, the East India company. Its functions were largely taken over by the Blackwall frigates, which had their own house flag; and these eventually yielded place to the ships of the Peninsular and Oriental Steam Navigation company, whose house flag dated from 1832. Few existing house flags can claim much greater antiquity (except that of the Hudson's Bay company), because the earlier sailing-ship lines went out of business after a period of competition with steamship companies of an almost equal seniority. Among the better-known British house flags are those of the Cunard White Star, Clan, British India, Royal Mail, Orient, Union-Castle, Canadian Pacific, Anchor, Bibby, Ellerman's Wilson and Blue Funnel lines. House flags are also flown by merchantmen of other countries, such flags as those of the Messageries Maritimes, the Batavier, the Lloyd Triestino and the Nippon lines being among the most familiar.

For flags carried by troops, *see* COLOURS, MILITARY.

(C. N. P.)

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(R. E. WY.; C. N. P.; GY. A.)

FLAGELLATA, the earliest name applied to a class of protozoans (acellular organisms) characterized by having hairlike protoplasmic processes called flagella (sing. flagellum). They are now generally grouped as a subphylum (sometimes as a class), Mastigophora. *See* PROTOZOA.

FLAGELLATION, the act of beating with whips, is a disciplinary or devotional practice found among many religious groups. For whipping as a method of punishment of crime, *see* FLOGGING.

Christian Church.—From the time of the primitive church it seems that flagellation was used as punishment for disobedient members of the clergy. It is not possible to say definitely when this usage was introduced and when it was eliminated. From the 4th century, self-inflicted flagellation was practised by both clergy and laity as the most efficacious means of penance. In the early middle ages the laity became especially attracted by this devotional exercise. About 1258, partly as a result of social disorganization and famine, and partly because of the apocalyptic prophecies of Joachim (*q.v.*) of Fiore and the extreme position of the Franciscan Spirituals, flagellant brotherhoods and processions composed of laymen and women, as well as clergy, began to be organized in Italy. From there they spread rapidly into Germany and the Low Countries. By the mid-14th century major parts of Europe were once more excited by a wave of migrating flagellants. The great plague pandemic had struck Europe, and fear became acute. The moral corruption of the church made it impossible for religiously sensitive persons to find peace within the church itself, and from this religious crisis flagellation arose, the flagellants seeking by their own efforts to mitigate the divine judgment that was felt to be at hand. They formed groups and traveled about the country on foot. Daily in two public ceremonies men whipped their backs and chests with leather thongs, while women chastised themselves in seclusion. The flagellants' piety, fears and hopes were expressed in processional hymns, fragments of which are preserved in the hymnbooks of later generations.

In the beginning the church approved of this lay penitential enthusiasm, but church officials soon became aware that the flagellants presented a menace to the priesthood itself. A definite part of their ritual was the reading of an apocryphal letter that proclaimed flagellation—not the ecclesiastical sacrament of penance—to be the only way to salvation. This heresy led Clement VI in 1349 (and later also the Council of Constance) to condemn flagellation and its ardent supporters. In Germany, where the flagellants became an organized sect, they were a target of the Inquisition. In Italy the church gradually absorbed flagellation and its penitential value through the organization of carefully supervised local brotherhoods. In the 16th century, the Jesuits revived lay interest in self-inflicted flagellation, especially in the southern European countries; under their guidance the flagellant brotherhoods penetrated into Latin America, where flagellation seems still to be occasionally practised. In the southwestern United States, especially in remote parts of the Sangre de Cristo mountains of New Mexico, the Penitentes are said still to exercise flagellation during Lent.

(G. G. KR.)

Other Religions.—Whereas in Christianity flagellation appears mainly as a self-inflicted penitential exercise, ceremonial whippings or beatings in antiquity and among primitive peoples are primarily concerned with rites of initiation, purification and fertility, which often include other forms of physical suffering. Floggings and mutilations may or may not be self-inflicted. Beatings administered by masked impersonators of gods or ancestors are a feature of many North American Indian initiations (*e.g.*, those of the Zuni and Navaho). Ritual floggings are also known from classical antiquity, for example among the Spartans at the festival of Artemis Orthia and at the Roman festival of Lupercalia. Flagellation is particularly common among Indians of South America, where it is practised after the killing and eating of certain animals, on entering a new house, at initiations and on many other occasions. Very often the flogging is not merely *pro forma* but actually causes severe pain, loss of blood and wounds.

The many theories proffered are inadequate to explain the phenomenon. It has been attributed to sadism, as a driving out of evil spirits, as purification and as an incorporation of the animal power residing in the whip, but none of these hypotheses seems to take into account the whole range of the custom. Perhaps some lost primitive myth accounting for the origins of certain blessings by a flogging suffered by a primordial being may have provided

the mythological cause and inner meaning of the flagellation rites. (R. J. Z. W.)

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FLAGELLUM, a relatively long, filamentous organelle characteristic of many protozoans, bacteria and certain algae having flagellated stages in their life cycles as well as of specialized cells (choanocytes) of sponges. Flagella serve primarily as swimming devices but in some cases may be used to create food-bearing water currents or to investigate the surroundings. Each filament consists of a sheath and an inner axoneme that generally is attached to a cytoplasmic granule (blepharoplast). In electron micrographs the axoneme typically shows 11 fibrils (2 central, 9 peripheral). Although they are usually placed anteriorly, flagella sometimes are attached posteriorly or laterally and occasionally form the margin of a ribbonlike undulating membrane, as in certain parasites (*e.g., Trypanosoma, Trichomonas*). Cilia (*q.v.*), similar in structure to flagella, are typically shorter, more numerous and usually arranged in rows. *See* also Protozoa; Bacteriology; Algae; Sponges. (R. P. H.)

FLAGEOLET, a wind instrument of the "fipple flute" class related to the recorder, the name being a diminutive of Old French *flageol*, a pipe or tabor pipe. Its principal "French" form, described from the 16th century, has a contracting bore, an elongated, bone-tipped mouthpiece and four fingerholes on the front and two thumbholes at the back. With keywork added this became the popular "quadrille flageolet" of the mid-19th century, made famous by the virtuoso Collinet. A variant is the Catalan *fluviol*, played as a tabor pipe with one hand only. An English adaptation from the 18th century, the "English flageolet," has six holes on the front and sometimes keywork; the "double flageolets" patented by Bainbridge and others shortly after 1800 had two parallel pipes arranged for playing in harmony. There also exist many folk instruments of the same class, described for convenience as "flageolet." (*See* also Wind Instruments: *Flutes;* Recorder.) (A. C. Ba.)

FLAGET, BENEDICT JOSEPH (1763–1850), U.S. Roman Catholic prelate, first bishop of the old northwest, was born Nov. 7, 1763, in Contournat, France. Entering the Sulpician society, he was ordained a priest in 1786 (or 1787), thereafter teaching theology. He was one of several Sulpicians sent in 1792 to establish the first seminary in the United States. During the following 17 years he served as missionary to Vincennes, Ind.; attempted to found a college in Havana, Cuba; and taught at Georgetown college in Washington, D.C., and at St. Mary's seminary in Baltimore, Md.

When Bishop John Carroll's (*see* Carroll, John) diocese of the United States was divided in 1808, Flaget was nominated for one of the four new sees; and on Nov. 4, 1810, he was consecrated by Carroll as bishop of Bardstown, Ky. His diocese extended from Kentucky to the Great Lakes, from the Alleghenies to the Mississippi.

Flaget's various religious establishments were the wonder of the Roman Catholic world, and he became one of the most influential men in the councils of the American church of that period. The Sisters of Loretto and the Sisters of Charity of Nazareth, founded in 1812, were engaged in the elementary education of girls. St. Thomas seminary was followed by the foundation of two boys' colleges near Bardstown, St. Joseph and St. Mary's, which became noted for the education of many leading southern statesmen. Among his priests were the famed missionaries Stephen T. Badin and Charles Nerinckx. His cathedral of St. Joseph in Bardstown, dedicated in 1819, is a monument to his memory. The see was moved to Louisville prior to Flaget's death on Feb. 11, 1850.

See J. H. Schauinger, *Cathedrals in the Wilderness* (1952) and *Stephen T. Badin: Priest in the Wilderness* (1956). (J. H. S.)

FLAGG, JAMES MONTGOMERY (1877–1960), U.S. illustrator, poster artist and portrait painter, particularly remembered for his illustrations of buxom girls and for his World War I recruiting poster, "I Want You." Flagg himself posed for Uncle Sam in the poster; his stern face and finger pointing directly at the viewer (similar to the Lord Kitchener poster used at the same time in England) were so compelling that the poster was reissued during World War II. A total of about 4,000,000 copies were distributed.

Born in Pelham Manor, N.Y., on June 18, 1877, Flagg studied at the Art Students' league in New York; later he worked with Sir Hubert von Herkomer in England and with Victor Marec in France. At the age of 12 he sold his first drawing to the well-known children's journal, *St. Nicholas;* in 1890 he became a regular illustrator for the same magazine. After 1892 he was a regular contributor to *Judge, Life, Cosmopolitan* and other popular U.S. periodicals and his illustrations were collected into books, which increased his fame.

In his early professional work Flagg used large areas of tone rendered in water colour (and thus difficult to reproduce cheaply and well); he soon abandoned this and began around 1907 to use a vigorous pen-and-ink technique in the tradition of the U.S. artists Charles Dana Gibson and John Singer Sargent.

His dashing line and sure draftsmanship were also evident in his portraits in oil and water colour, the only "serious" art he practised. These were exhibited in Paris and New York, but most of them were commissioned by the sitters, and Flagg was known to the general public mainly through his commercial art.

In his autobiography *Roses and Buckshot* (1946), Flagg represented himself as a bohemian, unfettered by convention, but his life was untouched by poverty. The great success of his work brought him fame and a comfortable income in his lifetime and his place in the history of U.S. commercial art was secure long before his death in New York city on May 27, 1960. (A. M. Fx.)

FLAGLER, HENRY MORRISON (1830–1913), U.S. financier, a pioneer in Florida development, was born at Hopewell, N.Y., on Jan. 2, 1830. About 1850 he became a grain dealer and accumulated a small fortune, but lost it in a salt-manufacturing venture. He borrowed money in 1867 and entered into partnership with John D. Rockefeller and others who owned oil refineries. The business was incorporated as the Standard Oil company in 1870. In later life he built palatial hotels in Florida and extended the Florida East Coast railway from Daytona to Miami and from there to Key West on bridges and causeways which later became part of a highway following the same route. He died in West Palm Beach, Fla., on May 20, 1913. (H. J. Sc.; X.)

FLAGSTAD, KIRSTEN MALFRID (1895–1962), Norwegian opera singer and the greatest Wagnerian soprano of the mid-20th century, was born at Hamar on July 12, 1895, into a family of professional musicians. She studied singing in Oslo with Ellen Schytte-Jacobsen, making her operatic debut in D'Albert's *Tiefland* at the National theatre, Oslo, on Dec. 12, 1913. She worked principally as a light soprano until 1928 when she joined the Storm theatre in Göteborg. In 1932, after a period of retirement following her second marriage, she found that her voice had become heavy enough to undertake Wagner's Isolde. In 1933 and 1934 she sang at the Bayreuth festival and made her debut at the Metropolitan Opera, New York city, as Sieglinde on Feb. 2, 1935. A year later, on May 18, followed her debut at Covent Garden Opera house, London, as Isolde. In this role and as Brünnhilde her greatness was at once recognized. The outbreak of war found her in the United States; she returned to Norway in 1941. Wartime retirement brought still more grandeur to her voice. Besides the great Wagnerian roles, Flagstad made memorable appearances in Gluck's *Alceste,* in Beethoven's *Fidelio* and in Purcell's *Dido and Aeneas.*

In 1953 she retired from public singing but continued to broadcast and make phonograph records. She was appointed director of the Royal Norwegian opera on its formation in 1958 but illness

forced her to resign in 1960. She died in Oslo on Dec. 7, 1962.
(WL. S. M.)

FLAGSTAFF, a city of northern Arizona, U.S., seat of Coconino county. Of the 60 sq.mi. within the city limits about 48 sq.mi., comprising Coconino national forest lands, are unoccupied. Arizona State college, founded in 1899, the Lowell observatory, the Naval observatory's Flagstaff station, the Atmospheric Research observatory and the Museum of Northern Arizona are located in Flagstaff. Once a mere cow-and-lumber town, it became a tourist centre, the railhead for the Glen canyon dam, 135 mi. N., the base of extensive logging and lumber operations and a trading centre for ranchers. The average annual precipitation is 19 in.; the altitude is 6,900 ft. Nearby are the Grand canyon, Oak Creek canyon, Hopi and Navaho reservations and five national monuments. Lumberjacks celebrating the 4th of July, 1876, nailed a U.S. flag to the top of a tall pine and called the unnamed settlement Flagstaff. A council-manager form of government was adopted in 1958. For comparative population figures *see* table in ARIZONA: *Population.*
(GA. D.)

FLAHAUT DE LA BILLARDERIE, CHARLES AUGUSTE JOSEPH, COMTE DE (1785–1870), French army officer and diplomat, better remembered for his exploits in gallantry than for his not inconsiderable public services, was born in Paris on April 21, 1785. His mother, Adèle Filleul, later marquise de Souza Botelho (*q.v.*), was then the wife of the comte de Flahaut (Alexandre de Flahaut de la Billarderie; beheaded at Arras in 1793), but Charles was generally recognized to be the offspring of her liaison with Talleyrand, with whom he was to be closely connected throughout his life. During the Revolution, his mother took him into exile in 1792, and they remained abroad until 1798. He entered the army as a volunteer in 1800 and received his commission after the battle of Marengo. He became aide-de-camp to Joachim Murat (and the lover of Murat's wife, Caroline) and was wounded at Enns, in Austria, in 1805. In Warsaw he met Anna Poniatowska, Countess Potocka, who became his mistress. He served in Portugal (1807), in Spain (1808) and then in Germany. Meanwhile Countess Potocka had established herself in Paris, but Flahaut was now the lover of Hortense (*q.v.*) de Beauharnais, queen of Holland, by whom he had a son, known later as the duc de Morny (*q.v.*). Flahaut fought in the Russian campaign of 1812 and in 1813 became general of division and aide-de-camp to Napoleon. After Napoleon's abdication in 1814 he was placed on the retired list. The Hundred Days brought him into active service again, but his mission to Vienna to secure the return of Marie Louise came to nothing. He was saved from exile by Talleyrand's influence but was placed under police surveillance. Later he settled in England, where in 1819 he married Margaret Elphinstone, afterward Baroness Keith in her own right. The French ambassador opposed the marriage, and Flahaut resigned his commission. His eldest daughter, Emily Jane, married Henry, 4th marquess of Lansdowne.

Flahaut returned to France in 1827, and in 1831, under the July monarchy, he was made a peer of France. He remained intimately associated with Talleyrand's policy and was ambassador in Berlin for a short time in 1831. He was afterward attached to the household of Ferdinand, duc d'Orléans. He was ambassador to Vienna from 1841 to 1848, when he was dismissed and retired from the army. After the *coup d'état* of 1851 he was again actively employed and from 1860 to 1862 was ambassador in London. He died in Paris on Sept. 1, 1870.

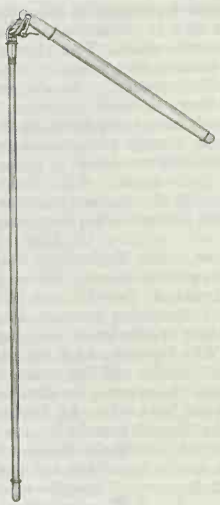
See A. de Maricourt, *Madame de Souza et sa famille* (1907).

FLAHERTY, ROBERT JOSEPH (1884–1951), U.S. film maker and explorer, called the father of the documentary film, was born at Iron Mountain, Mich., on Feb. 16, 1884. His *Nanook of the North* (1920–22), based on 16 months of living with and photographing Eskimos, set a new standard for dramatic interpretation of a way of life. In a review of his Samoan film, *Moana*, in the *New York Sun* (Feb. 8, 1926), John Grierson first called Flaherty's methods documentary. Flaherty collaborated with F. W. Murnau (*Tabu*, 1929–31) and John Grierson (*Industrial Britain*, 1933) and then spent 18 months on a tiny ocean-battered Irish island, filming *Man of Aran* (1933). He worked for Alexander Korda on *Elephant Boy*, for the U.S. Film service and Pare Lorentz on *The Land* (1941) and for the Standard Oil company on *Louisiana Story* (1948). His death occurred at Dunnerston, Vt., on July 23, 1951.

Flaherty preferred filming life in faraway places, declaring that primitive man had a freedom that modern man has lost. His inexhaustible curiosity and patient, probing camera provided accepted models of excellence for all nonfiction film makers. He was also the author of two novels and of *A Film-Maker's Odyssey* (1939). *See* also MOTION PICTURES: *The Art of Motion Pictures.*

See Richard Griffith, *The World of Robert Flaherty* (1953).
(R. D. MACC.)

FLAIL, a farm hand-implement used for threshing grain. A flail consists of two pieces of wood, the handstaff or helve and the beater, held together at one end by a thong. The former usually is a light rod about 5 ft. long, and the latter a cylinder about 30 in. long and $1\frac{1}{4}$ in. in diameter. With this implement one man could thresh 7 bu. of wheat, 8 of rye, 15 of barley, 18 of oats or 20 of buckwheat in a day. The flail is of immense but unknown antiquity, and until the middle of the 19th century flailing by hand was one of the chief methods of threshing. Variants were still used in less developed areas, such as west China, in the second half of the 20th century, and variants were used on vegetable and flower seeds and special crops when the quantity involved did not justify a special machine.



BY COURTESY OF SMITHSONIAN INSTITUTION
AMERICAN FLAIL OF THE 19TH CENTURY

FLAMBARD, RANULF (d. 1128), Norman bishop of Durham and chief minister of William II, went to England in the reign of William I. He served as a clerk in the royal chancery, where he rose (*c.* 1083) to be keeper of the king's seal. The Domesday survey (1086), which he may well have helped to organize, shows that he was then well endowed with numerous small estates, especially in Hampshire. Under William II he became the king's chaplain and was described as "chief agent of the royal will." For a time he was chief justiciar, *i.e.*, one of the principal administrative officers of the crown, and he was regularly among those leading men left in charge of affairs during William's absences from the kingdom. Ranulf's chief field of activity was finance, and under William II he had a general oversight and control of the royal fiscal system. He raised vast sums in taxation and earned notoriety for his extortionate exactions especially from ecclesiastical landowners. He undoubtedly kept churches in his hands during vacancies, exploiting their revenues not only for the king but also for himself. His unpopularity among the chroniclers can be taken as proof of his fiscal efficiency, but his plan to revise and equalize the tax assessment of the whole of England was never put into effect.

Under William II Ranulf's preferment was steady. He was given the collegiate churches of St. Martin's, Dover and Christchurch, Hampshire. As dean of Christchurch, he appropriated the canons' revenues to begin the rebuilding of the church. In 1099 he was appointed to the rich see of Durham, yet continued as a royal administrator. On the death of William II, Henry I imprisoned him in the Tower as the scapegoat for the late king's tyranny, but early in 1101 he escaped to Normandy and incited Duke Robert to invade England. Ranulf was restored to royal favour and to his bishopric (1101), but he remained influential in Normandy where he secured control of the bishopric of Lisieux

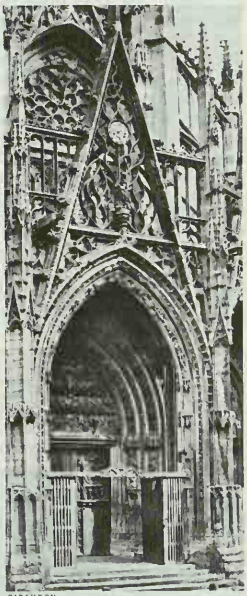
by enforcing the appointment first of his brother and then of his young sons. Though loyal and useful to Henry I, Ranulf never regained his old position as chief royal minister. Instead he applied his skill to administering the large diocese of Durham, treating the monks of his chapter with severity, and spending much on the completion of the great cathedral and on building the border fortress of Norham.

See R. W. Southern, "Ranulf Flambard and Early Anglo-Norman Administration," *Transactions of the Royal Historical Society*, 4th series, vol. xvi (1933). (G. W. S. B.)

FLAMBOROUGH HEAD, a promontory in Yorkshire, Eng., where the Yorkshire wolds, northernmost section of the English chalk hills, project 4 mi. into the North sea between Filey and Bridlington bays. Sea birds breed on the 400-ft.-high northern cliffs. The extremity, where there is a lighthouse 214 ft. above sea level, is fretted into bays, stacks and caves. Flamborough, a fishing village, is 2 mi. inland and midway between the north and south landings. A pre-Roman earthwork (Dane's Dyke) crosses the headland 3 mi. inland. Spectators lined the cliffs on Sept. 23, 1779, to watch the American John Paul Jones in the "Bon Homme Richard" win a bloody victory over H.M.S. "Serapis."

(G. DE BO.)

FLAMBOYANT STYLE, in architecture, the last phase of the Gothic in France, characterized by the dominance in tracery (*q.v.*) of the line of double curvature, known as the "ogee curve," which generates the flamelike forms that give the name flamboyant to the style. Flamboyant forms begin to appear in the late 14th century, as in one of the chapels of Amiens cathedral (1373). By the middle of the 15th century they were almost universal. Borrowing from the English the idea of the reversed curve and of flowing tracery, the French developed them with greater freedom (*see* DECORATED PERIOD and GOTHIC ARCHITECTURE). The best flamboyant tracery is often simpler and more direct than the English curvilinear work; grace of form and attenuation of line, a restrained use of cusps and generally slim proportions are the aims sought. In the 16th century, tracery returned to lower and more stumpy proportions with a great use of round and elliptical arches.



GIRAUDON

DOORWAY OF THE CHURCH OF ST. MACLOU, ROUEN, FRANCE, AN EXAMPLE OF FLAMBOYANT STYLE

All work of the flamboyant period is characterized by lavishness of detail, multiplication of miniature niches, fantastic and elaborate crockets, pierced, traceried gables, curved-sided pinnacles and the practice of intersecting and interpenetrating moldings of different profiles as, for instance, a cornice and a raking gable mold. Double and triple bases are frequent, the upper bases being penetrated by projecting shafts which have their own bases below. Among the outstanding examples of the style are the church of St. Maclou at Rouen (begun 1432); St. Wulfram at Abbéville (1480); upper part of the cathedral at Rouen (1481–92); the Palais de Justice at Rouen (*c.* 1500); north transept of the cathedral of Beauvais (1500–48); and the spire of the northwest tower of the cathedral at Chartres (1506). (T. F. H.; P. F.)

FLAMBOYANT TREE (*Delonix regia*), a strikingly beautiful flowering tree of the pea family (Leguminosae); other common names are royal poinciana, flame tree and peacock flower. Although native to Madagascar, it has been widely planted elsewhere in frost-free regions for its scarlet to orange flowers and its shade. It is a rapid grower, attaining 20–40 ft. in height, with one- to two-foot-long, pinnately divided leaves.

FLAME, as a phenomenon of the physical world, is generally understood to be burning gas. Its prerequisite is the formation of an explosive mixture, as, for example, coal gas and air. If such a mixture is ignited by a spark or small flame, the combustion spreads from the ignition source to the adjacent layer of gas mixture; in turn, each point of the burning layer serves as an ignition source for the next adjacent layer, and so on. In this way, reminiscent of Christiaan Huygens' principle for the propagation of a light wave, a combustion wave (also called flame front, combustion zone) is formed which propagates through the gas mixture leaving in its wake hot burned gas. (*See* also COMBUSTION.) The mixture propagates a flame only above some minimum and below some maximum percentage of fuel gas. These percentages are called the lower and upper limits of inflammability. Mixtures of average coal gas and air, for example, will not propagate flame if the proportion of gas is less than about 5% or more than about 31%. For natural gas the limits are about 4% and 15%, respectively. If the mixture is enclosed in a small vessel, or if it flows through a narrow tube, the chilling effect of the wall of the vessel narrows the limits of inflammability; and below some critical diameter whose exact magnitude depends mainly upon the nature of the fuel gas and the temperature of the enclosure, flame is quenched altogether, even if the mixture ratio is the optimum for combustion of the fuel gas to carbon dioxide and water vapour.

The combustion wave travels against the unburned mixture at a definite velocity, called the burning velocity. This velocity depends upon the composition of the mixture, increasing from zero at the two limits of inflammability to a maximum at some intermediate percentage of fuel gas. It does not exceed 270 cm. per second for air and hydrogen (hydrogen, the fastest-burning gas, comprises about 50% of coal gas) and about 50 cm. per second for most other common fuel gases; it remains much less than 1,000 cm. per second for mixtures of fuel gases with oxygen, except under conditions of turbulence or detonation (*see* COMBUSTION). Close to chilling surfaces the burning velocity always drops to zero. The distance over which the chilling is effective, the "quenching distance," is a well-defined measurable quantity. It increases as the composition of the mixture changes from the optimum to either the lean or rich side and decreases as the temperature of the wall is raised. It does not exceed 2 mm. for common fuel gases and air, and drops to the order of 0.01 mm. for mixtures of oxygen and hydrogen or acetylene.

Depending upon the conditions of mixture formation and gas flow, several types of flame structure may be distinguished and are described below.

Diffusion Flame.—Consider a slow stream of fuel gas flowing from a tube into the open atmosphere. From the mouth of the tube upward air diffuses across the boundary of the stream toward the centre of the stream and forms an envelope of explosive mixture around a core of flowing fuel gas. This latter core diminishes with height until, at some distance above the tube, it has disappeared. It thus assumes the shape of a cone. Near the surface of the cone the mixture is overrich in fuel, and farther outward it becomes progressively leaner. On ignition a combustion wave rapidly spreads through the whole envelope of explosive mixture, pressing forward from the faster-burning outer layers to the slower-burning inner layers until it hugs the cone of fuel gas. The wave is now in a position of equilibrium, being unable to penetrate farther into the gas stream because oxygen necessary for combustion is lacking there, and also unable to detach itself because the increased burning velocity in the oxygen-enriched outer layers would drive it back again toward the cone. The combustion zone thus maintains itself as a hollow cone above the tube, while the gas stream passes continually through it, carrying with it fresh molecules of fuel gas and sweeping away the hot combustion products (water vapour and carbon dioxide) and the incombustible atmospheric nitrogen which remains after the oxygen is consumed. At the same time, fresh air is penetrating by diffusion into and against this stream of hot burned gas, to meet the fresh fuel gas

in the combustion zone; and by the same process of diffusion a fraction of the burned gas, and also a fraction of the heat of combustion, penetrates into and against the inner cone of flowing fuel gas, diluting and heating it. Since common fuel gases contain hydrocarbons which at high temperature crack to form hydrogen and free carbon, the inner cone thus acquires a shell of hot, carbon-bearing gas adjacent to the combustion zone. This shell increases in thickness from the base of the cone upward. The hot carbon particles, being small, solid bodies, glow brightly and impart to flames of this type their characteristic luminosity. They burn in contact with oxygen at high temperatures. They accumulate readily on chilling surfaces; and when there is an oxygen deficiency in the stream, they cool below their ignition temperature and escape as soot into the atmosphere.

The combustion zone is visible as a faint bluish glow surrounding the inner cone. In a carbon-monoxide flame, which does not form free carbon and whose inner cone thus remains completely dark, the combustion zone is the only source of luminosity. This glow is chemiluminescent in character. The hot combustion products emerging from the zone emit no visible light but only infrared radiation of certain wave lengths.

In the flame of a candle or pocket lighter, liquid fuel is drawn into the wick by capillary suction and volatilized over the exposed length of the wick by heat supplied from the surrounding combustion zone. The quantity of streaming vapour, and therefore the height and volume of the flame, can thus be regulated by adjusting the length of the wick. In a candle the wick consists of braided cotton yarn in the form of a flat band which rises from a little pool of molten paraffin and curls over so that its tip projects into the air and burns. It thus remains constant in size. The wick material is chemically treated so that the ash residue is fusible and does not form a skeleton but collects at the tip in the form of a small bead. In the early days of straight-wicked tallow candles (the wick being merely twisted) the wick did not regulate itself and had to be cut from time to time ("snuffing the candle"). Irregularly shaped diffusion flames are also formed by burning wood, bituminous coal and other materials which give off combustible gases on heating.

When a gas stream issuing into the stagnant atmosphere has reached a certain height, it curls up into vortices which follow each other at more or less regular intervals. In large flames, vortices of combustion products may form around burning portions of the flame, shutting off the supply of oxygen, and the unburned core momentarily elongates, then contracts again as the vortex is carried away. This may repeat itself periodically, giving rise to the flicker of flames, sometimes accompanied by sooting. The regular rounded cone shape is lost.

If the flame is placed in an open, upright cylinder, the resulting chimney effect carries the air along with the burning gas; this eliminates the tendency to form vortices, and the flame is correspondingly steadied.

If air is added to fuel gas, the mixture still being above the upper limit of inflammability, the flame continues to burn by diffusion, though the combustion zone moves deeper into the core of fuel gas and less carbon is formed. The region of vorticity then is confined to the invisible burned gas well outside the luminous zone and a steady flame of regular rounded-cone shape results.

If sufficient air is added so that the mixture is below the upper limit of inflammability, an inner combustion zone is formed, surrounded by an outer mantle; the latter continues to burn as a soot-free diffusion flame as long as the volume of air in the stream is less than required for complete combustion (*see* below).

Flames of Turbulent Jets.—When a gas stream issuing from an orifice into the atmosphere exceeds a certain critical velocity, it breaks up into a turbulent jet which entrains the surrounding air and broadens out in the form of a cone. The flame in such a jet consists of a highly irregular interplay of vortices of gas and air mixture, forming transitory random patches of combustion waves throughout the jet, and no cohesive combustion surface exists. The hissing or roaring sound associated with turbulent jets is augmented by the combustion, and such flames are often very noisy. With common fuel gases the burning velocity is too low, and the flame readily blows off the jet, unless an effective pilot flame is provided at the base of the jet. A successful design consists in blowing a jet of oxygen from an orifice mounted concentrically in the mouth of a much wider tube, from which a comparatively slow stream of fuel gas flows. The oxygen jet entrains most of the fuel gas; however, some of the gas burns from the wide mouth as a slow diffusion flame that serves as a pilot for the jet flame.

Flames of Streams of Explosive Mixture.—Consider a mixture (*e.g.*, coal gas and air) of a composition well within the explosive range, flowing from a tube into the atmosphere. From some point of ignition, a combustion wave spreads out until it forms a continuous surface over the whole cross section of the stream. This surface can be distorted into various shapes by uneven gas velocities, but by the principle of wave propagation it maintains its continuity and propagates as a unit against the flow of unburned gas, in a contest between the burning velocity and the gas velocity. Three cases may arise: (1) if the gas velocity exceeds the burning velocity everywhere along the surface, the combustion wave blows off into the atmosphere and becomes extinct; (2) if the gas velocity is at any point smaller than the burning velocity, the combustion wave flashes back against the stream; and (3) if the gas velocity is maintained equal to the burning velocity at some point, though exceeding it everywhere else, the combustion wave becomes fixed in the gas stream and forms a stationary flame.

The gas velocity is zero at the boundary of the stream as a result of friction and rises steadily in the direction of the centre of the stream. Fig. 1(A) shows the conditions within the tube. The heavy curve shows the magnitude of the burning velocity near the wall. It is zero within the quenching distance, and beyond this distance it rises to a constant value. The other lines are curves of the gas velocity for three different gas flows. If the flow corresponds to curve 1, the gas velocity falls partly below the burning velocity, and the flame flashes back through the tube. If the flow corresponds to curve 2, the combustion wave can theoretically maintain itself at any position in the tube. In practice, however, it will not be possible to regulate the gas flow with the absolute accuracy required for this purpose. If the flow corresponds to curve 3, the gas velocity is everywhere larger than the burning velocity, and the flame is blown out of the tube.

In the latter case, as the combustion zone moves past the rim of the tube, it enters a region over which the chilling effect of the wall of the tube is gradually reduced, and consequently the curve of the burning velocity shifts toward the boundary of the stream. This is illustrated in fig. 1(B). Three burning-velocity curves are shown, corresponding to three heights, X, Y and Z, above the rim. At height X, close to the rim, the burning-velocity curve is about the same as in the diagram of fig. 1(A). At height Y it has shifted toward the boundary. At height Z the shift has become a maximum; here the chilling effect of the tube is small; nevertheless, the burning velocity drops to zero because the mixture is diluted by

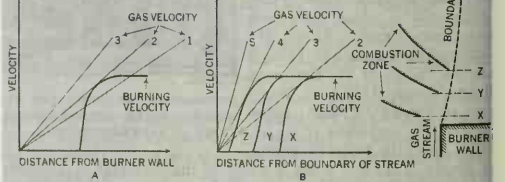


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FIG. 1.—(A) BURNING VELOCITY AND GAS VELOCITY INSIDE THE BURNER TUBE. CURVE 1, FLASH BACK; CURVE 2, FLASH-BACK LIMIT; CURVE 3, NO FLASH BACK. (B) BURNING VELOCITY AND GAS VELOCITY ABOVE THE TUBE RIM. CURVES X, Y, Z, BURNING VELOCITY AT HEIGHTS X, Y, Z; CURVE 2, FLASH-BACK LIMIT; CURVE 3, STABLE FLAME; CURVE 4, BLOWOFF LIMIT; CURVE 5, BLOWOFF

interdiffusion with air and because the adjacent air is carried along by the stream, thus forming an outermost boundary of nonexplosive gas. At greater heights the nonexplosive boundary layer broadens and correspondingly the burning-velocity curve recedes from the boundary; hence, if the gas velocity is as large as shown in curve 5, it exceeds the burning velocity everywhere and the flame blows off the tube. At any flow between limiting curves 2 and 4 the flame settles down to such a height above the rim that gas-velocity curve and burning-velocity curve meet each other tangentially. For example, let us suppose that the gas stream is adjusted to correspond to gas-velocity curve 3. If the combustion zone drops below height Y, the burning-velocity curve shifts to the right, the gas velocity is larger everywhere, and the combustion zone lifts up again toward height Y. If it should exceed this height, the burning-velocity curve shifts to the left, the gas velocity falls below the burning velocity at some distance from the boundary, and the combustion zone is driven back to its equilibrium position at height Y.

The flame thus remains stable between a critical lower and upper gradient of the gas velocity at the stream boundary, represented by the slopes of curves 2 and 4 and corresponding to flash back and blowoff, respectively. For a flame burning in air, the blowoff gradient increases sharply as the mixture is enriched with fuel gas, because in this case the interdiffusing air increases the burning velocity at the boundary, and blowoff can occur only when an appreciable layer of outer air is carried along by the stream. Rich flames are therefore much more stable. However, if the surrounding atmosphere does not consist of air, but of some inert gas, such flames blow off readily.

The critical boundary velocity gradients are measurable, and by means of hydrodynamic equations of flow they permit calculation of the stability of flame at any flow for various burner tubes.

In a stable flame the combustion wave is thus anchored to the rim of the tube, while inside the stream—where the gas velocity exceeds the burning velocity—it is blown up to a cone which is clearly visible because of its bluish or greenish luminosity. The angle of the cone surface against the direction of the gas flow is everywhere such that the burning velocity equals the component of the gas velocity normal to the surface; this is the condition of equilibrium governing the shape of the cone. If the flow lines remained parallel to the stream axis and if the combustion wave were a very thin mathematical surface moving everywhere with constant velocity, the tip of the cone would be exceedingly sharp and pointed. However, at the tip the flow lines diverge in fan-shape manner, and the combustion wave (being of not inconsiderable width) is disposed in a curve so that the various wave layers meet the above condition. Hence the luminous layer at the tip appears as a rounded dome.

The blowoff stability of a flame can be considerably increased by placing some solid object in the middle of the stream where dilution of the boundary by the surrounding air does not penetrate. The combustion wave anchors itself to such objects by the same process as described before, but the conditions within the stream favour stability at higher gas velocities than before. The principle of placing an obstacle inside the gas stream is widely used in flame-retaining devices and in grids for flame ports.

Flame Temperature.—The temperature in the luminous part of a candle flame and similar diffusion flames is generally lower than 1,500° C. In a flame of coal gas and air of optimum composition the temperature may be as high as 2,000° C., and in a corresponding natural-gas flame, 1,900° C. These figures increase if the gases are preheated before combustion. A gas-air flame cannot be used for welding and similar operations, although its temperature much exceeds the melting point of steel, because the heat is not delivered rapidly enough to overcome losses by radiation from the heated surface and conduction to colder parts of the metal. Oxygen-acetylene flames used for such operations are not only hotter but also deliver a much more rapid and concentrated heat flux as a result of the high burning velocity of such mixtures. The performance of gas-air flames is improved in blast lamps and blowtorches, which deliver rapidly a great volume of flame gas; such flames are used by glass blowers and plumbers.

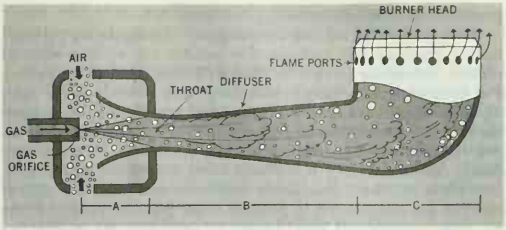

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FIG. 2.—AIR INJECTION BURNER. APPLICATION OF THE VENTURI PRINCIPLE TO OBTAIN UNIFORM DISTRIBUTION OF THE GAS MIXTURE TO THE FLAME PORTS: (A) TURBULENT GAS JET ENTRAINS AIR; (B) VELOCITY DECREASES, STEAM MOMENTUM IS TRANSFORMED INTO PRESSURE; (C) SLOW-MOVING, SLIGHTLY COMPRESSED GAS MIXTURE FLOWS UNIFORMLY THROUGH THE FLAME PORTS

Burners.—In air-injection gas burners used for domestic gas ranges and many industrial applications, the fuel gas issues from a small hole—the orifice—as a turbulent jet which entrains the surrounding air; the turbulent, fast-flowing mixture is then distributed to the flame ports by means of a Venturi duct (fig. 2). In this gradually expanding duct the gas motion decreases and a slight pressure is built up which forces the mixture uniformly through the portholes and thus permits any desired pattern of small flames on the burner head. The percentage of air in the mixture increases when the orifice is made smaller or the flame ports are enlarged. In the design of such burners, the tendency has been to keep the volume of entrained air noticeably below that required for complete combustion because in this way better flame stability is obtained; hence, a part of the fuel gas burns in the outer mantle by diffusion (*see* above). Air shutters are usually provided around the jet. The flame ports are spaced close together to form a grid, which further stabilizes the flame. Burners with closely spaced square grids are known as Méker burners.

In the ordinary Bunsen burner (*q.v.*) only a single flame is wanted; hence, a Venturi duct is unnecessary and the jet is passed into a short straight tube within which the turbulence subsides somewhat. The gas flow and air shutters are adjusted to produce a stable flame at the outlet of the tube. Enough turbulence usually persists to produce an unruly and slightly noisy flame. This is much more pronounced in the plumber's blowtorch; here a large jet of hot gasoline vapour burns partly in the zone of turbulent air entrainment. Such jet flames blow off readily and must be stabilized; this is accomplished by a perforated tube around the jet. The perforations near the jet base admit air and farther along the tube serve as a grid for a flame attachment. The tube also passes enough heat back to the fuel line to vaporize the liquid fuel. The latter is usually delivered to the jet by air pressure from a hand pump. The blowtorch must be primed before use by heating the perforated shield and the fuel line with a flame; otherwise, liquid fuel spurts from the orifice and no vapour jet is formed.

Burners in which a jet of air or oxygen is passed into fuel gas are termed blowpipes or blast lamps. As mentioned above, the jet flame is stabilized by the surrounding slow-burning diffusion flame of the portion of fuel gas that is not entrained by the turbulent jet (fig. 2). By using jet nozzles of various orifice diameters, and adjusting the control valves, sharp flames of very small and very large size can be produced. Burners of this type are made as hand torches and desk burners and are widely used for glass blowing and soldering. For blowing quartzware, blast lamps burning hydrogen and oxygen are suitable. The mouth blowpipe, a conical brass tube curved at the small end and terminating in a small round orifice, was first adopted for testing minerals in the 18th century. A small jet flame is blown within an alcohol flame and directed against a small sample of the mineral on a piece of charcoal or some other support. The flame gas above the jet tip tends to reduce and, below, to oxidize the sample. A grain of lead ore is thus alternately reduced to a small globule of metal and oxidized to a characteristic red and yellow oxide. Other minerals

give various other characteristic reactions.

Hand torches for welding are equipped with regulating valves, a mixing chamber and exchangeable nozzles for various sizes of orifices, depending on the thickness of the material to be welded. For oxyacetylene welding, which came into general use in 1900, an approximate 1:1 ratio of oxygen and acetylene is maintained because the resulting normal or neutral flame, as it is called, is the one required in practically all welding operations. This neutral flame, characterized by a brilliant, white inner cone and a faint, blue outer envelope, also serves as a reference point for adjustment of gas composition to produce other types of flame. If the gas ratio is increased with respect to acetylene, the carburizing flame, which is easily recognized by its additional zone of luminosity, is obtained; flames of this type are employed in welding steel and in hard-facing processes. Similarly, an increase in oxygen concentration gives rise to the oxidizing flame, which differs slightly in appearance from the neutral flame by reason of its shorter inner cone and which finds its special application in the welding of brass and bronze.

The cutting of iron and steel, as distinguished from welding, consists in raising the material to its ignition temperature and continuously oxidizing it with a stream of oxygen. In addition to the chemical reaction, there is a mechanical eroding effect of the oxygen stream which assists in the cutting process by washing molten metal out of the cut. Hence the tip of a cutting torch contains a central orifice supplying the cutting jet of oxygen surrounded by several other orifices which deliver the oxyacetylene mixture necessary for the preheating flame. In practice the preheating flame must be maintained during the cutting to compensate for heat losses by conduction and radiation. Industrially, use of the oxyacetylene flame has taken precedence over that of the oxyhydrogen flame, since the maximum temperature of the former is more than 400° C. higher than the highest temperature achieved in the oxyhydrogen flame.

The atomic hydrogen flame and its mode of generation are basically different from all other oxy-fuel-gas flames. Thus, the arc welding torch bears little resemblance to the common gas welding torch. It consists principally of a pair of tungsten electrodes around which a stream of hydrogen gas is passed. The action of the electric arc produces a dissociation into atomic hydrogen, the formation of which is visible as a pink cone-shaped area above the electrodes. This is the characteristic colour of the Balmer series spectrum of atomic hydrogen. On recombination of the hydrogen atoms the heat of formation of molecular hydrogen is liberated, which is responsible for the attainment of the high flame temperature (about 3,800° C.). Aside from the development of temperatures higher than those of other arcs and gas flames, the hydrogen atmosphere excludes contaminating gases, such as oxygen and nitrogen, from contact with the weld.

Fluorine and hydrogen are distinguished by a very high heat of reaction and a low specific heat of the reaction product, hydrogen fluoride. These, coupled with the fact that hydrogen fluoride is very stable and thus dissociates very little, result in exceedingly high flame temperatures between 4,000° and 5,000° C.

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FLAMEN, in ancient Rome, a priest devoted to the service of some one deity. There were 15 *flamines*, 3 *maiores*, the Dialis, Martialis and Quirinalis, serving respectively Jupiter, Mars and Quirinus, and 12 *minores*, of whom we can name 10; the Volcanalis, Cerialis, Carmentalis, Portunalis, Volturnalis, Palatualis, Furinalis, Floralis, Falacer and Pomonalis; of their deities, Volcanus (Vulcan), Ceres, Carmentis, Volturnus, Flora and Pomona are more or less well known, the others obscure. Emperor worship brought a new set of flamens, the *flamines Divorum*, in the service of dead and deified emperors.

The older flamens formed a group, *sacerdotium*, under the control of the Pontifex Maximus (*see* PONTIFEX); the *flamines Divorum* seem to have been attached to the college of pontiffs. The former had a distinctive dress, its outstanding feature being the *apex*, a kind of spiked cap. All had to be patricians; the *flamines maiores* had to be born of parents married by *confarreatio*, the ancient and practically indissoluble rite. The flamen Dialis must also live in a confarreate marriage; if his wife, the *flaminica*, died, he laid down his office (normally held for life). She and certain children, presumably his own if he had any, had some part in the ritual. He was hemmed about with an extraordinary network of tabus, intended to guard him against bloodshed, bonds, warfare or secular occupations, for he was always devoted to the service of Jupiter and must never be absent from Rome for more than three nights. Consequently it was almost impossible for him to hold a secular magistracy. The restrictions on the other flamens were lighter, though some existed.

We occasionally hear of a flamen, not one of the regular ones, attached to some corporation or priesthood.

See G. Wissowa, *Religion und Kultus der Römer*, 2nd ed., pp. 504 ff. (1912). (H. J. R.)

FLAME PHOTOMETRY is the study of spectra emitted in flames. The atoms of each element exhibit characteristic spectra; the wave lengths of light which they emit or absorb are invariable for all practical purposes. These spectra are emitted readily when elements are exposed to the very high energies of an electric arc, spark or high-temperature flame. The light emitted is seen as discrete lines when viewed through a suitable spectroscope, and its intensity depends on the amount of the element energized. Measurement of the wave lengths and intensities of light emitted by the excited atoms therefore constitutes a convenient device for qualitative and quantitative analysis (*see* SPECTROSCOPY).

The principles of flame spectroscopy were established in the middle and late 19th century. The construction in 1945 of a photoelectric flame photometer employing filters placed its practical utilization on a firm basis. The instrument, called a flame photometer, proved extremely popular for the simple, sensitive and precise analysis of sodium and potassium. Since this time, the field of flame photometry has become of the greatest scientific, medical and industrial importance. Studies of large numbers of fuels, burners and photoelectric detection devices have extended the analytical applications to many elements contained in materials varying from rocks, alloys and metals to biological tissues. Very sensitive applications are limited to the elements of the first two groups and the first transition group of the periodic table (*see* PERIODIC LAW), but in particular to those which require relatively little thermal energy to emit light. The advent of very hot flames in the 1950s began to remove this limitation.

All substances are prepared for flame photometry by similar procedures. The sample is dissolved in a liquid which is then aspirated and sprayed into a flame. The emitted light enters a spectrograph which isolates the wave lengths to be measured by means of a filter, prism or grating. A photocell receives the light and converts it into electric energy which in turn is displayed by a meter. A millionth of a gram in one millilitre of fluid is readily measured with a precision of 1% to 2%. Modern instruments permit the simultaneous measurement of several elements—instead of one at a time—by the employment of multiple photoelectric receivers. Such instruments are called flame spectrometers. Flame photometry has brought about the development of completely new areas of knowledge. An example in medicine is the field of salt and water or electrolyte metabolism, which was virtually nonexistent prior to the advent of the flame photometer. This instrument has revolutionized the recognition and treatment of a wide variety of conditions. *See* also SPECTROCHEMICAL ANALYSIS.

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FLAME THROWER. A military assault weapon that projects a stream of blazing oil or thickened gasoline against enemy

positions. As used in World War II and the Korean War it consisted basically of one or more fuel tanks, a cylinder of compressed gas to supply the propelling force, a flexible hose connected to the tanks and a trigger-nozzle equipped with some means of igniting the fuel as it was spewed forth. The portable type, carried on the backs of ground troops, had a range of about 45 yd. and enough fuel for about 10 sec. of continuous "firing." Larger and heavier units installed in tank turrets could reach out more than 100 yd. and carried enough fuel for about 60 sec. of fire. To achieve maximum results, several short bursts were usually fired rather than one long blast.

Modern flame throwers first appeared in the early 1900s when the German army tested two models, one large and one small, submitted by Richard Fiedler. The smaller *Flammenwerfer*, light enough to be carried by one man, used gas pressure to send forth a stream of flaming oil for a distance of about 20 yd. The larger model, based on the same principle, was cumbersome to transport, but had a range of more than 40 yd. and enough fuel for 40 sec. of continuous firing. Favourably impressed, the German army adopted these weapons and used them with surprise effect against Allied troops in 1915. The British and French soon countered with flame throwers of their own, but none of the World War I types had sufficient range or duration of fire to be satisfactory. Their chief effect seems to have been to terrorize the troops they were used against.

All major powers employed flame throwers in later years, both the back-pack type and the tank-mounted variety. Based on the same principle as Fiedler's early models, they incorporated technical refinements that made them far more effective, though still limited in range and duration of fire. British and U.S. flame throwers were fueled with napalm, a type of thickened gasoline that carried much farther than ordinary gasoline, burned with intense heat and clung like jelly to whatever it touched. These fearsome weapons were valuable for attacking enemy troops, burning away camouflage material and probing underbrush or the gunports of enemy positions. They were especially effective in World War II against the defensive-type warfare of the Japanese who stubbornly defended their caves and coconut-log bunkers on Pacific islands. During the 1950s the U.S. army chemical corps developed a lightweight, one-shot portable flame thrower that could be used against fortified positions at close range or adapted for use as a booby trap.

See also CHEMICAL WARFARE; GREEK FIRE; NAPALM.

(H. C. T.)

FLAMINGO, the name for several species of large, pinkish water birds characterized by a remarkably long neck and long legs, webbed feet and a heavy ducklike bill bent abruptly downward. Related to herons (*q.v.*), they constitute the family Phoenicopteridae, in the order Ciconiiformes. They have black wing quills, and most are rosy-white with scarlet shoulders, but the American flamingo (*Phoenicopterus ruber*) is bright vermilion.

The American flamingo occurs on the Atlantic and Gulf coasts of tropical and subtropical America, breeding locally in large colonies along mud flats in the Bahamas, Cuba, Haiti, Yucatán, Guiana and formerly the Florida Keys. They are gregarious birds; flocks numbering hundreds may be seen in long, curving flight formations and in wading groups along the shore. In feeding, the flamingo tramps the shallows, stirring up organic matter, especially small mollusks and crustaceans, which it strains from the muddy water by means of its sievelike lamellated bill. The nest is a truncated cone of clayish mud piled up a few inches in a shallow lagoon; both parents share 30 days incubating the one or two chalky-white eggs that are laid in the hollow of the cone. Downy-white young, with short legs and straight bills, leave the nests in two or three days and are fed by regurgitation of partly digested food of the adults.

W. SUSCHITZKY

AMERICAN FLAMINGO (PHOENICOPTERUS RUBER)

Phoenicopterus antiquorum breeds in west-central Asia, northwest India, Caspian sea and Persian gulf, South Africa and the Cape Verde Islands. *P. chilensis* ranges from Peru and Uruguay to Tierra del Fuego. The smaller *Phoenicoparrus andinus* and *P. jamesi* live in Chilean and Argentine Andes, the latter to southern Peru. *Phoeniconaias minor* is abundant in the lake district of east Africa, also occurring in South Africa, Madagascar, northwest India and possibly Senegal.

Fossil forms have been found in France and Oregon. *See* also BIRD.

(G. F. Ss.; X.)

FLAMININUS, TITUS QUINCTIUS (*c.* 227–174 B.C.), Roman general and statesman famous as a philhellene. During the second Punic War he was military tribune under M. Claudius Marcellus (208 B.C.) and propraetor *extra ordinem* at Tarentum (205–204). He became quaestor (possibly in 199) and consul in 198 when he was scarcely 30. He was allocated the province of Macedonia and the conduct of the war against Philip V (*q.v.*), a task for which he was eminently suited. It was Roman policy to champion the autonomy of the Greeks against Philip and so win their support. Flamininus had the necessary convictions and personality: he had enthusiasm for Greek culture as well as tact and adaptability.

Arriving in Greece in 198 he realized that future peace depended on breaking Philip's power, not merely humbling him. He secured the support of the Achaean league and then negotiated with Philip at Nicaea in Locris. Though proposals were submitted to the senate, negotiations broke down in circumstances which suggest that Flamininus, whose command had now been prolonged, may have been guilty of some sharp practice. Fighting was resumed, and Flamininus brought the war to a close by his brilliant victory at Cynoscephalae (*q.v.*) in 197. He proposed wise and generous terms; namely, that Philip should abandon all his dependencies outside Macedonia but should retain his throne. Then at the Isthmian games at Corinth in 196 Flamininus reached his most glorious moment. To the assembled Greeks he proclaimed their freedom: all the Greeks in Europe and Asia were to be free and governed by their own laws. After difficulties and delays, in 194 Flamininus and his army finally evacuated Greece, leaving it free under Roman protection. Many Greek cities honoured their deliverer: he was hailed as "saviour" and received homage alongside the gods; he shared dedications with Heracles and Apollo, and he was granted a priesthood (which survived until the time of Plutarch); a gold coinage bearing his portrait was issued in his honour.

At Rome he celebrated a triumph. In 193 he supported the Roman championship of Greek autonomy in Asia Minor. In 192 he was sent to Greece where he checked Nabis (*q.v.*), the tyrant of Sparta, and tried to rally the communities against Antiochus III, the Syrian king, and to counter the pro-Syrian policy of the Aetolians. When nevertheless the Aetolians called in Antiochus, Flamininus succeeded in persuading the Achaean league to declare war on both. After the defeat of Antiochus at Thermopylae (191) he helped to settle Greece. After his censorship in 189 he played a lesser role. In 183 he was sent to Prusias, king of Bithynia, to demand the surrender of Hannibal. In Greece his prestige was less than might have been expected: the Achaean league humiliated him by refusing to meet at his request, and in Macedonia his encouragement of Philip's son Demetrius, who had been a hostage in Rome, raised a suspicion that he might be undermining the son's loyalty to the father. His earlier achievements had, however, been great; his idealistic philhellenic policy had been implemented with great skill in diplomacy and war, and he had enabled the Romans to establish a protectorate over an autonomous Greece, whose local jealousies he may have underestimated. He died in 174.

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FLAMINIUS, GAIUS (d. 217 B.C.), Roman popular leader who challenged the authority of the senate, came of a plebeian family. During his tribunate (232), despite the opposition of the senate and his own father, he carried a measure to distribute among the plebeians the *ager Gallicus et Picenus*, land south of Ariminum (Rimini) recently taken from the Senones. He was the first praetor to hold that office in Sicily (227). As consul in 223, he took the field against the Gauls, who were alleged to have been roused to war by his agrarian law. Having crossed the Po, he defeated the Insubres after disobeying a senatorial order. Despite the senate he was granted a triumph by popular vote. As censor (220) he built the Circus Flaminius on the Campus Martius and constructed the Via Flaminia to Ariminum. In 218 he was one of the chief supporters of the *lex Claudia* which had the effect of debarring senators from commercial activities. His election to a second consulship for 217 reflected popular criticism of the senate's conduct of the war against Hannibal. Flaminius hastened to cover the western Apennines at Arretium (Arezzo), but when Hannibal got past Flaminius marched south, probably to try to join his colleague Servilius who was advancing from Ariminum. He fell into Hannibal's ambush at Lake Trasimene (Trasimeno), where he and his army perished. A bold popular leader who dared to challenge the senate, he must bear the blame for the disaster at Trasimene, even if it be suspected that none of his contemporaries might more successfully have faced Hannibal's genius. Much of the ancient tradition, which is senatorial in outlook, is biased against Flaminius.

See also PUNIC WARS; TRASIMENUS, LAKE.

GAIUS FLAMINIUS, his son, was quaestor under Scipio Africanus and took part in the capture of New Carthage (209 B.C.). In 187 he was consul with Marcus Aemilius Lepidus and built a branch of the Via Aemilia connecting Bononia (Bologna) and Arretium. In 183 he served on the commission to found the colony of Aquileia (*q.v.*).

See K. Jacobs, *Gaius Flaminius* (1938: in Dutch); H. H. Scullard, *Roman Politics, 220–150 B.C.* (1951). (H. H. Sd.)

FLAMSTEED, JOHN (1646–1719), English astronomer and clergyman and first astronomer royal at the newly founded Greenwich observatory, was born at Denby, near Derby, on Aug. 19, 1646. He was educated at the free school of Derby, but was forced to leave in 1662 because of bad health. During his illness he began to study astronomy, observing a solar eclipse on Sept. 12, 1662, and corresponding with several astronomers. His early studies were communicated to the Royal society in 1670 and were published in the *Philosophical Transactions*, gaining him general scientific recognition. In 1670 Flamsteed entered his name at Jesus college, Cambridge, and in 1674 took a degree of M.A. by letters-patent. He was ordained in 1675. He attracted the attention of Sir Jonas Moore whose influence with Charles II secured for him the position of astronomical observator upon the establishment of the Greenwich observatory in 1675. Except for a few gifts from Moore, Flamsteed supplied all of his own instruments from his salary of £100 a year and the income of the living of Burstow, Surrey, bestowed upon him in 1684 by Lord North. On the death of his father in 1688, a small inheritance provided Flamsteed with the means to construct a mural arc, with which he began systematic observations on Sept. 12, 1689. The latter part of Flamsteed's life passed in a turmoil of controversy regarding the publication of his results. He struggled to withhold them for presentation in completed form, but they were urgently needed, by Sir Isaac Newton and by Edmund Halley among others, for the testing of current theories. Newton, through the Royal society, led the movement for immediate communication, whence arose much ill-feeling between him and Flamsteed. In 1704 Prince George of Denmark undertook the cost of printing, and, despite the prince's death in 1708 and Flamsteed's objections, the observations were printed. The *Historia coelestis*, embodying the first imperfect Greenwich star catalogue, was issued under Halley's editorship in 1712. Flamsteed denounced the production (400 copies) as surreptitious and later, when Newton's influence with the government declined, secured and burned 300 of them. Flamsteed died at Greenwich on Dec. 31, 1719.

The preparation of his monumental work, *Historia coelestis Britannica* (3 vol. folio, 1725), was finished by his assistants Joseph Crosthwait and Abraham Sharp. The first two volumes included the whole of Flamsteed's observations, the third the *British Catalogue* of nearly 3,000 stars. The extent and quality of his work, which forms the basis of modern star catalogues, were the more remarkable considering his severe physical sufferings and straitened means.

See F. Baily, *Account of the Rev. John Flamsteed* (1835). (O. J. E.)

FLANDERS, COUNTY OF, a powerful medieval principality in the southwest of the Low Countries, which occupied territories that are now divided between the French *département* of Nord, the Belgian provinces of East Flanders and West Flanders, and the Dutch province of Zeeland (*qq.v.*). The name appears in the 8th century and is believed to mean "flooded land." The pagus Flandrensis was at first an inconspicuous Frankish district, but a remarkable line of Flemish counts succeeded in erecting a quasi-independent state on the borders between the French and the German kingdoms out of French and German fiefs. As the treaty of Verdun (843) had made the Scheldt river the dividing line between West and East Francia, the count of Flanders came to be a vassal of the French king for what he held west of the Scheldt (Crown Flanders or Kroonvlaanderen, the most important part of his countship) and a vassal of the German king for what he held east of it (Aalst, etc.; collectively called Imperial Flanders or Rijksvlaanderen as part of the Holy Roman empire). Linguistically also Flanders was a borderland, including Romance-speaking and Germanic-speaking peoples.

The Counts of Flanders in the Middle Ages.—In the Carolingian period the pagus Flandrensis was the region around Bruges. The rise of the Flemish dynasty began when the count or official administrator of the pagus, Baldwin I Iron-Arm or Ferreus, married the Frankish king Charles II the Bald's daughter Judith in 862 and was established as count with control over a number of pagi between the North sea and the Scheldt. His son and successor, Baldwin II (count from 879 to 918), who married the English king Alfred the Great's daughter Aelfthryth, was the founder of the *de facto* autonomous county and reigned independently over a vast territory along the coast of the North sea; he fought the Danish raiders (invasion of 879–883). His son, Arnulf I the Great (918–965), continued the policy of independence and territorial expansion, extending the southern frontiers of Flanders to the Canche river; the main enemy at this time was Normandy. Arnulf's son Baldwin III, however, who had been associated with him as count from 959, died before him (962), and when Arnulf himself died an internal crisis broke out under the rule of his grandson Arnulf II (965–988); but authority was restored under the latter's son Baldwin IV (988–1035), who consolidated his internal position and resumed the expansionist policy. This count looked eastward, coveting imperial territory, and succeeded in conquering lands in the Scheldt estuary and also Valenciennes, an important town on the Scheldt; clearly he thought of the Scheldt as the natural frontier for Flanders on the east. His son Baldwin V (1035–67), an equally able ruler, continued the eastward expansion, adding imperial territories such as Aalst and Termonde, east of the Scheldt, to his dominions. His son and successor Baldwin VI (1067–70), by marrying Richildis, heiress of the neighbouring Hainaut (*q.v.*), and thus becoming count of that principality himself, was the first to establish personal union between Hainaut and Flanders; but the succession of his son Arnulf III in 1070 was contested by Robert I the Frisian (d. 1093), another son of Baldwin V, who became count in 1071.

Robert the Frisian was a powerful ruler and a stern upholder of public order, who also took useful initiatives for the economic development of the county. His son Robert II, who had been associated with him as count from 1087, was succeeded in 1111 by his son Baldwin VII (d. 1119), called Baldwin with the Ax be-

cause of his repression of violence and crime. On his death the male line of the first dynasty of Flemish counts became extinct.

The next count, designated by Baldwin VII, was his cousin Charles, son of the Danish king Canute IV by Count Robert II's sister Adela. Surnamed the Good for his wise administration, Charles was assassinated at Bruges in 1127 and left no children. The French king Louis VI then intervened and had his candidate accepted as count: namely William Clito or the Aetheling, son of Robert Curthose, duke of Normandy (whose mother was a daughter of Baldwin V), and thus an enemy of Henry I of England, against whom the move was directed (1127). This intervention showed that the French crown was emerging from its period of weakness and consequently that Flanders would no longer enjoy undisturbed independence. William Clito, however, soon proved unacceptable to the Flemish population and on his death (1128) the county went to Thierry or Diederik (Dietrich) of Alsace, the son of Gertrude, another sister of Robert II. Thierry and his son Philip (1168–91) consolidated the counts' position and won great international prestige for the county, especially since Philip married Elizabeth of Vermandois and thus reigned over territories that stretched far south toward the region of Paris.

Philip's death without issue and the strong policy of Philip II Augustus of France brought Flanders to a perilous position, but the king failed to annex the county itself, to which Baldwin V of Hainaut, a brother-in-law of Philip of Alsace, succeeded as Baldwin VIII (1191–95), though considerable territory was lost in the south (Vermandois and Artois). Then Baldwin VIII's son Baldwin IX (VI of Hainaut), who became Latin emperor of Constantinople in 1204 (*see* BALDWIN I), was succeeded in 1205 by his five-year-old daughter Joan. The French king obtained custody of Joan and made her marry Ferdinand (Ferrand), a younger son of Sancho I of Portugal, in 1212, but in spite of his calculations Ferdinand took sides against him under Flemish pressure and joined the anti-French coalition formed by the emperor Otto IV and John of England. On the defeat of the coalition in the battle of Bouvines (*q.v.*) in 1214, Ferdinand was taken to Paris as a prisoner, but Joan was permitted to administer Flanders by the grace of the French crown. She died childless in 1244 and was succeeded in Flanders and Hainaut by her sister Margaret.

Margaret's reign (1244–80) was unfortunately marked by the struggle between the houses of Avesnes and Dampierre, the former being children of her marriage with Bouchard of Avesnes, which was annulled, the latter of her subsequent marriage with William of Dampierre (d. 1241). Finally Louis IX of France adjudged Flanders to Dampierre and Hainaut to Avesnes, but the rivalry between the two houses went on. It became rather dangerous for Flanders when the house of Avesnes obtained the county of Holland, on the northern flank of Flanders, in 1299, just when Margaret's younger son Guy of Dampierre, count of Flanders from 1278 to 1305, had to face a major crisis in Franco-Flemish relations. The French king Philip IV the Fair was in fact trying to bring Flanders directly under royal control and was finding support in the town oligarchies (such as the 39 *échevins* of Ghent), who were the count's political opponents. Guy, however, had the support of the rest of the population, especially in the towns, who felt themselves oppressed by the oligarchies. Against the French threat, Guy allied himself with Edward I of England (1294 and 1297), but when Edward had to withdraw his forces from Flanders in order to deal with the Scots the county was open to invasion. The French overran it in 1300 and took the old count prisoner. The people, however, detested the foreign rule, and on May 18, 1302, the French in Bruges were attacked by surprise and many of them killed (the "Matins of Bruges"). A powerful French army under Jacques de Châtillon then marched on Flanders for revenge, but the Flemings inflicted a disastrous defeat on it in the battle of Courtrai or battle of the Golden Spurs (July 11, 1302). This saved Flanders from French occupation, but the war dragged on till the treaty of Athis-sur-Orge (*q.v.*) in 1305. This treaty recognized Flemish independence, but imposed heavy financial burdens on Flanders and consequently led to considerable loss of territory in the south (Lille, Douai, Orchies) under the treaty of Pontoise (1312) between Philip IV and Guy's son and successor Robert of Béthune, now Robert III of Flanders (1305–22).

The 14th century brought a new political problem: the big towns, especially Ghent (about 50,000 inhabitants), tried to establish communal autonomy against the count and went far toward founding independent city-states. In consequence the counts looked for support to the king of France. Under Louis of Nevers, who succeeded his grandfather Robert of Béthune as count of Flanders in 1322, the outbreak of the Hundred Years' War led to another crisis: the count took the side of his suzerain, the king of France, but the Flemish towns, under the leadership of Jacob van Artevelde (*q.v.*), refused to follow him and took the English side instead, seeing as they did that English wool was indispensable for Flemish industry and prosperity. Louis of Nevers was killed fighting for the French in the battle of Crécy (1346). His successor Louis of Male (1346–84) established peace and followed an independent policy toward France, but his last years were obscured by the rising of Ghent under Philip van Artevelde (*q.v.*) and by the defeat of the Ghent militia by a French royal army in the battle of Roosebeke (West Rozebeke) in 1382.

The Burgundians and the Habsburgs.—Louis of Male left only a daughter, Margaret. Her first husband (1357), Philip of Rouvre, duke of Burgundy, had died in 1361, but in 1369 she had been married again, to Philip (*q.v.*) the Bold, brother of Charles V of France and, from 1363, himself duke of Burgundy. Thus when Louis died Philip the Bold succeeded to the county of Flanders. This was the starting point of an evolution that was to result in the unification of the Low Countries under the dukes of Burgundy and the house of Habsburg (*see* BURGUNDY). At first the Burgundians, Philip the Bold (count from 1384 to 1404), John the Fearless (1405–19) and Philip the Good (1419–67), acted as French royal princes and strove to play a role in French politics, taking sides against the Armagnacs and with the English. This changed under Charles the Bold (1467–77), who turned against France and attempted to build a Netherlandish-Burgundian realm between France and Germany and to give it strongly centralized institutions. On his death his young daughter Mary (*q.v.*), duchess and countess from 1477 to 1482, faced an internal and external crisis and found support by marrying Maximilian of Austria (*see* MAXIMILIAN I, Holy Roman emperor), thus bringing Flanders under the Habsburgs.

During the religious upheavals of the 16th century Protestantism won many adherents in Flanders, but the military occupation of the country by the Spaniards undid this development. The Counter-Reformation triumphed, and Flanders remained with the other southern provinces of the Netherlands under Spanish rule in the 17th century (during which it suffered severe territorial losses to the France of Louis XIV) and then under Austrian rule till it disappeared as a political entity in the course of the French Revolutionary Wars (*see* NETHERLANDS; BELGIUM: *History*). The title count of Flanders (comte de Flandre) remains in use, however, for princes of the Belgian royal family.

Institutions.—In the early middle ages Flanders shared the institutions of the Frankish kingdom. With the decay of these institutions under the later Carolingians the country became feudalized and was ruled by powerful princes—wealthy landowners—who sought to expand their territory by force of arms and to safeguard it by building castles. The population, though united under a common rule, was far from homogeneous. In the southernmost area it was mainly Gallo-Roman and Romance-speaking; farther north the Frankish settlement had been denser, so that the language was Germanic; and the coastal areas had been settled with people of Saxon and Frisian origin, of a less civilized way of life. The counts effectively united these peoples into one nation. An important new development set in from the 12th century onward, as the counts substituted for the old feudal structure an orderly administration and fiscal organization, with salaried officials (*baillis* instead of *châtelains* in the basic administrative circumscriptions), set up a centralized judicial system (using professional judges instructed in Roman law) and began extensive legislation. One of the main starting-points of this development was the safeguarding of public order by the counts (*pax comitis*). The role of Philip of Alsace was capital in this field. He gave to a great

number of towns charters (*keuren*), the contents of which varied little and which all went back to the charter of Arras of 1157–63. At the same time, but quite distinctly, there developed a powerful communal movement. For a full account of this development *see* COMMUNE (MEDIEVAL): *Flanders*. This led to the establishment in the numerous and wealthy towns of a town government with a considerable measure of independence. The towns were ruled by aldermen called in Flemish *schepenen* or in French *échevins* (Lat. *scabini*), who were administrators and judges at the same time. The constitutional history of Flanders is largely that of the struggle for supremacy between comital and communal authority. Finally the central authority was victorious and in the 16th century monarchical authority was firmly established. Representative institutions (estates) had grown up round the counts, especially from the 14th century onward; they were largely controlled by the three main towns of Ghent, Bruges and Ypres (*see* ESTATES-GENERAL).

Ecclesiastically, Flanders was divided between three bishoprics, none of which had its seat in an important Flemish city: Thérouanne and Tournai (in the metropolitan province of Reims) and Utrecht (in the metropolitan province of Cologne). In the 14th century Flanders was on the side of Rome against Avignon in the great schism of the papacy.

Economic Life.—At the outset the Flemish economy was agricultural, but there are very early signs of clothmaking of more than local importance. This was linked with the fact that the country raised large herds of sheep. Around the 12th century Flemish trade and industry became of real international importance. There also took place a crisis in the old manorial organization of agriculture and an expansion of money economy together with the rise of towns as centres of trade and industry. The role of the counts in fostering urban development was important. The cloth industry, which was soon working mainly with English wool and producing quality goods, had its largest centres at Ghent and at Ypres. International trade, however, was also very important. Till the 13th century the Flemish merchants conducted their trade abroad, especially at the fairs of Champagne (*q.v.*), but later merchants of all nations came to Flanders. The seaport of Bruges became a centre of world commerce. Flanders profited from its geographical situation, being an intermediary between the Mediterranean and the Scandinavian and Baltic countries and also between England and the Rhineland (especially Cologne). Toward the end of the middle ages the Flemish economy suffered for two main reasons: (1) the silting-up of the seaway to Bruges and the competition of Antwerp; and (2) the attempts by the towns to conserve artificially an industrial monopoly against normal development in the rest of the country. Even so, Flanders was a rich country whose contribution was of capital importance to the revenues of the Burgundian dukes.

Arts and Sciences.—Flemish architecture found its outstanding expression in civic buildings, belfries and town halls, though there were also some fine cathedrals (the Gothic style penetrated early in the 13th century). In literature, satire (for example *Van den Vos Reinaerde; see* REYNARD THE FOX) and the didactic genre (Jacob van Maerlant) flourished particularly. The names of the Flemish painters, the Van Eycks, Rogier van der Weyden, Hugo van der Goes, etc., belong to world art history (*see* PAINTING). For the sciences, the 16th century was very brilliant in the humanities, law and mathematics.

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FLANDIN, PIERRE ETIENNE (1889–1958), French conservative statesman remembered mainly for his support of collaboration with the German occupation, was born in Paris on April 12, 1889. The son of a wealthy senator and closely connected with important industrial and financial interests, he was a deputy from 1914 to 1940. A junior minister in 1920–21, he was minister of commerce and industry, finance or public works in several governments in 1924 and 1929–34. He was prime minister and foreign minister from Nov. 8, 1934, to May 30, 1935, and in this double capacity he concluded on May 2, 1935, a Franco-Soviet treaty of mutual assistance. He served as minister without portfolio under Pierre Laval in 1935–36 and foreign minister under Albert Sarraut (Jan. 24–June 3, 1936). When in March 1936 the Germans invaded the Rhineland, Flandin suggested the use of French armed forces but was supported only by a minority of ministers (Sarraut, Joseph Paul-Boncour and Georges Mandel). His failure to induce the French and British governments to act convinced him that Germany would dominate Europe and that France should accept the inevitable.

In the Vichy regime ill-health prevented Flandin from trying to play as important a part as his ability and sympathies might have allowed. He was associated with the more moderate collaborators. They succeeded in bringing him into the government as foreign minister in Laval's place, but his inclusion lasted only from Dec. 1940 to Feb. 1941, when Adm. Jean Darlan replaced him. After the liberation the high court of justice, on July 26, 1946, acquitted him of treason and sentenced him to five years of "national unworthiness" but remitted this sentence on account of some modest services he had rendered to the resistance. He defended his policies in a book entitled *Politique française 1919–1940* (1947). He died at St. Jean-Cap-Ferrat on June 13, 1958.

See *Le Procès Flandin devant la Haute Cour de Justice, 23–26 juillet 1946* (1947). (P. W. C.)

FLANDRIN, HIPPOLYTE (1809–1864), French academic painter, was born in Lyons on March 23, 1809. He was the second of three sons of a miniature painter, and all three brothers became prominent painters. Auguste (1804–42), the eldest, passed the greater part of his life as professor at Lyons; Jean Paul (1811–1902) became a well-known landscapist. After studying for some time in Lyons, Hippolyte and Paul set out for Paris in 1829. They entered the atelier of J. A. D. Ingres, who became their model as well as their friend and patron. Ingres led Flandrin from his original interest in horses and soldiers toward history painting. In 1832 Flandrin received the Grand Prix de Rome for his canvas the "Recognition of Theseus by His Father." He remained in Rome until 1838 and was greatly inspired by early Renaissance painting—especially Fra Angelico—during his stay in Italy. Turning toward religious painting, he developed a rather dry and cold pseudoclassic style related to that of the earlier German Nazarenes. Upon his return to France he received important church commissions for large-scale mural decorations. Most noteworthy among these are the murals in St. Séverin, St. Vincent de Paul and St. Germain des Prés in Paris; St. Paul at Nismes; and St. Martin d'Ainay in Lyons. In mid-19th century he was also greatly in demand as a portraitist among the ladies of the second empire, but his portraits are rather imitative of Ingres without his master's linear strength. Flandrin became an important teacher at the Academy and also inspired Dante Gabriel Rossetti and the English Pre-Raphaelites. In 1863 he returned to Rome where he died of smallpox on March 21, 1864.

See Louis Flandrin, *Hippolyte Flandrin*, 2nd ed. (1909); H. Delaborde, *Lettres et Pensées de H. Flandrin* (1865). (P. H. S.)

FLANNAGAN, JOHN BERNARD (1895–1942), U.S. 20th-century sculptor, one of America's most original "primitivising" sculptors, was born on April 7, 1895, in Fargo, N.D. Trained as a painter, he turned to sculpture a scant 17 years before his death, maturing his style during the last decade of his life despite many handicaps. Defining his sculpture as a species of occult fossil, Flannagan with a queer atavistic nostalgia dredged the subconscious for inspiration. Common fieldstone was the material he preferred for images which were only freed by an act of realization. "Jonah and the Whale" (1937), for example, was conceived as a rebirth motif, the fish being the symbol of the female principle. It was created with minimal modification of natural bluestone. The traumatic state of becoming was Flannagan's most effective poetic theme; it informed his major works, *e.g.*, "New One"

(1935), "Triumph of the Egg" (1937 and 1941), "Not Yet" (1940), "Beginning" (1941), influencing mother and child subjects and perhaps even the tumid "Dragon" motifs or monster fantasies (1933 and 1941). Consonant with their iconography was a technique permitting the emergence of indwelling spirit from inert matter. Hence, in both formal and philosophical regards Flannagan was close to the artists of ancient India. He had broached new subjects and techniques in wrought bronze when he took his life on Jan. 6, 1942.

See Flannagan's *Letters* (1942); Dorothy C. Miller, *The Sculpture of John B. Flannagan* (1942). (J. S. BT.)

FLANNEL is a fabric made in plain or twill weave, usually with carded yarns. It is napped, most often on both sides, from slightly to so thick that the twill weave is obscured. Fibre composition and amount of napping are dependent on the intended use. Flannel is a relatively warm fabric, since still air is held in the fabric because of the napping. If the fibre in the nap is resilient (like wool), the nap does not crush and therefore maintains its warmth. When the nap flattens, it often can be raised by brushing. Addition of a man-made fibre such as nylon or acrylic to the blend increases the resistance to abrasion and hence may lengthen the life of the fabric. Furthermore, some of these blends help to prevent stretching, so that a better fit is maintained. Crease retention is improved with some blends such as acrylic fibre.

Wool and Wool-Blend Flannels.—For outer wear—such as dresses, shirts, suits and coats—generally wool or blends with wool, or blends of man-made fibres, are used in an even-twill weave. With an all-wool flannel fabric excellent tailored garments can be produced. However, felting shrinkage can be prevented by blending with various man-made fibres, and washable men's suits are produced through blending wool with acrylic or polyester fibres, or both.

Cotton Flannels.—Cotton flannels are made with soft-spun filling yarns. There are various types, according to use. (1) Flannelette is a lightweight fabric napped on one side only, often printed and preshrunk; it is used largely for pajamas and nightgowns. (2) Diaper flannel has a high nap on both sides, which makes it soft and absorbent. (3) Baby flannel is similar but heavier and made with a more compact nap for infants' and children's wear. (4) Suède and duvetyn (slightly lighter weight than suède) flannels have a very short, compact nap, sheared to give a smooth, flat texture; they are used for outerwear such as sports shirts, jackets, etc. (5) Tarnish-resistant flannels are impregnated with chemicals that absorb sulfur fumes and are used for linings in silverware chests and jewelry boxes. (6) Outing flannel is made with coloured yarns or is piece-dyed and is napped lightly on both sides; it is used mainly for sleepwear. (7) Canton flannel is made with a warp-faced twill and napped back; it is used largely for work gloves. (8) Plaid flannels may be made from either plain or twill weave and napped on one or both sides; heavier weights are used for sportswear and shirtings, lighter weights for coated fabrics. (H. T. ST.)

FLARE, a combustible device used for signaling, illumination, pyrotechnic display or similar purposes. The term in pyrotechnics is applied to either coloured fire composition burned in a loose heap or to a similar composition charged into a rolled paper case to ensure longer and more regular burning. Flares are used in pyrotechnic displays for the illumination of the surroundings, such as a background of trees and foliage, rocks or old buildings.

The flare, or light, in its present form, can claim no greater antiquity than the early part of the 19th century, when the introduction of potassium chlorate permitted the development of genuine colour composition (*see* FIREWORKS). Previous to this the only colour had been the bluish white light produced by a mixture of sulfur, saltpetre and orpiment. These blue lights, as they were called, were and still are much used at sea for signaling and illumination. They were also known as Bengal lights, no doubt because Bengal was the chief source of supply of saltpetre.

The introduction of colours that could readily be recognized at a considerable distance opened up a much wider field for the use of flares at sea and from the middle of the 19th century many patents were taken out; most of these had for their object a means of self-ignition. Subsequent inventions provided for ignition on the same principle as the modern safety match and for the waterproofing of the surface. Lights of this kind are generally fitted with a wooden handle, in or to which is secured the means of ignition.

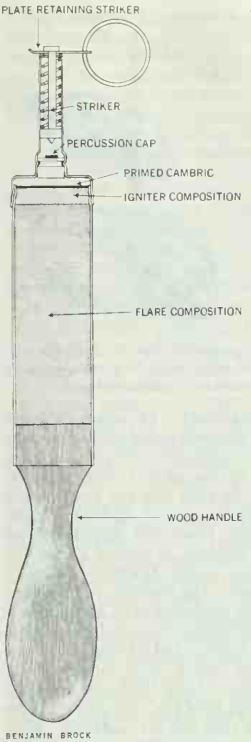


DIAGRAM OF A FLARE SHOWING MECHANISM OF WATERPROOF IGNITION

Flare is ignited by pulling the ring, which releases the striker and drives it into the percussion cap. The flash from this cap ignites the primed cambric, which in turn fires the igniter composition and this lights the flare composition

Coloured flares of high light intensity are carried as standard equipment in ships' lifeboats; the high intensity is obtained by the incorporation of magnesium, or magnesium alloy, in the composition. Flares are also used to give advance warning to motorists of highway obstructions. On both U.S. and Canadian highways all commercial vehicles carry flares to be used in the event of distress or breakdown.

Many types of flares and lights were used during World War I for illuminating and signaling; the largest were the Dover flares designed for antisubmarine defenses, while the smallest were those fired from a pistol by ground troops.

World War II hastened the development of flares, especially those carried by aircraft. These highly specialized stores ranged in size from the 1½-in. illuminating cartridge, the star of which burned for 10 sec., to the 5.5-in. reconnaissance flare weighing approximately 40 lb. and burning for 3½ min. with an intensity of 1,000,000 candle power. Flares for indicating targets often were coloured and, suspended on a parachute, ejected a series of stars of contrasting colour. Target markers weighing about 250 lb. and containing multiple candles also were used. (A. ST. H. B.; B. A. B.)

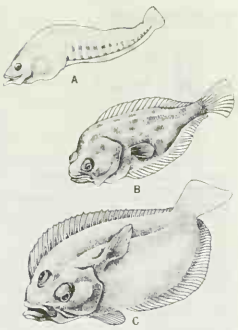
FLAT: *see* APARTMENT HOUSE; LANDLORD AND TENANT.

FLAT (in music): *see* ACCIDENTALS.

FLATFISH is the common name of fishes of the order Pleuronectiformes (Heterosomata), which differ from all other fishes in having both eyes on one side. As adults they live on the bottom, with the eyed side uppermost; this side is coloured whereas the underside is usually white (but exposure of underside to light will cause some development of pigment). Nearly all flatfishes are marine. The have minute floating eggs. The larval flatfish, which is symmetrical, with an eye on each side, swims near the surface of the sea; but after a time one eye moves round over the top of the head to the other side, some of the fins change position and the fish, leaning over gradually on the eyeless side, sinks to the bottom. In most flatfishes the dorsal fin grows forward onto the head; in some species with a long larval life this happens before the eye "migrates," so that in pushing its way between the dorsal fin and the head, the eye seems to go through the head from one side to the other. Many flatfishes are remarkable for their power of changing colour to resemble the ground on which they lie, and it has been established experimentally that they must see the ground in order to imitate it. The eyes stand out from the head and can be turned independently in different directions looking sideways, or sometimes one looking forward and the other backward.

Certain variant types are known. Many albino (pigmentless) flatfish have been found. Some species, which have the underside coloured, tend to have the fin arrangement symmetrical. Another abnormality commonly found is to have the eyes on the reverse side from that normal for the species. In these individuals the optic nerves, which normally cross only once, may be "doubly crossed."

The most primitive genus, *Psettodes*, from west Africa and the Indo-Pacific has perchlike features (dorsal fin not extending on the head; symmetrical pelvic fins, nostrils and skull characters) and indicates the derivation of flatfishes from some percoid ancestor allied to the sea basses (Serranidae). The other flatfishes, numbering about 600 species, are generally called either flounders, when the lower jaw is prominent, or soles, when the rounded snout projects beyond the small curved mouth; each of these groups includes a family with the eyes on the right side and another with the eyes on the left. The family Pleuronectidae, or dextral (right-eyed) flounders, include the halibut, plaice and other important food fishes of northern seas. The Bothidae, or sinistral (left-eyed) flounders, include the turbot; some of the American species of *Paralichthys* are also valued as food. The Soleidae, or true soles, with eyes on the right side include the well-known common sole (*Solea solea*) of Europe. The Cynoglossidae, or tongue soles, with eyes on the left side, inhabit tropical and subtropical waters.



KENNETH GOSNER

MIGRATING EYE OF A FLATFISH. (A) LARVAL STAGE; (B) INTERMEDIATE STAGE; (C) ADULT STAGE

In the more specialized forms, which feed exclusively on bottom-living invertebrates, the jaws of the blind side are more strongly developed than those of the eyed side, and have stronger teeth; in the soles the jaws of the eyed side are toothless. Most flatfishes grow to about one foot long, but the Atlantic halibut (*Hippoglossus hippoglossus*) may attain a length of 10 ft. and a weight of more than 500 lb. *See* also FISH. (C. HU.)

FLATFOOT is the term used in medicine to designate a depression of the arch of the foot. Usually associated with loss of the arch is a rolling outward of the foot and heel, resulting in a splayfoot position. Normally the arch is maintained by the shape of the bones and by the ligaments and muscles of the foot. Of these three, the muscles are most important. At an early stage the flat foot may be flexible and result from stretching of ligaments and weakness of muscles. At a later stage the shape of the bones may be altered and the deformity rigid.

Little is known regarding the causation of flatfoot. All infants have flat arches at birth. The normal arch does not appear until the infant begins to walk, thus developing muscle power. Failure of development of the arch may be a normal racial or familial characteristic; it is often seen, for example, in Negroes. In general, the problem is a disproportion between the weight to be borne and the muscles to bear it. In a few patients the deformity follows an injury.

Many symptoms have been attributed to flat feet—pain, swelling, muscular spasm, stiffness and awkward gait. Other vague symptoms in the extremities and back, sometimes considered as caused by flatfoot, probably are the result of the generalized muscle weakness which also produced flatfoot. Many persons with flat feet are entirely without disability or pain.

The aim of treatment is to secure proper position of the arch and heel by the use of adequate shoes, with or without supports, and to preserve that position by strengthening the muscles maintaining correction of arch and heel. Supports are indicated if pain is severe or fatigue excessive, but their prolonged use may weaken muscles and be harmful. Few persons have pain severe enough to require surgery. Rarely surgery is indicated for cosmetic reasons. (J. S. MS.)

FLATHEAD (SALISH), a Salishan-speaking Indian tribe of western Montana whose territory extended from the crest of the Bitterroot mountains to the continental divide, centring on the upper reaches of the Clark fork of the Columbia river. Their tribal neighbours were: north, the linguistically unrelated Kutenai; east, the Algonkian Blackfoot; south, the Sahaptin Nez Percé; west, the Salishan Coeur d'Alene and Kalispel. Friendship prevailed with all but the Blackfoot, against whose raids the tribe frequently had to defend itself. Salish was the native name of the tribe, but Flathead is now customary; although they themselves did not practise head-flattening, some of their slaves came from tribes that did. Flathead customs were typical of the Plateau culture area, of which they were the easternmost representatives. Political organization was tribal. Bison hunting was basic to the economy and horses were plentiful. The Flathead were consolidated with the Upper Pend d'Oreille and Kutenai in the treaty which the three tribes signed with the U.S. on July 16, 1855. Since 1872 they have resided primarily on a reservation at Flathead lake, Montana. The Flathead population there was estimated at about 2,500 in the 1960s. *See* also INDIAN, NORTH AMERICAN; SALISHAN. (V. F. R.; X.)

FLATMAN, THOMAS (1635–1688), English poet and miniature painter, more esteemed for his paintings than for his poems, only a few of which have survived in anthologies, was educated at Winchester (1649–54) and at New college, Oxford (1654–56). He left Oxford without a degree in 1657, having been made fellow of his college the previous year. In 1666 he was created M.A. of Cambridge by the king's letters. His collected works first appeared in 1674, as *Poems and Songs*, and an enlarged edition appeared in 1686; many of his verses, however, were printed separately, the most notable being "A Thought of Death" (imitated by Pope), "Death, a Song," and "Hymn for Morning." *Montélion's Almanack* for 1661 and 1662 and a mock romance, *Don Juan Lamberto*, have also been ascribed to Flatman by Anthony à Wood. He died in London, Dec. 8, 1688.

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FLATWARE is the term introduced toward the end of the 19th century to denote spoons, forks and similar articles such as fish knives, fish forks and serving utensils. Strictly speaking, it excludes knives, but in the U.S. the term flatware or flat silver is generally understood to include all table knives. This article is concerned with the manufacture of forks and spoons; for the manufacture of knives *see* CUTLERY. *See* also FORK; KNIFE; SPOON.

Flatware is made in a wide variety of designs in silver, silver plate, unplated nickel alloys, stainless steel and aluminum, tinned iron, brass and plastics; luxury services are made in gold. Wood is sometimes used for salad and spaghetti servers, mother-of-pearl for egg spoons and bone for mustard spoons. Handles, plain or ornamented, are either in one piece with the spoon bowl or the fork or fitted separately to tangs. Another wide range of spoons and forks is manufactured, usually in stainless steel, for use in cooking and preparing food.

Modern flatware is produced in all the cutlery centres of the world. During the 20th century the processes used in its manufacture developed to a high degree of mechanization. The metal, carefully refined, is cast into small ingots, each weighing (in the case of nickel alloys) about 40 lb. The ingots are reheated and rolled until sheets of the desired thickness are obtained; the sheets are then cut into strips of the required width. These processes involve the strictest control of metal behaviour and correct annealing to remove excessive strains. The strips are fed into machine "presses" to cut out each spoon or fork in its rough shape, one end being at first almost square for a spoon and rectangular for a fork. The ends of these "blanks" are rolled again in a direction at right angles to the centre line, thus reducing the thickness there without altering the thickness of the handle. The bowls of the more expensive spoons are at least half as thin as their handles. After being trimmed in another press, the blanks for spoons are ready for stamping in alloy steel dies that hollow the bowls and stamp a pattern on the handles. In the case of forks, slots are

cut out to form the prongs, which are then stamped in dies to the required curvature, tapered and pointed on abrasive belts. These processes are approximately the same whatever metal is used, although in manufacturing the cheaper products, made from thinner sheets, cross-rolling can be omitted and the stamping can be done in one operation. In the early 1960s large quantities of these thinner types were being made in stainless steel.

Subsequent finishing processes vary according to the metal used. In the case of silver, successively finer stages of buffing prepare the surfaces for final polishing or satin finishing. In the case of alloys that are to be plated, the articles, after being buffed, are wired individually on frames; quantities of 100 or more can be immersed simultaneously in the series of cleaning baths and plating vats. The articles to be plated become cathodes in the vat, the metal to be deposited, *e.g.*, silver, being the anode. In most factories the complete frames of articles are transferred automatically from baths to vats and finally to washing and drying. Strict control is maintained of the composition, strength and temperature of the plating solutions as well as of the voltage and amperage of the direct current to ensure that the correct thickness of coating is deposited. (*See* ELECTROPLATING.) The thickness of deposit is increased by some makers at the places of maximum wear, for example, on the centre of the convex surface of spoon bowls. The deposit of silver is specified in grams or pennyweights per dozen pieces and sometimes in actual thickness in millimetres or thousandths of an inch; but the more popular method of indication is use of the terms "30 years," "25 years" or "20 years" plate. The designation A one (A 1) is satisfactory as a guarantee of the quality of the deposit provided it is given by a manufacturer of good repute.

When the pieces have been plated their surfaces are dull and require polishing. Hand polishing is done by holding the articles upon rapidly rotating mops dressed with an aluminum compound or rouge. In the case of silver and silver plate a little of the metal is removed; in the plating process allowance is made for this by depositing more silver than is called for by the specification, the makers guaranteeing a "finished deposit." Mechanical polishing is done by machines in which numbers of spoons or forks are secured in racks and are applied en masse to rotating cylindrical mops.

The least expensive plating process is "bright plating," in which a very thin coating of silver or chromium can be deposited bright, thus eliminating the cost of final polishing. Such a coating does not last long and the process is therefore restricted to the cheaper grades of flatware.

Stainless steel is more difficult to polish than silver, silver plate or unplated nickel alloys. Techniques have been developed for stamping the cheaper varieties of stainless steel spoons and forks from prepolished sheet. In some countries electrolytic polishing of stainless steel has been satisfactorily developed.

Where cheapness and lightness are especially desired aluminum or plastics are employed in the making of flatware. Aluminum articles are stamped in one operation from metal sheets; plastic articles are molded.

In Europe, silver articles usually bear a hallmark (*q.v.*), which indicates that the metal contains a prescribed amount of silver. Other marks record the year of manufacture and the maker. United Kingdom hallmarks include the lion passant, which is the guarantee that the silver is not less than 92.5% pure; the assay office (town) mark; the monarch's head; the date letter recording the year of manufacture and the maker's full name, initials and/or trademark. In the United States the word "sterling" is accepted as a sufficient guarantee when used by a reputable supplier.

While well-proved 18th- and 19th-century patterns for flatware continue to be popular, the advent of new fashions in furnishings during the first half of the 20th century resulted in the introduction of many new flatware designs by all the manufacturing centres. Designs in stainless steel as well as in silver flatware are available to harmonize with any table appointments, furniture or room decoration. Although stainless steel articles need only to be washed after use there is still great demand for silver and silver plate flatware. (W. G. I.)

FLATWORM, a name applied generally to soft-bodied invertebrate animals of the phylum Platyhelminthes, which includes both free-living and parasitic members. Flatworms are bilaterally symmetrical, usually flattened, and lack respiratory, skeletal and circulatory systems and a body cavity (coelom). The body is unsegmented (no true metamerism) and has solid connective tissue (mesenchyme) filling the spaces between organs. Flatworms are generally hermaphroditic with complex male and female reproductive systems. They are the first animals in which tissues develop from three embryonic layers (the triploblastic condition) and in which occurs a head region containing concentrated sense organs and nervous tissue (the brain).

This article describes the biology of the phylum Platyhelminthes generally, but, except where otherwise indicated, emphasizes the free-living flatworms, class Turbellaria.

Introduction and Natural History.—The phylum consists of three classes: Turbellaria; Trematoda, or flukes; and Cestoda (Cestoidea), or tapeworms.

The Turbellaria (from the Latin meaning "a stir," referring to the tiny currents that they stir up in the water) possess a ciliated, one-layered epidermis. Although most are carnivorous and free-living in aquatic or moist terrestrial habitats, a few are external or internal commensals (living off a host but apparently not harming it) or are truly parasitic, usually in arthropods, mollusks or echinoderms. The mouth is located mid-ventrally near the middle or the head end of the body. Turbellarians of the order Acoela lack a true digestive tract, having in its place a mesenchymatous mass into which food is passed for intracellular digestion. All others, except some rare parasitic members, have a simple sac-shaped intestine, which may be lobed or highly branched, generally without an anal opening. Digestion is chiefly intracellular but may commence outside the body or in the lumen of the gut.

The Trematoda (from the Greek meaning "holelike," referring to the holelike character of the suckers, which practically all members possess) are exclusively parasitic. A fluke possesses a secreted, nonciliated cuticle, one or more suckers or hooks with which it clings to its host, and a digestive tract consisting of mouth,

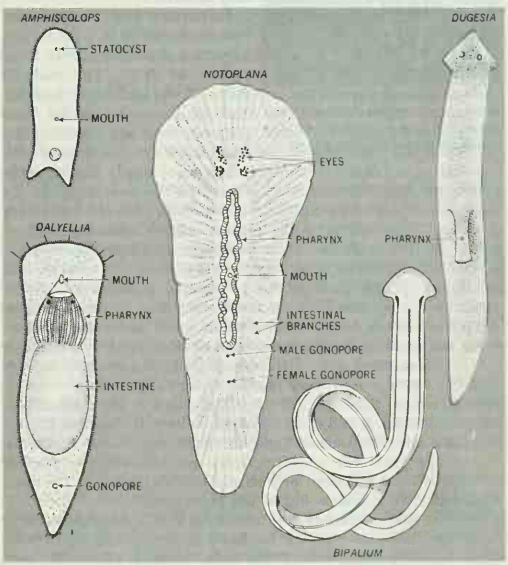


Fig. 1.—Some types of Turbellaria. Upper left, *Amphiscolops*, example of the order Acoela; lower left, *Dalyellia*, example of the order Rhabdocoela, section Dalyellioida; centre, *Notoplana*, common marine flatworm, order Polycladida, suborder Acotylea; upper right, *Dugesia*, common fresh-water planarian, order Tricladida, suborder Paludicola; lower right, *Bipalium kewense*, tropical land planarian often found in greenhouses, order Tricladida, suborder Terricola (Drawings are not to scale)

pharynx and a one- or two-branched intestine (often with lateral subbranches or diverticula). Its life cycle may be simple and direct or require two or more hosts. (*See* FLUKE.)

The Cestoda (from the Greek meaning "ribbonlike," referring to their shape) are parasitic as adults, almost exclusively in the intestine of vertebrates. A tapeworm possesses a secreted cuticle, and in most cases produces few to many reproductive sections (proglottids). Each proglottid contains one or two complete sets of hermaphroditic reproductive organs. Adhesive devices, consisting of suckers, hooks and spines, may be limited to the anterior end (on the scolex of those of the subclass Eucestoda), or occur both anteriorly and posteriorly (subclass Cestodaria). To complete its life cycle a tapeworm requires two or more hosts. (*See* TAPEWORMS.)

Turbellarians are widely distributed in fresh-water and marine habitats, and on land. Adult flukes and tapeworms parasitize vertebrates generally but also may occur in or on invertebrates; certain larval flukes (order Digenea) occur almost exclusively in snails and bivalve mollusks; and larval cestodes in invertebrates, especially arthropods, and in vertebrates. Turbellarians ingest small animals and plants or, in numbers, overpower larger animals and suck their juices. Turbellarians containing symbiotic algae (which benefit the host and are in turn benefited) in their tissues are said to digest the dead or dying algae. Flukes consume mucus and host tissues, which latter they abrade by sucker action or ingest directly (blood-inhabiting forms); tapeworms, which live in their hosts' digestive tracts, lie bathed in nutritive fluids, which they absorb.

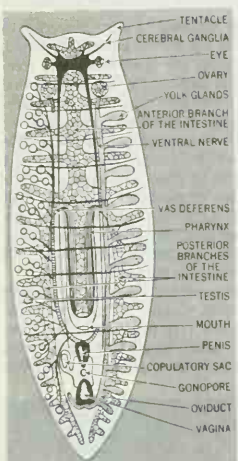


FIG. 2.—GENERAL STRUCTURE OF A TRICLADID TURBELLARIAN. THE THREE-BRANCHED INTESTINE IS CHARACTERISTIC OF THIS GROUP

Structure and Function.—Flatworms range in length from a fraction of a millimetre to 12 m. (about 40 ft.). The body is flattened and leaflike, or tapelike. The head may be set off from the body or grade imperceptibly into it. Cilia are evenly distributed or restricted to a certain surface (usually the ventral). In the smallest Turbellaria cilia are used for swimming; in the larger ones for creeping and for creating water currents for sensory purposes. The origin of the unusual cuticle (bearing suckers, spines, etc.) is in doubt, but is seemingly an adaptation to parasitism. Some Turbellaria may be gray, brown or black, with mottled or striped patterns due to pigment granules or cells located in the epidermis or mesenchyme; others, which possess symbiotic algae in the mesenchyme, are green or brown. Trematodes and cestodes usually are devoid of pigment, but the former may be coloured by food (bile, blood) in their guts, and in some cases both groups may show masses of dark eggs through a translucent, creamy, or whitish, tissue. Embedded in the epidermis of turbellarians are ovoid or rod-shaped bodies (rhabdoids) of several sorts and of uncertain function; they originate in epidermal or mesenchymal cells and frequently are concentrated dorsally or may be clustered anteriorly as rod tracts opening at the apex. Rhabdoids are absent in flukes and tapeworms.

Beneath the epidermis of turbellarians is a homogeneous or lamellated membrane which is absent in flukes and tapeworms. Club-shaped mesenchymal gland cells, opening externally, generally are present in all three classes. In turbellarians two major types of glands occur: one produces a slimy material upon which the organisms creep; the other secretes an adhesive substance for capture of prey, for adhesion and for cementing egg capsules to the substratum. Larval trematodes and cestodes possess similar glands whose secretions are used for adhesion, for producing cyst walls around resting stages and for penetrating hosts; some adult parasites have glands for adhesion and, in trematodes, for softening and digesting host tissues.

The mesenchyme consists of fixed and free cells as well as a fibrous matrix. A fluid occupies the minute open spaces and serves for distribution of nutrients and wastes. The mesenchymal cells, in certain groups, may differentiate during growth to become sex cells or may function in asexual reproduction, in repair or in regeneration. Regeneration has been investigated intensively in turbellarians, especially in the genera *Planaria* and *Dugesia* (*see* also REGENERATION).

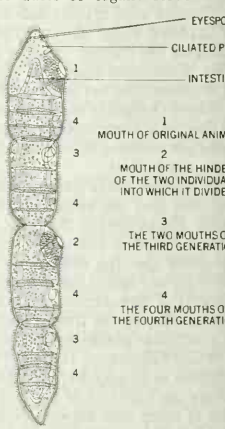
The musculature consists essentially of circular, longitudinal and oblique layers below the epidermis, or of transverse and longitudinal sheets in the mesenchyme. Dorso-ventral bundles, which alter the thickness of the body, also are generally evident. Each muscle fibre consists of a long, slender strand and may show incipient striations.

The nervous system consists of paired anterior cerebral ganglia and two to about ten longitudinal nerve cords. Primitive Turbellaria have the largest number of cords; these are reduced in higher forms to a ventral pair that, with the cross branches present in all flatworms, appears ladderlike. Sense organs are abundant in free-living flatworms and consist of tentacles; tactile bristles and papillae; statocysts for balance; ciliated pits and grooves for taste; and eyes. The eyes are usually pigment cups (ocelli) containing the enlarged free ends of retinal cells and are characterized by a rod border. Most of the adult parasites, except some trematodes of the order Monogenea, lack eyes, but larval trematodes may possess them.

The digestive system, modified in the turbellarian order Acoela and completely absent in tapeworms, consists essentially of a mouth, a muscular pharynx (which may be protrusible or not) and one or more intestinal branches (diverticula) that generally end blindly (hence an anus is absent).

The excretory system consists of tubes that course through the mesenchyme, connect internally to structures called flame cells and open externally at one or more pores.

Flatworms are, with rare exceptions, functional hermaphrodites. The male system consists of one to many testes whose ducts connect with an intromittent organ (penis or cirrus). The female system is more variable, consisting of one or more ovaries and ducts and other organs the homologies of which are obscure. The same duct may function as a vagina, uterus and seminal receptacle; in other worms separate ducts or organs serve these purposes. In almost all flatworms occur yolk glands (they may be incorporated in the ovary), which contribute yolk to the ovum, and an oötype, a region in which egg capsules are fashioned. The male and female ducts open generally on the ventral surface, either separately or at a common, often muscular, gonopore.



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK LTD.)

FIG. 3.—RHABDOCOELAN TURBELLARIAN (MICROSTOMA LINEARE) UNDERGOING THE PROCESS OF REPRODUCTION BY DIVISION

Development.—It is difficult to generalize upon developmental patterns in flatworms. Turbellarians of the orders Acoela and Polycladida have endolecithal eggs (yolk inside the ovum) and spiral cleavage of the annelidan type; they emerge from the egg as juveniles (young worms, not larvae) or (in some polyclads) as pelagic larvae (Müller's larvae) that resemble the annelidan trochophore. All other flatworms produce ectolecithal egg capsules (yolk outside the true ovum) and have a greatly modified cleavage and organogeny. Fluke and tape-

worm eggs produce larvae. Fluke larvae are usually ciliated (the miracidia of Digenea); tapeworm larvae may be ciliated (coracidia) or may be naked and bear six (hexacanth) or ten hooks (lycophora). Asexual multiplication occurs in some Turbellaria and is an invariable feature in larval Digenea but not in Monogenea or Cestoda.

Relationships of Flatworms.—Flatworms are ancestral to higher Metazoa (the multicellular animals), and through the planuloid-like Acoela show phylogenetic affinities to coelenterate planulae. The Acoela have given rise rather directly to the Alloeocoela and the Polycladida; the Alloeocoela, in turn, are ancestral to the Tricladida. The origin of the Rhabdocoela from Acoela is less clear, but seems probable. Trematoda and Cestoda are diphyletic (originating in two separate lines) and have descended from Rhabdocoela ancestors. Evidence linking flatworms to higher phyla is based, in part, upon developmental similarities (spiral cleavage of the egg), the presence of three germ layers and bilateral symmetry.

CLASSIFICATION

The following abbreviated classification of the class Turbellaria is taken from L. H. Hyman; representative genera follow the descriptions. Classifications of the classes Cestoda and Trematoda are given in the articles TAPEWORMS and FLUKE, respectively.

Order Acoela
" Rhabdocoela
Suborder Catenulida
" Macrostomida
" Lecithophora
Section Dalyellioida
" Typhloplanoida
" Kalyptorhynchia
Suborder Temnocephalida
Order Alloeocoela
" Tricladida
Suborder Maricola
" Paludicola
" Terricola
Order Polycladida
Suborder Acotylea
" Cotylea

Order Acoela.—Small marine turbellarians with mouth, simple pharynx or none, no intestine; lacking excretory system, oviducts, yolk glands and definitely delimited gonads. Examples, *Convoluta, Amphiscolops.*

Order Rhabdocoela.—Small aquatic turbellarians with saclike intestine and simple or bulbous pharynx; protonephridia and oviducts; gonads few, mostly compact.

SUBORDER CATENULIDA.—Fresh-water rhabdocoels with simple pharynx; single median protonephridium; single testis and unarmed penis with dorsal male pore; no yolk glands; asexual fission forming chain of organisms. Examples, *Stenostomum, Catenula.*

SUBORDER MACROSTOMIDA.—Marine and fresh-water rhabdocoels with simple pharynx; paired protonephridia; compact testes, penis with stylet and male pore behind female pore; no yolk glands; two families, Microstomidae, with asexually formed zooid chains, and Macrostomidae, without asexual reproduction. Examples, *Microstomum, Macrostomum.*

SUBORDER LECITHOPHORA.—Fresh-water, marine or terrestrial rhabdocoels with bulbous pharynx; paired protonephridia; yolk glands usually distinct from ovary; reproduction exclusively sexual.

Section Dalyellioida.—With doliiform (cask-shaped) pharynx. Family Dalyelliidae, with complicated cuticularized penis. Examples, *Dalyellia, Bresslauilla.*

Section Typhloplanoida.—With a rosulate (spherical) pharynx. Examples, *Mesostoma, Typhloplana.*

Section Kalyptorhynchia.—With a protrusible or eversible anterior proboscis and a rosulate pharynx. Examples, *Gyratrix, Polycystis.*

SUBORDER TEMNOCEPHALIDA.—Externally commensal rhabdocoels on fresh-water animals; cilia absent or sparse; anterior end with 2 to 12 tentacles; one or more adhesive discs posteriorly; found only in the tropics or subtropics. Examples, *Temnocephala, Scutariella.*

Order Alloeocoela.—Small marine or fresh-water turbellarians with simple, bulbous, or plicate (ridged) pharynx; lateral gut diverticula often present; mostly with numerous testes and two ovaries. Examples, *Prorhynchus, Plagiostomum.*

Order Tricladida.—Large to very large turbellarians with plicate pharynx and three-branched intestine; few to many testes, two ovaries with numerous yolk glands, copulatory bursa for receiving sperm, common gonopore.

SUBORDER MARICOLA.—Marine triclads with copulatory sac behind male apparatus. Examples, *Procerodes, Bdelloura.*

SUBORDER PALUDICOLA.—Fresh-water triclads with copulatory sac anterior to penis. Examples, *Planaria, Dugesia.*

SUBORDER TERRICOLA.—Terrestrial triclads often of great length and striking colour patterns. Examples, *Bipalium, Geoplana.*

Order Polycladida.—Almost exclusively marine, large, flat or elongate turbellarians; plicate pharynx leads into central intestine from which ramifies numerous peripheral branches; eyes generally numerous; testes and ovaries numerous; yolk glands absent.

SUBORDER ACOTYLEA.—Without a ventral sucker; pharynx ruffled, mouth midventral; tentacles near brain. Examples, *Stylochus, Notoplana.*

SUBORDER COTYLEA.—With a sucker behind female gonopore; pharynx often cylindrical, mouth anterior; tentacles on anterior margin. Examples, *Prosthiostomum, Eurylepta.*

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FLAUBERT, GUSTAVE (1821–1880), French novelist, whose work constitutes an epoch in the history of the art of fiction, was born in Rouen, Dec. 12, 1821. His father, Achille Cléophas Flaubert (1784–1846), who came from Champagne, was one of Guillaume Dupuytren's most brilliant pupils and was chief surgeon and clinical professor at the Hôtel-Dieu in Rouen. His mother (Caroline Fleuriot), a doctor's daughter from Pont-l'Évêque, belonged on her mother's side to the Cambremer de Croixmare family, which had produced a number of distinguished magistrates and was typical of the great provincial *bourgeoisie.*

Gustave Flaubert began his literary career in his school days in Rouen, his first published work appearing in a little review, *Le Colibri,* in 1837. He early formed a close friendship with the young philosopher Alfred Le Poittevin (1816–48), whose pessimistic outlook had a strong influence on him. No less strong was the impression made by the company of great surgeons and the environment of hospitals, operating theatres and anatomy classes with which his father's profession brought him into contact. It was, for instance, with Jules Cloquet, the most learned anatomist of his time, that Flaubert, on receiving his *baccalauréat* in 1840, was sent by his father to visit the Pyrenees and Corsica. Later, on reading *Graziella,* Flaubert was to remark that Lamartine would have written a more powerful novel if he had had a doctor's eye.

Flaubert's intelligence, moreover, was sharpened in a general sense. He conceived a strong dislike of accepted ideas (*idées reçues*), of which he was to compile a dictionary for his amusement. He and Le Poittevin invented a grotesque imaginary character, called "le Garçon," to whom they attributed whatever sort of remark seemed to them most degrading. Flaubert came to detest the "bourgeois," by which he meant anyone who "has a low way of thinking."

In Nov. 1841 Flaubert was enrolled as a student at the faculty of law in Paris. At the age of 22, however, he was recognized to be suffering from a nervous disease which was taken to be epilepsy, although the essential symptoms were absent. This made him give up the study of law, with the result that henceforth he could devote all his time to literature. His father died in Jan. 1846, and his beloved sister Caroline died in the following March after giving birth to a daughter. Flaubert then retired with his mother and his infant niece to his estate at Croisset, near Rouen, on the Seine. He was to spend nearly all the rest of his life there.

On a visit to Paris in July 1846, at the sculptor James Pradier's studio, Flaubert met the poet Louise Colet (*q.v.*). She became his mistress, but their relationship did not run smoothly. Her jealousy made separation inevitable, angry scenes took place and they parted in 1855.

In 1847 Flaubert went on a walking tour along the Loire and the coast of Brittany with the writer Maxime du Camp, whose acquaintance he had made as a law student. The pages written by Flaubert in their journal of this tour were published after his death under the title *Par les champs et par les grèves* (1886). This book contains some of his best writing; *e.g.,* his description of a visit to Chateaubriand's family home, Combourg.

So far it has been possible to deal chronologically with the events of Flaubert's life, but from this point the close interrelation between his works and his life, as well as his habit of recasting

his books in his search for perfection, makes this difficult. It therefore seems more convenient to deal with the creation of each of his major works separately, linking with it the concomitant events of his life.

L'Éducation Sentimentale.—Some of the works of Flaubert's maturity dealt with subjects on which he had tried to write earlier. At the age of 16, for instance, he completed the manuscript of *Mémoires d'un fou*, which contains elements that eventually appeared in *L'Éducation sentimentale* (2 vol., 1869; dated 1870). Before receiving its definitive form, however, this work was to be rewritten in two distinct intermediate versions in manuscript: *Novembre* (1842), and a preliminary draft entitled *L'Éducation sentimentale* (1843–45). Stage by stage it was expanded into a vast panorama of France under the July monarchy—indispensable reading, according to Georges Sorel, for any historian studying the period that preceded the *coup d'état* of 1851.

At Trouville, where his family owned some property, the young Gustave Flaubert in 1835 had formed a sentimental friendship with one of his sister Caroline's friends, Gertrude Collier, a daughter of the British naval attaché in Paris. But in 1836 this was forgotten when he met Elisa Schlésinger (née Foucault; 1810–88), to whom he returned a coat that she had left on the beach. Eleven years older than he and married to a music publisher, this woman (the Marie Arnoux of *L'Éducation sentimentale*) inspired a devastating passion in Flaubert. She no doubt loved him too, but their love was never consummated. Readers of *L'Éducation sentimentale* may take the famous opening sentences of its last chapter but one as a true representation of Flaubert's feeling for her:

> He traveled.
>
> He came to know the melancholy of steamers, cold awakenings in the morning under canvas, the shock of landscapes and ruins, the bitterness of discontinued friendships.
>
> He came back.
>
> He associated with people and he had other love affairs. But the memory of the first one made them indifferent to him . . .

La Tentation de Saint Antoine.—The composition of *La Tentation de Saint Antoine* provides another example of that tenacity in the pursuit of perfection which made Flaubert go back constantly to work on subjects without ever being satisfied with the results. In 1839 he was writing *Smarh*, the first product of his bold ambition to give French literature its *Faust*. He resumed the task in 1846–49, in 1856 and in 1870 and finally published the book as *La Tentation de Saint Antoine* in 1874. The four versions show how the author's ideas changed in the course of time. The version of 1849 is influenced by Spinoza's philosophy and nihilistic in its conclusion. In the second version the writing is less diffuse, but the substance remains the same. The third version shows a respect for religious feeling that was not present in the earlier ones, since in the interval Flaubert had read Herbert Spencer and reconciled the Spencerian notion of the Unknown with his Spinozism. He had come to believe that science and religion, instead of conflicting, are rather the two poles of thought. The published version has the form of a catalogue of errors in the field of the Unknown (just as *Bouvard et Pécuchet* was to be a catalogue of errors in the field of science).

From Nov. 1849 to April 1851 Flaubert was traveling in Egypt, Palestine, Syria, Turkey, Greece and Italy with Du Camp. Before leaving, however, he wanted to finish *La Tentation* and to submit it to Du Camp and to his friend the poet Louis Bouilhet for their sincere opinion. For three days in Sept. 1849 he read his manuscript to them, and they then condemned it mercilessly: "Throw it all into the fire, and let's never mention it again." Bouilhet gave further advice: "Your Muse must be kept on bread and water or lyricism will kill her. Write a down-to-earth novel, like Balzac's *Parents Pauvres*. The Delamare story, for instance. . . ."

Madame Bovary.—Eugène Delamare was a country doctor in Normandy who died of grief after being deceived and ruined by his wife. Delphine (née Couturier). The story is in fact that of *Madame Bovary* but it is not the only source of that novel. Another source is the manuscript *Mémoires de Mme Ludovica*, discovered by Gabrielle Leleu in the library of Rouen in 1946. This is an account of the adventures and misfortunes of Louise Pradier (née d'Arcet), the wife of the sculptor Pradier, as dictated by herself; and it bears a strong resemblance to the story of Emma Bovary, apart from the suicide. Flaubert, out of kindness as well as out of professional curiosity, had continued to see Louise Pradier when the "bourgeois" were ostracizing her as a fallen woman, and she must have given him her strange document. Even so, when inquisitive people asked him who served as model for his heroine, Flaubert replied, "Madame Bovary is myself." This was doubtless meant as a joke, but can be regarded as true if it is remembered that the idea was already in his mind in 1837 when he was writing *Passion et vertu*, a short and pointed story with a heroine, Mazza, resembling Emma Bovary. For *Madame Bovary* he took a commonplace story of adultery and made of it a book that will always be read because of its profound humanity. The Emmas of the 20th century do not take the stagecoach to rejoin their lovers but drive to them in their own cars, yet they pay the same price for their folly. While working on his novel Flaubert wrote: "My poor Bovary suffers and cries in more than a score of villages in France at this very moment."

Madame Bovary, with its unrelenting objectivity—by which Flaubert meant the dispassionate recording of every trait or incident that could illuminate the psychology of his characters and their role in the logical development of his story—marks the beginning of a new age in literature. It occupies the same position in the history of the novel as Claude Bernard's *Introduction à la médecine expérimentale* occupies in that of biology.

Madame Bovary cost the author five years of hard work. Du Camp, who had founded the periodical *Revue de Paris*, urged him to make haste, but he would not. The novel, with the subtitle *Moeurs de province*, eventually appeared in installments in the *Revue* from Oct. 1 to Dec. 15, 1856 (new edition in book form, 1857). The French government then brought the author to trial on the ground of his novel's alleged immorality, and he narrowly escaped conviction (Jan.–Feb. 1857). The same tribunal found Baudelaire guilty six months later.

Salammbô.—To refresh himself after his long application to the dull world of the *bourgeoisie* in *Madame Bovary*, Flaubert immediately began work on *Salammbô*, a novel about ancient Carthage, in which he set his sombre story of Hamilcar's daughter Salammbô, an entirely fictitious character, against the authentic historical background of the revolt of the mercenaries against Carthage in 240–237 B.C. His transformation of the dry record of Polybius into richly poetic prose is comparable to Shakespeare's treatment of Plutarch's narrative in the lyrical descriptions in *Antony and Cleopatra*. The novel appeared in 1862 (dated 1863) and had a great and lasting success. A play, *Le Château des coeurs* (1863), was not printed until 1880.

Trois Contes.—The merits of *L'Éducation sentimentale*, which appeared a few months before the outbreak of the Franco-German War of 1870, were not appreciated, and Flaubert was much disappointed. Two more plays, *Le Sexe faible* and *Le Candidat* (both 1873), likewise had no success, though the latter was staged for four performances in March 1874. The last years of his life, moreover, were saddened by poverty. In 1875 his niece Caroline's husband, Ernest Commanville, a timber importer, found himself heavily in debt. Flaubert sacrificed his own fortune to save him from bankruptcy. Flaubert found some consolation in his work and in the friendship of George Sand, Turgenev and his neighbour Edmond Laporte, and also in that of younger novelists—Émile Zola, Alphonse Daudet and, especially, Guy de Maupassant, who was the son of his friend Alfred Le Poittevin's sister Laure and regarded himself as Flaubert's disciple.

Flaubert temporarily abandoned work on a long novel, *Bouvard et Pécuchet*, in order to write *Trois Contes* (1877), which comprises the three short stories "Un Coeur simple," "La Légende de Saint Julien l'Hospitalier" and "Hérodias." This book, through the diversity of the stories' themes, shows Flaubert's talent in all its aspects and has often been held to be his masterpiece.

Bouvard et Pécuchet.—The heroes of *Bouvard et Pécuchet* are two clerks who receive a legacy and retire to the country together. Not knowing how to use their leisure, they busy themselves with one abortive experiment after another and plunge successively into scientific farming, archaeology, chemistry and

historiography, as well as taking an abandoned child into their care. Everything goes wrong because their futile book learning cannot compensate for their lack of judgment and because they have not had the general education that is a prerequisite of any intellectual activity. The profound meaning of this novel, which Flaubert left unfinished and which was published after his death (in the *Nouvelle Revue* from Dec. 15, 1880, to March 1, 1881; in book form, 1881), has been seriously misunderstood by critics who have regarded it as a denial of the value of science. In fact it is "scientism" that Flaubert is arraigning; *i.e.*, the practice of taking science out of its own domain, of confusing efficient and final causes and of convincing oneself that one understands fundamentals when one has not even grasped the superficial phenomena. Intoxicated with empty words, Bouvard and Pécuchet awake from their dream only when catastrophe overtakes their presumptuous efforts. Flaubert has been accused of presenting them as imbeciles, but in fact he expresses his compassion for them: "They acquire a faculty deserving of pity, they recognize stupidity and can no longer tolerate it. Through their inquisitiveness their understanding grows; having had more ideas, they suffered more." Flaubert's satire is thus to some extent the history of his own experience, told with a sad humour.

Flaubert died suddenly of an apoplectic stroke on May 8, 1880. He left on his table an unfinished page and notes for a second volume of his novel. Bouvard and Pécuchet, tired of experimenting, were to go back to the work of transcribing and copying that they had done as clerks. The matter that they chose to transcribe was the subject of the notes: it was to be a selection of quotations, a *sottisier*, or anthology of foolish remarks. There has been much controversy about this bitter conclusion, as the form that it was to take was left undetermined.

Flaubert's Method of Composition.—Flaubert worked slowly and carefully, and as he worked, his idea of his art became gradually more exact. His letters to Louise Colet, written while he was working on *Madame Bovary*, show how his attitude changed. His ambition was to achieve a style "as rhythmical as verse and as precise as the language of science" (letter of April 24, 1852). In his view "the faster the word sticks to the thought, the more beautiful is the effect." He often repeated that there was no such thing as a synonym and that a writer had to track down *le seul mot juste*, "the unique right word," to convey his thought precisely. But at the same time he always wanted a cadence and a harmony of sounding syllables in his prose so that it would appeal not only to the reader's intelligence but also to his subconscious mind in the same way as music does and thus have a more penetrating effect than the mere sense of the words at their face value. Composition for him was a real anguish.

Flaubert sought objectivity above all else in his writing: "The author, in his work, must be like God in the Universe, present everywhere and visible nowhere." It is paradoxical, therefore, that his personality should be so clearly discernible in all his work, and that his letters, written casually to his intimates and full of disarming sincerity, delicate sensibility and even exquisite tenderness, should be considered by some critics as his masterpiece.

Editions and Translations.—The critical edition by René Dumesnil of Flaubert's novels, short stories and travel notes in 12 volumes (1938–46) provides a definitive text, with variant readings, as well as an introduction and annotations. For Flaubert's juvenile writings and for his plays, reference can be made to the 18-volume Conard edition (1910–28). This includes five volumes of *Correspondance*, but these were superseded by a new edition in nine volumes (1926–33), followed by the four-volume *Supplément à la correspondance générale*, edited by R. Dumesnil, Jean Pommier and Claude Digeon (1954).

Some of Flaubert's novels have been translated into English several times. The following versions may be cited: *November*, translated by F. Jellinek (1932); *Sentimental Education*, translated by Anthony Goldsmith (1941); *The First Temptation of Saint Anthony*, translated from the version of 1856 by René Francis, new ed. (1924); *The Temptation of Saint Anthony*, translated by Lafcadio Hearn, new ed. (1932); *Madame Bovary*, translated by Gerard Hopkins (1949) and by F. Steegmuller (1957); *Salambo*, translated by E. Powys Mathers, new ed. (1950); *Three Tales*, translated by Mervyn Savill (1950); *Bouvard and Pécuchet*, translated by T. W. Earp and G. W. Stonier (1936). There are selections of his letters in English translations by J. M. Cohen with an introduction by R. Rumbold (1950); and by F. Steegmuller (1954).

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(R. DL.)

FLAVIAN, SAINT (d. 449), patriarch of Constantinople, was an adversary of the Monophysite heresy (*see* MONOPHYSITES). He became patriarch in 446 and in 448 presided at a Constantinopolitan synod which condemned Eutyches (*q.v.*). Flavian's announcement of this evoked from Pope Leo I the famous *Dogmatic Letter* of 449. The "robber synod" of Ephesus, contrived by court intrigue, deposed and excommunicated him in 449; his opponents so maltreated him that he died three days afterward in Lydia. The Council of Chalcedon (451) vindicated him, however, proclaiming him a martyr and saint; both the Latin and Greek churches commemorate him on Feb. 18.

Three letters of Flavian to Pope Leo I and one to Emperor Theodosius II are preserved; they may be found in J. P. Migne (ed.), *Patrologia Latina*, vol. liv, and *Patrologia Graeca*, vol. lxv.

(JN. SR.)

FLAVIAN I OF ANTIOCH (*c.* 320–404), bishop of Antioch from 381, was born probably at Antioch. With Diodorus of Tarsus; Flavian defended the Nicene faith against the Arian bishop Leontius. In the religious meetings they conducted, Flavian popularized the form of the lesser doxology that is derived from the baptismal formula, and he is believed to have originated the practice of antiphonal singing in church services. In 360 Meletius (*see* MELETIUS, SAINT), whom the Arians had ordained bishop of Sebaste, became bishop of Antioch, where his unexpected profession of the Catholic faith earned him several exiles. During these absences Flavian and Diodorus resumed the care of the faithful. Meanwhile, the Eustathians—Antiochenes who had separated from the Arian bishop after the banishment of the orthodox bishop Eustathius (331)—rejected Meletius and made Paulinus their bishop (*see* EUSTATHIUS, SAINT). The schism thus set afoot continued after Meletius' death. Flavian succeeded him in 381, and Paulinus appointed as his own successor Evagrius, the last bishop of the Eustathians. Recognition of Flavian as legitimate bishop of Antioch was at first withheld by the bishop of Rome, but it was secured in 399 through the intervention of John Chrysostom (*q.v.*), patriarch of Constantinople, and the influence of the emperor Theodosius.

Flavian died in 404. Some Eustathians continued in schism until 414.

See F. Cavallera, *Le schisme d'Antioche* (1905); Herzog-Haupt, *Realencyklopädie*.

(J. A. P. B.)

FLAVIAN II OF ANTIOCH (d. *c.* 518), patriarch of Antioch probably from 498 to 512, was chosen patriarch by the monophysitic emperor Anastasius I after he accepted the evasive Henoticon, the decree of union between the Monophysites (*q.v.*) and the Orthodox. In deference to orthodoxy, however, Flavian would not expressly repudiate the Council of Chalcedon. This equivocal policy only antagonized both sides, particularly the Monophysites.

At the synod of Sidon (511) Flavian maintained his position, but soon afterward, under constant harassment by his enemies, he yielded finally to their demand for a rejection of Chalcedon. It was too late. He was forced to abdicate and was banished to Petra in Arabia. There he died, probably in 518. (JN. SR.)

FLAVIO BIONDO (BIONDO FLAVIO or FLAVIUS BLONDUS) (1392–1463), Italian humanist and historian, was born at Forlì in 1392. After filling various posts as secretary, he entered the papal service as a notary in 1433 and was appointed apostolic secretary by Eugenius IV in 1434. He remained in the papal chancery (apart from the years 1449–53, when he was out of favour with Pope Nicholas V) until his death on June 4, 1463.

Of his four major works the *Roma instaurata* (composed 1444–46) and the *Roma triumphans* (1456–60) are landmarks in the history of antiquarian studies; the *Italia illustrata* (1448–53) is an original historical-geographical survey of Italy; and the *Historiarum ab inclinatione Romanorum decades* (1439–*c.* 1452), covering the millennium from the capture of Rome in A.D. 410 to 1441, contains the first humanist history of medieval Europe and provides, in the third and fourth decades (of the last, only two books were completed), a history of contemporary Italy that for fullness and reliability is unmatched in its time.

Other works by Biondo include a treatise on the question of spoken Latin in antiquity (*De verbis Romanae locutionis,* 1435); writings in favour of a crusade (1452–54); the first book of a Venetian history, *Populi Veneti historiarum libri* (1459–60); and a treatise *De militia et jurisprudentia* (1460). These works have been edited, or re-edited, together with the last book of the *Decades* (iv, 2) and letters by Biondo, by B. Nogara, *Scritti inediti e rari di Biondo Flavio* (1927).

See D. Hay, "Flavio Biondo and the Middle Ages," *Proceedings of the British Academy* (1959). (N. R.)

FLAVIUS, GNAEUS, Roman writer of the 4th century B.C., on legal procedure, was the son of a freedman but had a distinguished career which began when he was made secretary to Appius Claudius Caecus. Before Flavius' time, the technical rules of procedure in Roman law were known only to the patricians and pontiffs, part of whose power derived from the fact that they had to be consulted frequently on legal questions. Flavius, either by copying from a law book owned by Appius Claudius or by questioning the latter's friends, was able to work out the procedural system and published his findings under the title of *Jus Flavianum.* Thereafter he was immensely popular with the Roman people and was selected for a number of public offices, including that of senator. In 303 B.C. Flavius was made curule aedile (magistrate of public buildings and works) over the bitter protests of the nobles, with whom he was unpopular both because he had taken from them one of the sources of their power and because of his lowly parentage.

FLAVOUR is the total of the sensations perceived when a food or beverage is consumed; these sensations not only help a person identify substances but also furnish sources of enjoyment when eating and drinking.

Taste and Aroma.—The sensory organs involved in flavour perception are those of taste, smell and touch, with the nerve endings located in the nose and mouth.

Tasting occurs in the mouth, chiefly on the tongue through the taste buds. There appear to be only four basic receptor types responsible for the tastes—sweet, salty, sour and bitter. Examples of substances that induce the four basic tastes are sugar (sweet), salt (salty), lemon juice (sour) and quinine (bitter). Substances can be tasted only when they are in water solutions, and if a substance is not in solution when taken into the mouth it must be dissolved in saliva before it can be detected by the taste buds.

Smelling involves the olfactory nerve endings in the upper part of the interior of the nose. Aromas can reach these nerves either directly through the nostrils as in breathing or indirectly up the back passageway from the mouth. Because of their remote location, the olfactory nerve endings are best stimulated by "sniffing" through the nose or swallowing if food is in the mouth. Odours are smelled only when the material is in gaseous form; *i.e.*, a dispersion of molecules in air. While taste types are limited to four, the number of odours that can be identified is in the thousands. The trained flavour chemist is normally capable of distinguishing 10,000 different odours. Further, the sense of smell is extremely sensitive, requiring only minute quantities for detection; a few parts per million in air is sufficient for detection of many odours. The smell of brewing coffee or the cooking of onions, for instance, can be recognized at considerable distances. The sense of taste requires considerably higher concentrations of substances for detection, as much as several tenths of a per cent often being necessary to elicit a response. (*See* also SMELL AND TASTE.)

Touch sensations that contribute to taste originate in the nose, lips and throughout the entire mouth and throat. The many kinds of touch sensations are based on either the physical or chemical properties of the substance, or a combination of them. Physical properties of foods that produce touch sensations are particle size, texture, consistency and temperature; reactions induced by chemical properties include the coolness of peppermint, the "bite" of mustard and pepper, the warmth of cloves and the astringency of spinach. (*See* also TOUCH, SENSE OF.)

When a human consumes food, the simultaneous stimulation of the senses of taste, smell and touch create an immediate impression that causes the eater to accept the food and continue eating or reject and discard it. Many foods such as bananas, berries and other fruits, nuts, milk and a few vegetables have flavours that make them highly acceptable in their natural, uncooked state. Other foods derive their flavour through cooking, seasoning and flavouring or combinations of these. (*See* also NERVOUS SYSTEM: *Sensory Endings (Receptors);* SENSATION: *Senses;* FEELING, PSYCHOLOGY OF: *Theory of Feeling.*)

Flavour Development.—*Roasting.*—One of the earliest known and most impressive means of developing flavour is the cooking of meats and poultry over a fire. The high temperature caramelizes meat sugars, chars proteins and decomposes fats, resulting in development of highly aromatic roasted meat flavour. Wood fires, such as those made with hickory wood, may impart distinctive smoke aroma. Roasted meat flavour can also be produced by heat sources that use coke, charcoal, gas, electricity or any high-temperature fuel. To a lesser extent pan roasting, searing and pan frying also develop roasted meat flavour.

Flavour development by roasting is not confined to meat; for example, the flavours of coffee, cocoa and nut meats are developed by roasting. In the cooking of breads, cakes, cookies and pies, the outer crusts are often browned and have slightly burned, caramel flavour that is attributed to the roasting action of heat.

Baking, Boiling, Steaming.—Perhaps the simplest and best-known method of food preparation consists of cooking foods by placing them in boiling water or by allowing the steam produced by the water to heat the food. Meats, fish, cereals and vegetables are frequently cooked in this manner. While not usually thought of as such, baking, which is similar to roasting, is also a form of water cooking, involving the driving off of water in the form of steam from the baking food. During baking, boiling and steaming, the water will extract the volatile flavours and can carry them off; this extraction, if prolonged, can result in insipid flavour, as occurs when onions, carrots or parsnips are cooked too long. The effects of water extraction are not entirely adverse, however, and the method is used to prepare coffee, tea and other beverages.

For optimum flavour, vegetables should be boiled just long enough to produce tenderness. The food should be served immediately and not allowed to stand in the hot water. Some situations require lengthy boiling to develop flavour, as in the preparation of soup stock by boiling bones and meat to produce new aroma and flavour factors; but such situations are the exception to the rule.

As mentioned above, the outer crusts of breads, cakes and pastries are heated during baking to browning temperatures that are above the boiling point of water. Although the interiors of baked foods never reach browning temperature, the flavour changes produced in the interiors by baking greatly increase palatability.

The most important change is brought about by cooking or bursting the starch cells to eliminate the raw starch taste and produce the full, mouth-filling flavour of cooked doughs.

Presumably by accident, man long ago found that the predecessor of modern bread could be made if a yeast were allowed to grow in the dough with subsequent conversion of sugars to alcohol, release of carbon dioxide gas and creation of a unique flavour. The highly attractive flavour of bread comes not only from the inherent flavours in the grain but also from by-products of yeast fermentation, which are alcoholic in odour, followed by the aromatic materials produced by baking.

Aging.—Some foods and beverages highly prized for their flavours owe these flavours to the development process of aging for long periods of time. Such aged foods include brandies, cheeses and pickles, to mention only a few. Brandy, for example, is first distilled and then the distillate is stored in wooden barrels for years to develop desirable brandy flavour. During this aging process components of the wood are slowly extracted by the brandy, and at the same time components of the brandy are absorbed or adsorbed by the wood. This gradual change in the brandy's flavour-producing ingredients produces a so-called "mellowing" or blending of flavours. Cured cheeses depend on a slow fermentation or ripening process to develop distinctive flavour characteristics. With some pickles, the action of sugar, vinegar, herbs and spices is allowed to take place over a long period of time to develop optimum flavour.

Seasoning.—Salt, sugar, monosodium glutamate (MSG) and certain spices such as pepper are examples of seasonings that make outstanding improvements in flavour. Their mode of action is not clearly understood; however, enough is known to indicate that seasoning is a highly complex phenomenon.

It is learned from early writings that man has always sought salt to make his foods more palatable and to help preserve them when stored. The continents of North and South America were discovered because of man's quest for new routes to the spice treasures of the orient. The optimum flavour contribution of salt occurs most often at a concentration below that which would give a distinct salty taste; best seasoning results are obtained by adding salt to foods prior to cooking.

Sugar and other sweeteners such as honey, sirups and molasses are useful at the seasoning level in gravies, stews and vegetables.

Monosodium glutamate, used for centuries in the orient in the form of a vegetable sauce to improve the palatability of a predominantly rice diet, has in recent years been introduced in North America and many countries of Europe. Like salt, it has found important use as a seasoner for improvement of flavour. Although it adds no flavour or aroma of its own, it has the ability to blend and accentuate many flavour factors and makes important flavour contributions in soups, stews, meats, fish, poultry and vegetable dishes.

The spice pepper also belongs in the seasoning category, for it is used more often as a seasoning than as a flavouring agent. The demand for pepper has not diminished since the early caravans and explorers sought routes for procuring this highly prized substance. In early times, pepper no doubt did a great deal to improve the palatability of the unrefrigerated foods of the world. As a seasoning it is a blending agent, increasing the body of flavour and providing pleasant taste and aroma sensations.

Flavouring.—While the flavours of all natural foods are quite complex, the foods themselves are often made more appealing to the human palate by using them in combination with other foods, or by adding small quantities of highly aromatic flavouring agents such as spices, herbs and essential oils. The essential oils are the flavouring oils extracted from any natural product. Soups and stews in which meat and vegetables are cooked together are examples of foods combined to give optimum appeal. Spreads such as butter, oleomargarine, jams and jellies when eaten on breads make for more eating enjoyment. Much use of flavouring agents is now made by food processors and home use continues to flourish in many instances; cinnamon and nutmeg are used in pastries, vanilla in baked goods, clove in hams and celery seed in soups and stews. (For descriptions of the most common herbs, spices and other seasoning agents and their use in cooking, *see* FOOD PREPARATION: *Herbs and Spices*. Also *see* individual articles on each agent.)

History has demonstrated that man has continually sought compatible combinations of foods and flavourings to relieve the monotony of eating. While sources of available foods have always governed eating habits to some extent, man often seeks flavour in preference to good nutrition. Although there is no one flavour that is appealing to all, certain widely accepted foods all seem to possess the following characteristics: (1) an early initiation of appropriate flavour; (2) rapid development of a full body of blended flavour; (3) pleasant mouth sensations; (4) absence of unpleasant characteristics in either the initial impression or aftertaste; and (5) usually a quick disappearance of flavour on swallowing. Cooking, aging, seasoning and flavouring all contribute toward these five desirable features.

Flavour Testing.—The techniques used for judging the flavour of foods can be grouped into several major categories: (1) ranking and scoring; (2) difference testing; (3) the flavour profile method, an analytical descriptive method of characterizing flavour; and (4) consumer acceptance testing.

Early flavour testing was carried out by experts who because of training, experience and familiarity with foods were believed to make sound judgments. While many judgments on flavour are referred to teams of trained workers known as flavour panels, single experts are employed in the coffee, tea and wine industries. Here the expert rates his product against product standards known to be acceptable to the consumer.

Ranking and Scoring.—One of the simplest techniques of flavour judgment is ranking, which requires flavour panel members to arrange a series of samples in ascending or descending order of intensity based on a specific flavour characteristic. For instance, panel members might be asked to rank sweetness of sugar solutions so that a correlation might be made between sweetness and strength. Panel members are trained to recognize the flavour factor under study and relate it to reference intensity standards. Ranking methods are useful in the food industry chiefly in quality control in large-scale production; however, the method lacks precision when flavour differences are small, and the information developed is limited to one flavour factor.

The scoring method was originally developed by the dairy industry to rate products such as butter by numerical grade according to some predetermined standard; it is now widely used in the flavour appraisal of fruits and vegetables, as well as dairy products. Scoring is performed by panels previously trained in the particular qualities under observation. Many numerical scales are used, depending on the number of points considered convenient.

Difference Tests.—Difference tests were developed just prior to World War II as a means of introducing more precise measurement in the field of flavour testing. Many forms of difference tests are utilized, but all are intended to establish whether there is a detectable difference between two samples. The numbers of tasters and flavour samples evaluated are carefully controlled to meet a statistical model having a known theoretical distribution of responses based on chance. In the best known difference test, known as the triangle test, two of the three samples employed are identical, although all three are coded differently. The taster is asked to pick the odd sample. The chance probability of a taster picking the correct sample would be one out of three. Triangle tests for flavour are useful in production quality control to make sure each lot is as good as a standard.

Flavour Profile Method.—In the flavour profile method, panels of trained tasters describe the aroma and flavour of a food product in everyday language. Persons who have normal abilities to taste and smell and who are trained in sensory techniques of tasting and smelling are selected to work on flavour profile panels. They are also exposed to a number of flavour and odour situations in order to provide background experience for odour and flavour description. At least six months are required to train a panel member.

Panels first observe the total aroma of the food under test

and then give their impressions of each of the detectable aroma factors as they occur, describing these in associative terms. The panel then tastes the food and makes similar observations on the flavour-by-mouth and on the aftertaste. Each aroma and flavour factor is appraised on the basis of intensity, using the scale of threshold, slight, moderate and strong. Aroma factors are the sensations perceived on sniffing and include odours as well as touch factors. Flavour-by-mouth sensations are those perceived by all of the flavour senses, including the basic tastes, touch factors in the mouth and throat, and odour and touch factors in the nose.

Individual observations recorded in tabular form on a response sheet are interpreted by the panel leader. Flavour profiles have been found useful in quality control of flavour, in guiding product development and in flavour research.

Consumer Acceptance Testing.—To determine the flavour acceptability of a food, it is often necessary to obtain information direct from the consumer. A number of methods have been employed to accomplish this, with variations occurring in the size and composition of the panel of tasters, the method of presenting the samples, the means of gathering information and the method of interpreting the data. Flavour is best evaluated by consumers who are potential users of the food; for example, a ready-to-eat cereal should be judged by those who normally eat this type of breakfast food. In consumer testing, it is important to have a panel large enough to furnish statistically significant information. Although much consumer testing is done on a single exposure, best judgments are made in the home under normal use conditions and over a short period of time. Data are collected either by questionnaire or by interview. Great care is taken to obtain factual information with respect to flavour, since most consumers are incapable of describing their reactions adequately.

Consumer panel results are interpreted by workers who are experienced in consumer testing and attempt to project the findings in terms of proposed market sales.

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FLAX (*Linum usitatissimum*), a slender, annual herbaceous plant grown in many temperate and subtropical countries for the production of linseed oil and linen fibre. Flax is sown in the spring in temperate and cool climates and in late summer or early autumn (winter annual) in warm climates.

Origin and History.—Cultivated flax probably originated in the Mediterranean region from the wild flax (*Linum angustifolium*), the only species of wild flax with which it crosses readily. Several other species of *Linum* are grown as ornamentals. Flax was cultivated in prehistoric times, possibly at first for food. It was found in the ruins of the Stone Age lake dwellings of Switzerland and it is known that the ancient Egyptians made linen cloth from flax fibres. Later flax cultivation spread through Europe, parts of Asia and north Africa. It reached the United States during the colonial period where it was widely grown for fibre before the invention of the cotton gin in 1792 made cotton a cheaper fabric. The manufacture of linseed oil in the United States began in 1805.

Plant Characteristics.—The plants grow to a height of 12 to 40 in., with a distinct main stem and a short taproot. Two or more basal branches may arise from the lower part of the main stem and these, like the main stem, produce branches that bear the flowers. The lance-shaped leaves are borne alternately on the stems and branches. Each flower has five petals that are blue, white or pale pink and ten anthers that are blue or yellow. The flowers open in early morning and shed their petals by early afternoon. Daily blooming may continue for several weeks. The flowers are self-pollinated. The boll or capsule has five double-celled carpels and contains ten seeds when all of them develop. The shiny, flattened seeds are brown or yellow and from $\frac{1}{4}$ to $\frac{1}{3}$ in. long. A pound of flaxseed contains from 65,000 to 120,000 seeds. The varieties grown especially for fibre have long stems with few branches and seeds. The linen or bast fibres occur in the bark of the stem. Seed flax varieties have short, much-branched stems and many seeds.

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FLAX (LINUM USITATISSIMUM)

Fibre Flax Varieties.—The U.S.S.R. is the world's chief producer of flax fibre. Other leading producers include Poland, Germany, France, Northern Ireland, Ireland, Rumania, Belgium and the Netherlands. Some flax fibre is also produced in New Zealand, Australia, Japan, Argentina and Egypt. The United States was a minor grower of fibre flax, the crop having been grown chiefly in Oregon, but production virtually ceased in the mid-1950s.

Yields of fibre range from 300 to 800 lb. per acre in most countries, with still lower yields in the U.S.S.R. and much higher yields in Northern Ireland. The yield in the United States averaged about $1\frac{3}{4}$ tons of straw (or 400 lb. of fibre) per acre.

Cultivation and Harvesting.—Flax is best adapted to medium loam or clay soils. Flax grown on soils high in nitrogen often has a low fibre content. Clean land, well tilled to destroy weeds, is essential and a smooth, firm seedbed is desirable.

The crop is sown in early spring in most countries at a rate of 80–140 lb. of seed per acre. Some hand weeding of the flax field may be necessary. Flax is harvested for fibre when about one-half of the seeds are ripe and the leaves have fallen from the lower two-thirds of the stem, which stage usually is reached about 80 to 100 days after sowing. Most of the crop is harvested by pulling the plants from the ground by hand but pulling machines, which also bind the stalks, are available. After the crop has been pulled and bound, the stalks usually are set in shocks in the field for curing (drying). The dried stalks are deseeded by threshing, combing or beating the tops of the bundles. The seed, a by-product, is saved for sowing purposes, oil extraction or feed.

Preparation of Fibre and Yarn.—The deseeded straw is retted (partly rotted) to dissolve the gums that bind the fibres to the woody portion of the stem. Retting either by exposure to the elements (dewretting) or by submergence in water is practised, but the latter process provides uniformly better fibre. In dewretting, the common method in the U.S.S.R., the straw is spread out evenly and thinly on the ground, usually on grassland, where it is subjected to weathering and to the action of soil-borne bacteria that are present on the straw. Retting is completed after 7 to 21 days or more, when the bark of the stem is loosened so that it can be readily peeled from the woody core. The straw is then gathered, bound and again set in shocks to dry. In retting by submergence in water, the common method in most countries, the straw is immersed in ponds, sluggish streams or vats and allowed to steep until the bark is loosened. In vats the water is circulated to provide uniform retting. Retting by this process requires 6 to 8 days at a water temperature of 80° F. (26.7° C.) and up to 20 days when the water is cooler. The retted straw bundles are set in the fields in open shocks ("wigwams") to dry. Chemical retting is also possible but is much more expensive.

The fibre is separated from the woody core by breaking and scutching. Breaking is accomplished by passing the straw between fluted rolls or by crushing it between slatted hand-breaking frames. This breaks the brittle woody portions of the stem into short pieces called shives but leaves the flexible fibres largely intact. Scutching is accomplished by passing the broken straw through revolving beaters that free the fibres from the shives. Some machines do both breaking and scutching. The scutched fibre is baled and shipped to spinning mills.

At the spinning mill the fibre is hackled (combed) by machines that separate the short, tangled fibres and remaining shives. The resultant long, straight fibre, called line fibre, is further combed and then twisted into yarn on a spinning machine. The short or tangled fibres, called tow, may be used as is for upholstering or

padding, or may be carded to produce strands of parallel fibres that are then spun into coarse yarns. Fine yarns are used in weaving high-quality linen fabrics such as laces, household linens and dress goods. Coarse yarns are used for fabrics such as rough toweling, or for making twine, cord or rope. (*See* LINEN MANUFACTURE.)

Seed Flax Varieties.—About an eighth of the world production of flaxseed (linseed) is obtained as a by-product from fibre flax; the remainder is produced by seed flax varieties. Seed yields from seed flax varieties are about twice those from fibre flax under similar conditions. The United States, U.S.S.R., Argentina, India, Canada and Uruguay are the leading countries in linseed production but appreciable quantities are produced in many other countries on all continents. In the United States, North Dakota, Minnesota and South Dakota usually lead in total production but the highest yields per acre are obtained on irrigated lands in Arizona and California.

The crop is sown in autumn or early winter in California, Texas, Arizona and other warm climates and ripens about five months later. It is sown in the spring in northern Europe and in the northern half of the United States, where it matures in 80 to 120 days. Flaxseed usually is sown with a grain drill, about one inch deep, at the rate of 30 to 50 lb. per acre. Flax is an excellent companion crop with which to sow meadow grasses and legumes. A clean seedbed is best obtained when flax is preceded by an intertilled crop or a sod crop and when the land is worked frequently before sowing the flax. Certain weedy grasses as well as broad-leaved weeds in flax fields can be controlled with suitable chemical herbicides.

Seed flax is usually harvested and threshed with a combine but simple harvesting and threshing machines or hand methods are still used on numerous small farms in many countries.

Tow extracted from seed flax straw in the United States is used in making cigarette paper and Bible paper.

Linseed Oil.—Flaxseed contains from 33% to 43% oil and about 6% moisture. Large seeds are highest in oil content. Drought or temperatures above 90° F. (32.2° C.) when the seed is developing reduces size and oil content. A bushel (56 lb.) of linseed yields about 2½ gal. of oil in commercial crushing. Flaxseed is ground, steamed and then pressed to extract the oil. Solvents may then be used to extract additional oil from the press, or expeller, residue. The residue or oil cake remaining is used as a concentrated or conditioning feed for livestock. Linseed oil is used chiefly in paints and varnishes but also in making linoleum, oilcloth and other products. (*See* LINSEED AND LINSEED OIL.)

Diseases of Flax.—Flax is attacked by several diseases including wilt, rust, pasmo, anthracnose (all caused by pathogenic fungi), curly top and aster yellows (caused by viruses). These diseases are kept under fair control by chemical seed treatment or by growing resistant varieties. Before wilt-resistant varieties were developed, flax could be grown on the same land for only a few years before the crop failed because the soil became infested with the fungus causing the wilt disease. This fact led to the popular misconception that "flax is hard on land." From colonial times until about 1920 flax production shifted westward to new lands that were not infested with wilt. Later, resistant varieties became available for all parts of the United States.

See also references under "Flax" in the Index.

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FLAXMAN, JOHN (1755–1826), English sculptor and draftsman, was born at York on July 6, 1755. His father was a modeler of plaster casts, and his early training was largely received at home. He was awarded a medal by the Society of Arts at the age of 12 and at 15 began to exhibit at the Royal Academy. At 20 he was working for Josiah Wedgwood as a modeler of medallions, portraits, vases, plaques, etc., and this activity accounted for much of his later fame. He continued to work for Wedgwood till 1787, developing into a sensitive neoclassicist with a manner of seeing which during his mature years was everywhere the fashion.

In 1782 Flaxman married Anne Denman and in 1787 they set out for Rome. Flaxman soon ceased modeling for Wedgwood himself but continued to direct the work for other modelers employed by the manufacturer in Rome. He had intended to return after a stay of a little more than two years but was detained by a commission for a marble group of a "Fury of Athamas" from Frederick Hervey, earl of Bristol and bishop of Derry, and did not return until the summer of 1794, having in the meantime executed another commission ("Cephalus and Aurora") for Thomas Hope and having sent home models for several sepulchral monuments, including one in relief for the poet William Collins, in Chichester cathedral, and one in the round for Lord Mansfield in Westminster abbey.

But what gained a general and European fame for Flaxman in this interval were outline designs to the poets, in which he showed his natural affinity to the ancients. The designs for the *Iliad* and *Odyssey* were commissioned by Mrs. Hare-Naylor; those for Dante by Hope; those for Aeschylus by Lady Spencer. All were engraved by Piroli, not without considerable loss of the finer and more sensitive qualities of Flaxman's own lines.

In 1797 Flaxman was made an associate of the Royal Academy. Every year he exhibited work of one class or another, occasionally a public monument in the round but more often memorials for churches, with symbolic acts of mercy or illustrations of Scripture texts, both commonly in low relief. In 1800 he was elected full academician. In 1810 he was appointed to a chair of sculpture specially created for him by the Royal Academy.

The most important works which occupied Flaxman in the following years were the monument to Mrs. Baring in Micheldever church, the richest of all his monuments in relief (1805–11); that for the Worsley family at Campsall church, Yorkshire, which is the next richest; those to Sir Joshua Reynolds for St. Paul's (1807); to Capt. Josiah Webbe for India (1810); to Captain Walker and Captain Beckett for Leeds (1811); to Lord Cornwallis for Prince of Wales's Island (1812); and to Sir John Moore for Glasgow (1813).

For a good many years after his Roman period he produced no outline designs for the engraver except three for William Cowper's translations of the Latin poems of Milton (1810). Other sets of outline illustrations drawn about the same time but not published were one to the *Pilgrim's Progress* and one to a Chinese tale in verse, called "The Casket." In 1817 he returned to his old practice of classical outline illustrations and published the happiest of all his series of that type, the designs to Hesiod, excellently engraved by the sympathetic hand of William Blake. Immediately afterward he was much engaged in designing for the goldsmiths—a testimonial cup in honour of John Kemble and, following that, the great labour of the famous and beautiful though quite un-Homeric shield of Achilles. Almost at the same time he undertook a frieze of "Peace, Liberty and Plenty" for the duke of Bedford's sculpture gallery at Woburn and a heroic group of Michael overthrowing Satan for Lord Egremont's house at Petworth. He died on Dec. 3, 1826.

As a sculptor Flaxman was weakest when he was most ambitious and most inspired when he made the least effort. Of Flaxman's complicated monuments in the round, such as the three in Westminster abbey and the four in St. Paul's, there is scarcely one which has not something heavy and infelicitous in the arrangement. But in his simple monuments in relief there is almost always a far finer quality. He did not thoroughly understand composition on the great scale and in the round, but he did thoroughly understand relief and found scope in it for his remarkable gifts of harmonious design and tender, grave and penetrating feeling.

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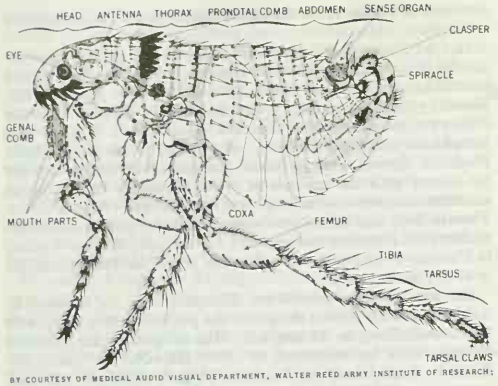
FLEA, an insect of the order Siphonaptera, members of which are of importance in the transmission of disease and often are



BY COURTESY OF MEDICAL AUDIO VISUAL DEPARTMENT, WALTER REED ARMY INSTITUTE OF RESEARCH; H. STARCKE

CAT FLEA (CTENOCEPHALIDES FELIS), MALE

serious pests. Fleas are small, wingless insects, whose bodies are strongly flattened laterally, bearing many bristles and, frequently, rows of broad flattened spines called combs (or ctenidia). Adult fleas, ranking in size from about $\frac{1}{32}$ in. to $\frac{6}{16}$ in., feed on the blood of man and other mammals, and birds. The active immature stage is a small caterpillarlike larva that lives in the resting places or nests of the host. About 1,600 species and subspecies of fleas are known.

Structure, Habits and Life History.—Anatomically, adult fleas are quite distinctive from other insects and exhibit many interesting modifications. The compressed, firm body, with strong legs and with backward-projecting spines and combs, enable fleas to move easily through the hairs or feathers of the host. The hind legs are particularly modified for jumping, enabling some fleas to leap 10 in. high or to span 14 in.—distances 50 to 100 times their body height or length! (An amusing and very incidental use of fleas' unusual strength is in "flea circuses" where these insects are made to pull miniature carts and perform other feats of power.) The mouth parts of the adult are modified for sucking blood and include elongate barbed stylets for penetrating the skin of the host. Some fleas have well-developed eyes, but fleas parasitizing subterranean hosts such as moles generally have greatly reduced eyes. The thorax, housing the muscles of the legs, is broad and stout in the many kinds of jumping fleas, but is often reduced in the sticktight and chigoe fleas. The terminal segments of the male are generally highly specialized and enclose the very complex genitalia.

Details of the life cycle of fleas are available only for a few species. There are four stages—the egg, larva, pupa and adult. The pearly white, oval eggs are deposited loosely on the body or in the haunts of the host animal. The larva feeds on organic debris such as dried blood and excrement. After three molts, the larva fashions a cocoon made of debris and silk and begins the pupal stage, preparatory to emerging as an adult. The entire life cycle may take only two or three weeks for some species, and the adults may live for weeks or months. Both sexes feed avidly and repeatedly on blood, but they may survive without food for weeks.

Some species of fleas, such as the shrew fleas, are highly host-specific, but other fleas parasitize a variety of animals. The cat flea, for example, infests not only domestic cats but also leopards, mongooses, foxes, civets, dogs, opossums and others; it will also readily feed on man in the absence of its accustomed host.

Medical and Economic Importance.—Severe dermatitis and intense pruritis may follow infestation by fleas. Although many animals acquire a partial immunity after constant or repeated attack, an occasional individual (especially in man) will become sensitized after exposure and develop an allergy. Species attacking man and livestock include the cat flea (*Ctenocephalides felis*), the so-called human flea (*Pulex irritans*), the dog flea (*Ctenocephalides canis*), the sticktight flea (*Echidnophaga gallinacea*) and the jigger or chigoe flea (*Tunga penetrans*). Poultry may be parasitized by the European chicken flea (*Ceratophyllus gallinae*) and the western chicken flea (*Ceratophyllus niger*).

Certain fleas that primarily feed on rodents or birds will sometimes attack man, particularly in the absence of their usual prey, as when rats are dying of bubonic plague and their hungry fleas must seek other food. Under such conditions, the tropical or oriental rat flea (*Xenopsylla cheopis*) may transmit the dreaded bubonic plague bacillus to man. Other species of fleas, such as *Xenopsylla brasiliensis* and *Nosopsyllus fasciatus*, may transmit plague but are not as important as *Xenopsylla cheopis*, for ecological and physiological reasons. Although some cases of plague in man still occur in some tropical regions, it is generally readily controlled. Plague (sylvatic plague) does occur, however, as a widespread infection or disease in several hundred different kinds of wild rodents in many parts of the world; it is maintained by fleas parasitizing these animals, and natural infection with the plague bacillus has been demonstrated in more than 90 species of fleas, representing 45 genera and 9 families. (*See* PLAGUE.)

Fleas, particularly *Xenopsylla cheopis*, are believed to be the principal vectors of murine typhus, a rickettsial disease of man; rats and mice serve as sources of infection (*see* TYPHUS FEVER: *Murine Typhus*). Fleas are considered of importance in the maintenance and spread of many enzootic (locally restricted) infections among rodents and other mammals, including tularemia and Russian spring-summer encephalitis (*see* also ENCEPHALITIS; RICKETTSIAE). Fleas may transmit myxomatosis, a virus disease of rabbits, which has been deliberately used to control rabbits in areas where they have been severe pests (*e.g.*, in Australia). Fleas are considered probable vectors of a filarial worm of dogs, and serve as the intermediate host of a common tapeworm (*Dipylidium caninum*) of dogs and cats (and occasionally children). In heavy flea infestations animals may be severely damaged or killed by the effects of flea bites and by the considerable loss of blood. Fleas are subject to parasitism by external mites and internal nematode worms; and by bacterial and protozoan infections.

In the chigoe or jigger flea (not to be confused with the "chigger," a larval mite), the fertilized female burrows into the skin of its host, generally on the feet, and lives within a cyst that forms around it. Intense itching accompanies the development and enlargement of the cyst as the abdomen of the gravid (pregnant) flea swells to the size of a pea.

Studies of the classification and ecology of fleas have contributed to the fields of zoogeography and medical ecology. Related mammals tend to be parasitized by fleas that themselves are related. Thus, the rabbitlike pikas (*Ochotona*), living in the Rocky mountains, are infested with two peculiar genera of fleas that also occur on pikas in the mountains of Asia, indicating the very close relationship of these geographically separated pikas. The occurrence of virtually identical fleas on ground squirrels in Manchuria and the western U.S. lends credence to the belief that sylvatic plague is of ancient origin in both regions.

Control.—In controlling fleas it is best to treat simultaneously both the breeding sites of fleas and the infested host, for, as mentioned earlier, the larval and pupal stages may develop off the host's body. For infested animals a commercial dust, spray, dip or aerosol containing an insecticide such as pyrethrum, rotenone, malathion or methoxychlor may be used. Methoxychlor and malathion may continue to kill fleas for a few weeks after application. The long-acting chlorinated hydrocarbons, such as lindane, chlordane and DDT, may be applied to the fur of certain infested animals (but not on cats or puppies). In some regions, however, fleas have become resistant to these hydrocarbon insecticides, and new toxicants may be required. The organophosphorous compounds offer promise as systemic insecticides; animals to be protected are fed these compounds, and the fleas feeding on such hosts die. For control of larval and adult fleas off the host, dieldrin, lindane or malathion may be applied to the pens and haunts of the affected animals. Repellents containing benzylbenzoate (applied to clothing), phthalate compounds or diethyltoluamide (applied to the skin or clothing) are effective in preventing attack by fleas.

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FLÈCHE, an architectural term that in France signifies any spire but in English usage is limited to those small, slender spires which are placed on the ridge of a roof of a church and not upon a tower. The flèche is usually built of a wood framework covered with lead or occasionally copper and is generally of rich, light, delicate design, in which tracery, miniature buttresses and crockets have an important part. They are frequently of great height, that of Notre Dame, Paris, being nearly 100 ft. and that of Amiens, 148 ft. The flèche is usually placed at the intersection of nave and transepts. Reims cathedral had, however, an additional flèche at the summit of the apse. *See* SPIRE.

FLÉCHIER, VALENTIN ESPRIT (1632–1710), bishop of Lavaur (1685) and Nîmes (1687), one of the celebrated court preachers under Louis XIV, was born at Pernes near Avignon, June 10, 1632. He was admired as a man of letters rather than as a devout preacher, and his sermons were particularly relished by women. He wrote *Mémoires sur les Grands Jours tenus à Clermont en 1665*. In dealing with the Huguenots, he proved himself a wise and humane bishop. He died at Montpellier, Feb. 16, 1710.

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FLECKEISEN, ALFRED (1820–1899), German philologist and critic, chiefly known for his work on Plautus and Terence, was born at Wolfenbüttel on Sept. 23, 1820. He was educated at the Helmstedt gymnasium and the University of Göttingen. After holding several educational posts he was appointed in 1861 to the vice-principalship of the Vitzthum'sches *Gymnasium* at Dresden, which he held until his retirement in 1889. He died on Aug. 7, 1899. In the knowledge of Plautus and Terence he was unrivaled, except perhaps by F. W. Ritschl, his lifelong friend. Fleckeisen's chief works are: *Exercitationes plautinae* (1842), one of the most masterly productions on the language of Plautus; *Plauti Comoediae*, i, ii (1850–51, unfinished); *P. Terenti Afri Comoediae* (new ed., 1898). His short treatise on orthography *Fünfzig Artikel* (1861) is considered most valuable. Fleckeisen was for many years editor of the *Jahrbücher für classische Philologie*.

FLECKER, JAMES (originally HERMAN) **ELROY** (1884–1915), English poet, whose power to use vivid images and varied verse forms to evoke atmosphere and feeling secure his place among the best-remembered lyrical poets of his time. Born at Lewisham, London, on Nov. 5, 1884, he was educated at his father's school at Cheltenham, and at Uppingham school (1901–02). He adopted the name James while at Trinity college, Oxford (1902–06); it perhaps symbolized his breakaway from unsympathetic parents, who wished him to become an ordained schoolmaster. Brilliant at school, especially in verse translation, at Oxford he excelled as a witty conversationalist and poet. Deciding to enter the foreign service, he studied Persian and Arabic at Cambridge (1908–10) and was sent to Constantinople in June 1910. Illness forced him to go home in August, but he returned in March 1911 and was transferred to Smyrna. In the same year he married a Greek, and became vice-consul at Beirut. In 1913 he fell ill again, and spent his last years in Swiss sanatoria. He died at Davos on Jan. 3, 1915.

Flecker's first collection, *The Bridge of Fire* (1907; reprinted with additions as *Thirty-Six Poems*, 1910), showed the love of exotic colour which drew him to the east. This, with his depth of feeling (as in the intensely personal poem "Stillness") sets him apart from the Parnassians, to whom he is akin in his liking for compactness and clarity and dislike of Romantic turgidity and egoism. Comparison of early and late versions of his poems show the care with which he revised, to produce memorable simplicity. His handling of metre to create widely different effects can be seen in the contrast between the dreamlike calm of *The Old Ships* (1915) and the compulsive beat of the longer *Golden Journey to Samarkand* (1913). The poetic play *Hassan* (1922; performed, with music by Delius, 1923; revived 1951) was greeted as the most notable verse drama since John Webster, and shows Flecker's ability to create dramatic situations. His sardonic wit appears in the fantasies *The Last Generation* (1908) and *A Visit and an Invitation* (1910). Other works include *The King of Alsander* (1914), in prose, and the three-act play *Don Juan* (1925). When he died Flecker was working on a blank-verse translation of the *Aeneid*, book vi, which, although unfinished, shows a notable advance in poetic power and prosody.

BIBLIOGRAPHY.—*Collected Poems* (1916; rev. ed. 1946); *Collected Prose* (1920); *Some Letters From Abroad*, with memoir by Helle Flecker (1930). *See* also G. Hodgson, *Life of J. E. Flecker* (1925).

FLECKNOE, RICHARD (*c.* 1600–*c.* 1678), English poet, dramatist and traveler, whose writings evoked both praise and ridicule, was possibly a Jesuit of Irish extraction. The most authentic information about him is *A Relation of Ten Years' Travels in Europe, Asia, Afrique, and America* (1654?), a collection of letters to distinguished persons in England and abroad. He went to Flanders in 1640, attempted in 1645 to negotiate in Rome the marriage of Béatrix de Cusance to Charles IV of Lorraine, traveled in the Levant, visited Portugal, and in 1648 "merely on curiosity" went to Brazil. Although he appears vain and cocksure, his letters are interesting, particularly his account of Brazil.

Flecknoe's picture of himself as a popular ladies' man contrasts sharply with Andrew Marvell's account in his poem, "Fleckno, an English Priest at Rome," which ridicules his threadbare asceticism and bad verses. The unpopularity which greeted his return to England may have resulted from his disapproval of the licence of the stage, implicit in his *Short Discourse of the English Stage* (1664; reprinted in J. E. Spingarn's *Critical Essays of the 17th Century*, 1908), which he prefixed to the revised version of *Love's Dominion* (1654), the only one of his five plays to be publicly performed. This may also account for the hostility of Dryden, who lampooned him in *MacFlecknoe* (1682) as being "Throughout the realms of Nonsense, absolute." Neither his poems in *Epigrams of all sorts . . .* (1670) nor his prose sketches in *Enigmatical characters . . .* (1658) warrant such an attack and both Lamb and Southey attempted to restore his reputation; Lamb prefixed some of Flecknoe's lines to his essay, "A Quakers' Meeting." Flecknoe remains a contradictory personality who praised Cromwell in *The Idea of his Highness Oliver* (1659) and the Stuarts in *Heroick Portraits* (1660).

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FLEET, NAVAL. The word fleet is used with several meanings, logically related but differing in their precise connotation. It is sometimes defined as the collective naval force of a country, and naval men frequently use it in this sense. For example, the first lord of the admiralty, in a statement to parliament in Feb. 1958, used a subtitle, "The Strength of the Fleet," followed by this explanation: "During the coming year the ships of the Fleet will be deployed as follows: (A.) Ships in the Operational Fleet, or preparing for service with it. (B.) Ships engaged on Trials and Training. (C.) Fleet Support and Auxiliaries. (D.) Ships in all classes of Reserve or undergoing extended refit, modernization, conversion, etc., during the course of the year." During and since World War II the Royal Navy has had a home fleet and a Mediterranean fleet, each with a commander in chief, besides a number

of commands, forces, stations and flotillas responsible to the admiralty and not to either fleet commander. Thus the word fleet means a large group of naval vessels of many types under a single commander in chief, and usually assigned to one geographical area. In a loose sense, fleet is applied to a large number of ships, as a fishing fleet, the Cunard fleet or a fleet of oil tankers.

The U.S. navy did not employ the word fleet officially until 1907 when the Atlantic fleet, Pacific fleet and Asiatic fleet were established. Previously there had been a home squadron, a Pacific squadron and so on. After temporary disruption of this arrangement during World War I, it was restored in 1922. During the years that followed, the U.S. fleet consisted of a battle force, scouting force, submarine force and base force. Since World War II there have been Atlantic and Pacific fleets, each with an admiral as commander in chief; Atlantic and Pacific reserve fleets, under the commanders of the Eastern and Western Sea Frontiers; and four numbered fleets, 1st in the Pacific, 7th in the far east, both a part of the Pacific fleet; 2nd in the Atlantic and 6th in the Mediterranean, both belonging to the Atlantic fleet. Each of the six subordinate fleets had a vice-admiral as commander.

Administrative and Tactical Groupings.—In the U.S. navy each of the two major fleets had commanders in charge of the air force, cruiser force, destroyer force, submarine force, amphibious force and service force. These officers were called type commanders or administrative commanders; some were vice-admirals, others rear admirals. Three to six vessels constituted a "division" of aircraft carriers, cruisers, destroyers, submarines, transports, mine sweepers and other types. The division commanders were considered to be tactical commanders primarily. Frequently a force commander would also command a division of his own force. Two divisions of destroyers or of submarines constituted a squadron, and the squadron commander commanded one of the divisions. Three destroyer squadrons made a flotilla. Rear admirals usually commanded aircraft and cruiser divisions and destroyer flotillas. Service force and amphibious force squadrons, destroyer and submarine squadrons were commanded by captains. Divisions of destroyers, submarines, and mine craft were commanded by captains or commanders.

Fleet Tactical Training.—Although a fleet comprises ships of various types it will not be an effective fighting unit unless the ships are capable of working together as a team and can be controlled by the commander. This necessitates continuous tactical training and study. A new naval vessel, or one which has undergone an extensive reconstruction, runs a series of trials over a measured-mile course, or over a range which can be measured accurately by means of positions on a chart. By means of such trials, calibration scales are developed and the ship's engineer officer knows how many revolutions of his propellers normally produce a given speed. By further trials, in an area where precise positions can be fixed by cross bearings, the new ship determines the necessary rudder angle to turn through 90° or 180° at usual speeds. These two processes are necessary steps in preparing the ship to steam in formation with other vessels and to make turns while in formation. When a new ship has "standardized" her own steaming and her own turning she is ready to steam with others, beginning with vessels of her own type.

Fleet Tactical Formations.—There are three elemental formations involving a single line of ships. If all ships present steamed in single file, all on the same course, one astern of the other, they would form a straight line. The Royal Navy called this formation "line ahead," while the U.S. navy called it "column." If the ships were abreast of each other, the Royal Navy called it "line abreast" and the U.S. navy simply "line." Any other form of line was called "line of bearing," with the bearing designated by signal.

A large fleet would usually form a more complicated formation. For example, three squadrons of eight ships each might steam with each squadron in column or line ahead, while the three flagships leading their respective squadrons might be abreast of each other. In the U.S. navy this formation would be line of squadron columns; in the Royal Navy it would be squadrons in line ahead, disposed abeam. More complicated formations presented no problems to ships accustomed to maintain position and distance in the elemental formations and to turn in standard turning circles on signal. Type commanders had the responsibility for developing tactical instructions for their own vessels so that these ships would conform to the standards of the fleet as a whole. Tactical commanders had the responsibility for ensuring that their own ships could maneuver with the fleet without becoming a menace to their neighbours in formation. Proficiency in fleet maneuvers was possible only if the fleet systematically and regularly steamed together at sea, in bad weather as well as in good. The study of fleet tactical manuals helped to expedite the attainment of high standards, but practice at sea was indispensable. When a fleet was well trained it could pass from one formation to another without confusion or delay.

Battle Formations.—In the days of sail, the great sailing ships of the line-of-battle formed in a single line to fight the enemy with broadsides, keeping their frigates on the unengaged side of their line for the protection of these vessels and to use them for repeating signals. In World War I and earlier the battleships formed the battle line, and kept their cruisers and destroyers ahead and astern of this battle line.

In World War II the presence of the aircraft carrier completely changed fleet dispositions. All formations were circular, with the carriers in the centre, battleships and cruisers deployed in a circle outside the carriers, and destroyers on an outer circle. One large ship was designated as guide and all others kept their bearing and distance on the guide. The carrier task force in the Pacific in 1944–45 usually consisted of 4 carrier groups, each in its own circular formation with 3 to 5 carriers, 2 or 3 battleships, 4 to 8 cruisers, 10 to 18 destroyers. When the carriers of a group launched or recovered planes, the entire circular formation of that group headed into the wind by simultaneous ship turns. In these formations the carriers were allowed slightly more leeway than the other ships in their station keeping, but they had to remain close to their designated positions.

NATO Tactical Formations.—After the establishment of the North Atlantic Treaty organization (NATO) all of the participating navies combined to devise uniform tactical instructions, doctrine and formations for cruising and battle. All formations became circular. Thus the tactical practices of the Royal Navy and the U.S. navy merged in the common instructions governing the NATO navies.

TYPES OF VESSELS

Combatant vessels include the aircraft carrier; battleship; cruiser; submarine; frigate and other destroyer (*qq.v.*) types, including corvette and sloop; and escort and patrol vessels. All of these types are men-of-war. Gunboats, which vary considerably in size, armament and speed, submarine chasers and motor torpedo boats also belong to the combatant vessels classification, although their effectiveness is much limited in bad weather.

Mine craft and amphibious types are in a slightly different category. Mine layers and mine sweepers frequently enter enemy waters in wartime and have little or no defense against enemy attack. Vessels of the various amphibious types, including attack transports, attack cargo vessels, landing ships or fast transports, as well as the smaller landing craft and rocket launchers are all designed to enter enemy territory under fire and sustain enemy attacks, although they are extremely vulnerable. Command ships are subject to the same hazards.

During and since World War II, mine craft and amphibious craft have been considered combatant ships because of the nature of their normal employment in wartime, although they are obviously not fighting ships in the same sense as the types listed in the preceding paragraph.

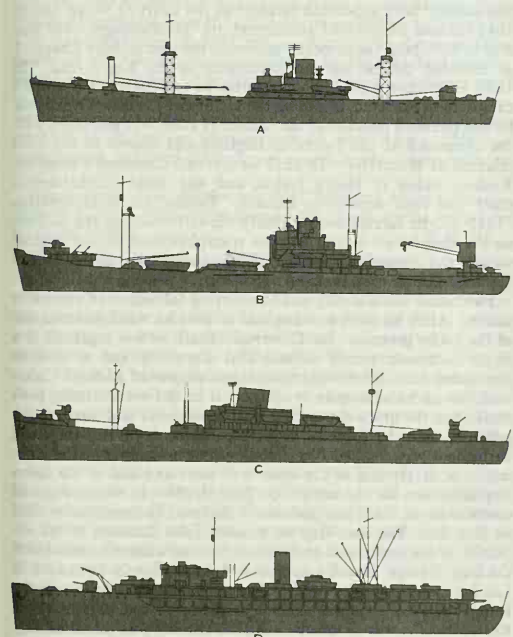
Fleet auxiliary vessels are manned by officers and men of the navy and are built for the service of the fleet. The U.S. navy is proud of the fact that it pioneered in the development of destroyer and submarine tenders, fleet repair ships and fleet oil tankers. The tenders for destroyers and submarines were developed when vessels of these two types were much smaller than they were after World War II. They supplied food, clothing, miscellaneous stores

and repair facilities which were beyond the capacity of the destroyers and submarines themselves. Fleet repair ships were capable of many kinds of repair work which were impossible for the largest men-of-war to execute with their own facilities, and they undertook jobs for which the tenders lacked equipment.

During World War II many repair ships were commissioned to specialize in particular types of repair work, such as the overhaul of diesel engines, etc. Seaplane tenders served the large long-range patrol planes and furnished living quarters for their men, as well as repair facilities for the planes. Ammunition ships were partly improvised in World War II, but the U.S. navy had a few that were designed for this duty; they were able to control temperatures and humidity in their ammunition and powder storage spaces to avoid any possibility of deterioration. The fleet oil tankers were equipped for fueling ships at sea while under way, and they had facilities for passing supplies across to the ships receiving fuel oil while the fueling was in progress.

Fleet supply ships were equipped to carry fresh meat and other refrigerated items, as well as what the navy calls dry provisions, meaning food in cans, barrels, sacks or packages; they also had stowage for potatoes and for miscellaneous ships' stores, including stationery, cleaning materials, paints, etc. Fleet stores ships were fitted for carrying miscellaneous fleet supplies, including dry provisions, so arranged that particular items could be supplied to tenders and other ships which requested them. Submarine rescue vessels usually were seagoing fleet tugs fitted with some special equipment which would be especially useful in helping damaged vessels, including submarines. Salvage vessels varied in their facilities and equipment, but some of them were employed in the extensive work of clearing harbours after many ships had been sunk by gunfire or aerial bombs or both.

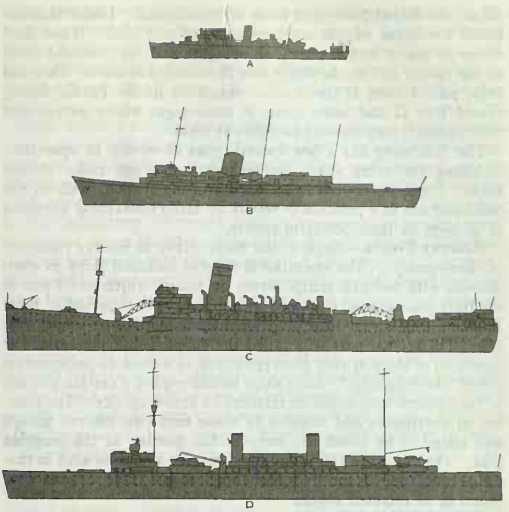
Service Squadrons in Advanced Areas.—Before World War II the fleet organization of the U.S. navy included a fleet base force, sometimes called the "fleet train," which became the service force during that war. A few squadrons of this force, notably service squadron ten, became especially well known for their effective and immediate service to vessels of the fleet in the forward areas in the Pacific. This squadron began operating in Majuro atoll in Feb., 1944, and afterward moved to Eniwetok, thence to Ulithi. The squadron had one or more of each of the types of fleet auxiliary vessels described in the preceding paragraph, plus many others.



ADAPTED FROM "JANE'S FIGHTING SHIPS," 1957–58

SILHOUETTES OF U.S. AUXILIARY SHIPS

(A) Attack cargo ship U.S.S. "Bellatrix"; (B) seaplane tender U.S.S. "Pokomoke"; (C) attack transport ship, President class; (D) destroyer tender ship U.S.S. "Cascade"



ADAPTED FROM "JANE'S FIGHTING SHIPS," 1957–58

SILHOUETTES OF BRITISH AUXILIARY SHIPS

(A) Ocean minesweeper, Algerine class; (B) royal yacht (hospital ship) H.M.S. "Britannia"; (C) heavy repair ship H.M.S. "Ranpura"; (D) destroyer depot ship H.M.S. "Woolwich"

Perhaps even more important than the ships available, the squadron equipment included three floating dry docks: one small one capable of lifting 1,000 tons, a medium dock to lift 3,000 tons and a gigantic sectional floating dock able to lift 80,000 tons, and thus able to take any ship of the fleet. A barracks vessel had quarters for 60 officers and 1,000 men. There were four repair barges besides the repair ships, four ocean-going fleet tugs, four harbour tugs, four rescue tugs and one salvage barge in addition to two salvage ships. There were also net tenders, net layers and a net cargo ship to keep the lagoon entrance closed to enemy submarines. Two floating cranes, a degaussing barge, water barges, picket boats and patrol boats completed the aggregation afloat in the lagoon. Later a dozen large concrete stores barges were brought to the atoll and these were used as floating storage. Some of them had refrigeration in some storerooms. Supply and stores ships discharged their cargoes into these barges and returned to the mainland for reloading.

Other service squadrons were established and located at other islands or atolls in the Pacific. It would be difficult to exaggerate the value of these service squadrons because they made it possible for a number of seriously damaged ships to be patched up sufficiently to return to the mainland for major repairs. The repair ships and tenders demonstrated that they could accomplish almost anything in the form of repairs, but there was so much to be done that it was necessary to send to the mainland for the big jobs rather than tie up all the repair facilities of the squadron.

The Royal Navy's fleet support and auxiliaries listed by the first lord in his report to parliament (mentioned above) included: destroyer depot ships, submarine depot and support ships, repair ships, deep diving vessels, mine layers, a coastal mine-sweeping headquarters ship, a survey ship, boom defense vessels and harbour accommodation ships.

The only noncombatant ships in the U.S. navy were hospital

ships; the Royal Navy had none in commission. Under international law these vessels carry no arms of any kind. When they cruise at sea in wartime they show lights and keep the red cross on the funnel and on the ship's side illuminated at night. Hospital ships joined each of the service squadrons in the Pacific during World War II and while there, in anchorages where men-of-war were present, they showed no lights at night.

The U.S. navy has a few special types of vessels in operation, including surveying ships, icebreakers and ocean radar station ships. These latter remain on fixed cruising stations well off the coast and are in a position to report by radio concerning anything to be seen on their powerful radars.

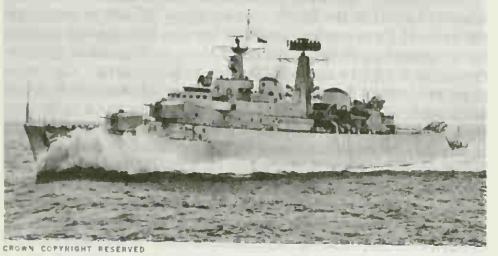
Reserve Fleets.—Ships of the Royal Navy in reserve consisted of three groups. The operational reserve included ships in commission with reduced complements on board, which could put to sea fully manned and equipped within a very short period of time. It was a substantial force and included a number of escort vessels. The second part was called the supplementary reserve. It consisted of ships in very good condition, in a state of preservation called "moth-balling." Such ships would require a certain amount of time before they could be restored to active service. The number of destroyers and frigates in these first two reserve groups was stated to be about the same as the number in the seagoing fleet. The vessels in this maintained reserve would be kept in that status until their useful lives had ended, unless their services were found to be required sooner.

The third class was called the extended reserve. It consisted of ships of wartime design and construction which had not been modernized. The majority of the vessels had not had a refit for five years or longer. These ships were tied up in an unattended condition; their maintenance cost was almost nothing, but under these circumstances they were deteriorating. They were cruisers 18 to 20 years old, destroyers 14 to 17 years old, ocean mine sweepers built in wartime and frigates 14 to 17 years old. It was stated explicitly that the five carriers in reserve could not be modernized; that even if they were cut down to the water line their hulls would not be satisfactory for modernization.

The reserve fleets of the U.S. navy in the early 1960s were located on the two coasts. About 28 destroyers were in commission in reserve with partial crews and did some operating. About 34 destroyer escorts were assigned to naval reserve training and had full crews of reservists assigned on a mobilization basis. These vessels regularly made one week-end cruise per month and one annual cruise of 14 days, with their assigned complement of reserve officers and men.

A small number of reservists serving on active duty were the instructors for their shipmates, and these men were the shipkeepers between cruises. A number of submarines were assigned for reserve training, but these ships were partially moth-balled with their propellers removed. The reservists assigned to them made their training cruises in regularly commissioned submarines.

All other ships of the Atlantic and Pacific reserve fleets were in "moth balls," with the ships dehumidified and all their equipment and machinery in a state of preservation. Groups of ships



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BRITISH GUIDED MISSILE DESTROYER "DEVONSHIRE" (1962) SEEN UNDERGOING TRIALS

BY COURTESY OF U.S. DEPARTMENT OF THE NAVY

OCEAN RADAR WARNING SHIP U.S.S. "LOOKOUT"

in this status were berthed at piers on both the east and west coasts. The navy department planned to scrap some older battleships, aircraft carriers, cruisers and submarines but not destroyers or destroyer-type vessels from the reserve fleets.

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(J. B. HN.)

FLEETWOOD, CHARLES (d. 1692), English soldier and statesman, a powerful supporter of his father-in-law, Oliver Cromwell, was the third son of Sir Miles Fleetwood of Aldwinkle, Northamptonshire, and of Anne, daughter of Nicholas Luke of Woodend, Bedfordshire. He was admitted into Gray's Inn on Nov. 30, 1638. He joined the earl of Essex's life guard at the beginning of the Civil War, was wounded at the first battle of Newbury, obtained a regiment in 1644 and fought at Naseby. He had already been appointed receiver of the court of wards and in 1646 became member of parliament for Marlborough. He was said to have been the principal author of the plot to seize Charles I at Holmby, but he did not participate in the king's trial. In 1650, as lieutenant general of the horse, he took part in Cromwell's campaign in Scotland, including the victory of Dunbar. Next year he was elected a member of the council of state, was entrusted with the command of the forces in England and shared in the final triumph at Worcester. In 1652 he married Cromwell's daughter Bridget, widow of Henry Ireton, and was made commander in chief and lord deputy in Ireland. During his administration (1652–55) he carried out ruthlessly the settlement of the soldiers on the confiscated estates and the transplantation of the original owners and showed great severity in the prosecution of the Roman Catholic priests (*see* IRELAND: *History*).

Fleetwood was a strong and unswerving follower of Cromwell's policy. After his return to England in 1655 he was appointed one of the major generals. On Cromwell's death he was regarded as a likely successor, and it is said that Cromwell had in fact so nominated him. Fleetwood nonetheless supported Richard Cromwell, though he subsequently allowed, if he did not instigate, petitions from the army demanding its independence and finally compelled Richard by force to dissolve parliament. When the Long parliament was recalled Fleetwood became a member of the committee of safety and of the council of state and one of the seven commissioners for the army. On June 9, 1659, he was nominated commander in chief, but parliament declared his commission void on Oct. 11. The next day he assisted John Lambert in his expulsion of the parliament and was reappointed commander in chief. On Gen. George Monck's approach from the north, he stayed in London and maintained order. The army on Dec. 24 restored the Rump and Fleetwood was again deprived of his command. At the Restoration he was included among the 18 who were punished only by perpetual exclusion from public office, and his public career therefore closed. He died at Stoke Newington on Oct. 4, 1692.

See Maurice Ashley, *Cromwell's Generals* (1954).

FLEETWOOD, WILLIAM (1656–1723), English bishop and celebrated preacher, was born in the Tower of London on

Jan. 1, 1656, and was educated at Eton and King's college, Cambridge. He was ordained (*c.* 1688) and became bishop of St. Asaph (1708), then of Ely (1714). A zealous Whig, he deplored the policies of Queen Anne's Tory ministers, and the preface to his *Four Sermons* (1712)—discourses originally given on the deaths of Mary II, William duke of Gloucester and William III and on the accession of Queen Anne—was publicly burned by order of parliament. More than 714,000 copies of it circulated, however, as No. 384 of the *Spectator*. Fleetwood's *Chronicon preciosum, on Account of English Money* (1707) was a pioneer work in the study of economic history. He died at Tottenham on Aug. 4, 1723.

See *A Compleat Collection of the Sermons, Tracts and Pieces . . . by William Fleetwood (With an Account of his Life by W. Powell)* (1737).

FLEETWOOD, a municipal borough (1933), seaport and resort in the North Fylde parliamentary division of Lancashire, Eng., at the mouth of the Wyre, 9 mi. N.N.E. of Blackpool. Pop. (1961) 27,760.

Fleetwood looks northward over Morecambe bay to the Lake district and has large sandy beaches and a championship golf course. A market is held Tuesdays and Fridays. It is a large fishing port, with ancillary industries. Coastal and Irish trade shipping is carried on. A ferry crosses the Wyre to Knott End-on-Sea, and there is a steamer service to the Isle of Man. Rossall school (founded 1844), formerly Rossall hall and the seat of Sir Peter Hesketh Fleetwood (1801–66; who laid out the town in 1836 and for whom it was named), was incorporated by royal charter in 1890.

FLEGEL, EDWARD ROBERT (1855–1886), German traveler, who attempted to open up west Africa for the Germans, was born on Oct. 13, 1855 at Vilna, Russia. He was appointed to a post in Lagos, west Africa, in 1875 and in 1879 traveled up the Benue river about 125 mi. farther than the point previously attained by European travelers and was commissioned by the German-African society to explore the whole of the Benue country. In 1880 he went by way of the Niger to Sokoto and there obtained permission from the sultan for an expedition to Adamawa. This was undertaken in 1882 and on Aug. 18 he discovered the source of the Benue near Ngaundere. In 1883–84 he again explored on the Benue. After a short stay in Europe, Flegel returned to Africa in April 1885 with a commission to open up the Niger-Benue basins to German influence and so prevent the British from establishing themselves in that part of west Africa. He was unsuccessful and died at Brass (Guinea) in the Niger delta on Sept. 11, 1886.

Flegel wrote *Lose Blätter aus dem Tagebuch meiner Haussafreunde* (1885); *Vom Niger-Benuë; Briefe aus Afrika*, edited by K. Flegel (1890). (R. M. P.)

FLÉMAL (Flemael), **BERTHOLET** (1614–1675), Flemish painter, a pioneer of the classicist movement in his country, was born at Liège on May 23, 1614. He studied under Henri Trippez and Gerard Douffet. He went to Italy in 1638, returning via Paris, where he decorated the churches of the Grands Augustines and the Carmes Déchaussés. He returned to Liège in 1663. In 1670 he was elected member of the Paris Academy, and he painted the ceiling of the audience chamber in the Tuileries (destroyed in 1871). He is one of the most important masters of the later Flemish school. His style is modeled on that of Poussin. Most of his numerous religious pictures in the churches of Liège were destroyed and lost during the French Revolution. However, there are several works still extant in the cathedral and in the churches of St. Jean, St. Barthelemy and Ste. Croix. Others are in the museums of Liège, Bamberg, Brussels, Dresden, Fontainebleau, Cassel, Stockholm, Niort and in the Louvre, Paris. Flémal was also a distinguished portrait painter. His self-portrait was engraved by Jean Duvivier.

Flémal died at Liège on July 10, 1675.

FLÉMALLE, LE MAÎTRE DE: *see* Campin, Robert.

FLEMING, SIR ALEXANDER (1881–1955), British bacteriologist and discoverer of penicillin and 1945 Nobel laureate in medicine, was born at Lochfield, Ayrshire, Scot., on Aug. 16, 1881. He was educated at Kilmarnock academy and St. Mary's Hospital medical school, University of London, winning academic distinction at both institutions. Following his graduation he did research work at St. Mary's under Sir Almroth Wright, pioneer in vaccine therapy, and became interested in bacterial action and antiseptics. During World War I Fleming served as a captain in the army medical corps (1914–18) and was mentioned in dispatches.

After military service, during which he was able to make further studies of the problems of infection and use of antiseptics, Fleming returned to laboratory work and teaching bacteriology at St. Mary's. In 1919 he was appointed Hunterian professor and in 1928 Arris and Gale lecturer at the Royal College of Surgeons. In the laboratory Fleming's interest continued in antibacterial substances which would be nontoxic to animal tissues. The first fruit of his search was the discovery of the antibiotic lysozyme. His epochal discovery in 1928 of the antibacterial powers of the mold from which penicillin is derived was a "triumph of accident and shrewd observation." While he was engaged in research on influenza, mold had developed accidentally on a staphylococcus culture plate, and Fleming discovered that the mold had created a bacteria-free circle around itself. Experimenting further, he found that a liquid mold culture, which he named penicillin, prevented growth of staphylococci, even when diluted 800 times. He published his results in the *Journal of Experimental Pathology* in 1929.

Fleming was made fellow of the Royal society in 1943, was knighted and given the John Scott medal in 1944, and awarded the Nobel prize with Sir Howard Walter Florey and Ernst Boris Chain (*qq.v.*) in 1945. He died March 11, 1955, in London. *See* also Penicillin.

FLEMING, PAUL (1609–1640), one of the outstanding German poets of the 17th century, was born on Oct. 5, 1609, at Hartenstein in Vogtland, the son of the court chaplain at Wechselburg. He studied medicine at Leipzig, where he made the acquaintance of Martin Opitz von Boberfeld (*q.v.*), who encouraged his literary ambitions. He took part in an adventurous trade mission to Russia and Persia (1633–39), to which the traveler Adam Olearius was secretary, and died in Hamburg on April 2, 1640. As a poet, Fleming developed from the neo-Latin poetry of his youth to the personal German love lyrics and religious verse of his maturity. A disciple of Opitz, he soon outstripped his master, writing poetry characterized both by formal subtlety and by an emotional depth, lyric power and sincerity unusual at that time. His *Teutsche Poemata* appeared in 1642, his *Geist und weltliche Poemata* in 1651.

Bibliography.—His collected poems (German and Latin) were edited by J. M. Lappenberg, 3 vol. (1863–65); selections by J. Tittman (1870) and H. Österley (1885). *See* also H. Pyritz, *Flemings deutsche Liebeslyrik* (1932); H. Mayne in *Deutsche Dichter* (1927).

(D. G. D.)

FLEMING, SIR SANDFORD (1827–1915), leading Canadian authority on railway surveying and engineering, associated particularly with the building of the Intercolonial, the Canadian Pacific and Newfoundland railways, was born at Kirkcaldy, Scot., on Jan. 7, 1827. He received his early education there and emigrated to Canada in 1845. After further engineering training he joined the Ontario, Simcoe and Huron railway and rose to be its chief engineer. After involvement with railway projection and construction in eastern Canada, Fleming led a reconnaissance across the prairies and mountains to find a practicable route for the Pacific railway. In 1880 he retired from the C.P.R. and devoted himself to various scientific projects and to writing. His initiative led in 1884 to international agreement on one world-wide scheme for standard time. He was concerned about imperial communications, representing Canada at the 1888 and 1894 colonial conferences. From 1880 until his death in Halifax, Nova Scotia, on July 22, 1915, he was chancellor of Queen's university. A supporter of the Royal Canadian institute and charter member of the Royal Society of Canada, Fleming received the C.M.G. in 1877 and K.C.M.G. in 1897. (P. G. Co.)

FLEMISH LANGUAGE. In a narrow sense, Flemish (Vlaams) refers to the local dialects of the provinces of East and West Flanders (*Oost- en West-Vlaanderen*) in western Belgium and of the adjoining section of France to the west. In a broader sense, Flemish refers to the standard language and the various

dialects of northern Belgium. This broader use of the term often leads to the belief that Flemish is a separate language, though this is not the case. Just as the standard language of southern Belgium is identical with that of France, so the standard language of northern Belgium is identical with that of the Netherlands. In place of Flemish (for northern Belgium) and Dutch (for the Netherlands), the single term Netherlandish (*Nederlands*) is generally used in scientific writings. At the level of local dialects, northern Belgium and the Netherlands (except the Frisian speaking province of Friesland) are part of the Netherlandish-German dialect area which stretches from the North sea to the Alps. *See* NETHERLANDIC LANGUAGE; GERMANIC LANGUAGES. (W. G. MN.)

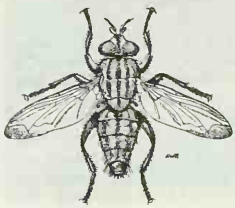
FLEMMING, WALTHER (1843–1905), German anatomist who contributed important findings about cell structure, was born on April 21, 1843, at Sachsenberg, near Schwerin in Mecklenburg. He studied medicine in Tübingen, Berlin and Rostock and began his academic career at the Rostock institute of anatomy in 1871. Then after serving three years (1873–76) as professor in Prague he became professor of anatomy in Kiel in 1876 and held this position until 1901, when he resigned because of illness. He died in Kiel on Aug. 4, 1905. He became prominent as a student both of the fine structure of tissues and of the structure and biology of the cell. His most important contributions to histology concerned connective and adipose tissues under various physiologic and pathologic conditions. For his classic studies of resting and dividing cells he used the large cells of the salamander larvae; these he observed both in the living tissue and in material fixed and stained with methods of his own design. He established definitely the sequence of the cyclic changes, especially of the nucleus and the chromosomes, during cell division. He extended his observations to many other animal and plant cells, including germ cells, and made fundamental contributions not only to cell biology in general but also to the cellular basis of heredity in particular. (F. WN.)

FLEMYNG (FLEMMING or FLEMYNGE), **RICHARD** (*c.* 1378–1431), bishop of Lincoln and founder of Lincoln college, Oxford, was born in Yorkshire and educated at University college, Oxford. Prebendary of York (1406) and junior proctor at Oxford (1407), he evinced Wycliffite sympathies for which he incurred the censure of Archbishop William Arundel. From 1408 he was rector of Boston, Lincolnshire, and on April 28, 1420, was consecrated as bishop of Lincoln. In 1423, as president of the English nation at the councils of Pavia and Siena, he eloquently championed the papacy. The favour of Pope Martin V conferred on Flemyng the see of York (1424), but Henry V refused to confirm the appointment. In 1427 Flemyng obtained the royal licence empowering him to found a college at Oxford primarily for the training of disputants against the Wycliffite heresy, which he had long since abandoned. He died at Sleaford, Lincolnshire, on Jan. 25, 1431.

See A. B. Emden, *A Biographical Register of the University of Oxford to A.D. 1500*, vol. ii (1958). (PL. GN.)

FLENSBURG, (Dan. FLENSBORG), a town and seaport of Germany, which following partition of the nation after World War II became part of the *Land* (state) of Schleswig-Holstein in the Federal Republic of Germany. The republic's most northerly town, it is situated at the head of the Flensburg fjord about 80 km. (50 mi.) N.W. of Kiel by road. Pop. (1961) 98,526. The principal buildings are the Nikolaikirche (built 1390, restored 1894) with a spire 90 m. (295 ft.) high; the Marienkirche, also medieval with a lofty spire; the Nordertor, "the gateway to Scandinavia," and the Nordermarkt with Neptune's fountain; Schrangen, the general museum, and the German house, the local scientific museum. Flensburg is on the main railway from Hamburg to Fredericia (Denmark). It has good port facilities and trades in coal; industries include shipbuilding, fish smoking, rum production and metalworking. After World War II it once more became a naval base. Educational establishments include a school of marine engineering. Founded at the end of the 12th century, Flensburg received civic rights in 1284 and was frequently pillaged by the Swedes after 1643. In 1848 it became the capital of the province of Schleswig under Danish rule, and after the Danish War of 1864 it was occupied by Prussia. In the plebiscite held in 1918, after World War I, Flensburg voted to remain in Germany. In World War II the town was occupied by Allied forces in May 1945.

FLESH FLY, any species of the family Sarcophagidae (order Diptera), particularly of the genus *Sarcophaga*. Most flesh flies superficially resemble the house fly; they have blackish stripes on the gray thorax and a checkered pattern of light and dark gray on the abdomen. Many species are scavengers, the females depositing young larvae on carrion; others are parasitic in various insects, snails and earthworms. *Sacrophaga cistudinis* parasitizes box turtles; certain other species attack newborn wild animals, causing great losses. Most of the flesh flies are tropical, although the family in general is widespread. Flesh-eating maggots formerly used in the treatment of human osteomyelitis and gangrene are of the closely related family Calliphoridae, or blowflies (*see* BLOWFLY). *See* also FLY. (G. W. Bs.)



FROM C. H. CURRAN, "INSECTS OF THE PACIFIC WORLD" (THE MACMILLAN COMPANY)

A TYPICAL FLESH FLY, SARCOPHAGA; THE FEMALES DEPOSIT LIVING LARVAE ON MEAT

FLETCHER, ALICE CUNNINGHAM (1838–1923), U.S. ethnologist, a distinguished early student of American Indian life, was a pioneer in the study of Indian music and devoted much of her life to the improvement of Indian welfare. She was born in Cuba (where her Bostonian parents were visiting) on March 15, 1838, and was privately educated. With the encouragement of F. W. Putnam of the Peabody museum at Harvard, Miss Fletcher studied the Plains and Prairie Indians, among whom she lived for a number of years. Together with her adopted Omaha son Francis La Flesche, she wrote her major work, *The Omaha Tribe* (1911), which remains one of the best anthropological studies of its kind. Her other important works are *The Hako: a Pawnee Ceremony* (1904) and *Indian Story and Song From North America* (1900).

From 1883 to 1893 Miss Fletcher served as special agent on problems of land allotment to the Omaha, Winnebago and Nez Percé tribes. In the early 1880s she became associated with the Peabody museum, where she held a fellowship from 1891 until her death in Washington, D.C., on April 6, 1923.

For a complete bibliography *see* W. Hough, "Alice Cunningham Fletcher" in *American Anthropologist* (April–June 1923).

FLETCHER, ANDREW (1655–1716), OF SALTOUN, Scottish patriot and opponent of arbitrary government, the son and heir of Sir Robert Fletcher (d. 1664), was born at Saltoun, East Lothian. He was a member of the Scottish parliament that met in 1681. Fletcher was a fearless and active opponent of the duke of Lauderdale's administration. He left Scotland about 1682, subsequently spending some time in Holland as an associate of the duke of Monmouth and other malcontents. He accompanied Monmouth to the west of England but left the army after quarreling with and killing Heywood Dare, one of the duke's English supporters. During the next few years he is said to have traveled in Spain, and he fought against the Turks in Hungary. Having in his absence from Scotland lost his estates and been sentenced to death (Jan. 1686), he joined William of Orange at The Hague (1688). After William's accession Fletcher's estates were restored to him (1690). He soon became a leading member of "the Club," an organization that aimed at reducing the power of the crown in Scotland and that formed the core of the later "country" party. Fletcher became a member of the Scottish parliament again in 1703, at a critical juncture in Scottish history.

The failure of the Darien expedition (1698–1700) had aroused a strong feeling of resentment against England, and Fletcher and the national party seized the opportunity to attempt to gain greater independence for their country. His famous "limitations" (upon the royal prerogative) were rejected by the Scottish parliament but, much watered down, they reappeared in the Act of Security (1704), which declared that the two crowns should not pass to the same head until Scotland was secured in its liberties, civil and

religious. The act really forced England into the union, to avoid a civil war after Queen Anne's death. After the passing of the Act of Union (1707), Fletcher retired from public life. He died in London in Sept. 1716.

Fletcher was a fine scholar and a graceful writer. His chief works are: *A Discourse of Government With Relation to Militias* (1698); *Two Discourses Concerning the Affairs of Scotland* (1698); and *An Account of a Conversation Concerning a Right Regulation of Government for the Common Good of Mankind* (1704). He did a real, if homely, service to his country by introducing from Holland machinery for making "pot barley."

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FLETCHER, GILES (*c.* 1548–1611), English poet and author and father of the poets Phineas and Giles Fletcher, who published an interesting account of his visit to Russia in *Of the Russe Common Wealth* (1591). The son of Richard Fletcher, the vicar of Cranbrook, Kent, he was born in 1548 or 1549 at Watford, Hertfordshire, and educated at Eton and at King's college, Cambridge. He was employed on diplomatic service in Scotland, Germany and Holland; and in 1588 was sent to Russia to the court of the tsar Fedor I, with instructions to conclude an alliance between England and Russia, to restore English trade and to obtain better conditions for the English Muscovy company. He returned to England in 1589, and in 1591 published *Of the Russe Common Wealth*, a comprehensive account of Russian geography, government, law, methods of warfare, church and manners. The Russian government was alarmed at the book's freedom and had it suppressed. In 1610 Fletcher was employed to negotiate with Denmark on behalf of the merchants of the Eastland company. He died in London in the following year and was buried on March 11, 1611.

Of the Russe Common Wealth was issued in an abridged form in Richard Hakluyt's *Principal Navigations, Voyages, Trafiques and Discoveries* (2nd ed., 1598); in *Purchas his Pilgrimes* (1625); and also as *History of Russia* in 1643. Fletcher also wrote *De Literis antiquae Britanniae* (1633); a treatise on "The Tartars," to prove that they were the ten lost tribes of Israel; Latin poems published in various miscellanies; and *Licia, or poems of love . . . Whereunto is added the Rising to the Crowne of Richard the Third* (1593). This series of love sonnets, followed by some other poems, was published anonymously. Most critics have accepted it as the work of Giles Fletcher on the evidence afforded in the first of the *Piscatorie Eclogs* (1633) of his son Phineas, who represents his father (Thelgon) as having "raised his rime to sing of Richard's climbing."

FLETCHER, GILES (*c.* 1584–1623), English poet principally known for his great baroque devotional poem, *Christs Victorie, and Triumph in Heaven, and Earth, over, and after death,* was the younger son of Giles Fletcher (*c.* 1548–1611; *q.v.*). He was born in London about 1584 and was educated at Westminster school and at Trinity college, Cambridge. After taking orders, he held a college living, and his sermons at St. Mary's were famous. Thomas Fuller states in his *Worthies* (1662) that Fletcher's prayer before his sermon was a continuous allegory. He left Cambridge about 1618 and soon after received the rectory of Alderton, Suffolk. He died in 1623.

The theme of Fletcher's masterpiece, *Christs Victorie* (1610), owes something to the *Semaines* of Du Bartas, but the devotion, the passionate lyricism and the exquisite vision of paradise are Fletcher's own. The poem is written in eight-line stanzas owing something to Edmund Spenser of whom, like his brother Phineas, Giles was a disciple. The first five lines rhyme a, b, a, b, b, and the stanza concludes with a rhyming triplet, resuming the conceit which nearly every verse embodies. Like most amateurs of the conceit, he is sometimes grotesque, but when he forgets his ingenuity he attains a depth of melody that delighted Milton, who followed him to some extent in *Paradise Regained* (1671).

Fletcher contributed a poem on the death of Queen Elizabeth I to *Sorrowes Joy* (1603), and in 1612 he edited *The Young Divines Apologie for his Continuance in the Universitie* of his cousin Nathaniel Pownoll. His last work was the prose *Reward of the Faithfull* (1623). There is an unpublished manuscript by him in the library of King's college, Cambridge, *Aegidii Fletcherii versio poetica Lamentationum Jeremiae.*

BIBLIOGRAPHY.—*The Poetical Works of Giles and Phineas Fletcher* were ed. by F. S. Boas, 2 vol. (1908–09). *See* also H. E. Cory, *Spenser, the School of the Fletchers, and Milton* (1912) and A. Esch, *Giles Fletchers "Christs Victorie and Triumph": Eine Studie zum Epenstil des englischen Barock* (1937).

FLETCHER, HARVEY (1884–), U.S. physicist who made notable contributions to the science of acoustics, was born in Provo, Utah, Sept. 11, 1884. He graduated from Brigham Young university in 1907 and received a Ph.D. *summa cum laude* in 1911 from The University of Chicago. He taught physics at Brigham Young until joining Bell Telephone Laboratories, Inc., in 1916, where he remained for 33 years, working primarily in the fields of speech, music and hearing. Fletcher appreciated the importance of precise measurement and the value of organizing fundamental information into useful relationships. Throughout the period, new instrumentation and techniques of measurement were under continuous development. The basic knowledge so obtained was fundamental to the rapid growth of the science of psychoacoustics and its application to communications. Much of the work is described in Fletcher's book *Speech and Hearing in Communications* (1929). On retirement as physical research director in 1949, Fletcher joined the staff of Columbia university and established a new department of acoustical engineering. In 1952 he returned to Brigham Young university as director of research and in 1954 became dean of the college of physical and engineering sciences. (J. C. SC.)

FLETCHER, PHINEAS (1582–1650), English poet best known for his religious and scientific poem *The Purple Island,* elder son of Giles Fletcher (*c.* 1548–1611; *q.v.*) and brother of Giles the younger (*c.* 1584–1623), was born at Cranbrook, Kent, and baptized on April 8, 1582. He was educated at Eton and at King's college, Cambridge. His pastoral drama, *Sicelides A Piscatory* (1631) was written in 1615 for performance before James I at King's college but only produced after the king's departure. Fletcher became chaplain to Sir Henry Willoughby, who presented him in 1621 to the rectory of Hilgay, Norfolk, where he spent the rest of his life. He had married Elizabeth Vincent of Risley, Derbyshire, in Aug. 1615. In 1627 he published *Locustae, vel pietas Jesuitica* (*The Locusts or Apollyonists*), two parallel poems in Latin and English attacking the Jesuits. An erotic poem, *Brittain's Ida* (1628), though bearing Spenser's name, is to be included in the Fletcher canon, since it appears in the unique manuscript preserved at Sion college, London, of his *Piscatorie Eclogs.* Entitled there *Venus and Anchises,* it bears additional stanzas which prove his authorship. In 1632 appeared two theological prose treatises, *The Way to Blessedness* and *Joy in Tribulation,* and in 1633 his magnum opus, *The Purple Island.* It included his *Piscatorie Eclogs and other Poetical Miscellanies.* He died in 1650, his will being proved on Dec. 13.

The Purple Island, or the Isle of Man, is a poem in 12 cantos describing in cumbrous allegory the physiological structure of the human body and the mind of man. The manner of Spenser is preserved throughout, and the chief charm of the poem lies in its descriptions of rural scenery. Some critics see in the allegorist of *The Purple Island* a link between Spenser and Bunyan. The *Piscatorie Eclogs* are pastorals, the characters of which are represented as fisherboys on the banks of the Cam, and are interesting for the light they cast on the biography of the poet himself (Thyrsil) and his father (Thelgon), and on Phineas' friendship with Cambridge men, such as the musician Thomas Tomkins (Thomalin). Phineas Fletcher's poetry has not the sublimity sometimes reached by his brother Giles. The mannerisms are more pronounced, the conceits more farfetched, but the verse is fluent and musical; his lyric poetry lacks neither colour nor ardour, as is seen in the "Epithalamium" of the Sion college manuscript.

BIBLIOGRAPHY.—*Poems,* ed. by A. B. Grosart, 4 vol. (1869); *Poetical Works of Giles and Phineas Fletcher,* ed. by F. S. Boas, 2 vol. (1908–09); *Venus and Anchises . . .* , ed. by E. Seaton for the Royal Society of Literature (1926). *See* also H. E. Cory, *Spenser, the School of the Fletchers, and Milton* (1912), and A. B. Langdale, *Phineas Fletcher* (1937). (M. E. SN.)

FLEUR-DE-LIS (literally "lily flower"), a stylized emblem or device much used in ornamentation and, particularly, in heraldry. Strictly, it consists of three petals or leaves—the central one erect, the other two curving right and left away from it—joined by a horizontal band below which the feet of the three petals are visible. Variant forms are: (1) the *fleur-de-lis au pied coupé* or *au pied nourri*, in which the feet are absent or are replaced by a trapezoid pedestal; (2) the *fleur-de-lis remplie* or *florencée* or *épanouie*, with stamens shown between the petals and with the petals themselves divided like flowers at their upper extremities. If a lily is represented naturalistically in heraldry, it is called a

THREE MODIFICATIONS OF THE FLEUR-DE-LIS
(A) Middle ages; (B) 17th century; (C) 18th and 19th centuries

lis-de-jardin ("garden lily") to distinguish it from the *fleur-de-lis*.

An emblem like the fleur-de-lis is often found in art from the earliest times in many parts of the world and may not always signify a flower. The principal importance of the emblem, however, derives from its association with the French royal arms. There is a legend that a lily, emblematic of purity, was sent from heaven to Clovis (*q.v.*) at his baptism, and it has been suggested that the name fleur-de-lis is a pun on *fleur de Louis* (Louis-Clovis); but perhaps the figure was derived from that of a dove descending (symbolic of the Holy Spirit). Louis VI of France used the device both on his seal and on coins; Louis VIII wore blue vestments embroidered with gold lilies at his consecration; and soon a blue shield sprinkled with golden fleurs-de-lis (*d'azur, semé de fleur-de-lis d'or*) was adopted as the royal arms. Charles V of France in 1376 limited the number of fleurs-de-lis to three (*d'azur, à trois fleur-de-lis d'or*), in honour of the Holy Trinity. The association of the device with the French crown led to its inclusion in the arms of numerous gentlemen and municipalities in France, and the English kings during the Hundred Years' War began quartering the French arms with their own, in which they were to remain till George III's time.

The red lily (*fleur-de-lis épanouie*) is the badge of Florence in Italy.

FLEURUS, a town of Hainaut province, Belg., is situated between the industrial region of Charleroi and the hills sloping toward Waterloo, 12 km. (7½ mi.) by road N.E. of Charleroi. Pop. (1961 est.) 8,172. The main features are the Romanesque church (*c.* 1150–1200) of which only the tower and central nave remain, Soleilmont abbey with its Cistercian nuns, the Naveau windmill (1667; Napoleon's observatory during the Waterloo campaign) and the memorial (1936) to the three French victories on the town's territory. Fleurus is a junction of several local railways. There are coal mines, and machinery, domestic appliances, furniture and foodstuffs are produced.

Built on the site of a Gallo-Roman agricultural centre and first mentioned in 868, Fleurus has been a chartered town since 1115 and the scene of several battles. During the Thirty Years' War, in the first battle, Aug. 19–29, 1622, the Lutheran forces under Count Mansfeld and Christian of Brunswick defeated the Spaniards under Cordova. The second battle of Fleurus (July 1, 1690) was between the French army of the duke of Luxembourg and Allied troops under the Prince of Waldeck (*see* GRAND ALLIANCE, WAR OF THE). Waldeck's army was enveloped on both flanks and turned by a rare tactical movement. Luxembourg himself swept round the enemy's left, through Ligny. Although outnumbered in troops and guns, the French achieved victory, killing about 5,000 Allied soldiers for the loss of half that number of their own men. Luxembourg helped to gain his nickname of "the upholsterer of Notre Dame" by sending 150 colours and standards to Paris after this victory. The third battle (June 26, 1794) was part of Marshal Jourdan's campaign against Coburg's Austro-Dutch forces, in which the first balloon-mounted observer (French Col. J. M. J. Coutelle) helped Jourdan's victory. The so-called fourth battle (June 16, 1815) is better known as Ligny (*see* WATERLOO CAMPAIGN).

(R. M. AN.)

FLEURY (ABRAHAM JOSEPH BÉNARD) (1750–1822), French actor, noted as a comedian, was born at Chartres on Oct. 26, 1750. He began his stage apprenticeship at Nancy, where his father was an actor at the court of King Stanislaus I. He went to Paris in 1778 and almost immediately was made a full member of the Comédie Française, although the public was slow to recognize him as the greatest comedian of his time. In 1793 Fleury was arrested in consequence of the presentation of the politically controversial play *L'Ami des Lois* by Jean Laya. When liberated, Fleury appeared at various theatres until, in 1799, he rejoined the rehabilitated Comédie Française.

Fleury retired in 1818 and died on March 3, 1822.

FLEURY, ANDRÉ HERCULE DE (1653–1743), the last of the great French cardinal-ministers of the *ancien régime*, was born at Lodève, in Languedoc, on June 22, 1653. The son of a collector of ecclesiastical revenue, he entered the church and secured the patronage of Cardinal Pierre de Bonzi, grand almoner to Queen Marie Thérèse. His handsome appearance and fine manners made him *persona grata* at the French court, where he became almoner to the queen in 1679 and to Louis XIV in 1683. Bishop of Fréjus in 1698 "by divine wrath," Fleury was appointed by Jesuit influence tutor to the future Louis XV in 1715. His ascendancy over the young king paved Fleury's way to political power when the duc de Bourbon was disgraced in 1726. On June 11, 1726, at the age of 73, Fleury assumed office as minister of state and on Aug. 20 was made cardinal in order to afford him precedence in the royal council. Until his death in 1743 Fleury controlled French policy with an iron hand and enjoyed the *de facto* but not titular position of *premier ministre*.

Fleury surrounded himself with gifted and experienced collaborators. He restored Henri d'Agueseau to the position of chancellor and gave him the opportunity to begin codifying the civil law. Requiring a strict but not frugal economy to enable France to recover from the financial aftermath of the War of the Spanish Succession, he chose as his finance ministers first Michel Robert Le Pelletier des Forts from 1726 to 1730, then Philibert Orry from 1730 to 1745. The former restored the system of farming out the indirect taxes, which had been suspended by law between 1721 and 1725, and on June 15, 1726, fixed the metallic content of the French currency, thus preventing its debasement. Orry reformed the assessment of the main direct tax, the *taille*, gave a great impetus to the growth of external trade through the *bureau de commerce* and, in 1738, began the construction of a magnificent road system by means of the royal *corvée*. Even in foreign policy, his own special domain, Fleury relied on the assistance of Germain Louis de Chauvelin as foreign minister until he found it necessary to dismiss him in 1737. Such ministerial stability was wholly exceptional in France in the 18th century and was one of the factors contributory to the success of Fleury's administration.

Fleury's main achievements, however, were in diplomacy. He began by remaining faithful to the English alliance and by working, in close association with Sir Robert Walpole, for the dissolution of the Austro-Spanish alliance of 1725, so that the Anglo-Spanish hostilities of 1727 were prevented from developing into a European conflict. After 1731, however, Fleury progressively undermined British influence in Europe, and by 1740 he had won for France the diplomatic hegemony of Europe. Forced to take part in the War of the Polish Succession against Austria and Russia in support of the candidature of Stanislaw Leszczynski, Louis XV's father-in-law, he encouraged British neutrality and thus excluded Great Britain from the peace settlement. In 1733 he contracted the first "Family Compact" between France and Spain by sponsoring the claims of Don Carlos (*see* CHARLES III, king of Spain) in Italy. By restricting French military operations in Germany and

Italy, he was able to effect a *rapprochement* with Austria. When the negotiations that had started in 1735 brought the war to an end with the treaty of Vienna in 1738, Fleury, in return for recognizing Augustus III as king of Poland and for guaranteeing the Austrian pragmatic sanction, gained the reversion of Lorraine, the greatest territorial acquisition made by France in his century.

In 1740, on the death of the Holy Roman emperor Charles VI, Fleury recognized the succession of Maria Theresa to the Austrian dominions and wished to support the imperial claims of Charles Albert of Bavaria by diplomacy but not by war. His main mistake at this juncture was to connive at the aggressive anti-Habsburg plans of the marshal de Belle-Isle (*q.v.*), which were to commit France to the War of the Austrian Succession.

In religious affairs Fleury employed rigorous disciplinary measures against the Jansenists and the *parlement* of Paris. He succeeded in imposing acceptance of the bull *Unigenitus* in 1730. He died in Paris on Jan. 29, 1743.

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FLEURY, CLAUDE (1640–1725), French ecclesiastical historian, was born at Paris on Dec. 6, 1640. He was nominated an advocate to the *parlement* of Paris in 1658, but nine years later he turned to theology and by 1672 was in orders. In 1684 he became abbot of the Cistercian abbey of Loc-Dieu, in Brittany. In 1689 he was appointed subpreceptor of the dukes of Burgundy, of Anjou and of Berry, and thus became intimately associated with Fénelon, their chief tutor. On the completion of the education of the young princes the king appointed him prior of Argenteuil, near Paris (1706), and he resigned that of the abbey of Loc-Dieu. Fleury, who had been made confessor to the young king Louis XV in 1716, because, as the duc d'Orléans said, he was neither Jansenist nor Molinist, nor Ultramontanist, but Catholic, died on July 14, 1725. His great learning was equaled by the modest simplicity of his life and the uprightness of his conduct.

Fleury's chief work, the *Histoire ecclésiastique*, which comes down to 1414 and was completed by others down to 1778, has passed through many editions, the first being that of Paris, 20 vol. (1691; partial Eng. trans., 3 vol., 1842–44). It is the first large history of the church. His other works include *Histoire du droit francois* (1674; Eng. trans., 1724), *Les Moeurs des Israélites* (1681; Eng. trans., 1805) and *Les Moeurs des Chrétiens* (1682; Eng. trans., 1698).

See F. Gaquère, *La Vie et les oeuvres de Claude Fleury, 1640–1723* (1925).

FLEXNER, the family name of a family with several distinguished members, notably two brothers, both born in Louisville, Ky., who won prominence in medicine, one as a pathologist and the other as a medical educator.

Simon Flexner (1863–1946) was born March 25, 1863. After receiving his medical degree from the University of Louisville in 1889, he studied at Johns Hopkins university, Baltimore, Md., at the universities of Strasbourg, Berlin and Prague, and at the Pasteur institute, Paris. He was associate professor of pathology (1895–98) and professor of pathological anatomy (1898–99) at Johns Hopkins and professor of pathology at the University of Pennsylvania (1899–1903). He then was director of laboratories (1903–35) and institute director (1920–35) of the Rockefeller Institute for Medical Research, New York. In the army during the Philippine insurrection and World War I he rose to the rank of colonel. He was a charter member of the Rockefeller foundation (1913–28), a founder (1915) of the Peking Union Medical college in China and chairman of the Public Health council of the state of New York. He isolated the Flexner bacillus of dysentery and developed a curative serum for spinal meningitis. He published numerous scientific monographs. With James Thomas Flexner he wrote *William Henry Welch and the Heroic Age of American Medicine* (1941). He died in New York city on May 2, 1946.

Abraham Flexner (1866–1959), born Nov. 13, 1866, received his B.A. degree from Johns Hopkins university in 1886. He taught Greek in the Boys' High School at Louisville until he established his own preparatory school in 1890. After obtaining an M.A. degree at Harvard university in 1906, he studied in Berlin. He surveyed for the Carnegie Foundation for the Advancement of Teaching all of the 155 medical schools then operating in the United States and Canada. His findings, published in 1910 as Bulletin no. 4 of the Carnegie foundation, resulted in a wholesale closing of the worst of the schools and the consolidation and reorganization of others. As secretary, and later director of studies and medical education, of the general education board (1913–1928), he played a leading role in the reorganization of the schools and the establishing of higher standards for medical education. In 1930 he organized the Institute for Advanced Study, Princeton, N.J., bringing together one of the world's most distinguished groups of scientists and humanists. He served as director until 1939. His books include *Medical Education: A Comparative Study* (1925); *Universities: American, English, German* (1930); (with Esther S. Bailey) *Funds and Foundations* (1952); *I Remember: An Autobiography* (rev. ed., 1960). He died in Falls Church, Va., Sept. 21, 1959. (J. F. Le.)

FLICKER, a general name for small ground-loving, ant-eating, North American birds, aberrant woodpeckers. The flickers belong to the genus *Colaptes;* their bills, more slender than those of other woodpeckers, are slightly downcurved, but these birds are still capable of drilling nest holes high in a dead limb or stump, where five to nine white eggs incubate for two weeks.

EDWIN J. HOWARD FROM NATIONAL AUDUBON SOCIETY

YELLOW-SHAFTED FLICKER (COLAPTES AURATUS)

The yellow-shafted flicker (*C. auratus*) is about 12 in. long; brownish gray above, barred with black; brownish white below, washed with yellow. A red crescent is on the back of the head; black spots and a black crescent are on the breast; and a black "moustache" is present in the male. The white rump and yellow underwings and tail are conspicuous in flight. *C. auratus* ranges from the Atlantic to the Rockies and from the northernmost limit of trees to the Gulf.

The red-shafted flicker (*C. cafer*), west of the Rockies and from Alaska into Mexico, has a brown crown, red underwings and tail and a red "moustache" in the male. The gilded flicker (*C. chrysoides*) is found in the southwest. Other species occur in Cuba and south Mexico. *See* also Woodpecker. (G. F. Ss.; X.)

FLIEDNER, THEODOR (1800–1864), German pastor and founder of the nursing deaconesses at Kaiserswerth, was born on Jan. 21, 1800, at Eppstein near Wiesbaden. After study at Giessen and Göttingen he became pastor at Kaiserswerth near Düsseldorf (1822). Travels to collect money for his impoverished parish took him to Holland, where he became acquainted with the work of "deacons" among the Mennonites, and to England, where he was impressed by the social work of Elizabeth Fry. The contemporary interest of his own church in home missions, especially in hospital, reformatory and prison work, further crystallized his aims. In 1826 he founded the Rheinisch-Westfälische Gefängnisgesellschaft for the care and aftercare of prisoners and in 1836 the hospital at Kaiserswerth. This was the beginning of the Rheinisch-Westfälische Diakonissenverein, an institution for unmarried women wishing to undertake church social work. He soon founded other mother houses on the Kaiserswerth pattern in Germany and abroad. In 1849 he took four sisters to the United States and founded a deaconess house at Pittsburgh, Pa.; in 1851 he took four to Jerusalem at the invitation of Bishop S. Gobat. He also founded an institute for male nurses in 1844 at Duisburg, today called the Diakonenanstalt Mühlheim-Selbeck. Fliedner died at Kaisers-

werth on Oct. 4, 1864, having founded more than 100 deaconess institutes and published many missionary works.

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(C. L. A. R. H.)

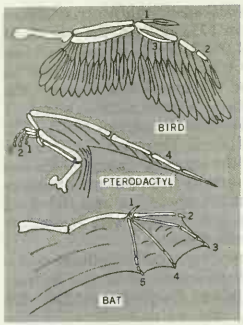
FLIGHT (NATURAL). The ability to fly was probably first developed in animals about 200,000,000 years ago, by certain large cockroachlike insects that lived in the trees and ferns of Mesozoic forests (the coal measures of today). The first vertebrate animals to use this means of locomotion were the pterodactyls or flying reptiles. Only much later in geologic time did the birds and bats begin to dominate the aerial environment. Today these two groups, together with the multitude of insect types, provide examples of the different ways in which nature has developed life in the air.

Man's first attempts to fly were based on his observation of flying animals, which have always aroused his envy and stirred his imagination. "The way of an eagle in the air" was "too wonderful" for the author of Proverbs. The more practical-minded Greeks had the legend of Daedalus (*q.v.*), who was supposed to have built wings of wax and feathers that he and his son Icarus used in flying. The history of man's miming of bird flight and the steps that led up to modern aeronautics are incompletely documented: they extend from the imaginative sketches of Leonardo da Vinci (about 1500) to the experiments of such inventive men as Sir George Cayley, W. S. Henson, S. P. Langley, Otto Lilienthal, the Wright brothers and numerous others. Since many of these inventors constructed flying machines based on their own concepts of the mechanism of bird flight, many and varied craft were built. When airplanes began to move at speeds much faster than those of natural fliers, it seemed that man could no longer learn about flight from the animal world; yet there are still so many gaps in the knowledge of natural flight that it is not altogether certain that the help so far obtained from nature has been exhausted. (For an account of man's struggle to attain mastery of the air *see* AVIATION, HISTORY OF.)

Basic Conditions Allowing Flight.—Flight cannot occur in a vacuum; it depends on the pressure or weight of the atmosphere. Since air, like any other fluid, presses against every surface that it surrounds, it can support a flying object—but only when that object can somehow reduce the pressure of air on its upper surface and the turbulence (or "drag") that such a surface creates. How this can be accomplished was indicated by Daniel Bernoulli in 1738: his principle states that the pressure in a fluid is reduced when its velocity increases. When air flows over the smooth surface of a wing, the increase in speed over the curved upper surface results in a reduction of pressure on that surface; since the pressure on the flatter undersurface remains nearly normal, the wing is pushed up, or lifted.

Applying this principle to flight the following generalizations may be made. The wings of a flying animal, like those of an aircraft, are airfoils aerodynamically adapted to exploit the motion of the air. The speed required to induce a reduction of pressure on the upper surface is produced by movement of the wing through the air, either by motion of the whole animal or by flapping. Airplanes maintain their motion by means of propellers or jets, but sailplanes (gliders) and animals in nonflapping, gliding flight rely on the force of gravity and soar by using air currents to counter gravity. (For a detailed discussion of the principles involved in flight, *see* AERODYNAMICS.)

The Structure of a Flying Animal.—All the more efficient fliers have easily recognizable wings, but there are also many other types of animals that can prolong their glides from the trees to the ground by means of special structures on various parts of their bodies. Thus the flying frog has large webbed feet, the flying dragon (a lizard) has a flexible membrane down each side of its body; the flying squirrel has a membrane of skin extending along the sides of its body between the wrists and hind legs. An unusual example is the flying fish, in which the pectoral fins are greatly enlarged; this fish can glide for considerable distances over the surface of the sea.



MODIFIED FROM C. R. DE BEER, "VERTEBRATE ZOOLOGY," 1928. SIDGWICK AND JACKSON

FIG. 1.—WING CONSTRUCTION IN FLYING VERTEBRATES (NUMERALS INDICATE THE DIGITS; 1 IS COMPARABLE WITH THE THUMB IN MAN)

The wings of pterodactyls, birds and bats developed from the front pair of limbs, but the construction is different in each case (fig. 1). The wing surface of a bird is formed by feathers borne on the forearm and an enlarged second digit; the first and third digits are present but reduced. The wing of a pterodactyl was a fold of skin supported mainly on the greatly enlarged fourth digit. The wing of a bat is a fold of skin supported on all digits except the first and extending to the short hind legs and tail. The greater efficiency of birds over other vertebrates may depend on the construction of the feathers, which have been found to allow air to pass from the upper to the lower surface of the wing but not in the reverse direction. It is possible that this enables birds to reduce the turbulence of the boundary layer of air; it also provides an explanation of the greater aerodynamic efficiency of the bird's wing as compared to a model of similar size and shape. The wings of insects, by contrast, are not modified limbs but are specialized thin folds of the continuous cuticle that covers the entire surface of these animals. Insect flight has evolved from the start as an additional method of locomotion and is not derived, as is the flight of all vertebrate animals, from an earlier form of locomotion on land or in the water.

Principles of Gliding and Soaring Flight.—Comprehension of the fundamental principles underlying nonflapping flight was expressed by Lord Rayleigh who in 1883 remarked that "whenever . . . a bird pursues his course for some time without working his wings we must conclude either (1) that the course is not horizontal, (2) that the wind is not horizontal, or (3) that the wind is not uniform." In still air a bird that is not moving its wings must descend at a more or less steep angle, like a glider; the few accurate measurements of this angle that have been made give figures of the rate of descent at 1 foot for every 8½ horizontal feet traveled for the fulmar, to 1 foot for every 23 horizontal feet, for the American black buzzard. The aerodynamic force from the wings both pulls the body forward through the air and supports the bird's weight (fig. 2). If α is the angle of glide, L the vertical lift (equal to the weight) and D the total horizontal drag, then

$$\frac{L}{D} = \frac{1}{\sin \alpha}$$ is known as the glide ratio.

Measurements of the flight performance of a gliding bird are by no means easy to make. The curves in fig. 3 were obtained

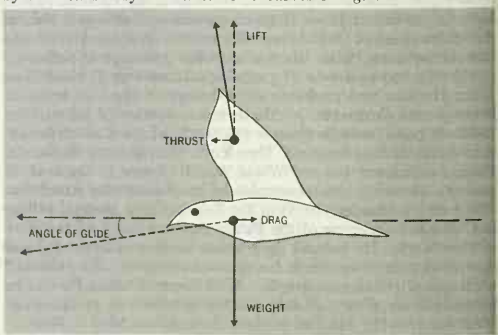
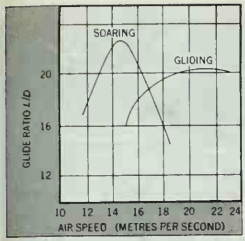


FIG. 2.—ANALYSIS OF FORCES ON A GLIDING BIRD. FORWARD COMPONENT OF FORCE, DERIVED FROM PRIOR WING FLAPPING, BALANCES THE DRAG OF THE BODY, AND THE VERTICAL LIFT BALANCES THE WEIGHT



FROM A. RASPET, "BIOPHYSICS OF BIRD FLIGHT," REPRINTED FROM "SCIENCE," BY PERMISSION, 1960. BY PERMISSION OF AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

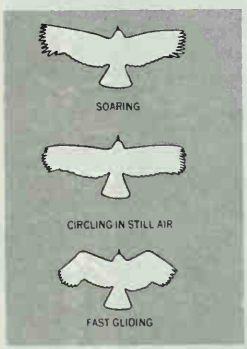
FIG. 3.—GLIDE RATIOS FOR THE AMERICAN BLACK VULTURE, OR BLACK BUZZARD, UNDER DIFFERENT CONDITIONS OF FLIGHT

by A. Raspet by following the American black vulture, or black buzzard (*Coragyps atratus*), and observing it from a sailplane of known performance. C. J. Pennycuick made measurements for the fulmar by tracking the birds optically from a point on a cliff top.

In both cases the uncertainty is introduced by the ability of the birds to change the area and plan of their wings under different conditions (fig. 4). When a bird of prey is gliding at great speed it bends its wings at the elbow and wrist joints; when gliding lazily in still air it holds the wings straight. When circling in soarable air the wing is brought forward and the primary feathers at the tips of the wings are spread so that they separate from each other over a length of about one-fifth of the wing; this enables the bird to develop maximum lift at low speeds without loss of control. Vultures and other efficient soaring and gliding birds have been observed even to extend the bastard wing (alula), formed by the first digit, so as to form a leading-edge slot and still further delay the stall at low speeds. It is clear from fig. 3 that these different attitudes of the wing can greatly affect the gliding angle at various flying speeds.

The very high performance of soaring birds has stimulated wind-tunnel research into their aerodynamic characteristics. Fig. 5 shows the measurements of the sinking speed at various flying speeds of a model of a gull as compared with the performance of an actual gull in flight. At a speed of 30 m.p.h. the sinking speed of the model is a little more than double that of the actual bird. This illustrates the difficulty of reproducing in the laboratory the exact conditions occurring in nature; the difference probably arises partly from the special properties of the wing feathers and partly from the ability of the living bird to make continual adjustments in its flight to take advantage of the air movements.

Soaring in an Upward Current of Air.—If the wind is uniform soaring flight is possible only when the upward component of the air motion is equal to, or greater than, the sinking speed of the animal (the vertical component of the glide). In many soaring birds the minimum sinking speed may be as low as two feet per second, and air motion with at least this upward component is common in nature. The two main conditions under which upward movement of air occurs are when the wind is deflected by mountains or sea cliffs and when thermal circulation of the atmosphere is induced by the heating of the ground by the sun. The former condition provides strong and reliable lift for a short distance above the surface of the ground; thermal upcurrents may be weaker but often extend to considerable heights and are found over vast stretches of the countryside. Birds such as the gulls, which make use of the soaring conditions near sea cliffs, have wings that are not so specialized as those of the thermal soarers; also gulls often have to flap their wings in order to reach their feeding grounds. By contrast the vulture needs to flap its wings only long enough to raise itself in the morning to a sufficient height to make use of the rising currents of air; sailplane pilots who have soared with these birds confirm the extraordinary extent to which they can rely on the energy supply provided by nature. Vultures will follow each other or a sailplane into the rising columns of air and ultimately space themselves out across the countryside at a distance so that they can just see the next bird. (In this way when one finds a carcass many others can descend rapidly to share the feast.)



FROM A. RASPET, "BIOPHYSICS OF BIRD FLIGHT," REPRINTED FROM "SCIENCE," BY PERMISSION, 1960. BY PERMISSION OF AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FIG. 4.—WING PLAN OF THE BLACK BUZZARD UNDER DIFFERENT CONDITIONS OF FLIGHT

Soaring When the Wind Is Not Uniform.—Lord Rayleigh indicated in general terms the mechanism by which the energy necessary to maintain flight could be derived from the variability of the wind. He pointed out that it is the velocity of the bird relative to the air, not its velocity relative to the ground that determines the forces acting on it; the bird can at any time, by climbing upward, turn some of its kinetic energy into potential energy and vice versa. Reduced to its simplest form this type of soaring (dynamic soaring) is merely a process of correcting for the turbulence in the air in such a way that potential energy is gained. It is possible that many birds, by making small adjustments to their flight, can gain energy from the small-scale turbulence of the air.

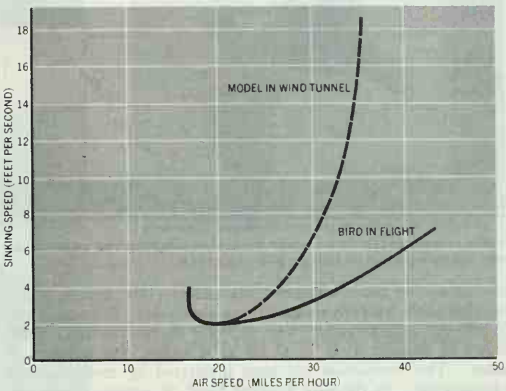


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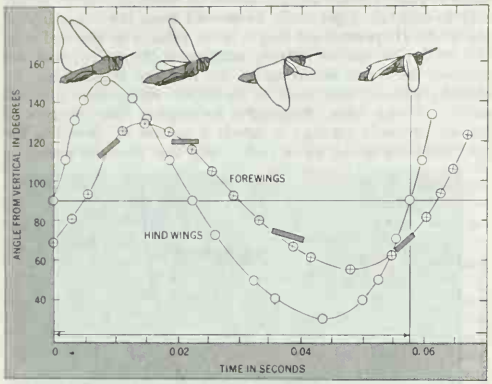
FIG. 5.—COMPARISON OF SINKING SPEEDS OF A LIVING GULL AND A MODEL

The best example of dynamic soaring is provided by the albatross, which uses the gradient of wind velocities near the surface of the sea. It is known that the velocity of the wind diminishes down to the surface of the water because of the influence of friction at the surface and of eddy motion in the air; by a variety of turning maneuvers the albatross can take good advantage of such a gradient. The following explanation is based on the studies of P. Idrac: At the end of a downward glide, with the wind behind it, the albatross nears the surface of the water. In order to gain altitude it turns and faces upwind (into the wind); the initial speed gained during the preceding glide generates lift and the bird climbs. During the climb the bird's air speed (but not its speed relative to the water below) remains constant because of the progressively increasing velocity of the wind at higher levels. Upon reaching a certain altitude, at a level where the bird cannot climb higher without losing air speed, the albatross turns and faces downwind (goes in the direction of the wind) to begin its downward glide. At this point the bird begins to gain air speed for two reasons: (1) the force of gravity (the potential energy of height becomes the kinetic energy of motion); and (2) it is entering air which is moving more slowly over the water. Therefore, as the albatross enters the lower altitudes it continues to gain speed relative to the progressively diminishing tail winds. When the bird again nears sea level, it turns upwind and repeats the maneuver. The natural way to combine these effects is to describe circles in an inclined plane, always descending when moving to leeward and ascending when moving to windward.

In strong winds a very swift bird like the albatross (whose average speed is 72 ft. per second) can extract sufficient energy

from the air to enable it to glide for considerable distances in the troughs of waves. The wind gradient near the ground is used by many other birds to enable them to gain height immediately after taking off from a flat field; they will climb into the wind and immediately dive diagonally downwind after reaching the top of the wind gradient.

Flapping Flight.—The vast majority of birds, bats and insects use their wings not only to enable them to glide through the air but also to move wherever they choose; this requires active flapping of the wings by means of special muscles. Although wings in different animals assume very different shapes, the basic mechanism of flapping flight is, as far as is known, the same in all cases. This mechanism has been illustrated by motion-picture photography. In the slow flapping flight of pigeons, either just after take-off or just before landing, the forward velocity is very low. The downstroke is really a forward and downward movement, and the upstroke involves considerable flexion of the wing and a backward flick at the top of the stroke. In this type of flight it is probable that the primary feathers at the wing tip are doing most of the aerodynamic work; the bird obtains lift and most of the total propulsive thrust from the upstroke, but only lift from the downstroke. For a pigeon this is a tiring mode of flight and cannot be maintained for more than a few seconds.



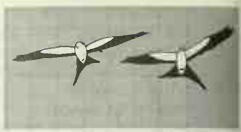
T. WEIS-FOGH, "PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY"

FIG. 6.—WING CYCLE OF A LOCUST WITH BARS SHOWING THE TWISTING OF THE FOREWING AT FOUR INSTANTS IN THE CYCLE

In normal flight, where the bird is moving forward through the air, the wing movements are different: the backward flick of the wing tip at the end of the upstroke has disappeared, and the main propulsive thrust is now obtained from the downstroke, which is more nearly vertical and of smaller amplitude. The inner third of the wing, which has small flapping amplitude, generates lift throughout the cycle of beat. The outer third, during the downstroke, produces most of the propulsive thrust, and before the upstroke the wing is rotated so that the tip rises naturally because of the forward movement. The tip feathers do not separate, and the air is always directed to their lower surfaces so that they have a positive incidence. Most birds are capable of achieving a smooth change from one mode of flight to another as their forward speed increases.

In all flying animals there is this upward rotation of the wing during the upstroke, and in rapid flight this serves to generate lift at the expense of forward kinetic energy. In the hovering flight of hummingbirds and small insects the rotation of the wing is so great that the tip turns over on the upstroke, again generating lift; in these hovering fliers it is more correct to speak of the forward and backward strokes of the wings, since they move more nearly in a horizontal plane, with the body tilted upward at a steep angle.

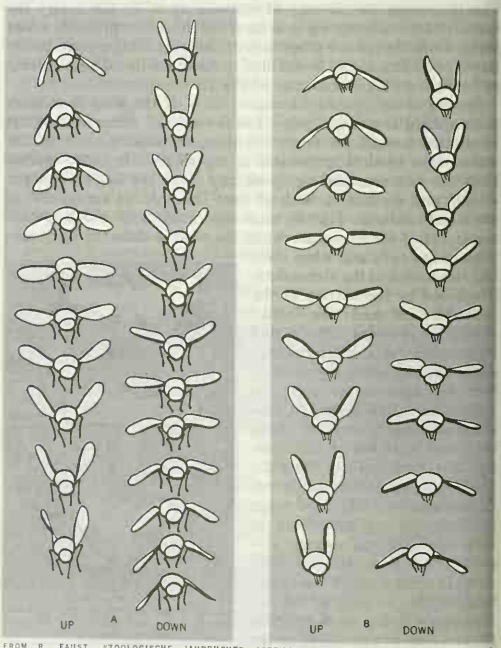
Insects present some special problems, since nearly all of them possess two pairs of wings that do not move up and down at exactly the same time. Fig. 6 shows the cycle of movement of the forewings and hind wings of a locust flying steadily forward at about 10 ft. per second. The hind wings move up and down before the forewings do, and have a larger amplitude of beat; they produce 70% of the lift and their twisting is such that they give forward thrust during both the down- and upstrokes. In contrast to the locust, where the movement of both pairs of wings is important for flight, beetles use their hardened forewings as fixed planes, rather like the wings of an airplane, and all the thrust comes from the hind wings, which can be compared to the propeller except that they move up and down instead of rotating. Bees and butterflies have their two pairs of wings coupled together so that they beat as one, and in flies the hind wings are lost altogether. In spite of this great variety of size and form of wings, it does not appear that any new aerodynamic principles are involved in insect flight, except perhaps when the wings are less than one-tenth of a millimetre long; at these very small dimensions the form of air flow changes.



FROM J. H. STORER, "THE FLIGHT OF BIRDS," "CRANBROOK INSTITUTE OF SCIENCE BULLETIN," NO. 28, 1948

FIG. 7.—AMERICAN SWALLOW-TAILED KITE TWISTING ITS TAIL TO STEER

The Control of Flight.—Natural flight produces many problems of balance, control and forward movement. Since the atmosphere is rarely steady, flying animals have to face the problem of taking-off and alighting without damage to their delicate structures. The tail feathers of a bird can be spread to give some control of fore-and-aft balance, and the forked tails of kites, swallows and swifts can be twisted to enable the bird to turn sharply (fig. 7). But in birds, as well as in bats and insects, balance is maintained chiefly by adjustment of the degree of twisting and folding of the wings. Fig. 8 shows the normal twisting of the wings of a fly and the way the wings are twisted differently during the down-



FROM R. FAUST, "ZOOLOGISCHE JAHRBUCHER ABTEILUNG FUR ALLGEMEINE ZOOLOGIE UND PHYSIOLOGIE DER TIERE 63," 1952. GUSTAV FISCHER, JENA

FIG. 8.—SUCCESSIVE WING POSITIONS OF A FLY SHOWING THE WING TWISTING: (A) STRAIGHT FLIGHT; (B) BANKING

FLIGHT (NATURAL)

Whinchat braking flight before landing. The tail is lowered and fanned out, and the wings are fully extended with the primary feathers spread apart

Black-headed gull in soaring flight. The wing structure of such birds as the gull, vulture and albatross enables them to sustain soaring flight for long periods without frequent wing strokes

Redwing in slow flapping flight with wings at the top of the upstroke. In this type of flight the primary feathers at the wing tip are doing most of the aerodynamic work

A hummingbird hovering, photographed by electronic flash at 1 7000th of a second. The wings beat backward and forward often as many as 50 times per second

BIRDS AND A MAMMAL IN FLIGHT

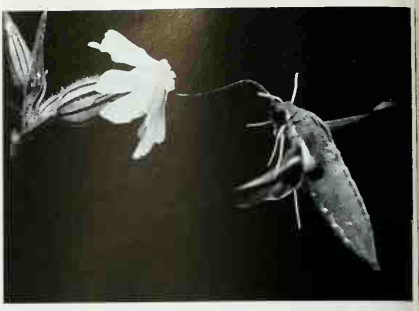
A griffon vulture soaring. The spreading of the primary feathers at the wing tip delays the stall at low flying speeds

Horseshoe bat in flapping flight with wings on the upstroke. The bat is the only mammal that exhibits true flight

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM LEFT) ERIC HOSKING (TOP RIGHT) GÖSTA HÅKANSSON—ANNAN PHOTO FEATURES (CENTRE) JOHN MARKHAM, (BOTTOM RIGHT) S. C. BISSERÔT

FLIGHT (NATURAL)

Wasp in flight with its legs in position for landing

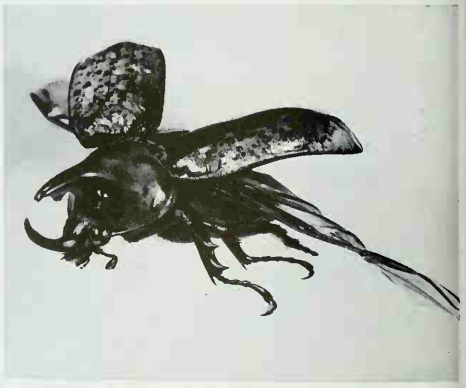


A hawk moth hovering beside a flower while extracting nectar through the extended proboscis

A hover fly approaching a flower. Capable of changing its direction in flight easily and rapidly, the hover fly darts erratically from flower to flower

Ladybird beetle about to fly. The membranous wings, folded under when at rest, have emerged from beneath the hard forewings, which are raised

Horsefly, with legs extended, banking slightly as it is about to land. Flies maintain balance in flight by adjusting the degree of twisting and folding of the wings



Rhinoceros beetle in flight, during which the hard forewings act as fixed planes like the wings of an airplane, all the forward thrust coming from the hind wings

INSECTS IN VARIOUS ASPECTS OF FLIGHT

PHOTOGRAPHS: (TOP LEFT AND RIGHT) HERMANN EISENBEISS, (CENTRE LEFT) JOHN WARHAM, (CENTRE RIGHT) JOHN MARKHAM, (BOTTOM LEFT) HAROLD V. GREEN—ANNAN PHOTO FEATURES, (BOTTOM RIGHT) RUSS E. HUTCHINS

stroke when the fly is banking. It is important to realize that the wing is a living structure with muscles and sense organs that enable the animal to change the form of the wing during flight. A hummingbird hovering in front of a flower—or a bat catching a moth, or a bee entering the small opening of its hive—are each performing an act of balance more difficult and complicated than that of a skilled acrobat.

Often these maneuvers depend on a very well-developed visual sense; birds, for example, are quite unable to fly in a fog or complete darkness. Among the insects, however, the two-winged flies have evolved a special organ similar in its operation to the gyroscopic instruments of the airplane; thus a fly has perfect control of its balance even under conditions when its eyes are ineffective. Bats have greatly developed yet another sense, that of hearing; during flight they emit a variety of sounds, most of them inaudible to the human ear, and can locate objects with great accuracy through the echoes received by their sensitive ears. They use this sense both to avoid obstacles and to catch the nocturnal insects on which they feed.

Measurements of Performance.—It is by no means easy to make accurate measurements of the speed at which birds and insects fly in their natural surroundings, and casual estimates are likely to be much in error. The most reliable observations suggest that the fastest flying birds, such as geese and ducks, rarely exceed 60 m.p.h.; however, there are disputed reports of swifts that, during short maneuvers, can more than triple that speed. Small- and medium-sized birds normally fly at speeds between 10 and 30 m.p.h. At the other extreme, hummingbirds are well known to be able to hover or even fly backward. The normal forward speed of a locust is 10 ft. per second; it is unlikely that any insect exceeds 40 ft. per second under normal conditions.

The maximum wingbeat frequency measured in a bird is nearly 50 strokes per second for a hummingbird. The wingbeat frequency of the honeybee and of many flies is between 100 and 200 beats per second. The smaller the animal, the faster it can beat its wings; the highest known wingbeat frequency is that of a small midge with the remarkable figure of 1,000 beats per second. At the other extreme, one stroke per second is sufficient to propel a large pelican. The wing loading of birds in pounds per square foot varies from 4.2 for the Canada goose to 0.3 for the swallow and, among insects, from 0.05 for a butterfly to 2.5 for the bumblebee.

Birds have been observed in flight above 20,000 ft.; geese probably fly highest, having been photographed at 29,000 ft. That birds can tolerate such heights, which undoubtedly have an appreciable effect upon blood circulation and breathing, gives an indication of the efficiency of the physiological systems of these natural fliers. Almost as remarkable are the great distances traveled by migrating birds. For the navigational problems involved in bird migration, *see* MIGRATION, BIRD. *See* also BIRD: *Natural History and Habits.*

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FLINCK, GOVAERT (1615–1660), Dutch painter, was born at Cleves on Jan. 25, 1615. He first studied under L. Jacobszon in Leeuwarden and later entered Rembrandt's studio, becoming one of the master's most accomplished followers. As a painter of biblical and allegorical subjects he at first modeled himself very closely on Rembrandt's style, as, for example, in his "Crucifixion" (1643?) in Basel, but later he developed a more florid and oratorical manner, in which he appears to have been influenced by Rubens, as in the allegory of 1654, "Amalia van Solms Mourning the Death of Her Husband, Prince Frederick Henry of Orange," in the Rijksmuseum, Amsterdam. Flinck's most successful genre was portraiture. In this, too, his earlier works are extremely close to his master, for instance the "Portrait of Rembrandt," signed and dated 1639, in the National gallery, London, which had passed (with the aid of a forged signature) as a self-portrait by Rembrandt himself. In later portraits his own individuality is more apparent, and he is especially successful in his groups, among which one may single out the portrait of "A Goldsmith and his Family" in Brussels, and the splendid large groups of "Civic Guards" in the Rijksmuseum. Flinck died at Amsterdam on Feb. 2, 1660. (R. E. W. J.)

FLINDERS, MATTHEW (1774–1814), English navigator who has been described as the father of Australian hydrography, was born at Donington, Lincolnshire, on March 16, 1774. He entered the Royal Navy in 1789. In 1795 he accompanied Gov. John Hunter to New South Wales and during the next four years he explored, with George Bass, the southeast coasts of Australia by boat journeys, on which Tasmania was circumnavigated and Bass strait discovered.

In 1801 Flinders was appointed to command of the sloop "Investigator" in order to "complete the investigation of the coasts of Terra Australis." He surveyed the entire south coast from Cape Leeuwin to Bass strait and reached Port Jackson on May 9, 1802. In April he had met the French expedition under N. Baudin in Encounter bay, and France subsequently claimed the land to the west. Sailing from Port Jackson on July 22, 1802, Flinders charted the east coast of Australia and the Gulf of Carpentaria. Finding his ship unsound he sailed west and south of the continent and returned to Port Jackson on June 9, 1803. In August he sailed for England in the "Porpoise," which was wrecked off the Great Barrier reef. After rowing back to Port Jackson for relief, Flinders sailed again, on Oct. 11, in the "Cumberland"; compelled to put in to Mauritius for repairs, he was interned by the French authorities. He was released in June 1810, and reached England broken in health. Flinders' narrative, *A Voyage to Terra Australis*, was published on July 19, 1814, the day of his death. (R. A. SN.)

FLINDERS RIVER, the longest river in Queensland, Austr. It is 520 mi. long but only about the lowest 70 mi. are perennial. The river rises in the eastern highlands and flows in a great arc, first westward and then northward to the southern end of the Gulf of Carpentaria. It was discovered, and named after Matthew Flinders (*q.v.*), by Capt. J. L. Stokes in H.M.S. "Beagle" in 1841. The upper basin is good pastoral country, mainly for beef cattle, but the country behind the mangrove-fringed coast is poor and little developed. (O. H. K. S.)

FLINT, AUSTIN (1812–1886), U.S. physician who first described the heart sound that came to be known as an Austin Flint murmur, was born at Petersham, Mass., on Oct. 20, 1812, and graduated in medicine from Harvard university in 1833. He taught medicine at Buffalo Medical college, of which he was one of the founders, from 1847 to 1852. Between 1852 and 1861 he was professor of medicine at several other medical schools, including Rush Medical college and the University of Louisville. In 1861 he became professor of medicine at Bellevue Hospital Medical college, New York, where he remained until his death. He was a prolific writer on medical subjects, his best-known textbook being *Diseases of the Heart* (1859–70). He died in New York city on March 13, 1886.

His son, AUSTIN FLINT (1836–1915), was born in Northampton, Mass., on March 28, 1836, and graduated from Jefferson Medical college in 1857. He taught physiology at several medical schools, the last one being Cornell University Medical college (1898–1906). His *Textbook of Human Physiology* (1876) was for many years a standard book in U.S. medical colleges. He died in New York city on Sept. 22, 1915. (E. B. BY.)

FLINT, TIMOTHY (1780–1840), U.S. clergyman and writer, an important social historian of the early Ohio valley, was born near North Reading, Mass., July 23, 1780. After graduation from Harvard in 1800 he served as a Congregational minister at Lunenburg, Mass., 1802–14. In 1815 he left for the Ohio valley, engaging in missionary work for a time and farming at St. Charles, Mo. Subsequently he visited Louisiana and was principal of a

seminary at Alexandria. Plagued by ill health, he moved to Cincinnati, O., where he edited the *Western Monthly Review* (1827–30) and devoted himself to literary work. He served briefly as editor of the New York *Knickerbocker Magazine* (1833). Besides editorial work, Flint wrote history, biography and four novels. His *Recollections of the Last Ten Years* (1826) is a valuable account of early western life and manners. In 1826 he also published his best novel, *Francis Berrian: or the Mexican Patriot*, in which he utilized some of his own experiences. *A Condensed Geography and History of the Western States* appeared in 1828 (rev. ed., 1832), his edition of the *Personal Narrative* of the adventurer James O. Pattie in 1831 and his biography of Daniel Boone in 1833. *George Mason, the Young Backwoodsman* (1829) is a novel of Mississippi river life, and *The Shoshonce Valley* (1830) is a far western romance notable for its fantastic plot and lush description. He died at Reading, Mass., on Aug. 16, 1840.

See J. E. Kirkpatrick, *Timothy Flint* (1911), which contains a bibliography. (J. T. Fn.)

FLINT, a city of southeastern Michigan, U.S., about 60 mi. N.W. of Detroit; the seat of Genesee county. Pop. (1960) city, 196,940; standard metropolitan statistical area (Genesee county), 374,313. The city was named for the Flint river. The first settlement occurred at the Grande Traverse, where the Mackinaw trail crossed the river; there Jacob Smith, a Detroit fur trader, established an outpost in 1819, soon after the land passed from Indian control. The emigration of settlers from western New York led to the organization of the county, with Flint as the county seat, in 1836. Flint became the trading centre of the Saginaw valley farming area and was incorporated as a city in 1855.

For the next 30 years, Flint was one of Michigan's lumbering centres, but with the depletion of the pine stands in the 1880s, Flint's importance declined. The success of the two-wheeled road carts manufactured by the Durant-Dort Carriage company in 1886 opened its manufacturing era. By 1900 Flint was widely known as the "Vehicle city," with a population of more than 13,000 and a production of more than 100,000 horse-drawn wagons and carriages annually. The body, spring and wheel companies of the carriage industry became the suppliers for the rapidly expanding Buick Motor company, organized in 1903. Thereafter, the city's growth paralleled the business successes of William C. Durant and other former carriage makers. In 1908 Flint's major manufacturing resources were consolidated into the General Motors company. Flint's continued growth reflected the success of the automotive industry, and in the second half of the century it was the site of the largest single manufacturing operation of the General Motors corporation. Supplying the needs of that industry and other commercial activities are two railroads, the Grand Trunk Western and the Chesapeake and Ohio, and many trucking lines. Flint's retail trade area has a radius of 25 mi.

At mid-20th century, more than 90% of the total manufacturing labour force was engaged in some phase of the automotive industry. According to the 1950 federal census, more than 85% of Flint's population was native-born. By 1958, however, it was estimated that less than 20% of its population was born in Genesee county. The continued migration to the automobile factories, begun in 1904, had considerable influence on Flint's metropolitan population.

Flint adopted the commission-manager form of municipal government in 1930. The rapid growth of the metropolitan fringe area after World War II encouraged efforts to bring the whole area of 162 sq.mi. under a single government.

A new municipal centre, including a city hall, municipal court building, police department headquarters and health department building and auditorium, was completed in 1958.

In addition to its public school system, Flint's educational institutions include a publicly supported junior college; the General Motors institute, a private technical school; the Mott foundation (which offers a program in co-operation with the community schools); and the Flint college of the University of Michigan. A combined campus for the city's two colleges was dedicated in 1954, and four years later a natatorium, art centre, planetarium and theatre were completed. A new public library was also opened in 1958. The city park system includes golf courses, swimming pools and over 1,750 ac. of parks. (R. H. V. B.)

FLINT (Y Fflint), a municipal borough of Flintshire, Wales, on the Dee estuary, 12 mi. W.N.W. of Chester by road. Pop. (1961) 13,690. At Pentre, along the coast, was a Roman settlement. Flint castle was built on an isolated rock by the river by Edward I, whose architects laid out the town, geometrically, beneath it and who granted the first charter in 1284 that created the town a free borough. The castle held out against Owen Glendower; it was held for the king by Sir Roger Mostyn during the Civil War but taken, after siege, by parliamentary forces under Sir Thomas Myddelton, and finally dismantled in 1647. It is now maintained by the ministry of works. First a market town and seaport, Flint became, in the 19th century, a coal-mining and lead-smelting town. The introduction of rayon manufacture, still the chief industry, brought it prosperity in the 20th century and other industries include paper mills at Oakenholt, iron and steel works at Shotton and aircraft manufacture at Broughton. Its boundary was extended in 1934 to include Bagillt.

FLINT: *see* Chert and Flint.

FLINT AND OTHER STONE TOOLS. During the several hundreds of thousands of years before he discovered metals and learned to work them, man made his tools of stone, bone, ivory, antler and wood. For the greater part of this long period, the Stone Age, tools made of perishable materials have rarely been preserved, and present knowledge of the material cultures of prehistoric man is therefore based to a great extent on his stone tools. The Stone Age is divided into two main periods, the Paleolithic (Old Stone Age) and the Neolithic (New Stone Age); a short intermediate period, the Mesolithic, is demarcated in Europe. The Old Stone Age itself is divided into several stages, and each stage is characterized by one or more stone tools. The term "industry" is used to designate the assemblage of tools of a given stage.

OLD WORLD

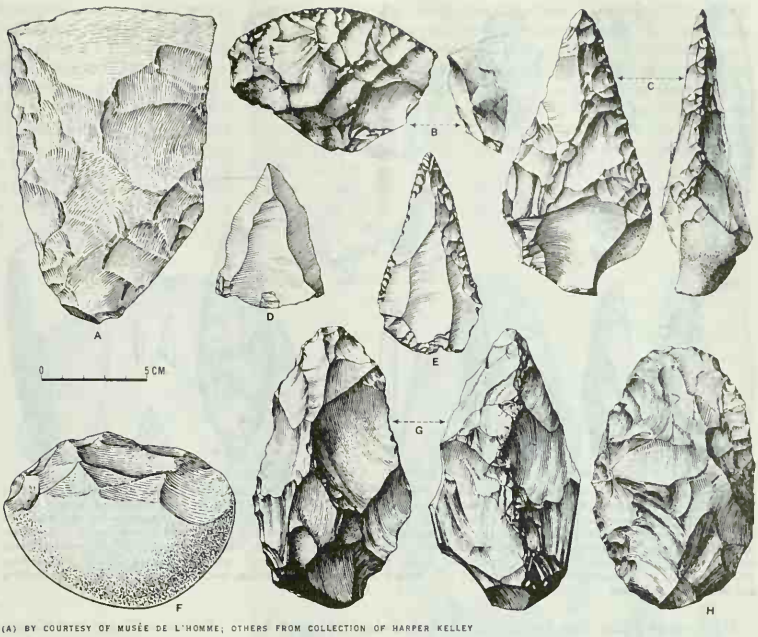
Materials and Manufacture.—Whenever they were available prehistoric man preferred to use flint and similar siliceous stones, both because of the ease with which they could be chipped and for the sharp cutting edges characteristic of this type of material. However, in many regions flint does not exist and man was obliged to use whatever material was at hand. Some rocks, such as quartz, are difficult to work, while others, such as sandstones, quartzites, obsidian and various volcanic rocks, can be made into excellent tools. In general, Paleolithic man knew how to make the best use of the raw materials at his disposal and soon mastered the necessary techniques for the working of different types of stone.

The basic principle in the manufacture of stone tools is the removal of a flake or series of flakes from a stone matrix. It is characteristic of all stone that a blow struck near an edge of a block will detach a chip or flake. Flakes may be removed from blocks by various natural causes such as wave action, pressure in the earth and soil creep, but those produced intentionally by man exhibit definite characteristics. Their most important attribute is the bulb of percussion which appears on the lower surface of the flake just below the point where the blow was struck. Bulbs of percussion vary in size and shape, some being large and prominent, others small and flat, depending on the force and direction of the blow, the nature of the stone and the object with which the blow was struck. The surface upon which a blow was struck is called the striking platform. The block from which a flake has been detached, the core or nucleus, bears the imprint of the bulb in the form of a bulbular cavity and also lateral ridges left by the removal of the flake. These ridges often form a definite pattern from the edges toward the centre, showing that a piece has unquestionably been the work of man. Flaking produced by natural causes is usually haphazard, and fractures by frost or heat are characterized by a series of concentric rings as opposed to the ripple marks left by a man-made fracture.

Stone stools were chipped by two principal methods: (1) percussion and (2) pressure. Chipping by percussion may be done either by striking a block of flint with a hammer held in the hand or by striking the block itself on the edge of a fixed stone; the

latter method is called the anvil method. The hammer used in percussion chipping may be of stone, wood or bone. The use of a wooden billet or bar permits the removal of longer, thinner and flatter flakes, and, as wood is resilient, it does not shatter the edge of the flint and leaves smaller and flatter bulbs than those obtained by stone on stone. Pressure flaking, as the name implies, consists of applying pressure by means of a pointed stick or bone near the edge of a flake or blade, to detach small flakes from both sides. This method was used mostly to put the finishing touches on tools or to produce a desired shape.

Uses and Categories.—Stone tools were probably used for cutting, chopping, scraping, grubbing and perforating, and in later periods for projectile points, for working bone and for engraving. They may be roughly classified into three categories: core tools, in which the block itself was destined to be utilized as a tool; flake tools, chips removed from a core to be used either with or without additional chipping; and blade tools, elongated and thin flakes which were transformed into specialized tools. These three categories may be found in most Stone Age cultures. Certain industries belonging to the Mesolithic are characterized by very small blades which were made into tools called microliths or "pygmy" flints. In the Neolithic, stone tools were often finished by polishing, after being shaped by chipping. Preliminary shaping was done at times by pecking or battering before polishing.



(A) BY COURTESY OF MUSÉE DE L'HOMME; OTHERS FROM COLLECTION OF HARPER KELLEY

FIG. 1.—REPRESENTATIVE FLINT AND OTHER STONE TOOLS

(A) Cleaver, Lower Paleolithic; (B) side scraper, showing (right) striking platform and bulb of percussion on lower face, Lower or Middle Paleolithic; (C) pointed hand axes, wood technique, Lower Paleolithic; (D) triangular point, Middle Paleolithic; (E) point, Lower or Middle Paleolithic; (F) pebble tool, Lower Paleolithic; (G) hand axes, stone on stone, Lower Paleolithic; (H) oval hand ax, wood technique, Lower Paleolithic

For convenience certain assemblages are referred to as "hand-ax (core) industries" or "flake-tool industries" or "blade-tool industries," the tool type in question being the predominant or most typical element, although the other types may be present as well. Flakes are bound to be associated with hand axes, if only as by-products of their manufacture, but often the trimming flakes were also used as tools.

Among the oldest known tools, especially in Africa, are pebble tools: pebbles or small boulders either roughly chipped to produce a cutting or scraping edge or trimmed on alternate faces to produce a chopping edge. Pebble tools were usually made of very hard rocks, and the form of the pebbles made them difficult to work. The variety of pebble-tool types was therefore strictly limited.

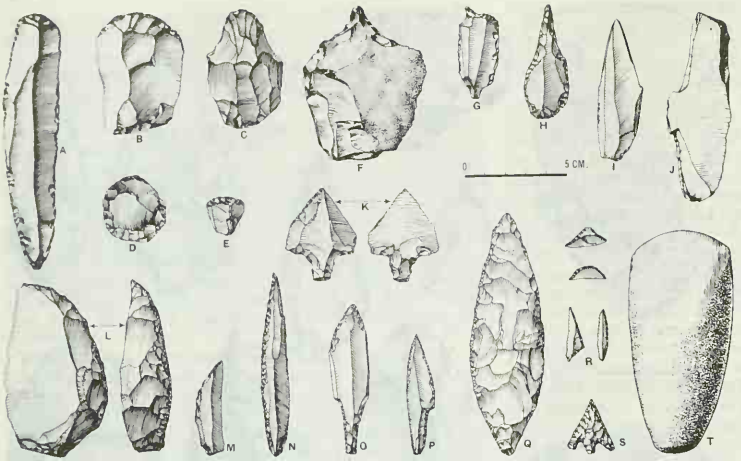
In Europe the principal core tool of the Lower (Early) Paleolithic, the hand ax or biface (*coup de poing* in French), was made from a flint nodule or from tabular flint, if this material was available. When nodules were employed, the shape of the nodule itself determined to a considerable extent the form of the tool. They were worked by the removal of a series of flakes alternately from two sides, making them into cutting or chopping tools, but often the cortex or crust of the nodule was retained over a portion of the surface of the piece. The use of large blocks of tabular flint often allowed the removal of a very large flake which in turn was transformed into a hand ax, and this was often completely reworked so that no trace was left of the original flake surface. In general, thin hand axes were the result of the use of either tabular flint or large flakes. The hand ax was the all-purpose tool of the Lower Paleolithic, and the fact that this type was employed during a very long period of time shows that it was an essential element of the tool kit of prehistoric man. The oldest tools of the Paleolithic were made by the stone-on-stone method. The later introduction of the use of wood resulted in finer and more delicate workmanship. Frequently a hand ax reveals that the rough preliminary flaking was done by stone and that wood was used to finish the piece.

Flake tools were made either from chips resulting from the manufacture of hand axes or from flakes deliberately struck from cores. They were either used as struck off, or, more often, rechipped to form points, scrapers, perforators, etc. The cores themselves were at times subject to only a minimum of preparation before the flakes were detached, while at other times they were carefully prepared to permit the removal of flakes of a predetermined shape. When raw material was available in large blocks, only a minimum of preparation was necessary to detach a series of flakes destined to be rechipped into the desired tool type.

Blade tools, as the name implies, were made from elongated, narrow flakes struck from rectangular, pyramidal or conical cores and then retouched into specialized tool types, such as scrapers, knives, perforators, gravers and projectile points.

Classification by Type.—The study of stone-tool industries necessitates a classification by type and the use of a terminology which is clearly understood. The following list includes the principal types, but limited space imposes simplification. Certain terms are conventional and do not necessarily denote an actual use. "Points" may have been used as knives and "knives" may have been used as points.

Pebble Tools.—This type abounds in Africa and Asia, and in quite advanced stages as well as in the earliest. They consist of roughly chipped pebbles and their flakes, and are sometimes referred to as choppers and chopping tools. In Burma fossil wood was used, and in Java silicified tuff. In Africa quartz and quartzite pebbles were often employed.



(B, H, K AND R) BY COURTESY OF MUSÉE DE L'HOMME; OTHERS FROM COLLECTION OF HARPER KELLEY

Fig. 2.—(A) End scraper on utilized blade, Upper Paleolithic; (B) end scraper on flake, Middle or Upper Paleolithic; (C) keeled scraper, Upper Paleolithic; (D) round scraper, Upper Paleolithic or Neolithic; (E) thumbnail scraper, Mesolithic; (F), (G), (H) awls, Upper Paleolithic; (I), (J) gravers, Upper Paleolithic; (K) tanged point on retouched flake, Aterian, north Africa; (L) knife, flake with blunted back, Middle Paleolithic; (M) blunted-back blade, "Chatelperron" point, Upper Paleolithic; (N) blunted-back blade, "Gravette" point, Upper Paleolithic; (O) tanged point, "Font-Robert" point, Upper Paleolithic; (P) shouldered point, Upper Paleolithic; (Q) laurel-leaf point, Upper Paleolithic; (R) microliths of geometric forms, Mesolithic; (S) tanged and winged arrowhead, Neolithic; (T) ax made by pecking and polishing, Neolithic

Hand Axes.—The type tool of the Lower Paleolithic may be oval, heart-shaped or pointed. Many variations of the general types occur, as well as any number of intermediate forms. With only slight differences because of the materials employed, the same types are found in many old world regions. In western Europe, south of the glaciated areas, hand axes are often present in great numbers. In Britain and northern France, flint predominates with some use of chert (a flintlike quartz) and sandstone. In southern France and Spain, quartzites were used owing to the absence of flint in large blocks. In Africa, except for a few regions, quartzites, quartz, sandstones and various volcanic rocks were used, and the hand axes were often made from large flakes. In east Africa, obsidian, usually employed for flake or blade tools elsewhere, was used occasionally for making hand axes. The tradition extended into India, and to some extent into Java, whenever the local stone material was of sufficient size and quality.

Cleavers.—A component of hand-ax industries, these are characterized by a sharp, straight cutting edge, sometimes oblique, at the extremity. They are particularly common in Africa, because large flakes are easily converted into this rather special form. The finished product presents a sharp and resistant working edge. Bifacial or semibifacial trimming was used in shaping them. In western Europe, cleavers follow the hand-ax tradition, being mostly made from nodules of flint.

Scrapers.—The most common of all tool types is found in various forms in all industries. It is a flake or blade, with the extremity or the side retouched, often in a convex working surface. End scrapers were made on the end of a flake or blade of any thickness; side scrapers on the side of a flake; core scrapers were made on small blocks or were actual cores reutilized as scrapers. Keeled scrapers present a systematic and symmetric removal of tiny blades to form a thick, fluted scraper extremity. Round scrapers are present in later cultures; very small ones are referred to as "thumbnail" scrapers.

Points.—These are either flakes or blades retouched to form a pointed tool, or in some cases perfect triangular points struck from a core specially prepared to allow the removal of a point requiring no further trimming. The earliest points were flakes shaped into a point by retouch on one or both edges. In north Africa pointed flakes of one stage also have a central tang, or extension, for hafting. Points made on blades were often pointed by perpendicular retouch (called blunting), as well as by flatter retouch. Blunted-back blades are found in several Upper Paleolithic stages. Pointed blades with a central tang exist, as well as shouldered points (*pointes à cran*), which have a lateral notch at the base for hafting. The finest workmanship produced the famous laurel- and willow-leaf points, thin bifacially symmetrical leaf-shaped points. In the Neolithic, arrowheads of various types exist: triangular, concave base, tanged, leaf-shaped, etc.

Gravers.—This is another type (*burin* in French) found in great numbers and used for working bone and antler, and for engraving. Both flakes and blades were used in their manufacture, which consisted of the removal of a small blade or series of small blades obliquely from the extremity of the piece to form a narrow chisel edge. A great many different types are found and a few specialized forms characterize certain industries.

Knives.—Flakes and blades were sometimes utilized as knives, usually with the cutting edge unretouched and the opposite edge either occupied by the cortex or blunted by perpendicular trimming.

Awls.—These are flakes or blades with an extremity retouched to form a perforating tool. Awls may be fairly thick for heavy work or very narrow and elongated for delicate work.

Composite Tools.—The above types often appear as two-purpose tools, with various combinations such as double-end scraper, scraper-graver, scraper-awl and awl-graver.

Microliths.—Tools of very small dimensions appear in the Upper Paleolithic in the form of tiny blunted-back blades. Microliths are characteristic of the Mesolithic and are of regular geometrical forms: triangles, trapezes and lunates. They are probably elements of composite tools, fixed in shafts or handles.

Axes.—Often referred to as "celts," axes are common in the Neolithic. Both chipped and polished kinds are found and a wide variety of types includes adzes and perforated axes (battle-axes). Perforated mace heads also exist. (H. Ke.)

NEW WORLD

Comparison With the Old World.—All the basic techniques by which primitive man in the old world fashioned stone artifacts —percussion chipping, pressure chipping, pecking, grinding, polishing and carving—were also common in the new world. Accordingly, most of the terminology employed above for the old world is applicable for the new, although a few specialized methods in each hemisphere were rare or absent in the other. Likewise, inferred functions of stone artifacts, though often merely guesses, are similar.

In the new world, obsidian was used only rarely until the last few thousand years, probably because its brittleness required advanced control of chipping techniques. Otherwise, as in the old world, chipped implements were usually made of quartzites and various siliceous rocks such as flints, cherts and jaspers. Implements for food grinding, usually shaped by pecking with a hard, sharp rock, were made from relatively coarse-grained material such as limestone, sandstone, granite or basalt according to what was available. Objects to be carved or polished were made from similar rocks or from various fine-grained materials.

The main distinctions between the old and new worlds, there-

fore, were not so much in materials, techniques or inferred functions as in the length of existence and extent of geographical distribution of the specific forms of stone artifacts. In the old world, for example, it is well established that a Lower Paleolithic culture, characterized by multitudes of crude percussion-chipped "fist axes" (or hand axes) and pebble tools (or choppers), existed for hundreds of thousands of years over immense areas in Europe, Africa and southern Asia. By contrast, in the new world identical implements are found in scattered areas but their significance is only poorly understood. Thus, in central Texas and southern California, fist axes and pebble choppers are known to occur as minor elements in postglacial cultures no more than 7,000 years old. In parts of Michigan, Wyoming, California and Mexico there is some evidence that such simple tools may belong to considerably older culture levels; *i.e.*, to Late Pleistocene (glacial) times. Similarly, such old world implements as burins and microflints occur in widely scattered parts of the new world; but in this case they appear to fall into postglacial times rather consistently.

Radiocarbon datings of greater than 37,000 years (*i.e.*, beyond the range of determination in the laboratories involved) have been obtained on charcoal from hearths of apparently human origin in Texas and California. Strangely, these localities have so far revealed only flakes, scrapers and hammerstones which, in themselves, are too common and too long-lived to be indicative of any particular age.

Lack of a consistent set of terms for new world archaeological stages has hampered discussion of the time position of various types of stone artifacts. The postglacial period or Holocene covers the last 7,000 years if judged by the final extinction of characteristic mammals of the Pleistocene, or the last 11,000 years, approximately, if judged by the rapid rise in sea level that resulted from the melting of the great ice sheets. Cultural material associated with now-extinct Pleistocene mammals up to about 10,000 years ago has been called the Paleo-Indian, Paleo-American or Lithic stage. A more complex Archaic stage began between 9,000 and 10,000 years ago and in some regions persisted until modern times; in others it was succeeded by further advancements such as agriculture and/or pottery making. The latter traits mark a Neo-Indian, Neo-American or formative stage beginning about 4,000 years ago in some regions, later in others. A fourth stage, the Historic, corresponds in general with European explorations and settlements after A.D. 1492.

Types of Artifacts.—*Pebble Tools or Choppers.*—These were made by breaking smooth stream pebbles across, then percussion chipping the broken end into a cutting edge. The unbroken, rounded end fits conveniently into the palm. They occur sporadically in North America in the Paleo-American and Archaic stages.

Core Tools or Fist Axes.—These were also made from stream pebbles or from very large flakes but were fashioned over both faces by percussion chipping. They occur in the western United States, Texas, Mexico and very widely in South America in the Paleo-American and Archaic stages. In Oklahoma and Arkansas a later, special form occurs which is double bitted and which was probably hafted around the constricted middle.

Knives.—Common in all stages, these were made in a variety

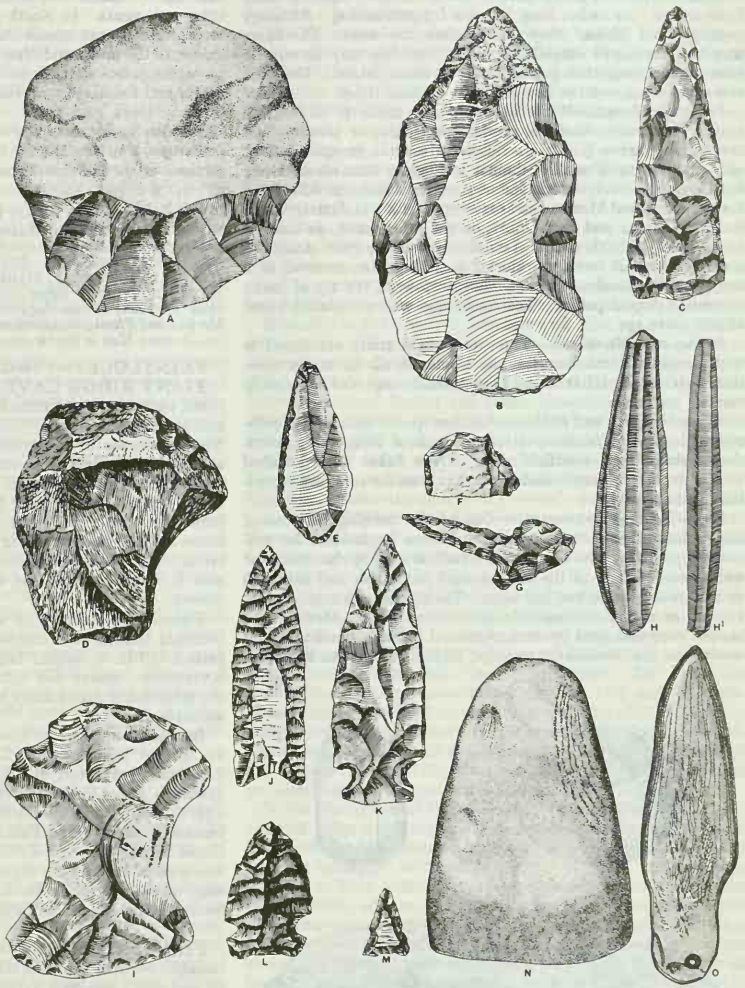


FIG. 3.—NEW WORLD FLINT AND OTHER STONE TOOLS

(A) Pebble tool or chopper, Paleo-American; (B) core tool or ax, Paleo-American and Archaic; (C) knife, Paleo-American to Historic; (D) plano-convex scraper, Paleo-American to Historic; (E) flake scraper with retouched edges, Paleo-American to Historic; (F) graver, from end of Paleo-American to Historic; (G) awl or "drill," Archaic to Historic; (H–H') obsidian core with detached prismatic flake, central Mexico, Archaic to Historic; (I) chipped double-bitted ax, Oklahoma and Arkansas, Neo-American; (J) fluted spear point, Clovis type, Paleo-American; (K) corner-notched spear point, Archaic to Historic; (L) side-notched atlatl or dart point, Archaic to Historic; (M) side-notched arrow point, Neo-American to Historic; (N) ungrooved polished ax or "celt," Neo-American to Historic; (O) projectile point of ground slate, Eskimo, Neo-American to Historic

of shapes from large flakes, well shaped and thinned by percussion chipping, often followed by pressure retouching.

Scrapers.—By definition, these are unifacially-worked or plano-convex cutting implements. When a flake of whatever size was detached from a pebble or core, one smooth face was left unworked while the opposite face was shaped in varying degrees by percussion and/or pressure chipping. The resulting scrapers may be irregular in shape, oval, circular, turtleback, thumbnail, etc., or they may be thin flakes with retouching on one face. Many forms occur throughout America in all time levels.

Gravers.—These are usually small flakes, unshaped except for one or more tiny, sharp projections formed by pressure chipping. They occur widely.

Drills.—These artifacts have a thick, narrow, tapering shaft from one to four inches long, suitable for perforating. Although usually called "drills," they seldom show any wear. The bases may be irregular or shaped like a "T"; or they may be remade from broken projectile points with the stems intact They are common throughout the new world in Archaic times.

Projectile Points.—While attempts are made to distinguish knives from points used on spears, atlatl darts or javelins, and arrows, only arrow points are relatively easy to recognize. Not only are they much smaller, thinner and lighter than other classes but they appear very late in the new world: about A.D. 400 in the United States and Mexico and as late as A.D. 1200 in Andean South America. Spear and dart points, on the other hand, go back at least 12,000 to 15,000 years. A notable trait of the Paleo-American stage is a special technique known as fluting; *i.e.*, removal of a large flake longitudinally from the base toward the tip of many lanceolate-shaped points. This technique was abandoned about 10,000 years ago.

Burins and Microliths.—These old world traits are found in some areas in North America, the former in all the stages mentioned above, the latter in the Late Archaic stage and some early ceramic cultures.

Prismatic Cores and Flakes.—Another special trait, found principally in central Mexico, is the removal of long, thin, prism-shaped flakes from obsidian cores. These flakes were detached with such perfectly controlled blows that even the cores are beautifully symmetrical.

Food-Grinding Implements.—One of the defining features of the Archaic stage is the appearance of stone implements for pulverizing various plant foods. The earliest and by far the most widespread of these is the milling stone, a flattish slab in which an oval basin was pecked and worn. The motion was rotary, using a mano or muller conveniently held in one hand. Mortars and pestles were also used by nonagricultural peoples, but less extensively. In the Neo-American stage, metates of various kinds appeared in connection with grinding maize. These were flat on top or troughed, and the grinding motion was back and forth, using a mano of either one-hand or two-hand size. In Central America they often had three legs or were carved into animal effigies. All these implements were commonly shaped by pecking, then automatically smoothed on their work surfaces.

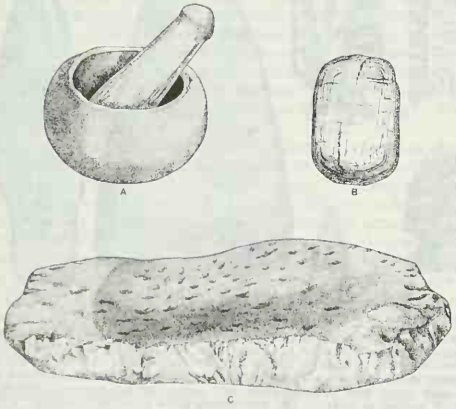


FIG. 4.—STONE TOOLS FROM ARCHAIC THROUGH HISTORIC PERIODS
(A) Mortar and pestle; (B) mano or muller; (C) milling stone

Stone Bowls and Lamps.—Stone bowls, probably for cooking and storage rather than food grinding, were made in some areas in Late Archaic times. Stone lamps were made by Eskimos. In most cases steatite was used and shaped by carving.

Miscellaneous.—In the Late Archaic and Neo-American stages, a great variety of artifacts was shaped by pecking and finished by polishing. Those of greatest distribution were grooved axes, celts, adz blades, tubular and discoidal beads, pendants, earspools and other ornaments. In North America atlatl weights such as boat stones and banner stones, tubular pipes and elbow pipes were made; in the arctic and New York state, ground-slate knives and projectile points were made. Plummet stones were made in California and Louisiana, and effigies of man and animals were made in many areas.

See also ARCHAEOLOGY: *Prehistory; Neolithic and Bronze Ages in Europe; The New World: Early Man.* *See* also the *Archaeology* sections of the individual continent and country articles.

(A. D. KR.)

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FLINTLOCK: *see* SMALL ARMS, MILITARY.

FLINT RIDGE CAVE SYSTEM, in Mammoth Cave National park (*q.v.*) in Kentucky, is an integrated complex of caves and underground rivers. Thirty-five miles of passages are known. The integration of the system has been established by surveys and exploration and by an extensive series of dye tests conducted on the underground drainage. Flint Ridge is an erosional plateau of ten square miles, capped by layers of resistant sandstone and impervious shale and underlain by 275 ft. of relatively pure limestones, all bedrock being of Middle Mississippian (Carboniferous) Age. This unique stratigraphic sequence in a karst (*q.v.*) area is responsible for the unusual characteristics of this cave system.

Especially prominent, in addition to its great length, are the localized abundance of distinctive vertical shafts, many of which exceed 150 ft. in height; fantastic and extensive sulfate mineral decorations; sparse but attractive stalacto-stalagmite displays; the magnificent size of many of the cave passages; and archaeologic artifacts.

Individual caves which have played a part in the region's colourful history include Salts, Colossal, Unknown, Floyd's, Potato, Logsdon, Great Onyx and Blair. The hub and gateway of the system is Floyd Collins' Crystal cave, named after its discoverer (1917) who also lost his life there (1925) trying to find a new entrance, and its Blind Fish river which issues as Pike spring on Green river (the base-leveling surface stream of the region), where all of the affected drainage converges. Much of the knowledge of this system is due to the efforts of attack teams of the National Speleological society and the Cave Research foundation.

(E. R. P.)

FLINTSHIRE (SIR FFLINT), a county of north Wales, is bounded north by the Irish sea and the Dee estuary, east by Cheshire and south and west by Denbighshire. Included in Flintshire, which has an area of 255.2 sq.mi., are the detached parish of Marford and Hoseley, lying 2½ mi. S.E. of the main part of the county, and the hundred of Maelor, a separate rural district, lying 8 mi. S.E. of the main part.

Physical Features.—The county is dominated by the Clwydian hills running south-southeast to north-northwest. Their western slope to the Vale of Clwyd is steep but the eastern slope over

much of the county to the Vale of Dee is more gentle. The Clwydian hills are entirely of Silurian Age; their highest point is Moel Fammau (1,820 ft.) on the Flint-Denbighshire boundary. The Silurian strata of the hills, all of Ludlow Age, are faulted against the Triassic (Bunter) Red beds in the Vale of Clwyd. On the eastern flank of the range the Silurian is overlaid by Carboniferous rocks which, for their economic value, are the most important rocks in the county. A band of Carboniferous Limestone passes from Prestatyn on the coast, forms the Halkyn mountain (943 ft.) and continues west of Mold to beyond the county boundary. Above these beds come the Holywell Shales while upon them lies the Gwespyr Sandstone. Farther to the east the Coal Measures extend from Talacre through Flint and Mold to Hope. A purple sandstone succeeds the Carboniferous Limestone in the neighbourhood of St. Asaph.

The Alyn enters the county near Moel Fammau and passes Cilcen and Mold with a section of underground drainage in the Carboniferous Limestone near Hesb-Alyn ("the drying up of Alyn") and bends south to Caergwrle, re-enters Denbighshire and joins the Dee. The Dee enters Flintshire near Overton and divides Maelor from Denbigh on the west, then passes Chester and forms the eastern boundary of the county on the northeast. It enters the Irish sea by means of a wide but shallow estuary. The north-eastern part of Flintshire is a low-lying country bordering the Dee estuary which extends westward to the mouth of the Clwyd valley. This has been one of the great "ways" into Wales for many centuries. Short stretches of blown sand occur between Rhyl and Talacre. The climate is colder than that of neighbouring counties but the northern coastal strip has a low rainfall. The valleys of the Alyn and the Clwyd are rich agricultural land. The hills which were formerly open moorland are now being planted in part by the forestry commission.

Archaeology and History.—Flintshire has a notable number of prehistoric sites, as well as medieval castles and sites connected with early industries. Caves in the Lower Carboniferous rocks bordering the Vale of Clwyd have yielded plentiful remains of Pleistocene mammals, particularly Cae Gwyn and Ffynnon Beuno near Tremeirchion and the Gop cave, Newmarket, or Trelawnyd. Microliths found in the Gop cave suggest Mesolithic occupation and a Mesolithic site has also been recorded near the coast at Prestatyn. Few traces of Megalithic influence survive in the county. Neolithic occupation has been proved at Dyserth and Gwaenysgor in the north near the coast, and the Gop cave was used in Neolithic times for burial and shelter. The later Bronze Age was obviously an important time in the county's prehistory. Barrows are numerous especially on the Halkyn-Brynford plateau. Sir Cyril Fox's excavation of the earth circle and barrow at Lower Stables farm in a distant part of Ysceifiog parish is a notable piece of work, and a barrow containing concentric stone circles and cairns with a food-vessel burial has been excavated at Pant-y-Dulath in Tremeirchion parish. A gold ceremonial cope or tippet, now in the British museum, London, was found at Mold in 1823. About the same time a gold torque was found somewhere in the parishes of Caerwys or Ysceifiog, and a gold hoard just over the county boundary at Maesmaenan or Maes Mynan. The Caergwrle cup, in the National Museum of Wales, is probably of this period. A jet necklace of unusual type appeared in a barrow at Llong. The impressive hill forts on the Clwyd range have yielded finds of Roman coins.

A Celtic tribe known as the Deceangli held what is modern Flintshire as their territory. They were overrun by the Romans in an early campaign and the great legionary fortress at Chester must have kept them in subjection. Considering the nearness of Chester, the scarcity of Roman remains in Flintshire is a mystery. Some of the land may have been densely forested and uninhabitable. There were Roman smeltingworks at Flint and pigs of lead have been found marked "Deceangl," an ancient tribal area that was later called Tegeingl in Welsh. A Roman bathhouse of legionary type has been found at Prestatyn and the important and ancient Talargoch lead mines are nearby.

The post-Roman centuries saw Flintshire under the influence of the Celtic saints, the Saxons and the Northmen. St. Beuno, who has been called the St. David of the north, is commemorated by legends in Flintshire. The lives of St. Kentigern (*q.v.*) ascribe to him the foundation of the monastery of St. Asaph (*q.v.*), later the cathedral city of the diocese. One of the few relics of ancient Christianity in the county is a late sculptured cross, Maen Achwyfan, in Whitford parish. The Anglo-Saxon occupation of the more fertile low-lying part of the county left its mark on place names as far north as Prestatyn. The famous earthwork, Offa's dyke, a poor defensive work with a gap of more than 20 mi. between Pantasaph and Treuddyn, is backed by the shorter and better-preserved Watt's dyke, which begins near Holywell and runs out of the county beyond Hope. Sir Cyril Fox in his standard work (*Offa's Dyke*, 1955) shows that the dykes start 12 mi. apart at Prestatyn and Holywell and that the lines almost converge at a point outside the county.

The Normans at first found north Wales an easy prey. A great castle and a borough were built at Rhuddlan. The twin lordship of Mold and Hawarden became the prize of the Montalt family who had castles at both places. Flintshire was the natural route into north Wales and for 200 years, as Welsh resistance stiffened, war in the county was almost unceasing. The earls palatine of Chester fought many of the early battles. Henry II suffered a decisive check (1156) in the forest of Ewloe. Henry III relied greatly on his favourite castle at Dyserth and struggled to defend it in a long war and through many truces. Edward I finally built a great castle and a borough at Rhuddlan on a new site, and a castle and bastide at Flint, and achieved a final conquest in 1284. The Welsh had revived notably under Owain Gwynedd and the two Llewelyns (*see* LLEWELYN), and the result of this 100 years of fighting was that Welsh influence penetrated almost to the walls of Chester.

Edward I in 1284 formed the county of Flint out of the northern cantred of Tegeingl, taken from the Welsh principality of Gwynedd; the hundred of Maelor, taken from the dowager of the Welsh princely line of Powys Fadog; and Hope and Hopedale, anciently part of Powys and taken immediately from the last Welsh prince, David. The county was in three detached portions. When Henry VIII suppressed the lordships of the march, in the acts of union (1536–42) he gave Moldsdale and Hawarden to Flintshire and so joined the cantred of Tegeingl to the land of Hopedale, leaving the county in two main portions, as it is still.

In the Civil War (1642–52), Flintshire was solidly royalist and the castles, Hawarden, Flint and Rhuddlan, were garrisoned again to protect the communications between Chester and north Wales and Ireland. After the fall of Chester, the castles surrendered slowly and were slighted (dismantled) by order of parliament.

The county contains two medieval religious houses—Basingwerk abbey, near Holywell, a Cistercian house founded about 1131, and Rhuddlan priory (*c.* 1258), a house of Dominicans which was later incorporated into Plas Newydd farmhouse. The rise of the great Welsh religious denominations in the 18th and 19th centuries caused a profound change in the social life of Wales. Flintshire had early associations with Puritanism. Calvinistic Methodism did not flourish so well as in other parts of north Wales, though the western section of the county was much affected. Holywell has always been a Roman Catholic centre.

In the second half of the 19th century Daniel Owen (1836–95) of Mold wrote a number of Welsh novels depicting the life of his times and earned a permanent place in Welsh letters. The county has been influenced in its architecture as in its life as much from England as from Wales. In addition to the notable Edwardian castles—Flint, with an unusual plan, and Rhuddlan—there is the interesting castle of Ewloe, built by Welsh princes in imitation of Norman work. In the 16th and 17th centuries a large number of country houses, such as Fferm, Gwysaney, Rhual, Golden Grove, Plas Teg, Vaenol, witness to the county's prosperity, and in the 18th century Leeswood hall was built from the profits of lead mining. The most elaborate church is perhaps the old Perpendicular church of St. Mary in Mold, built by the Stanleys in Cheshire style.

Population and Administration.—The population of Flintshire (1961) was 149,888. The largest towns are: Rhyl (21,825); Flint (13,690); Prestatyn (9,360); Holywell (8,459); Connah's

Quay (7,850); Buckley (7,699); Mold (6,857).

Flintshire is divided into four rural districts, six urban districts and the municipal borough of Flint. Between the census of 1931 and that of 1961 the population of the county increased by 36,828 chiefly because of industrial development. Flintshire is within the Wales and Chester circuit and the assizes are held at Mold, the county town; there is one commission of the peace. Considerable interest is taken in technical and agricultural education, the county council having provided a modern and extensive technical college and a horticultural college. The main part of the county is in the diocese of St. Asaph but there is a small portion in that of Chester. The county returns two members to parliament, for East and West Flint.

Agriculture, Industries and Communications.—The Vale of Clwyd is well known for its pasture lands. Much of the land in the county is under crops and grass. Oats, mixed corn and wheat are the chief crops. Milk production is the main enterprise while pigs and poultry contribute materially to the farming economy. There is a high livestock density, Friesians being a leading breed followed by Ayrshires and Shorthorns. Early lamb production is significant, Welsh ewes being crossed with Border Leicester and Down rams.

Rich mineral deposits have been known from early times as the Romans mined lead in Flintshire and later copper and lead were worked. Throughout the 19th and early 20th centuries a considerable quantity of coal was mined and there are still coal mines in the county. Copper and lead are no longer worked. In the first half of the 19th century large industries sprang up and there was a substantial increase in the county's population and prosperity. The principal manufacturing industries include iron and steel, rayon, aircraft, chemicals, papermaking, woolen textiles, cement, brickmaking and quarrying in its various forms. Steel, especially steel sheet, is produced on a large scale on Deeside. There are large ironworks producing mainly a manganese alloy of iron. In the Flint area are some of the largest rayon plants in Europe manufacturing rayon staple fibre by the viscose process, with distribution to Lancashire, Yorkshire and abroad. Rhyl and Prestatyn are popular seaside resorts on the north coast.

The Chester-Holyhead main railway line runs along the east and north coasts of the county and a branch line from Chester to Mold serves the central area. There is an excellent bus service over the whole county.

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FLOCK, in the textile industry, is a word describing several types of waste materials used for flock printing: (1) woolen or cotton waste, old rags, etc., reduced to a degree of fineness by machinery (used also for stuffing); (2) very short fibrous particles of wool, rayon, cotton, etc., chiefly those obtained from shearing pile fabrics, napped goods, etc.; (3) rayon flock obtained from rayon staple or tow, as well as from the wastes mentioned above. Flock cellulose is the impalpable powder of cellulose used for flocking purposes as well as for filler for molding powders.

Flock printing is the application of these wastes, by means of an adhesive, to fabrics to give the impression of small embroidery work or to letter fabric (as a college pennant). Since any cloth may be flocked and the method is very inexpensive, flocking caused a great decline in the use of fabrics woven by the once-popular lappet, swivel and clipspot methods. Flocking also includes solid effects applied to materials, including attractive suede effects. (G. E. L.)

FLODDEN, BATTLE OF, English victory over the Scots fought near Branxton, Northumberland, on Sept. 9, 1513. To divert troops from the main English army, then in France under King Henry VIII, James IV of Scotland crossed the border (Aug. 22) with an army of about 30,000 men supported by artillery and captured the castles of Norham and Ford. Thomas Howard, earl of Surrey, lieutenant in the north, gathered an army of about 20,000 men—mostly infantry, including 500 regulars of his own retinue, but with some archers under Sir Edward Stanley; a mounted contingent under Lord Dacre; 1,000 soldiers and sailors led by his son, Lord Thomas Howard, admiral of England; and the gunners manning the royal ordnance. Forced by shortage of supplies to provoke a speedy engagement, Surrey challenged James, who agreed to wait for him until noon on Friday Sept. 9. Surrey reached Wooler Haugh (Sept. 6) and the Scots took up a strong position on Flodden edge, facing south, disregarding a second challenge to fight on Milfield plain. On the morning of Sept. 9 Surrey marched northward around the enemy's east flank, crossed the river Till and turned south to attack the Scots from the rear. James perhaps believed that Surrey would not attack after the hour appointed and that he was making for Berwick or the Merse, but hearing of the southward turn he changed front and drew up his army on Branxton hill, facing north. The battle began between 4 and 5 P.M. James neglected an initial opportunity of overwhelming the English vanguard. The rear guard then came up, and the more mobile English guns silenced the Scottish artillery, forcing James to advance downhill. But his spearmen lost their close formation, and in the subsequent melee the English 8-ft. bill (a staff ending in a hook-shaped blade) proved superior to the Scottish 15-ft. spear. The Scottish left wing, although at first successful, was driven back by Dacre's horsemen; the next Scottish division was vanquished by the admiral's men, who then attacked the exposed flank of James's corps, already engaged with Surrey's command. The Scots fought dourly—James fell only a spear's length from Surrey—but Stanley's archers drove in the Scottish right and decided the battle. By nightfall the remnants of the shattered army had been destroyed, and Scotland had lost its king with at least 10,000 of his subjects, including high officers of church and state and many nobles.

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FLODOARD (893 or 894–966), Frankish priest and chronicler whose works provide some essential information on a sparsely documented period, was born probably at Épernay and was educated at the cathedral school of Reims. After his ordination he was appointed to a parish by Archbishop Hervé (Herivaeus; d. 922) and enjoyed his confidence and that of his successor, Seulfus (d. 925). He visited Rome (936–937) and was received by Pope Leo VII. He subsequently became deeply involved in the disputes between Herbert, count of Vermandois, who sought to install his son Hugh as archbishop, and Artold, Flodoard's patron and the candidate of the French king Rudolph. For several months in 940–941, when Hugh had the upper hand over Artold, Flodoard was deprived of his benefice and imprisoned. He later became a canon of Reims but failed in an attempt (951) to become bishop of Noyon. He died on March 28 or May 17, 966.

Flodoard at various times had custody of the archiepiscopal archives at Reims, and his *Historia Remensis ecclesiae* is an abstract of their most important contents. It reproduces documents especially vital for the history of the 8th and 9th centuries, including a long catalogue of the letters of Archbishop Hincmar. Flodoard's *Annales*, covering the years 919–966, likewise shed an important light on certain aspects of those rather obscure times. His poems in honour of various saints bear impressive witness to the standard of scholarship and Latin grammar still maintained in the Reims school. Flodoard's complete works are printed by J. P. Migne, *Patrologia latina*, vol. cxxxv (1853). There is an edition of the *Annales* by P. Lauer (1905). (J. De.)

FLOGGING was for a long time one of the most common methods of punishing criminals and of preserving discipline in the home, school, armed forces and prisons. In the Mosaic code flogging was a punishment for crime. Slaves were frequently flogged to death when they were sufficiently numerous to be of little value, but the flogging of Negro slaves in the southern states before the

American Civil War was exaggerated in abolitionist literature: the fact was that these slaves were too valuable to have their efficiency reduced by severe punishment. Both soldiers and sailors received many lashes for their offenses, the latter being flogged at the mast or through the fleet, receiving a stipulated number of lashes on each ship. During the 19th century imprisonment gradually took the place of corporal penalties as a punishment for crime. The courts, however, retained the power of sentencing a prisoner to be whipped when convicted of crimes of violence. The situation was greatly changed in England, Scotland and Wales by the Criminal Justice act of 1948, by which the courts were deprived of the power to sentence a person to a whipping in most cases. However, except in Scotland, the power to inflict corporal punishment was retained in cases of mutiny, incitement to mutiny and gross personal violence to an officer of a prison when committed by a male person.

In the second half of the 20th century the flogging of certain criminals was still prescribed by law in Great Britain, Canada, some continental and Asiatic countries and in the state of Delaware in the United States, where public whippings might be administered at the discretion of the court for 25 different crimes. In 1953 Maryland repealed its law which had prescribed corporal punishment for wife beaters.

The instruments and methods of flogging have varied. In maintaining discipline in the home and school, sticks, rods, straps, whips and other objects are used. Elsewhere the lash has been widely used, usually with ingenious refinements and elaborations. One of the most brutal of these is the cat-o'-nine-tails. This is constructed of nine knotted cords or thongs of rawhide attached to a handle. Even more effective in producing pain and ultimately death is the Russian knout. This is an instrument consisting of a number of dried and hardened thongs of rawhide interwoven with wire, the wires often being hooked and sharpened so that they tear the flesh.

A particularly painful, though not so deadly, type of flogging is the oriental bastinado, or blows delivered on the soles of the feet with a light rod or knotted cord or lash. Flogging was formerly executed with great brutality. The backs of the condemned were frequently lacerated and salt was poured into the wounds to increase the pain. *See* also TORTURE; FLAGELLATION.

(H. E. BAR.; P. E. L.; R. G. CL.)

FLOOD, HENRY (1732–1791), Irish statesman and orator, whose early leadership of opposition to the English government did much to achieve legislative independence for Ireland in 1782. Henry was the illegitimate son of Warden Flood, chief justice of the king's bench in Ireland. He was educated at Trinity college, Dublin, and Christ Church, Oxford, and entered the Irish parliament as member for Kilkenny in 1759, becoming member for Callan in 1760.

Flood soon showed his parliamentary skill and managed to create a small but effective opposition inside parliament and to arouse public opinion in favour of reform in the country. He quickly evolved a program of reform, demanding shorter parliaments, the reduction of the pension list and the creation of a constitutional militia and an independent Irish legislature. In 1767 there was a change in the Irish government. Previously the viceroy had generally governed through "undertakers"—owners of parliamentary boroughs who ensured a government majority in the house of commons by distribution of crown patronage. But Lord Townshend, who was appointed viceroy in 1767, determined to take personal control of the government and to make some concessions to Irish opinion. The change was shown when an octennial bill, advocated by Flood, which limited the duration of parliament to eight years, was forced on the English government in 1768.

The strength of the new parliamentary opposition led by Flood was demonstrated when a new parliament met in 1769. A money bill sent by the English privy council for ratification in the Irish parliament was rejected, although the Irish house demonstrated its loyalty by voting unusually large supplies. Townshend immediately prorogued parliament and in the next 14 months spared no effort to win a government majority by the liberal use of patronage. He failed. When parliament met in Feb. 1771 Flood's impassioned opposition nearly secured the defeat of the customary congratulatory address to the viceroy and on Flood's motion the money bill was thrown out without a division. Lord Townshend could do nothing and he was recalled in 1772. Flood and his friends published in 1773 *Baratariana*, a work inspired by this struggle, with Flood himself contributing a series of letters in the style of Junius.

Flood had now reached a position as an independent Irish statesman that had never before been attained. By his oratory and parliamentary tactics he had overcome the strength of the government's influence to arouse a real spirit of independence in parliament, the parliamentary boroughs and the country. Lord Harcourt, who succeeded Townshend as viceroy, realized the importance of Flood to the opposition and determined to conciliate him. In 1775 he offered Flood the post of vice-treasurer, with a salary of £3,500 a year, and Flood, who had always believed reform could only be achieved constitutionally with the support of the government, accepted. In doing so he lost the position of undisputed leadership of the opposition which he had gained; he was largely replaced by Henry Grattan (*q.v.*), who entered parliament in the session during which Flood became a minister.

Flood continued in office for nearly seven years. During this period he necessarily remained silent on the subject of the independence of the Irish parliament. But events in Ireland gradually made his position untenable. In 1778 the creation of a volunteer force to defend Ireland against a possible invasion by France, which had become the ally of the American colonies, then in revolt, changed the Irish situation. A volunteer convention, formed with all the regular organization of a representative assembly but wielding the power of an army, began menacingly to demand the removal of the commercial restrictions that were destroying Irish prosperity. The government was forced to give way; the whole colonial trade was in 1779 thrown open to Ireland for the first time and other concessions were also extorted. Flood now abandoned his office to rejoin his old party but he was not officially dismissed until 1781. He found to his chagrin that he was eclipsed by Grattan. But though Flood had lost control of the movement for independence of the Irish parliament, the agitation, backed as it now was by the volunteer convention and by increasing signs of popular disaffection, led at last in 1782 to the concession of the demand, together with a number of other important reforms.

Flood regained prominence over the question that arose after independence had been gained, known as the Simple Repeal controversy, as to whether England, in addition to the repeal of the acts on which the subordination of the Irish parliament had been based, should not be required expressly to renounce for the future all claim to control Irish legislation. This dispute led to the rupture of friendship between Flood and Grattan, each of whom assailed the other with unmeasured but eloquent invective in the house of commons. Flood's view prevailed—for a renunciation act such as he advocated was ungrudgingly passed by the English parliament in 1783—and for a time he regained popularity at the expense of his rival. His determination to force the issue with the English government was widely regarded as being motivated by the desire to regain personal influence. In the struggle between the volunteers and the parliament, he supported the volunteers. In Nov. 1783 he introduced a reform bill, after first submitting it to the volunteer convention. The house of commons refused leave to introduce the bill, which contained no provision for giving the franchise to Roman Catholics—a proposal Flood always opposed—ostensibly on the ground that the attitude of the volunteers threatened the freedom of parliament. It was finally introduced, and rejected, in March 1784.

In 1783 Flood purchased a seat for Winchester in the English house of commons from the duke of Chandos, and for the next seven years he was a member at the same time of both the English and Irish parliaments. He remained a firm opponent of Roman Catholic emancipation, even defending the penal laws on the ground that after the revolution they "were not laws of persecution but of political necessity"; but after 1786 he does not appear to have attended the parliament in Dublin. In the house at Westminster, where he refused to enroll himself as a member of either

political party, he disappointed the expectations aroused by his achievements in Dublin. At the dissolution in 1790 he lost his seat in both parliaments and he then retired to Farmley, his residence in County Kilkenny, where he died on Dec. 2, 1791.

See Warden Flood, *Memoirs of Henry Flood* (1838); W. E. H. Lecky, *Leaders of Public Opinion in Ireland,* vol. i (1903).

FLOOD, the rise of the waters of a natural stream above a level associated with the beginning of damage. Damage stage is usually reached when the stream is bank full; that is, when the channel is completely occupied. Beyond this, overflow of the flood plain (*q.v.*) is reached. Flood plains range from a narrow marginal width in the confined, steeply sloped valley of mountainous country to one extending many miles from the river channel.

Four thousand years of recorded history tell of man's repeated failure to evade the destructiveness of floods. The fertile valleys of the Yangtze and Yellow rivers in China have lured him back after each disastrous flood, only to drive him forth again as these rivers rechart their courses in unstable alluvial plains which to this day have defied man-made controls. In striking contrast, the floods of the Nile have been turned to a decided advantage. For thousands of years its orderly and controlled rise and fall have provided fertility and moisture for the fields within its flood plain. (*See* also NILE: *Hydrology.*)

Excessive rains caused floods of great damage in Paris in 1658 and 1910, Warsaw in 1861 and 1934, Frankfurt am Main in 1854 and 1930, and Rome in 1530 and 1557. The Darling river in Australia was reported to have flooded extensive areas in 1864 and 1886. In 1927 monsoon rains swelled the rivers throughout India to such extent that enormous property damage resulted. In 1099 a storm tide flooded the coasts of England and the Netherlands causing 100,000 deaths. In early 1953 disastrous storm tides flooded the coasts of England, the Netherlands and Belgium resulting in the loss of nearly 2,000 lives.

Records for the Danube, dating back to the 11th century, tell of serious floods in 1342, 1402, 1501 and 1830, resulting from ice jams during the spring rise. In 1824 St. Petersburg (Leningrad) and Kronstadt suffered an ice-jam flood in the Neva in which 10,000 persons were drowned.

Lisbon in 1755 and Hilo, Hawaii, in 1946 experienced floods caused by tsunamis, or sea waves of earthquake origin (*see* EARTHQUAKE). Johnstown, Pa., was practically destroyed in 1889 by a flood following the failure of a dam behind which runoff from a moderate storm had been allowed to concentrate.

Lying athwart a zone in which dry, cold air masses from the arctic meet warm, moist air originating in the Caribbean and South Atlantic, the United States east of the 90th meridian is subject to storms and floods which extreme contrasts in temperature and moisture invariably bring about. Among the results are the spectacular floods of the Connecticut, Susquehanna and Potomac rivers in 1936, the Ohio in 1936 and 1937, and the Mississippi in 1884, 1927, 1937, 1943, 1947, 1951 and 1952.

The encroachment of industrial and community development on the natural channels of nearly all the larger rivers has contributed substantially to the extent of flood damage. Unless such encroachment is halted by some form of flood-plain zoning, flood damage can become staggering. In certain eastern and western states flood danger is increased by the possibility that seasonal rains may combine with thawing of major snow accumulations.

Flood-producing storms of limited areal extent occur throughout the whole of humid United States. These storms are of the thunderstorm type, occurring as single or multiple convective "cells," and are capable of producing phenomenal downpours. Property damage and loss of life from floods created by this type of storm constitute an appreciable percentage of the total loss. The storm of July 1942 in Pennsylvania afforded an outstanding example of this type, more than 30 in. of rain in 12 hours having been observed at the storm centre.

With the exception of the arid southwest and the Great Basin, no region of the United States is immune from floods in any month of the year. The primary cause of flood is rain concentrated within relatively short storm periods. However protracted storms, such as that of Jan. 1937, blanketed the whole of the Ohio basin and caused the greatest flood of record on that river. The great flood of 1937 took 137 lives and caused an estimated property damage of $417,700,000 in the Ohio and lower Mississippi basins.

Following a two-month period of above-normal precipitation, rains of unprecedented intensity over much of the state of Kansas in July 1951 resulted in the greatest flood in more than a century in the Kansas river basin and adjoining areas. Twenty-eight lives were lost and property damage amounted to nearly $1,000,000,000.

Hurricane rains of 1955 caused floods of record or near-record proportions in many streams in southern New England, southeastern New York, eastern Pennsylvania and New Jersey which took 180 lives and caused an estimated damage of $686,000,000.

Monetary loss from floods averages $300,000,000 annually in the United States. This figure would be much higher were it not for various means of flood control, such as protective levees, channel improvement, storage reservoirs and flood warnings.

Early precedent in protecting the fertile alluvial plains of the lower Mississippi valley at government expense established the policy of flood control under and by federal agencies, the principal one of which is the corps of engineers, United States army. The department of agriculture, with its soil conservation and forest services, carries out programs of soil and forest conservation that are in many cases the indirect means of retarding and absorbing storm runoff, thus reducing the height to which floods would otherwise rise.

The weather bureau, through its flood forecasting service, reduces flood damage by providing opportunity to remove goods and evacuate populations. Losses are still further reduced by the efforts of the American Red Cross, the army engineers and the coast guard in caring for persons driven from their homes by floods.

Many sections of Asia and the far east frequently suffer severe floods. In India, for example, some parts are flooded every year with considerable damage. Floods of major importance occurred in many parts of India during 1952 to 1956. These started with the Brahmaputra and tributaries doing extensive damage with large loss of dwellings and cattle. Heavy southwest monsoon rain (June–September) caused the Godavari floods of 1953 which were unprecedented in 50 years. Southwest monsoon rain caused severe floods in all the south Indian states again in 1954 although less severe than those of 1953. Floods also occurred during this period in Assam, Bihar and West Bengal. Some of India's rivers reached the highest flood of record in 1955. The Mahanadi, Orissa's largest river, reached a record level and marooned 300,000 people. Severe floods also developed in the Jumna, the Beas, the Ravi and the Sutlej rivers in the northwest of India. The Ravi completely changed its course during this flood, swamping hundreds of villages on both sides of the Pakistan-India border. Floods continued in 1956 with the Jumna river reaching the highest level on record at Delhi, and with the Ganges river seriously affecting the states of Bihar, Uttar Pradesh and West Bengal. India's floods result primarily from rain; however, snow melt makes a contribution from those rivers arising in the Himalayas. Nearly half the total population (half a billion people) continually face the danger of floods.

Australia's largest rivers are the Murray, Darling, Fitzroy and Burdekin which together comprise a drainage area of approximately 740,000 sq.mi. or about one quarter of the continent. Flooding occurs periodically in these major rivers but even more frequently in the smaller eastern and southeastern streams.

Major floods occurred in New South Wales in 1955 on the Macquarie, Castlereagh, Namoi, Hunter and Gwydir rivers, taking 50 lives and leaving nearly 40,000 homeless in 40 towns.

Some of the heaviest rains of history occurred in 1956 in southeastern Australia, flooding rivers and forming a sea 40 miles wide between the towns of Hay and Balranald.

The British Isles occasionally are subjected to flooding from abnormally heavy storms. Outstanding recent events were the Lymouth flood, causing 28 deaths, the North Devon, North Somerset and Sussex floods, all in 1952, the northern England and southwest Scotland floods of 1953 and the Weymouth flood of 1955 which resulted from 11 in. of rain in less than 24 hours at Martins-

town, Dorset.

See also River and River Engineering.

Bibliography.—For the most notable floods in America and Europe up to 1917: Alfred J. Henry, "The Distribution of Maximum Floods," *Monthly Weather Review*, vol. xlvii, pp. 861–867 (Dec. 1919). C. S. Jarvis, two papers which contain extensive bibliographies: *Supplementary Gleanings From the Field of Hydrology* (Sept. 1943), 67 references to floods, and "Floods in the United States," United States Geological Survey *Water Supply Paper 771* (1936), 207 references from American and European sources. Jarvis discussed floods in Europe and Asia from the middle ages on, and the Nile floods since beginning of records about A.D. 620, in "Flood-Stage Records of the River Nile," *Transactions* of the American Society of Civil Engineers, vol. lxii, pp. 1012–71 (1936), 65 references. C. E. P. Brooks and J. Glasspoole, *British Floods and Droughts* (1928), discusses in detail floods in rivers and along the coasts of the British Isles since A.D. 9. Lowell Thomas in *Hungry Waters* (1937) takes up in detail the great 1937 flood of the Ohio valley and gives an account of floods in Canada, Europe, Asia and other rivers of the U.S. prior to 1937. "Kansas-Missouri Floods of June–July 1951" (1952) and "Floods of April 1952—Upper Mississippi, Missouri and Red River of the North" (1954) in Weather Bureau *Technical Papers 17* and *23*. (M. Bb.; W. E. Ht.)

FLOOD (IN RELIGION AND MYTH) is the name given to the cataclysm that was said to have covered most of the earth with an immense inundation and to have caused the death of all but a few of the human race. Most civilizations record a tradition about this event, which is best known from the account in the Old Testament and in the Gilgamesh myth.

Biblical Accounts.—The story of the flood in Gen. vi–ix is, as biblical criticism has shown, a fusion of two closely interwoven versions, one based on the 8th-century B.C. tradition known as "J" (Yahweh), the other on the 6th-century B.C. priestly tradition called "P," which represents a less primitive and more theological attitude (*see* Genesis: Pentateuch).

The J Source.—Yahweh has decided to destroy the human race, which is basically evil, save for one just man, named Noah. Yahweh warns Noah of the coming cataclysm, and commands him to go into the ark with his household and pairs of animals, seven of the clean and one of the unclean, in order to preserve the species. The waters cover the earth, and every living thing is destroyed except for those in the ark. After the rain has ceased, Noah releases a raven, which returns to the ark because it can find nowhere else to rest, and a dove, which does the same. Seven days later the dove is released again, and returns with an olive branch in her beak. After a further seven days the dove does not return after her release. Noah then leaves the ark and makes a thank offering to Yahweh, who in his turn is reconciled with mankind, promising never again to smite every living thing.

The P Source.—Noah is an upright man in the midst of a perverse generation which God has decided to obliterate. He is commanded to make an ark of certain precise measurements which is to shelter him and his, together with two of each species of living things and provisions for them all. Noah is 600 years old when the flood begins: "all the fountains of the great deep burst forth, and the windows of the heavens were opened" (Gen. vii, 11). The ark carries its load while the waters rise for 150 days. Then comes a wind which brings calm, and the waters begin to sink. In the seventh month, on the 17th day of the month, the ark comes to rest "upon the mountains of Ararat." A further period of time, carefully measured, has to pass before Noah with his family and animals can leave the ark. God then blesses Noah and his sons, and makes a covenant that he will never send another flood on the earth.

Mesopotamian Accounts.—The Assyrian text of the epic of Gilgamesh on cuneiform tablets discovered at Nineveh comes from the library of Ashurbanipal (7th century B.C.), but undoubtedly repeats an earlier original. A fragment of a Babylonian version found at Nippur goes back to the 19th century B.C. (*See* also Gilgamesh, Epic of.)

Assyrian Version in Cuneiform Script.—Gilgamesh, king of Erech (Uruk), much distressed by the death of his friend Enkidu, realizes that his own life too must one day end. He remembers that only one human being, Ut-Napishtim ("Uta is my life"), has received eternal life, after surviving a flood which he has described in all its episodes. When the gods decided to destroy the city of Shuruppak, Ea advised his protégé Ut-Napishtim to build a vessel according to a specified plan and to bring into it his family, craftsmen, animals, gold and silver. Flood and storm are then unloosed, to the great dismay of the gods who have commanded them. The earth is submerged, and "mankind is turned into clay." Seven days later there is a lull, and the vessel comes to rest on Mt. Nisir. After another seven days a dove, a swallow and a raven are sent out. Only the last finds a place to alight, so does not return. The survivors come out of the ark and make a sacrifice upon which the gods descend. The wrath of Enlil is appeased, and after blessing Ut-Napishtim and his wife he grants them immortality.

There is also another cycle, parallel to the epic of Gilgamesh, in which the hero's name is Atrahasis ("the most wise"). The tablets on which it is found were excavated at Nineveh and at Sippar. These documents in Akkadian, like Hebrew a Semitic language, had been preceded by others written in Sumerian, which is not Semitic.

Sumerian Version From Nippur.—The gods, except for Inanna and Enki, have decided to send a flood "to destroy the seed of the human race." The king Ziusudra is saved in a giant ship which he has built in accordance with instructions from a god who takes pity on him. He makes a thank offering for his escape and ultimately receives an "eternal inspiration" and goes to live in the country of Dilmun.

Late Babylonian Version.—The latest Babylonian version of the flood story was written about 275 B.C. by Berossus, priest of Marduk (Bel) at Babylon. Xisuthros is commanded by Cronus to build a ship for his family, friends and animals, and load it with food, as a flood is imminent. The cataclysm is then unleashed. When it is over, Xisuthros releases birds in order to find out how far the water has sunk, and it is only after this has been done three times that they do not return. Xisuthros then leaves the ship with his wife, his daughter and the pilot, and makes a sacrifice to the gods. These four become invisible, and those left in the ship are begged to become virtuous and to return to Babylon, then to Sippar, where Xisuthros buried all existing writings before the flood. This is a long journey for them, as the ship has come to rest on the Corydaean mountains of Armenia.

Evidence for the Flood in Historical Sources.—Besides these more or less legendary narratives, there are brief references to the flood as a historic fact. For instance, Weld-Blundel's prism (W.B. 444) mentions Ubar-Tutu, father of Ut-Napishtim according to the Gilgamesh epic, and then, after enumerating five cities and eight kings, it continues, "the flood came. After the flood had come, kingship descended from heaven. The kingship was at Kish." A tablet (W.B. 62) mentions two kings of Shuruppak (the city of the flood) including Ziusudra (as in the Sumerian version of the story). For ancient historiographers, therefore, the flood marks a distinct break in the train of events.

Archaeological Evidence in Mesopotamia.—Excavations in Mesopotamia have revealed conflicting evidence about the flood. In strata dating from before 2000 B.C., when the first Sumerian narrative was probably written, flood layers have been found at levels which do not correspond stratigraphically. At Ur a deposit of clean water-laid clay whose depth varies from 3.7 to 2.7 m. appears to go back to between 3000 and 4000 B.C., whereas at Kish a similar deposit, only 0.3 m. deep, dates from about 2800 B.C. In Erech and Shuruppak the flood layers date from the same period (*c.* 2800 B.C.), but differ in depth (1.55 m. and 0.6 m. respectively). Further, at Nineveh excavators found at a depth of between 21.1 and 21.3 m. a series of 13 alternate strata of mud and riverine sand, which show an important climatic change (*c.* 3000–4000 B.C.).

The conclusion to be drawn from these excavations seems to be that there was not merely a single flood but many. Probably one of these cataclysms brought such destruction in its train and made such a great impression that it became a theme of cuneiform literature. It was known as *the* flood, caused first by an unusually violent rising of the Tigris and the Euphrates (Iraq still suffers from such disasters, as witness the flood in the spring of 1954), augmented perhaps by torrential rain (*cf.* Gen. vii, 4, 12) if not also by a tidal bore (*cf.* Gen. vii, 11). Such violent upheavals of water could not fail to bring about almost total destruction of

life in the area save for a few privileged exceptions.

Relationship Between the Biblical and the Mesopotamian Floods.—That the various accounts of the flood given above are connected is beyond all doubt, and it is equally clear that the biblical narrative enshrines the Israelite version of an earlier Mesopotamian tradition (extant in cuneiform texts) which was reshaped by the Hebrew writers of the 8th and 6th centuries B.C. This Babylonian tradition must have been brought from Mesopotamia by the patriarchs and later transferred to Canaan where there was no memory of such a flood, which is a specifically Mesopotamian disaster.

Religious Meaning of the Biblical Flood.—Into this story drawn from earlier sources the biblical narrative introduces new elements which reveal teaching about God and his purposes for mankind. The flood in Genesis is understood as an instrument of God's justice, which because of man's wickedness dealt out destruction on all save the righteous Noah and his family. The flood story also marks an important stage in the relationship of man to God, for God in his mercy then promised that such a cataclysm would never happen again and made the first of the covenants recorded in the Bible, that made with every living creature, whereby the earth should continue, with its ceaseless cycle of the seasons and the harvest.

In the New Testament the flood story is used as a "type" of the last judgment. Jesus Christ compared the unexpected coming of the last judgment to the flood, making the comparison a warning of the necessity for watchfulness (Matt. xxiv, 37 ff.; Luke xvii, 26 ff.). The story is used in II Pet. ii, 5 as a reminder that God punishes the ungodly while delivering the righteous. A further interpretation is found in I Pet. iii, 20, where the floodwaters are said to prefigure the saving waters of Christian baptism.

The Flood in Greek Mythology.—The story of the flood is first explicitly mentioned in Greek literature by Pindar (5th century B.C.). A full version is to be found in the mythological compendium called *Bibliotheca* wrongly ascribed to Apollodorus (2nd century B.C.). Zeus has decided to destroy the human race, but King Deucalion, advised by his father Prometheus, builds an ark in which he and his wife Pyrrha take refuge with a store of provisions. Zeus submerges Greece in torrential rain, so that only a few others are able to escape by climbing up into the mountains. The ark of Deucalion floats for nine days, after which it comes to rest on Mt. Parnassus. When the rain ceases Deucalion comes out of the ark and makes a sacrifice. Zeus, thus appeased, then sends Hermes to offer Deucalion anything he wants. Deucalion chooses to increase the human race; he throws over his shoulder stones which turn into men while those thrown by Pyrrha become women.

This legend about Deucalion was not the only flood story current in the Greco-Latin world. Dionysius of Halicarnassus (1st century B.C.) in his work on Roman antiquities refers to a flood in the reign of King Dardanus of Arcadia, and the church historian Julius Africanus (*c.* A.D. 200) speaks of a flood in the time of Ogyges, king of Thebes in Boeotia. References to these floods are found in other sources, and by the 5th century A.D. the poet Nonnus in his *Dionysiaca* counts three floods, first Ogyges', then Deucalion's, then Dardanus'.

J. G. Frazer suggested that these various narratives are not based on actual events but were invented to account for certain obvious physical features of the Greek landscape: the formation of Lake Copais from overflow (flood of Ogyges), the rising in the valley of the Pheneus (flood of Dardanus) and the split in the mountains of Thessaly (flood of Deucalion).

The story of the flood of Deucalion was popular at Hierapolis on the Euphrates. A version in the *De dea Syria* wrongly ascribed to Lucian (2nd century A.D.) relates that after the flood all the waters disappeared into a cleft in the earth at Hierapolis, beside which Deucalion built a sanctuary to Hera. Twice a year thereafter, in memory of this miracle, worshipers brought sea water to the sanctuary and poured it into the cleft. Similarly, Pausanias (2nd century A.D.) was informed that an offering of honey cakes was made annually at Athens at the cleft in the ground near the temple of Olympian Zeus where the floodwaters had drained away. It is worth adding that coins of the 3rd century A.D. from Apamea Cibotus in Phrygia (Asia Minor) show the ark, with the name Noah written on it. This is the first known instance of the iconography of the flood which later becomes so familiar, especially in Romanesque paintings and sculptured capitals.

Legends of the Flood in Other Traditions.—The flood is not mentioned in the Vedic hymns of ancient India (1500–1000 B.C.), but in the Sanskrit Shatapatha Brahmana (6th century B.C.) there is the story of Manu, who was informed by a small fish that a flood was to take place and advised to build a ship. Manu reared the fish until it grew big, and when the flood began it pulled him in the ship to a mountain, thus saving him alone from death. When the waters sank, Manu came out of the ship and offered a sacrifice of butter and milk, from which sprang a woman, to be the mother of the race of Manu; *i.e.*, mankind. Later variations of this legend are also known. (*See* also MANU.)

Legends of a flood are also found in southern Asia, the Indian archipelago (Sumatra, Borneo, Celebes), New Guinea, Australia, Melanesia, Polynesia and the American continents from Alaska to Cape Horn, as well as in the folklore of certain European countries—Wales, Lithuania and Rumania—and in eastern Russia. But in Africa, including Egypt, there is scarcely a trace of it. In most of these stories constant features are the saving in a vessel of a remnant (whether a single person, man and wife, brother and sister or a larger group), often with the help of a god, and the subsequent repeopling of the earth by natural or miraculous means.

Origins of the Legends.—It seems that the traditions of the flood fall into two groups, to one of which belong the cuneiform (both Sumerian and Akkadian) and Hebrew narratives. These may to some extent have inspired the Greek story of Deucalion, and just possibly that of Manu in Sanskrit literature. Behind them would lie a historical flood of catastrophic proportions which inundated the Tigris-Euphrates basin. To the other group belong the rest of the legends which, having no necessarily factual basis, are to varying degrees mythical or legendary and are not connected with the first group.

BIBLIOGRAPHY.—The most convenient collection of flood stories from all parts of the world in J. G. Frazer, *Folklore in the Old Testament*, vol. 1, pp. 104–361 (1918). *See* also A. Jeremias, *Das alte Testament im Lichte des alten Orients*, 4th ed., pp. 128–160 (1930). For monograph on the Mesopotamian and biblical flood stories with archaeological evidence *see* A. Parrot, *Déluge et arche de Noe* (1953; Eng. trans., 1955). For Greek flood stories *see* H. Usener, *Die Sintflutsagen* (1899). (A. PA.)

FLOOD CONTROL: *see* RIVER AND RIVER ENGINEERING; DAM; RESERVOIRS; LAND RECLAMATION.

FLOOD PLAIN, a plain made of sediment deposited by a river. When the gradient of a river becomes very slight, it is unable to carry all the material brought downstream, and consequently the lower valley becomes filled with alluvial deposits. In times of flood the river torrent tears off and transports an unusually large quantity of sediment; in the flooded lower valley the rush of water is checked, and the stream in consequence drops its extra load.

Flood plains are sometimes of great extent. In the United States, that of the Mississippi below its confluence with the Ohio has an occasional width of 80 mi. with a total area estimated at 50,000 sq.mi.

Flood plains may be caused by a graded river's meandering from side to side and thus widening its valley and ultimately covering the widened valley with sediment. Any sudden increase in a river's velocity and volume or obstruction across its course may result in a flood plain, but flood plains are most commonly found in the lower reaches of such large rivers as the Rhine, Nile or Mississippi. The flood plain is usually bounded by levees.

Sections of the Missouri river flood plain show a great variety of material of varying depth and of coarseness ranging from heavy gravel through fine sand to fine silt. It is probable that any section of such a plain would show similar deposits.

The flood plain during its formation is characterized by marshes, meandering or anastomosing streams, oxbow lakes and bayous (*q.v.*), and is occasionally completely drowned. When the drain-

age system is entirely diverted for any cause, the flood plain may become a smooth area of great fertility, similar in appearance to the floor of an old lake, from which it differs, however, in that it is not quite flat. It has a gentle slope along the original downstream course and also usually from the edges toward the centre. *See* also PLAIN.

FLOOR, the lower horizontal surface of an enclosure; used, also, almost interchangeably with "story," to designate different levels or planes of rooms, one above the other. The floor may be a prepared surface of the ground or an elevated area. In primitive buildings the leveled surface of the ground was covered with matting as a protection against dampness; in regions of heavy rainfall, a platform or floor set above the ground and supported on posts provided a protection from surface water.

In modern buildings the floor areas resting on the ground are insulated from moisture by replacing the top soil with coarse gravel or crushed rock, which leaves large volumes of voids to permit free drainage and cut off the capillary action which might otherwise penetrate the floor slab.

A floor area free of the ground is both a structure and a finished surface. The structure must have sufficient strength to carry loads. The upper surface should be protected by a covering or wearing surface capable of withstanding traffic. The underside may be exposed or covered, depending upon the aesthetic requirements or the need for protection against fire. The upper, or wearing, surface is called the finished floor; the underside, either exposed or finished, is the ceiling.

Wood, steel, concrete or a combination of these materials may be used in the construction of the floor. The structure is similar to that of flat roofs of the same materials, except that the distances between supports are usually less to accommodate heavier loads. For light wood construction in dwellings, the joists are supported by bearing partitions in the first and upper stories, or by beams and posts where the supporting partitions would not coincide with the locations of the walls of the rooms. In the basement story the bearing partitions and the first floor joists are usually carried on wood or steel girders supported on posts and the basement walls.

The finished floors are usually hardwood strips (oak or maple) having a $2\frac{1}{4}$-in. face width, and tongued and grooved at the edges and ends. The strips are blind-nailed through the tongue to the underfloor using cut nails. The strips are laid at an angle with the underfloor and parallel to the partitions or outer walls. The flooring strips are sanded when laid to remove any inequalities at the edges and to provide a smooth clean surface for the finish. The finish consists of a filler, followed by a built-up surfacing of wax properly polished.

The floors of multistoried industrial buildings carrying heavy loads (as well as those of commercial buildings and schools carrying relatively light loads) may be constructed of reinforced concrete slabs supported directly on columns or carried on concrete or steel beams attached to supporting columns. For lighter constructions steel panels or light steel joists supporting a light concrete slab or fill may be used.

For the finished floor wood, cork, linoleum, tiles and masonry (*e.g.*, flagstone, marble, brick, slate, granolith, terrazzo) have practical and aesthetic qualities. *See* ROOF; CARPENTRY.

(E. N. G.)

FLOOR COVERINGS. Many materials are used as floor coverings; those considered in this article have been classed as smooth-surfaced floor coverings and include linoleum, rubber floor coverings, cork tile, asphalt tile, printed felt base and the many varieties derived from vinyl chloride resins. The use of these materials increased greatly after 1920; in the 1960s the extensive use of concrete flooring in homes and commercial buildings had further expanded the market.

Linoleum, the first smooth-surfaced floor covering to be used widely, was introduced about 1860. Frederick Walton invented the linoleum-making process, in which linseed oil is oxidized to produce the binder for cork and other fillers. He built the first linoleum factory at Staines, Eng., and in about 1900 developed the straight-line inlaying machine, which greatly increased the variety of patterns that could be produced. Production of linoleum increased steadily until about 1950, after which it decreased, mainly because of competition from newer materials.

Printed felt base was first manufactured in Erie, Pa., about 1910. Production gradually increased until yardage became much greater than that of linoleum. But, like the output of linoleum, the production of this material is now decreasing although large volumes are still manufactured.

Cork tile has been made for many years and continues to be produced in large volume, although not in the volume of linoleum or the newer materials. Rubber flooring has been produced for many years, and the volume has shown a gradual increase. However, it is a relatively expensive material and the yardage produced is not a major portion of the total floor covering manufactured.

Asphalt tile was first produced about 1930. The volume of production has increased rapidly and in the 1960s it exceeded the yardage for linoleum. Vinyl floor coverings were first produced in the United States about 1945 and their use has expanded greatly. Vinyl coverings are made in a wide variety of types, and the total vinyl usage is about the same as that of linoleum.

Floor coverings are offered in a variety of forms. The flexible materials are available in roll form; the trend, however, is toward tile, and nine-inch square tile is most widely employed. The tiles are offered in a variety of thicknesses from $\frac{1}{16}$ to $\frac{3}{16}$ in., and in some cases the tile is even thicker. A backing of felt may be used.

These floor coverings, except those in which thin films are employed, are manufactured by mixing the plastic material with fillers and pigments to create a plastic mix that is rolled into sheets and then calendered to the desired thickness. If a backing is used the plastic sheet is calendered onto the backing.

A variety of decorative effects, including mottles, *jaspé* and spatter patterns, are obtained by blending in one or more other mixes of the same general composition as the base in sheet or chip or granule form. By controlling the extent of mixing, a wide variety of these effects may be achieved. In some cases the added colour is mixed little, if at all, and it may be compressed rather than rolled into the sheet.

Linoleum.—In the original process for manufacturing linoleum, a thin film of linseed oil was allowed to oxidize. Since oxidation proceeds principally on the surface, fresh oil was continually applied to the surface of the oxidized film. The film was started on a light cotton scrim, and linseed oil was poured over the film while it was festooned in tall stoves or sheds. After weeks of exposure, during which the thickness of the oil film reached several inches, the oxidized oil was fluxed with a natural resin, such as rosin or kauri gum. Cork and other fillers, such as wood flour (pulverized dried wood) and whiting, were mixed with the blend of resin and oxidized oil.

The shed process was cumbersome and slow, and it was replaced by a faster method in which linseed oil is oxidized in large cylindrical kettles where the oil is stirred at elevated temperatures. The oxidization is continued until the oil barely flows at reaction temperature; then the oil is blended with rosin in heated kettles equipped with agitators. Often the rosin is added to the oxidizing kettles while the air is blown into the mixture at elevated temperatures; a plastic material of high viscosity is then formed.

The mixture of oxidized oil and rosin is blended with wood flour and whiting. In modern practice cork is no longer widely employed as a filler. The use of cork declined largely because of both the trend to brighter colours and the scarcity and relatively high cost of cork.

The binder, fillers and pigments are mixed, then calendered in sheet form and applied to a backing. Burlap was the principal material used for backing until World War II, but it became scarce during the war and was replaced by felt saturated with asphalt. Burlap is still used, however, for heavier gauges of linoleum. Saturants of light colour are often used in place of asphalt to waterproof the felt.

The backed linoleum is hung in tall buildings or stoves, which are heated to harden the linoleum. The hardening process may

take weeks. Linoleum tile is made by prolonging the heating until a much harder material is formed.

While the modern process described can be used to produce plain or solid patterns, many decorative effects are obtained by blending mixes of various colours. Marble effects are achieved by mixing blends of two or more colours. The degree of mixing must be controlled carefully to obtain the desired effect. Geometric patterns are produced by granulating mixes of various colours and applying the granules through stencils. Tile and textured effects are obtained in this same manner. The granules are integrated under pressure and then stoved. Spatter patterns are produced by adding granulated mixes in various colours and granule sizes to the surface of a calendered sheet and again calendering. At one time a printed surface was applied to linoleum, but this practice has long been abandoned.

Most linoleum is made in rolls 6 ft. wide, $\frac{3}{32}$ in. thick and with a felt backing. Some grades are offered in a thickness of $\frac{1}{8}$ in. and with burlap backing.

Felt Base.—This low-cost floor covering, often referred to as printed felt base, is produced by printing a heavy film of paint on felt that has been saturated with asphalt. Before the paint is applied, the felt is sealed with one or two layers of coating to keep the asphalt from discolouring the paint and to level the surface; a backing coat also is applied at this time. A variety of paint vehicles have been employed; usually oleoresinous varnishes form the paint base, although alkyd resins have been used. The requirements for a satisfactory paint are rather severe since the paint must (1) have a low volatility when applied; (2) exhibit little tendency to flow; (3) dry readily in thick films much heavier than the usual paint film; and (4) produce a durable wearing surface with high gloss.

The paint is printed on the felt base from wooden blocks that are coated with paint and then applied to the surface of the felt. Many colours are applied in the usual printed pattern, and each colour is printed separately. The printed felt is then dried by heating in ovens, either in horizontal racks or in festoons. The paint must not flow if the festoon system is used. Maturing is finished in a few days. Printed felt base is available either in roll form or in rugs of various sizes and in several thicknesses.

Asphalt Tile.—Linoleum does not give good service when subjected to dampness or alkaline conditions, and a need arose for a floor covering that would perform well under these conditions. Asphalt tile met these requirements. It is comparatively low in cost and is available in tile form so that it can be installed easily by the homeowner.

The name "asphalt tile" is essentially a misnomer, since asphalt is used only in the very darkest shades of tile; lighter-coloured resins are used for most of the asphalt tile now on the market. The first tiles made from asphalt were quite dark in colour and were used mostly in industry. The name, however, has persisted.

The manufacture of asphalt tile is somewhat simpler than the manufacture of linoleum since the binder is thermoplastic and is not cured. Scraps, cuttings and trimmings can be reworked, and the tile can be packaged as soon as the calendered sheet has been cut and the tile has cooled.

Asphalt tile is made by mixing about 25 parts by weight of a resin and plasticizer with about 75 parts by weight of fillers and pigments. The filler consists of about 35% of asbestos fibres, 60% of ground limestone and up to 5% of pigments. The fillers and binder are premixed in some cases to shorten the mixing cycle.

Asphalt, gilsonite, dark-coloured coal tar and petroleum resins are used for dark-coloured asphalt tile while limed tall oil pitch is often used as the plasticizer for the darkest shades. For the lighter colours, coumarone-indene (coal-tar) resins were the first resins used. With the rapid increase in consumption of asphalt tile, however, petroleum resins came to be used, but the addition of polystyrene was required to make a suitable resin. Much of the tile on the market in the early 1960s contained some polystyrene, although the amounts used by various manufacturers varied considerably. Plasticizers for light-coloured tile also must be light in colour; limed tall oil is usually employed in combination with mineral oils or synthetic alkylated aromatic hydrocarbons. Since tall oil is saponifiable, the amounts in which it is used must be kept to a minimum in order to preserve the alkali resistance of the tile.

After the resin, plasticizer and fillers have been thoroughly mixed they are sheeted on mixing rolls and finally calendered to the thickness of the final tile, either $\frac{1}{8}$ or $\frac{3}{16}$ in. Mottle colours are usually added on mixing rolls, and the spatter colours are added in granular form just prior to calendering.

The sheet is then cut into nine-inch square tiles, cooled and packed. Originally the tile was offered in a wide variety of marbleized effects, but the spatter patterns have become more popular. In some cases the colour granules cover most of the surface of the tile; simulated cork surfaces are made in this way.

Vinyl Asbestos Tile.—Vinyl asbestos tiles are formed from vinyl chloride polymers or vinyl chloride-vinyl acetate copolymers. Copolymers are used more frequently than polymers because they are softer and more readily plasticized. (*See* also PLASTICS: *Polyvinyl Chloride Resins.*)

Vinyl asbestos tile is made by mixing about 25 parts of a binder with about 75 parts of filler consisting of ground limestone, asbestos fibres and pigments. The binder consists of a vinyl chloride polymer or vinyl chloride-acetate copolymer, phthalate ester plasticizers and materials that stabilize the vinyl resin in heat and light. The asbestos content is usually lower than in asphalt tile. Mixing procedures are similar to those for asphalt tile although working temperatures may be somewhat higher. Mottle colours are added on the mixing rolls after the mix is blended and sheeted or just before it is calendered, depending on the type of decoration desired. The most popular thickness for vinyl asbestos tile is $\frac{1}{16}$ in., although heavier gauges are offered. The material is offered usually as nine-inch square tiles, although other sizes are available. In addition to mottles, terrazzo and spatter patterns, tile is also decorated with bronze and aluminum flakes. Vinyl asbestos tile is somewhat more flexible than asphalt tile but often cracks on repeated flexing.

Vinyl Floor Coverings.—Rug-size floor coverings made from vinyl resins have proved popular and are now offered in a wide variety of forms. One variety is similar to printed felt; the paint coat consists of a vinyl chloride resin and a plasticizer. This is usually printed as a plastisol coating consisting of very finely divided vinyl chloride resin suspended in a plasticizer and pigmented. When heated, the resin dissolves in the plasticizer; no further curing is required.

Calendered vinyl floor coverings are also produced from calendered sheets on felt backing. These are offered in several different forms but usually in rolls or as tiles $\frac{1}{16}$ in. thick. Calendered vinyl sheets on felt backing are also offered in an alkali-resistant variety.

Homogeneous vinyl tile is made from vinyl chloride polymers plasticized with a phthalate ester. Fillers are employed but asbestos is not used in these flexible tiles. Pigments and stabilizers for the vinyl resin are used in the blend. The tile is produced in thicknesses of 0.08 to 0.125 in. and in 9-in. squares and in other tile sizes.

Some varieties are offered in translucent form. In this type little or no filler is used and the decoration consists of geometric shapes or metallic flecks throughout the tile. Many of these simulate the appearance of marble.

Rubber Flooring.—Rubber flooring for many years was made of natural rubber, but in recent years synthetic rubber, particularly the styrene-butadiene copolymer, has been employed in most rubber flooring. The rubber is mixed with resins to improve processing; fillers, pigments and curing agents are mixed, and the mix is then sheeted and cured in heated presses. Rubber tile is usually offered in plain or mottle patterns, in thicknesses of $\frac{1}{8}$ in. and $\frac{3}{16}$ in., in squares of 6 in., 9 in. and 12 in., and in rolls.

Cork Tile.—Ground cork has long been used to make floor coverings. When cork is heated at high temperatures the particles knit and form a resilient composition. Heating takes hours by conventional methods since heat is transferred through the cork

very slowly. High-frequency heating (*q.v.*) reduces the heating time to minutes. Cork tile is offered in tan and dark brown colours, thicknesses of $\frac{1}{8}$ in., $\frac{3}{16}$ in. and $\frac{5}{16}$ in., squares of 6 in. and 9 in. and also in rectangular shapes.

Properties of Floor Coverings.—All of the floor coverings described in this article have found their own fields of application and each has properties that make it suitable or unsuitable for particular applications. Asphalt tile is lowest in cost, the dark shades of asphalt being the least expensive. Linoleum is next lowest in cost, followed by vinyl asbestos, cork and rubber. Homogeneous vinyl tile is the most expensive of all those described.

When comfort and quiet are essential, cork tile is superior; appearance and maintenance, however, are not strong points of cork. Linoleum has had a long history of successful performance, but it cannot be used below grade, as in basements, or in areas where high moisture or alkaline conditions prevail. Asphalt tile has been widely adopted under these conditions because it is resistant to water and alkali. Rubber flooring is used mostly in public buildings and has many excellent properties; it is not too easy to maintain, however, nor is it particularly resistant to grease. Vinyl flooring is offered in so many forms that generalizations are difficult. Homogeneous vinyl tile, however, offers good resistance to water and alkali, is grease resistant and has good colour stability.

See also CARPET MANUFACTURE; RUGS AND CARPETS.

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FLOQUET, CHARLES THOMAS (1828–1896), French statesman, a vigorous champion of the republican cause, was born at St. Jean-Pied-de-Port (Basses-Pyrénées) on Oct. 2, 1828. He was called to the bar in 1851 and made his name by fearless attacks on Napoleon III's government in a series of political trials. When Alexander II of Russia visited the Palais de Justice on June 3, 1867, Floquet greeted him with the cry, "Vive la Pologne, Monsieur!" Floquet delivered a scathing indictment of the second empire at the trial of Prince Pierre Bonaparte for shooting Victor Noir, and he took part in the setting up of the republican regime on Sept. 4, 1870. In 1871 he was elected deputy for the Seine *département* in the national assembly. During the Commune he helped to form the Ligue d'Union Républicaine des Droits de Paris, whose first president he became, in an endeavour to prevent civil war. He was imprisoned for a short time after the Commune. Floquet then edited the *République Française*, became president of the municipal council of Paris and in 1876 was elected deputy, as a Radical. In 1885 he succeeded Henri Brisson as president of the chamber. On the fall of Pierre Tirard's government in 1888, he became prime minister and minister of the interior on April 3, with a cabinet of Radicals pledged to revise the constitution. Heated debates during the Boulangist agitation culminated in Floquet's famous taunt of June 4, "At your age, General Boulanger, Napoleon was dead." There followed a duel between Floquet and Boulanger on July 13, in which the general was severely wounded. On Feb. 14, 1889, Floquet was defeated on the proposed revision of the constitution and resigned. Re-elected president of the chamber in November, he had to resign in 1892, when implicated in the Panama scandal. He lost his seat in the chamber in 1893, but was elected to the senate, for the Seine *département*, in 1894. Floquet died in Paris on Jan. 18, 1896. There is an edition of his *Discours et opinions* by A. Faivre (1885).

See J. Chastenet, *La République des républicains* (1954).

FLOR, ROGER DE (d. 1305), military adventurer and mercenary captain, was born at Brindisi in southern Italy, the son of a German falconer called Blum (*i.e.*, Flower; Sp. *Flor*) in the service of the emperor Frederick II. Roger went to sea as a boy with the Knights Templars, entered their order and became commander of a galley. When Acre in Palestine fell to the Saracens in 1291 he made his fortune by blackmailing refugees, for which he was denounced by his grand master. He fled to Genoa and then entered the service of Frederick III, the Aragonese king of Sicily, who made him his vice-admiral and commander of his Catalan mercenaries, the Almogávares (*q.v.*). At the close of Frederick's war with the Angevins in 1302, Roger, who spoke fluent Greek, offered his services to the Byzantine emperor Andronicus II, then hard-pressed by the Turks; and in Sept. 1303 he arrived at Constantinople with 6,500 men and 36 ships. The emperor gave him the title of grand duke, as commander of the imperial forces in Asia Minor, and the hand of his niece in marriage. Roger fought with great success against the Turks, but his evident intention to found a principality of his own, combined with the predatory activities of his Catalans, forced Andronicus to recall him at the end of 1304. His pride was flattered with the title of *Caesar*, but his troops considered themselves cheated of their pay; and the Byzantines, incited by the emperor's son Michael IX, lost patience with their arrogant mercenaries. Roger was invited to Michael's palace at Adrianople and there assassinated on April 4, 1305. His death was avenged by his troops in a prolonged war against the Greeks.

See G. Schlumberger, *Expédition des "Almugávares" ou routiers catalans en orient, de l'an 1302 à l'an 1311* (1902). (D. M. N.)

FLORA, Italian goddess of the flowering of plants. Her worship at Rome, where she had her own priest (flamen), goes back to very early times. Her festival (*Floralia:* April 28–May 3) was instituted in 238 B.C. on the advice of the Sibylline books, and at the same time a temple was dedicated on the slopes of the Aventine near the Circus Maximus. The *Floralia* was accompanied by much indecency. Harlots considered this their special season, and the games included lewd mimes. Flora's head, distinguished only by a floral crown, appears on coins of the republic.

The term flora is used in botany collectively for the plant growth of a district.

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FLORE AND BLANCHEFLEUR: *see* AUCASSIN AND NICOLETTE.

FLORENCE, WILLIAM JERMYN (BERNARD CONLIN) (1831–1891), U.S. actor, whose greatest success was in Benjamin Woolf's *The Mighty Dollar*, which he is said to have performed over 2,500 times. He was born in Albany, N.Y., July 26, 1831, of Irish parents. Reared in New York city, he became a call boy at the Old Bowery theatre under F. S. Chanfrau. While working to support his mother and her seven younger children, he rehearsed plays at night, and in 1850 began to do dialect impersonations. In 1851 he married Malvina Pray, and thereafter the two generally appeared together on the stage.

Florence's first success was in *A Row at the Lyceum* (1851); following this, he established his reputation as Captain Cuttle in *Dombey and Son*, Bob Brierly in *Ticket-of-Leave Man* and Sir Lucius O'Trigger in *The Rivals*. His last appearance was with Joseph Jefferson, with whom he had maintained a successful partnership. He died in Philadelphia, Nov. 18, 1891. Florence was one of a select number of Americans to win the ribbon of the Société Histoire Dramatique. (S. W. H.)

FLORENCE OF WORCESTER (d. 1118), English monk, usually accepted as the author of *Chronicon ex chronicis*, which is valuable for late Anglo-Saxon and early post-Conquest history. Its basis is the universal history (from the creation to 1082) compiled by Marianus Scotus, an Irish recluse at Mainz. The author of the *Chronicon*, like Marianus, was a careful annalist with a marked interest in chronology. He supplements Marianus' scanty treatment of English affairs by drawing on Bede, Asser, lives of English saints, laws, the Anglo-Saxon Chronicles and also on local records and traditions.

Under the year 1118 the *Chronicon* records the death of Florence (July 7), but it is continued without break to 1131 by a John of Worcester, who, later, added material up to 1140. On the

interpretation of the notice under 1118 depends Florence's claim to authorship, but what Orderic Vitalis has to say of John's historical work at Worcester suggests that John's part in the whole *Chronicon* is more substantial than has been traditionally allowed. After 1131, the *Chronicon* was copied at other monasteries, in several cases continued and frequently used by chroniclers.

The standard edition is *Florentii Wigorniensis monachi Chronicon ex chronicis*, ed. by Benjamin Thorpe, English Historical society, two volumes (1848–49), which excludes Marianus' text where possible and follows the *editio princeps* of 1592 by William Howard in printing the continuation to 1141, and adds a second continuation to 1295; translation of English material to 1295 by R. Forester in Bohn's *Antiquarian Library* (1854).

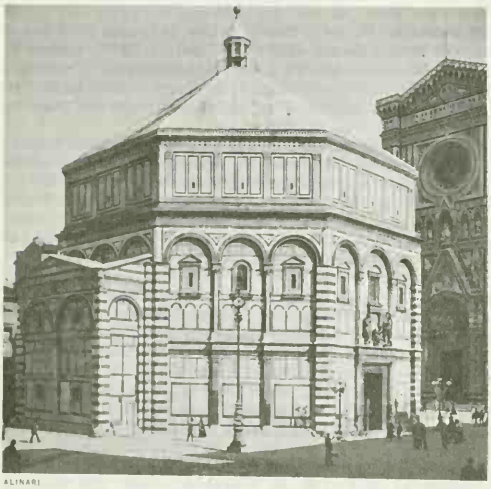
See *The Chronicle of John of Worcester, 1118–1140*, ed. by J. R. H. Weaver, *Anecdota Oxoniensia* (1908); D. Whitelock, *English Historical Documents*, vol. 1, pp. 113 ff., 121 (1955). (G. Sn.)

FLORENCE (Firenze), formerly the capital of Tuscany, now capital of Firenze province, Italy, lies 145 mi. N.N.W. of Rome. Pop. (1960) 431,000. Florence is favourably situated where the Arno river, after leaving the Apennines and before flowing into the plain, is at its narrowest and therefore easiest to cross. Because of its site near the three Apennine passes, of which two lead to Bologna and one to Faenza, Florence became one of the foremost centres of communication of central Italy. It has equally easy access to the Tyrrhenian seaboard.

The surrounding hills are among the many attractions of the Florentine landscape. The rigour of the winter (minimum temperature 5° C. [23° F.]) and the heat of the summer (maximum 35.7° C. [96.3° F.] in July) do not last long: between the seasons the temperature is delightful. The local gardens and fields produce such an abundance of blossoms that Florence is known as *la città del fiore* ("the city of the flower"); the city's emblem is a flower which also was struck on the obverse of the Florentine gold coins (hence called *florins*).

Known as "the Athens of Italy," Florence was the cradle of the Italian Renaissance and is one of the foremost art centres of the world, second only to Rome in its monuments and art treasures. (O. D. S.)

Architecture and Art.—The oldest surviving building in Florence is almost certainly the Battistero or Baptistery (S. Giovanni Battista), which is of disputed date, but it is probable that the present building is of the 11th or 12th century and replaced a much earlier one. Of other Romanesque churches one of the finest is S. Miniato al Monte, south of the city, which goes back to 1062, although most of it is somewhat later. These very classical buildings, with their peculiar striped appearance due to the decorative use of bands of white and dark gray-green marble, were a formative influence on the great outburst of architectural activity in Florence in the 13th to 15th centuries.



ALINARI

BAPTISTERY OF S. GIOVANNI, PROBABLY THE OLDEST SURVIVING BUILDING IN FLORENCE, DATING IN ITS PRESENT FORM FROM THE 11TH OR 12TH CENTURY

After 1250 a wave of church building arose and, at the same time, the Florentines began several large public buildings, including the Duomo or Sta. Maria del Fiore (the great cathedral begun in 1294 and not consecrated until 1436) which was regarded as a state enterprise. In the 14th century, the nuclei of building activity were centred on the cathedral and on the Palazzo Vecchio, or town hall.

The first great church to be built for one of the new orders was Sta. Maria Novella, the main Florentine church of the Dominicans. It represents an entirely new style, conditioned by French Gothic (and particularly by the Cistercian forms of it), but with far less verticality and with a spaciousness inherited from the classical and Romanesque churches. The spacious effect is probably also due to the fact that churches for the new orders were designed for huge congregations drawn by the preachers. The first plan of Sta. Maria Novella was made by 1246; it was a new kind of church designed for a new religious purpose in a new, Italian, Gothic style. Sta. Croce, at the opposite end of the city, was the headquarters of the rival Franciscan order and was reputedly designed by Arnolfo di Cambio (*q.v.*) from 1294–95. It is less ambitious architecturally than Sta. Maria Novella for it retains the traditional flat timber roof where Sta. Maria has stone vaults. Sta. Croce is notable for its wealth of Trecento frescoes, including those by Giotto (*q.v.*) decorating two chapels, and for the *quattrocento* and later tombs. Arnolfo also worked on the cathedral in 1300. He died soon afterward, and his plans were much enlarged, though little changed, by Francesco Talenti (1355–65). Between the times when Arnolfo and Talenti held the surveyorship it passed (1334–37) to Giotto on the strength of his painting rather than his architectural skill. He did not alter Arnolfo's plans but instead began the campanile, or bell tower, at the side of the west front. The crowning feature of the cathedral, and the great landmark for miles around, is the huge ribbed dome designed by Filippo Brunelleschi (*q.v.*). The dome (1420–36) was constructed entirely without centring. The opening is about 138½ ft. across (slightly larger than St. Peter's, Rome, and much larger than St. Paul's, London). The decoration of the cathedral occupied much of the 15th century and many of the finest sculptors worked on it, in particular, Donatello and Luca della Robbia (*qq.v.*) at the time when Lorenzo Ghiberti (*q.v.*) was occupied with his bronze doors for the Baptistery (1403–52). The main front of the cathedral remained incomplete until 1875 when the present neo-Gothic design was made by E. de Fabris.

The major public buildings erected in the 14th century were the Bargello (now the National Museum of Sculpture) and the Palazzo Vecchio, which as the seat of government was sufficiently fortified to withstand rioting. The 308-ft. bell tower, built out over the palazzo façade, carries the bell used as a city alarm. The palace (1298–1314) is attributed to Arnolfo. South of the palace the Loggia dei Lanzi was built as a public meeting place in 1376. The church of Or San Michele was originally a grain store but became the church of the guilds, which formed the political centre of Florence. On its façades are niches holding statues of the patron saints of the various guilds; many of these figures are among the most important examples of early 15th-century Florentine sculpture, including those by Ghiberti, Donatello, Nanni d'Antonio di Banco (d. 1421) and Andrea del Verrocchio (*q.v.*).

The Spedale degli Innocenti (the Foundling hospital) was the first hospital of its kind and is also an architectural landmark, as it was designed by Brunelleschi about 1419 and it, rather than the cathedral, is the first Renaissance building. It was finished by Brunelleschi's pupils while he turned to church building, his two main works being S. Lorenzo and (on the left bank) S. Spirito. Both are Latin cross designs (derived from traditional models such as Sta. Croce), disciplined by the mathematical proportion that was Brunelleschi's major contribution to Renaissance architecture.

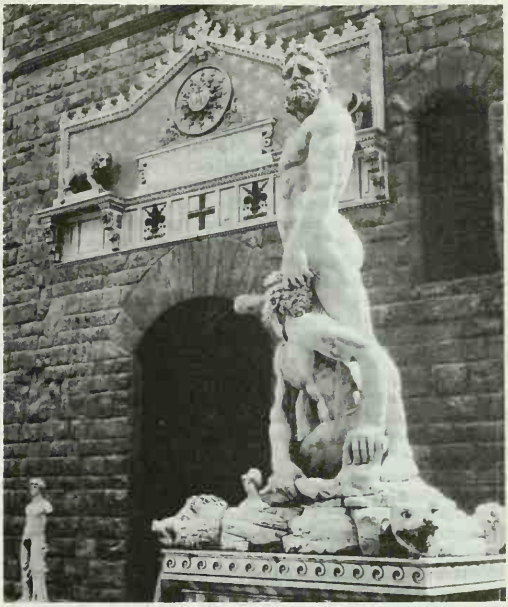
S. Lorenzo was the parish church of the Medici (*q.v.*), for which family Brunelleschi first built the Sagrestia Vecchia (old sacristy) at S. Lorenzo before rebuilding the church proper. The old sacristy is the burial place of several Medici and was one of the first Renaissance buildings on the central plan system. It is built as a cube surmounted by a hemispherical dome half the height of the cube. The decorations—which did not please Brunelleschi—were by his friend Donatello. In 1520, Michelangelo began the Sagrestia Nuova (new sacristy) as another Medici chapel in a style clearly based on Brunelleschi's old sacristy opposite. The later Medici commissioned a still larger funerary chapel behind the church choir and between the other two chapels: this (the "chapel of the princes") is by Matteo Nigetti and was begun in 1605. It is one of the least successful of the few baroque buildings in Florence. The cloister of S. Lorenzo contains the Biblioteca Laurenziana (Laurentian library), also by Michelangelo and one of his most important works in architecture.

Brunelleschi built S. Spirito, his last church design, as a revised edition of the ideas in S. Lorenzo. The only other important church on the left bank is Sta. Maria del Carmine, which is of interest because of the frescoes of Masaccio (*q.v.*), the foundation of *quattrocento* painting and the most important series painted in Florence since Giotto's in Sta. Croce.

Also on the left bank is the huge Palazzo Pitti, begun in the mid-15th century and implausibly attributed to Brunelleschi. It was soon greatly enlarged by Bartolommeo Ammanati (*q.v.*) as a residence for the Medici; other alterations were made later. It became the ducal residence after Cosimo I gave up living in the Palazzo Vecchio and for this reason it was connected with the Palazzo degli Uffizi (by Giorgio Vasari [*q.v.*] and others, 1560 onward), which housed the government offices, by a long corridor carried over the Arno on top of the Ponte Vecchio. The corridor was badly damaged during World War II, when the Germans destroyed all the old bridges save the Ponte Vecchio and also blew up the old quarters at both ends of it. After the war the Sta. Trinità and alla Carraia bridges were reconstructed according to the original plans, and the new Amerigo Vespucci bridge was built of prestressed concrete. Behind the Pitti palace, the Boboli gardens, among the largest and most splendid of Italian formal gardens, slope steeply up the hillside. At the top the Fortezza di Belvedere (1590) affords a breathtaking panorama of Florence.

The palaces of Florence shaped many of the western ideas of city living. The Florentines were among the first to revive the classical idea of great houses which combined warehouses and shops on the ground floor with apartments above. Usually the palace was built by a wealthy merchant (not noble) family, which had offices on the ground floor and lived on the cool, spacious floor immediately above (*piano nobile*); the upper floors, smaller and hotter, being rented or used for lodging employees and relatives. Many such palaces are still used for the same purposes by the families that built them. The Palazzo Davanzati, now a museum of furnishings, is a splendid example, built at the end of the 14th century. The finest examples are from the 15th century: the Palazzo Medici-Riccardi, by Michelozzo (*q.v.*); the Rucellai, by Leon Battista Alberti (*q.v.*); later palaces include the Pazzi-Quaratesi and Strozzi and the 16th century Palazzo Pandolfini designed by Raphael.

Cultural Institutions.—The Pitti and Uffizi are the two principal art galleries of Florence, containing an unsurpassed representation of Tuscan painting from the 13th to the 17th centuries and a fair representation of other Italian and foreign schools. Some early and less important works are also to be found in the Galleria dell'Accademia, the chief treasure of which is Michelangelo's famous statue "David." The main collection of Tuscan sculpture is, however, housed in the Bargello. Most of the numerous churches of Florence contain interesting paintings, but two must be mentioned specifically: S. Marco and SS. Annunziata. Both contain important frescoes; the former monastery of S. Marco is a museum dedicated to its two most famous inhabitants, Savonarola and Fra Angelico (*qq.v.*). Angelico painted the splendid series of frescoes on the walls.



AUTHENTICATED NEWS

MARBLE STATUE OF HERCULES AND CACUS BY BACCIO BANDINELLI (1493–1560), OUTSIDE THE PALAZZO DELLA SIGNORIA (PALAZZO VECCHIO), FLORENCE

Florence contains a total of 40 museums, for the most part devoted to works of art. Noteworthy, however, are the collection of ancient arms and armour in the Museo Stibbert, the exhibition of apparatus and instruments in the Museo Nazionale di Storia delle Scienze (National Museum of the History of Science) and the Museo degli Strumenti (Museum of Ancient Musical Instruments) in the Via degli Alfani. (P. J. My.)

Near Sta. Croce is the Biblioteca Nazionale Centrale (Central National Library) which since 1870 has received a copy of every book issued in Italy and contains about 4,000,000 items, including manuscripts and incunabula. The Laurentian library contains first editions and a collection of manuscripts, including richly ornamented missals, bibles and codices of great beauty. The Biblioteca Riccardiana adjoining the Palazzo Medici-Riccardi also contains valuable manuscripts. A famous international library is the Gabinetto Viesseux which belongs to the commune of Florence and is on the ground floor of the Strozzi palace. (*See* LIBRARY: *Italy*.)

The university is descended from the "Studio Fiorentino" founded in 1349, which Lorenzo de' Medici transferred to Pisa in 1472; there still remained in Florence the important study of medicine which led the scientific movement of the age, though the university was not legally constituted until 1923. Specialized learned institutions include an observatory; academies of fine arts, science and letters, agrarian economics and philology; institutes of Etruscan and Italic studies, of the history of art and of optics; an agrarian entomological station; the Italian Dante society, the Italian Botanical society and the Society for Geographical Studies.

Communications.—Florence lies on the most direct railway route (opened in 1934) between northern and southern Italy; this line runs through about 30 tunnels in the 60-mi. stretch to Bologna, including one of 11½ mi. under the Apennines north of Vernio. Lateral railways connect Florence with Pisa and Leghorn to the west and with Faenza and Ravenna to the northeast. The main trunk motorway, the Autostrada del Sole, passes west and south of the city, which is linked by another motorway with the coast road joining Pisa and Viareggio. The city is served by buses and trolley buses, with bus services radiating over the province and motor

coach services to Rome, Genoa and other cities. From the airport at Perétola, 6 km. (4 mi.) N.E., Florence is linked with Venice by daily air services, but most visitors traveling by air land at Pisa.

Industries.—The artistry of the Florentines accounts for their highly developed handicrafts, examples of which are displayed in the shops crowding the Ponte Vecchio and exhibited at the annual Craftsmen's fair each spring. These products include statuettes, art reproductions, gold and silver wares, Florentine mosaic (an *intarsia* of hard stones), ornamental glass and pottery, leatherwork (including gloves and shoes), furniture, wrought iron, embroidered linen and plaited straw goods. By the 1960s Florence had become an influential centre of women's fashions and the fashion shows staged in the Pitti palace attracted numerous buyers from the western world. With about 70,000 industrial workers, the city is not a major manufacturing centre, most of its factories being in the northern suburb of Rifredi, with glass, foodstuffs, clothing, machinery (precision instruments and oil-drilling equipment), bicycles, plastics, soap, pharmaceuticals and furniture as the chief products.

A very large part in the economy is played by tourism. The beauty of the city and the renown of its artistic treasures combined with its cultural activities draw increasing numbers and by the 1960s Florence had an annual average of nearly 1,000,000 visitors, the greatest number coming from the U.S. Periodical events are the *Scoppia del carro* ("bursting of the cart") on Easter day, when a cart laden with fireworks is ignited before the cathedral by a rocket shaped like a dove which descends on a string from the high altar; the Maggio musicale, the annual May festival of music, with concerts, opera performances and ballets; the biennial Antique Dealers' fair; the horticultural show held with the Craftsmen's fair; the medieval pageantry, processions and fireworks displays on June 24, the feast of St. John the Baptist (the city's patron saint); and the Festa delle Rificolone in September with a regatta on the Arno. Numerous artistic and musical conventions and performances are held, as well as fashion parades and exhibitions.

Firenze Province rises to the north and east of the city toward the steep wooded slopes of the Apennines, reaching 5,426 ft. in Mt. Falterona. To the south gentler slopes, often planted with vines, rise toward the Chianti hills. The fertile vale of the Arno widens west of the city. The population (1961 census) is 1,010,291 and the area 150 sq.mi. The plain and hills surrounding Florence produce wheat, maize (corn), olives, wine and fruit. Flowers are an important product of the district. The chief non-fruit-bearing trees are the pine, cypress, ilex and poplar, with forests of beech, oak and chestnut in the upper valley of the Arno around Vallombrosa. Forestry is of importance in the upland areas, and with agriculture employs nearly 30% of the total population. The chief industrial centres are Prato, one of the major European producers of wool textiles; Empoli, a town 33 km. (20½ mi.) W. of Florence producing matches, glass, clothing and woodwork; and the region of Sesto Fiorentino, whose chief products are ceramics, porcelain and chemicals. Fiesole, an attractive hill town, lies 8 km. (5 mi.) N.E. of Florence. The great Florentine genius Leonardo da Vinci was born at Vinci, 11 km. (7 mi.) N. of Empoli. The province contains a number of pleasant summer resorts, mostly small towns or villages in the valleys north and east of Florence. U.S. military cemeteries of World War II are at Castelfiorentino, 29 km. (18 mi.) S.W. of Florence, and Le Tavarnuzze, 10 km. (6 mi.) S. of Florence; the British military cemeteries are at Fiesole and to the east of the city near Rovezzano. (X.)

HISTORY

Origins.—Florentia was founded by the Romans at the foot of the hill on which stood the Etruscan town of Faesulae (Fiesole, *q.v.*), seat of a *lucumo*, or Etruscan chief.

Some say that, in the valley of the river Arno, which at that time was marshy, due to the branching of the river in various streams, a Florentia of Etruscan origin already existed, founded about 200 B.C. This town is supposed to have been an outpost of Faesulae and to have shared a common political destiny in its relations with Rome, until it was destroyed by Sulla in 82 B.C. as a result of the Social Wars. Such a thesis seems however disproved by the fact that the Florentine plain has not preserved relics of Etruscan dwellings, and that Florus' reference to the "municipia splendidissima" (Epitomae ii, 9) does not concern Florence. Some large Etruscan tumuli tombs of earlier times are to be found on the hill slopes north of the plain, while in the centre of the city, sepulchres of Villanovian times have been discovered which bear witness to a settlement of prehistoric Italian peoples that was probably abandoned after the 8th century B.C.

The Florentia that has come down through history was instead a colony of Julius Caesar's veterans, assigned according to the *Lex Julia Agraria* passed in 59 B.C.; a further similar assignment of land took place under the triumvirate of Octavius (*Liber coloniarum: "Colonia Florentina deducta a triumviris, adsignata lege Julia centuriae caesarianae"*). The name Florentia (*i.e.*, town of flowers) was probably chosen as an augury and the city did in fact flourish, growing in importance also because the roads from east to west, along the Arno valley, and from north to south, across the valley, were extended through the city. A permanent bridge a little upstream of the present Ponte Vecchio was built across the river at the beginning of the 1st century A.D.

The Roman Town.—The Roman township took the form of a rectangular *castrum*, or defended garrison town, traversed by two wide straight streets: the *cardo maximus* stretching from north to south, and the longer *decumanus* from east to west. The walls were of brick, with four gates reinforced by cylindrical towers. The layout of the *castrum* is still evident in the plan of the centre of the town. The roads formed a network of 48 rectangular *insulae*, the central one, exposed and paved with marble, constituting the forum and flanked by the *Capitolium*, the temple dedicated to the three chief divinities. The city contained *thermae*, or baths, a theatre (beside the southeastern wall) and a large amphitheatre arising outside the eastern walls where the still existing medieval streets follow an elliptical course. On the *mundus*, the centre of the city, at the crossing of the *cardo maximus* and the *decumanus*, the Column of the Market, or of Abundance, was later set up: it was replaced in its original position in 1956.

Florentia is mentioned by Pliny the Elder and Tacitus records a protest to the Roman senate against a project to divert the waters of the Chiana toward the Arno (because of the threat of flood the city had arisen at some distance from the river). In the 3rd century A.D. it was sufficiently important to be chosen as the seat of the *corrector Italiae*, governor of Italia (one of the provinces into which the peninsula had been divided). Commerce and craftsmanship, favoured by an abundant water supply, brought prosperity; numerous eastern travelers and merchants took up residence there, in the suburb on the south bank of the Arno.

Christianity.—Christian teaching first spread from the *suburbium*, and Christian cemeteries were planted north of the walls and on the other side of the river, near the first churches, S. Lorenzo and Sta. Felicita. St. Miniatus, martyred under the persecution of Decius (250), was buried on the summit of Mons Florentinus and venerated there, hence the church dedicated to S. Miniato al Monte. In 313 a bishop (Felice) is first mentioned; in 393 St. Ambrose of Milan came to Florence to consecrate the church of S. Lorenzo, outside the northern city walls. This was the bishopric of St. Zenobius (4th–5th century).

Subjugation by Goths, Byzantines and Lombards.—In 405 the Ostrogoths of Radagaisus besieged Florence and were defeated with heavy losses in a fierce battle (Aug. 23, 405) by the imperial general Stilicho and his army of Romans, Visigoths and Hun horsemen. Events during the town's subsequent domination in turn by Goths, Byzantines (539) and Lombards (*c.* 570) are obscure: the only centres of surviving civilization were the monasteries, which are among the most ancient recorded. Florence was the seat of a *curtis regia*, or administration of the crown estates, with a Lombard duke, the last of whom was Gudibrandus (780–790), and enjoyed a renewed vitality during the Carolingian period. Legend later attributed to Charlemagne the town's reconstruction and the Florentine nobility commonly traced their origin back to his time. Charlemagne halted there on his return

journey from Rome, in 780 and later at Christmas 786. Several churches (the Baptistery of S. Giovanni being already constructed) date back to Carolingian times, while in 825 (Capitulary of Olona) Florence was chosen as one of the eight centres of theological teaching in Italy. It was the capital of a *comitatus*, or military countship.

Margraviate.—During the transition from the Carolingian to the Saxon empire, Tuscany was a margraviate under a margrave count of Florence. Among the margraves were Hubert, who founded the Benedictine abbey—the Badia—of Florence; and, above all, his son the margrave Hugh of Brandenburg (*c.* 970) (the anniversary of whose death in 1001 is still celebrated in Florence), who, fixing his seat in Florence, endowed churches and monasteries generously and also benefited the population. At that time flourished the fervent spiritual teaching of St. John Gualbert (995–1073), founder of the abbey and order of Vallombrosa, reformer of ecclesiastical life and inspirer of a new sense of civic consciousness in the population (*see* VALLOMBROSIANS).

Progress toward political and administrative autonomy became more evident under the rule of the Countess Matilda (*q.v.*; 1046–1115), daughter of Boniface of Canossa (margrave of Tuscany 1027–1052) and ally of Pope Gregory VII in the conflict with the emperor Henry IV of Saxony over lay investiture. Henry unsuccessfully besieged Florence which remained loyal to Matilda. In 1082 members of the Florentine nobility (*boni homines* or *sapientes*) took part in public life and administration and, with the loosening of feudal ties after the death of the countess, the population began to organize itself into autonomous groups, often attached to parish churches. The authority of the bishops and of the *vices domini*, administrators of the diocese, became more important than that of the imperial representatives, or *gastaldi*.

Between the 11th and 12th centuries the first period of Florentine art made its appearance in the Romanesque architecture of churches (S. Miniato al Monte, S. Salvatore, the Baptistery, Badia Fiesolana, SS. Apostoli, S. Iacopo Soprarno). Artisan and mercantile activity prospered and the main highway from the north to Rome was built through Florence.

The Growth of the Comune.—The territorial expansion of the city under the *comune* (*see* COMMUNE [MEDIEVAL]), to the disadvantage of the feudal lords and of the cities bound to the emperor, led to a series of successful wars against castles of powerful families in the *contado*, or surrounding country (Alberti, Adimari, Ubaldini, Cadolingi, Guidi, Ormanni, Buondelmonti). Prato was seized (1107), Fiesole was destroyed (1125) and an outlet toward the sea was sought which involved wars against Lucca. These aggressive actions were unsuccessfully condemned by papal interdictions. In 1138 the civic authority of the consuls (from six to eight) was established. They were assisted by a council of 100 *boni homines*, but the consular appointments became contended for by the *grandi*, noblemen then resident in the town, forming the *consorterie delle torri*. The emperor Frederick I Barbarossa tried to re-establish a rigid feudal system in Tuscany: he made San Miniato, near Pisa, the centre of imperial administration for the collection of feudal dues (*regalie*). But his legate, Archbishop Christian of Mainz, allied to Siena and Lucca, was defeated by the Pisans near the Serchio and by the Florentines at Colle di Val d'Elsa (1173). Henry VI later recognized the actual state of the rights of Florence over the *contado* (1187). The city henceforth gained supremacy over the others of Tuscany; after 1170, a new circuit of walls was built, skirting the Arno and including the *borghi*, districts of craftsmen and merchants that stretched along the main roads. Soon, though, even this circuit was overtaken by the rapid increase of building: a fresh zone was made to encompass the districts south of the Arno.

Continual struggles of the Alberti and Uberti families against the consular regime led to the institution of a supreme authority, or *podestà*. This was at first desultory (1185), entrusted to notable citizens, later (1193) regular and, from 1207, was reserved to foreigners. The Tuscan league (1197), formed by various cities in opposition to the emperor, contributed further to the expansion and growing strength of Florence.

Guelphs and Ghibellines.—The rivalry which had been latent for some time between the principal families of the town became an open struggle at Easter 1215, with the assassination of Buondelmonte dei Buondelmonti by representatives of the oldest feudal nobility (Amidei, Alberti, Uberti, Lamberti and Arrighi). As the city government supported the emperor Otto IV, the culprits escaped justice by espousing the cause of the rival emperor Frederick II of Swabia, who would not recognize communal autonomies. They formed the "party of the Ghibelline," opposed to the "party of the Guelph" prevalent in the city government. At first the two parties were equally powerful, and the city continued its policy of expansion at the expense of Pisa, Pistoria and Siena, increasing its trade and building new monuments. Churches, monasteries and hospices arose as a result of Franciscan and Dominican popular preaching encouraging new fervour among the *popolo minuto*, that is, the working classes of labourers and small craftsmen.

The political success of Frederick II (victory of Cortenuova against the Lombard league, 1237) favoured the supremacy of the Ghibellines in Florence. His excommunication by Gregory IX (1239) clarified the position of the two parties: but the Guelphs of Florence had to leave the city (1239) and were defeated at Signa by the Ghibellines and the imperial troops. A Ghibelline signory (*signoria*) came to power in Florence, the *podestà* being appointed by the emperor, while further turmoil was caused by the religious controversy against the Paterine heretics and by the anti-Ghibelline preaching (1244–45) of St. Peter Martyr of Verona. The Ghibelline government having become despotic, a violent uprising of the citizens followed. Frederick of Antioch, a bastard son of Frederick II, had been elected *podestà* (1246) and intervened with 1,600 German horsemen, compelling the Guelphs to leave the city again (1248). There followed the first example of mass exile, with destruction of houses and confiscation of properties, but the death of Frederick II (1250) and the decline of Swabian power rapidly weakened the Ghibelline party. (*See* also GUELPHS AND GHIBELLINES.)

The First Democracy (Il primo popolo).—Several *boni homines* of the middle class, representing the interests of the merchants and craftsmen of the city guilds, established in 1250 alongside the authority of the *podestà* and his council, a *capitano del popolo* (captain of the people) assisted by 12 elders and two councils. He was head of the military force of the 20 companies of *popolani*. The symbol of the *popolo* (people or democracy) was the lion, and the residence of the *capitano* the Bargello palace. In 1252 the gold florin was minted; it became the most valuable currency in Europe and an extremely efficient instrument in trade and banking relations between Florence and other countries. But the power of the Guelph city aroused the antagonism of almost all the Tuscan towns, encouraged by exiled Ghibellines. After some partial successes, the intrigues of Cardinal Ubaldini, the energetic conduct of the exiles backed by Frederick II's son Manfred, king of Sicily, and the intemperance of some of the citizens led the Guelphs of the *primo popolo* to a terrible defeat, at Montaperti (Sept. 4, 1260). Count Guido Novello of Poppi became the new *podestà*, imposed on Florence by Manfred. The constitution of the *popolo* was repealed, the Guelphs were exiled en masse and their houses were destroyed. Some even proposed razing the entire city: but Farinata degli Uberti, head of the Ghibelline nobles, opposed such an extreme measure.

The Guilds.—Charles I of Anjou in alliance with the French pope Clement IV descended into Italy and defeated and slew Manfred at Benevento in 1266; Ghibelline domination of Florence ended. Attempts at reconciliation were made by the popes Clement IV and Gregory X, but the Guelph party prevailed favouring the ambitious Charles of Anjou. The government was reorganized, and the *capitano del popolo* replaced by the *capitano di parte Guelfa*. Pope Nicholas III, being anxious to maintain the balance of power between the French king and the emperor Rudolf of Habsburg, sent his nephew Cardinal Latino Frangipani Malabranca in 1279 as peacemaker. The cardinal established a government consisting of two supreme magistrates, *podestà* and *capitano* (*conservator pacis* or keeper of the peace), two councils and a general council of 100. Of the 14 *boni homines*, actual arbiters of the city, 8 were to be Guelph and 6 Ghibelline.

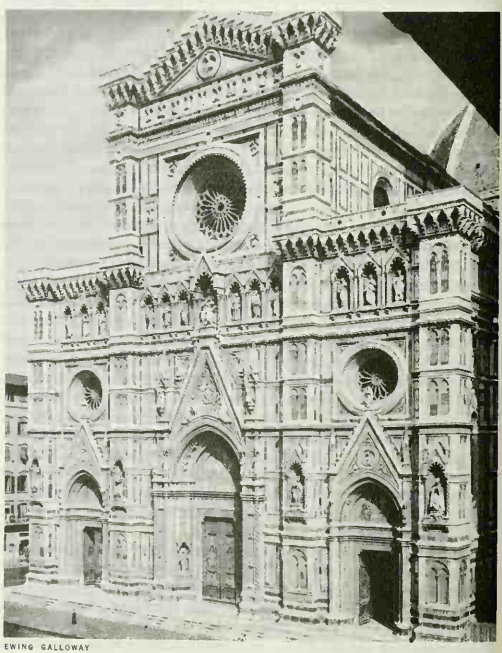
In the meantime, the city guilds (*Arti*), with their statutes for trade organization and social assistance, acquired an ever increasing importance above party politics. The consuls of the seven greater guilds, wise and influential citizens, were chosen, six in number, to assist the *conservator pacis*, now become *defensor Artificum et Artium*. They were called *priori* (presidents) and had their first seat in the Torre della Castagna. Their political importance grew rapidly, and later the consuls of the five middle guilds were also admitted to the government. As a result, the republic fell into the hands of the *popolani grassi*, that is, the wealthy middle class. During this period Florence continued its struggle for supremacy over the Ghibelline towns, such as Pisa with which peace was made in 1293, and Arezzo, defeated in 1289 at Campaldino (a battle in which the young Dante is said to have taken part).

The Ordinances of Justice.—In order to limit still further the power of the nobles, or magnates, and to promote more thoroughgoing social justice and in recognition of the growing predominance acquired by the guilds in the life of the city, Giano della Bella, a nobleman who upheld popular rights, passed in 1293 the *Ordinamenti di Giustizia*, or Ordinances of Justice, which opened public offices also to the nine lesser guilds and excluded the nobles from the signory. A new magistrate, the *gonfaloniere di giustizia*, was created as the supreme civic authority to enforce this law with the power to take severe measures against the nobles. But the latter, Corso Donati in particular, incited the people against Giano and forced him to exile (1295). They did not, however, succeed in repealing the *Ordinamenti di Giustizia*, which always remained, with slight modifications, the basis of the city's political and democratic life. In those same years was begun the construction (1298) of the Palazzo dei Priori, later called Palazzo della Signoria; and many prosperous artisan boroughs were founded by the Florentines in the *contado*, almost in defiance of the surviving feuds.

The Whites and the Blacks.—In May 1300, the rivalry, long latent between the factions striving for power, came to a head with the fights of the Donati against the Cerchi. The Guelphs sided with the former, being called Blacks (*Neri*); those discontented with the government and favouring Ghibelline tendencies joined the latter and were called Whites (*Bianchi*). Pope Boniface VIII sent Cardinal d'Acquasparta to try to reconcile the two parties, but in reality he favoured the Blacks, who invoked the intervention of Charles of Valois, brother of the king of Naples. The signory of which Dante was member as a *priore* decreed the exile of the heads of both factions. This solution caused much discontent, and when Charles of Valois reached Florence (1301), the government was overthrown and the Whites severely repressed by the *podestà*, Cante dei Gabrielli, who confiscated their property and exiled them. Among the exiles were Dante Alighieri (1301) and Ser Pietro di Ser Parenzo of Incisa, the father of Petrarch. Joining the previously exiled Ghibellines, the Whites tried in vain to re-enter the city, where the Black party had split into two factions, *Donateschi* and *Tosinghi*, that is, nobles and *popolani*. The latter prevailed, and the old and haughty Corso Donati was killed (1308). The descent into Italy (1310) of Henry VII of Luxemburg, whom the pope crowned emperor, raised the hopes of the exiles: but Florence, supported by other Guelph cities and the king of Naples, firmly defied the new emperor, who abandoned an attempt to besiege the city in 1312 and died soon after.

Meanwhile the city flourished and another exceptionally large wall was built around it, on both sides of the Arno. The greatest medieval architect, Arnolfo di Cambio (1232–1301), contributed to the building of this wall. His name is also associated with the building of the Palazzo dei Priori and the great new cathedral of Sta. Maria del Fiore. Other great churches in Gothic style were Sta. Croce, Sta. Maria Novella, Sta. Trinita, Sta. Maria Maggiore. The revival of sculpture took place with Arnolfo himself, the Pisan Andrea da Pontedera and the Sienese Tino di Camaino. Andrea Tafi, Gaddo Gaddi, Cimabue and especially Giotto (1266–1336) excelled in painting: in literature, Brunetto Latini, Guido Cavalcanti, the poets of the *Dolce Stil Novo* (sweet new style) and above all Dante Alighieri (1265–1321). With Dino Compagni and Giovanni Villani historical prose was born in Florence; the common Tuscan tongue of Florence acquired the dignity and importance of a national language. The guilds prospered, in particular the wool and silk guilds and the *Calimala* (merchants' guild). Florentine bankers were the most powerful and important in Europe, often at the service of foreign kingdoms.

The 14th Century.—The struggles with the empire having come to an end, Florence had to deal with a difficult local problem arising from the increasing power of the Ghibelline signoria of Pisa, ruled by Uguccione della Faggiuola, and of Lucca, where Castruccio Castracani (*q.v.*) had become lord. The Florentine *comune* therefore sought the assistance of powerful protectors, such as Robert of Anjou, king of Naples, appointed *signore* from 1313. He did not succeed in avoiding the Guelph defeat at Montecatini (1315), and the consequent imposition, on the part of the discontented population, headed by Simone della Tosa, of a *bargello* (head of the city police), first represented by Lando da Gubbio, who was the ruthless instrument of repression. The *Ordinamenti di Giustizia* were strengthened, and King Robert's lordship was no longer renewed. The officers were drawn by lot to avoid plots and riots. Castruccio Castracani defeated the Florentines at Altopascio (1325) and advanced, destroying everything up to the walls of the city. In order to cope with him the town entrusted absolute lordship to Charles of Calabria (1326), who obtained handsome rewards but did not achieve any success in war. Castruccio's death (1328) liberated Florence from the nightmare of destruction at the hands of the great leader; the death of Charles of Calabria, soon after, put an end to his overbearing government. The *comune* modified its constitution, creating a council of 98 members, which included a wider representation of the various classes and was responsible for choosing the public officers. The four preceding councils became two, that of the *podestà* and of the *popolo*. The three highest authorities were the *podestà*, the *capitano* and the *gonfaloniere di giustizia*. It was then possible to resume the policy of territorial expansion: through



EWING GALLOWAY

FAÇADE OF STA. MARIA DEL FIORE, THE CATHEDRAL OF FLORENCE, BEGUN IN THE 13TH CENTURY, COMPLETED LATE 19TH CENTURY

battles or transactions Florence obtained Pistoia (1331), Cortona (1332), Arezzo (1337) and Colle di Val d'Elsa (1338). But it was confronted by heavy internal difficulties: the bankruptcy of the great banks of the Bardi and Peruzzi (1339) resulted in the collapse of the town economy; famine and plague brought poverty and discontent, and caused disagreement among the nobles and the people once more; and finally an unsuccessful campaign against Lucca and the Della Scala of Verona forced the *signoria* into offering the command of the city again to a foreigner, Walter de Brienne, duke of Athens, acclaimed *conservatore del popolo* and captain of the army (1342). The nobles hoped to secure through him the abolition of the democratic *Ordinamenti di Giustizia*, but these were nevertheless maintained by the duke, who was eager to win the support of the increasingly significant *popolo minuto*. The discontented nobles, the *popolo grasso* and the clergy stirred up the city against the duke's tyrannical rule compelling him to leave (July 26, 1343). The *grandi*, taking credit for this liberation, repealed the *Ordinamenti* and formed a mixed government of nobles and *popolo*. But the working classes, or *popolo minuto*, conscious of their own strength and civil rights, rebelled violently and obtained the restoration of the *Ordinamenti*, from a signory composed of members from all 21 guilds, and excluding the nobles (1343).

The Parte Guelfa.—The economic difficulties of the *comune*, the depopulation caused by the Black Death (1348) and unceasing rivalries among citizens, favoured the reactionary politics of the *parte Guelfa*, which sought to maintain the privileges of the *popolo grasso* in alliance with the nobles. The political rights of the *popolo minuto* were restricted to the city and not extended to the *contado* and the other subservient towns; an attempt was made to reduce the 21 guilds whose members were eligible for the government to 14, with the exclusion of those persons who did not swear allegiance to the party or who were secretly accused of *"Ghibellinism"* (1358). Finally, under Lapo da Castiglionchio (1372), the *comune* was linked with the party, which was entitled to approve measures for discussion. On the other hand, a new council, the *dieci di libertà*, was appointed to secure public order: it consisted of nobles, *popolani grassi* and *popolani minuti*. Armed conflicts were often fomented by the ambitions of powerful families such as the Ricci and the Albizzi.

Meanwhile Florence regained its supremacy over various towns: Prato was bought, Pisa economically subdued through the terms of the peace of 1364 and San Miniato conquered; the threat of Giovanni Visconti, lord and archbishop of Milan, who had acquired Bologna and was menacing Tuscany, was successfully resisted with the agreement of the Guelph emperor, Charles IV. Among the mercenary captains in the services of the republic at that time was the English *condottiere* Sir John Hawkwood. In 1375 a long territorial war was begun against the pope at Avignon, Gregory XI, whose legate at Bologna, Cardinal Guillaume de Noellet, threatened Florence as well as other Tuscan cities, which then became allies of Florence and of Bernabò Visconti of Milan. A new committee was created: the *Otto di guerra* (the Eight of War), called the "Eight Saints," in defiance of the pope. Ignoring the interdiction of Gregory XI, Florence carried on its war, in which Caterina Benincasa (afterward St. Catherine of Siena) intervened in vain as a peacemaker. After his return to Italy, pope Urban VI finally signed peace in 1378.

The Ciompi.—The *parte guelfa* tried to use the *Otto di guerra* as a weapon against the democratic *comune*, but the *popolo* secured the election of Salvestro dei Medici as *gonfaloniere* against Lapo da Castiglionchio and Piero degli Albizzi (1378). Salvestro's resignation caused an uprising of the population, in particular of the *ciompi*, the lowest class of labourers and wage earners, deprived of political rights. The *ciompi*, or "people of God," had been restless for some time: they rioted on July 21, 1378, and led by the carder Michele di Lando they occupied the Palazzo dei Priori. The signory was overthrown and a strongly demagogic government established with Michele di Lando as *gonfaloniere*. Three new guilds were added to the previous ones, and three of the nine *priori* had to be members. But this aroused a reaction in defense of the integrity of the *comune* on the part of the greater guilds and in response the *ciompi* set up the *Otto di Sta. Maria Novella*, as a rival revolutionary government. Michele de Lando himself contributed to the repression of the radical *ciompi*, who were isolated and persecuted, and their guild suppressed. The government of the other two workers guilds, the *Tintori* and the *Farsettai*, who had renounced the radical *ciompi*, lasted till 1382: then the greater guilds regained the upper hand, in the interest of the privileged classes of merchants and bankers. Michele di Lando was exiled, and the attempt of the *ciompi* to lead the government concluded the cycle of the democratic and corporate *comune*, which was already approaching its end.

The Oligarchy.—Under the supremacy of the greater guilds and of the most powerful families among their members, the government of Florence proceeded toward a mercantile oligarchy. The *popolani* were excluded from the ballots and the number of eligible candidates from eminent families (Strozzi, Pitti, Pazzi, Albizzi, Antinori, Peruzzi, Rucellai, Tornabuoni, Sassetti) enrolled in the guilds merely for political convenience multiplied. Those like Donato Acciaiuoli and Alemanno dei Medici, son of Salvestro, who opposed this gradual suppression of democratic rights were banished. The main contestants for supremacy were the Albizzi and the Alberti: when Benedetto Alberti was exiled in 1387, Maso degli Albizzi, an influential member of the wool guild—the wealthiest of the city—was the most powerful citizen left. Elected *gonfaloniere* in 1393, he was the arbiter of political life in Florence for almost 30 years, together with his wise counselors Gino Capponi and Niccolò da Uzzano.

That authority should be retained by a few seemed justified by the precarious state of foreign affairs; a most serious threat to Florence was the powerful Gian Galeazzo Visconti of Milan, who aimed to possess himself of central Italy with the help of a strong army. Niccolò da Uzzano made an alliance with Venice, while Charles VI of France intervened in Lombardy. Visconti's death relieved Florence of danger, and the republic was able, after vicissitudes of fortune, to conquer Pisa in 1406 by cutting off that city's provisions and by coming to a secret understanding with the Pisan Gambacorta. Thereby Florence had won an outlet to the sea, indispensible to the mercantile economy then dominated by the silk guild. In 1421 Leghorn also was bought, and for its own fleet Florence created the *consoli del mare* (consuls of the sea).

About the end of the Great Schism, Florence took the side of the antipope Alexander V, elected by the schismatic council of Pisa (1408); then that of his successor John XXIII (Baldassarre Cossa, who died in Florence in 1419) from whom the republic acquired Cortona in 1414. Another war was planned against Ladislas of Anjou, king of Naples, who marched on Florence, but died in 1414 before reaching it. Later, an attempt to conquer Lucca (1429–33), against Paolo Guinigi, proved unsuccessful.

The city enjoyed a further period of artistic and literary splendour. Contemporary with the great Tuscan artists of the 14th century were Petrarch (1304–74) and Giovanni Boccaccio (1313–75) in literature; Andrea Orcagna (1344–68), Francesco Talenti, Andrea di Bonaiuto in the figurative arts. The era of the Renaissance began ushered in by the architects Filippo Brunelleschi (1377–1446), Leon Battista Alberti and Michelozzo Michelozzi; the sculptors Donatello (1386–1466), Lorenzo Ghiberti, Nanni d'Antonio di Banco and the Della Robbias; the painters Masaccio (1401–28), Paolo Uccello, Beato Angelico and Filippo Lippi. There was a revival of culture and science in the monasteries and in their libraries humanism was born with Marsilio Ficino, Coluccio Salutati, Poggio Bracciolini, Niccolò Niccoli and others. Alongside the severe, closed medieval dwellings, noble palaces (Antinori, Medici-Riccardi, Pitti, Rucellai, Pazzi-Quaratesi, Strozzi) and elegant churches (S. Lorenzo, Santo Spirito, S. Marco, Cappella dei Pazzi, Spedale degli Innocenti) arose. Manners became more elaborate and refined, feasts more frequent; a new interest was taken in music and singing, and a new importance given to feminine fashion and to the elegance of women.

Ascendancy of the Medici.—Maso degli Albizzi died in 1417 and was succeeded by his son Rinaldo. In the meantime, Giovanni dei Medici (1360–1429) had rapidly gained economic power and

prestige in the city: as a banker and moneylender he had accumulated a large fortune, which he administered wisely, without taking part in public life. Elected *gonfaloniere* in 1421, he gained further popularity by opposing Rinaldo degli Albizzi's attempt to suppress the last four lesser guilds, a measure of no real political interest in a city whose old republican institutions were now almost void of significance. Moreover, he fostered the alliance of Florence with Venice, against Milan and Naples. His son Cosimo (1389–1464), more ambitious than his father, cultured, clever and very wealthy, inevitably attracted the rivalry of Rinaldo degli Albizzi, who feared the decline of his own house. Having seized him through treachery Rinaldo imprisoned Cosimo and had him condemned by the signory to ten years exile in Padua in 1432. Attempts were made to bankrupt him, but his bank proved stable and the Medici gained further esteem and popularity. Pope Eugenius IV, who resided in Florence, also intervened on his behalf and the signory soon recalled Cosimo from exile and exiled Rinaldo degli Albizzi instead. Cosimo returned to Florence in 1434 and his adversary left, never to return.

The city was then ripe for government by a single ruler, and with the return of Cosimo who was later to be called *Pater Patriae* (father of his country), the history of the Medici family was to be, for the next three centuries, the history of Florence and Tuscany. (*See* MEDICI.)

Cosimo's rule was always concealed and never public, as he refused all titles of command. His most efficient weapon was the financial one, which he used mercilessly to strike his apparent or likely enemies, ruining them by means of a system of progressive taxation (*decima scalata*), to the benefit of the lower classes. A wise administrator of his wealth, he patronized artists, writers and scholars, and successfully made war on the duke Filippo Maria Visconti of Milan whom he defeated at the battle of Anghiari in 1440, but later made an alliance with his successor, Francesco Sforza.

After his death Cosimo was succeeded by his son Piero (1416–1469), called the *Gottoso* (gouty), who in spite of his infirmity and short rule, acted with energy, and also with magnanimity, against his opponents Luca Pitti and Niccolò Soderini. Upon his death, the government of the city went to his elder son Lorenzo (1449–92). He, together with his brother Giuliano (1453–78) until the latter was killed in the Pazzi conspiracy, was the city's resplendent leader, patron of artists and men of letters; yet the only title he accepted was that of *magnifico signore*. His skilful diplomacy ensured peace and political balance among the Italian states in spite of the threats of foreign powers.

The Expulsion and Return of the Medici.—An anti-Medicean reaction headed by the fervent Dominican preaching friar Girolamo Savonarola (*q.v.;* 1452–98) started during the last years of Lorenzo's life. After the death of Lorenzo his son Piero (1472–1503) was forced to leave Florence, after yielding to the demands of the invading Charles VIII of France. A republic of strongly religious character dominated by Savonarola was established in 1494. In the arena of Italian and foreign politics, opposed by supporters of the Medici, the austere Savonarolan republic led a troubled existence: it succumbed, and the Dominican friar himself was imprisoned and executed in 1498. After the ecumenical Council of Pisa (1510), the Medici returned to Florence, backed by the Spanish army (1512), with Lorenzo's two sons Giuliano (1479–1516) and Giovanni (1475–1521; the future Pope Leo X), and Lorenzo's grandson Lorenzo II, duke of Urbino (1492–1519). After the election of Cardinal Giulio dei Medici (illegitimate son of Giuliano, Lorenzo's brother) as Pope Clement VII (1523), the city overthrew the despotic regency of Cardinal Silvio Passerini, expelling once more the younger Medicis, Ippolito (1511–35), illegitimate son of Giuliano, and Alessandro (1511–37), illegitimate son of Lorenzo II, and proclaiming the republic (1527).

The Later Medici.—Florence, allied to Francis I of France, was besieged by a strong imperial army of Germans and Spaniards and the republic was compelled to surrender in 1530. Alessandro dei Medici re-entered the city in 1531. He became the first duke, but soon after was murdered by his cousin Lorenzino. His place was taken by Cosimo I (1519–74), son of *condottiere* Giovanni delle Bande Nere; belonging to a lateral branch of the family. Created grand duke in 1569, he united almost all Tuscany under his rule, governing with ability and firmness. His rule ushered in a long period of peace and Florence, as the capital of Tuscany, enjoyed once more splendour and prosperity while members of the family married into some of the principal royal houses in Europe.

Cosimo was succeeded by his son Francesco I (1541–87), a genial man of disorderly life. After his sudden death, his brother Ferdinand I (1549–1609) continued his work, encouraging the arts, commerce and industry; he made Leghorn the most important Tuscan port, and began the draining of the Fucecchio and Maremma marshes.

Ferdinand was succeeded by his son Cosimo II (1590–1621) and by his grandson Ferdinand II (1610–70). Both lacked great political qualities but were patrons of science and scientific academies. The son and successor of Ferdinand II was Cosimo III (1642–1723), who, though unhappy in his dynastic marriage to Marguerite Louise d'Orléans, was an upright and pious ruler; compelled to accept the policy of the great powers, he succeeded however in ensuring a certain autonomy to Tuscany. His son, the skeptic, dissipated, sickly Giovan Gastone (1671–1737), died without heirs and the dynasty became extinct, while his sister, Anna Maria Ludovica (1667–1743), married to William of Neuburg, elector palatine, left the legacy of her family's art treasures to Florence.

The Grand Dukes of Lorraine.—In conformity with the wishes of the emperor Charles VI the Tuscan grand duchy was assigned under the treaty of Vienna (1735) to Francis, duke of Lorraine, who became husband of Maria Theresa of Austria in 1736, grand duke of Tuscany in 1737 and later, in 1745, Holy Roman emperor. For almost 30 years Florence was governed by foreign regents, who tried to introduce reforms, limiting the privileges of the feudal nobles and those of the clergy, and making the civil jurisdiction uniform. Florence, however, suffered severe spoliation, particularly under the regency of the count Emanuele de Richecourt and of Marshal Antoniotto Botta-Adorno. In 1765, the younger brother of Francis I, Leopold I (1745–92), became grand duke. This energetic ruler undertook vast and important reforms, reclaiming the land of the Maremma and executing major public works. He applied the economic theories of English liberalism, and gave Tuscany the most modern and daring constitution of the times. He abolished capital punishment, torture, and the confiscation of property and completely reformed the administration of justice. In his ecclesiastical policy, he tried to subdue the Tuscan church to the lay state, limiting the prerogatives of the clergy and supporting the bishop Scipione de' Ricci and Tuscan Jansenism (synod of Pistoia, 1786). But this policy, together with economic difficulties, caused discontent among the people, and when Leopold ascended the Austrian throne (1790) his son Ferdinand III, who succeeded him in the grand duchy, had to abolish many of his father's reforms.

The 19th Century.—In spite of the proclaimed neutrality of Tuscany, during the French Revolution, the troops of General Gualtier entered Florence in 1799, and Ferdinand fled to Austria. French occupation was opposed by the popular and Catholic movements of the so-called *"Viva Maria!"* and left Tuscany impoverished and in disorder. In 1801, by the treaty of Lunéville, Tuscany was taken away from Ferdinand III and handed to Ludovico of Bourbon, duke of Parma. After the latter's death (1803), it passed to his son Carlo Ludovico, under the regency of his mother Maria Luisa. During the French first empire, Elisa Baciocchi, sister of Napoleon, was created grand duchess (1809) and tried to revive in Florence the splendour of a princely court. The fall of Napoleon compelled the grand duchess to abandon Tuscany, where, after a brief occupation by the Neapolitan troops of Joachim Murat, Ferdinand III was restored (1814). Piombino was annexed to the grand duchy and, after the death of Maria Luisa of Parma, the duchy of Lucca (1847). The restoration of the house of Lorraine was well received by the population, weary of adventures and disorders and anxious to return to an enlightened and progressive *ancien régime*. Ferdinand III, assisted by his great minister Vittorio Fossombroni (*q.v.*), resumed the policy of re-

forms and public works (land reclamation in the Maremma); the policy was continued after his death (1824) under the paternalistic government of his son Leopold II (1797–1870). By that time railways, telegraphic communication and modern industries had been established in Tuscany. Florence had become the hospitable residence of exiles and political refugees, the haunt of writers, artists and patriots. During the liberal movements and the first War for National Independence (1847–48), Leopold II sanctioned the constitution, but was discouraged by the intemperance of the mob and demagogues, and fled to Gaeta (Jan. 1849). He returned soon afterward (April 1849) backed by Austrian arms; the constitution was abolished, and while the nationalistic sentiments were felt always more strongly among the Tuscans, the split between the grand duke and his subjects became deeper, also due to the presence of the Austrian troops, who remained there until 1855. At the beginning of the new war of Piedmont and France against Austria, the peaceful Florentine revolution of April 27, 1859, caused the grand duke to abandon Tuscany and Victor Emanuel II of Piedmont assumed a provisional protectorship. With the plebiscite of March 1860, the Tuscans overcame their municipalistic traditions and expressed their desire to unite with Piedmont under Victor Emanuel II. With the proclamation of the kingdom of Italy in 1861, the history of Florence and Tuscany is identified with that of Italy, of which Florence was the provisional capital (1865–70) before the taking of Rome.

Contemporary History.—When, early in 1871, the provisional capital of Italy was fixed in Rome, Florence was left disordered and impoverished. Most of its finest palaces, convents and monasteries had been occupied by ministries, public offices, schools, hospitals, barracks and prisons. Their alteration and defacement meant a great loss to the architectural heritage of the city, while preventing, for reasons of misunderstood economy, the execution of important new public works. Because of population growth, vast residential districts sprang up around the ancient centre of the town, which was soon to prove inadequate to the exigencies of a modern city. The medieval circle of walls was pulled down, and in the name of hygiene and decency, the oldest centre of the town was wantonly cleared out (1885–95). A talented architect, Giuseppe Poggi (1811–1901), succeeded in maintaining a certain nobility and grandiosity, in his new urban plan of new squares and encircling *viali di circonvallazione* (outer avenues), on both banks of the Arno (*e.g.*, the Viale dei Colli, or "Avenue of the hills," and the Piazzale Michelangelo). Two new bridges spanned the river, east and west of the four older ones.

With the new century, Florence—now the capital of the administrative regional district of Tuscany—continued to enlarge, often uncontrolledly and confusedly. A new artistic, literary and cultural revival made Florence once again, for a while, the intellectual capital of Italy, the seat of a university (1923) and of the Central National library, while ever growing tourism gave to the city increasing economic relief. New areas were cleared around some of the most important monuments; a great stadium (1933; architect, P. L. Nervi) and a new railway station (1935; architects, G. Michelucci and associates) were built, regarded as masterpieces of early modern architecture.

During World War II, Florence was declared an "open city," but was damaged even so by bombardments on the outskirts. In Aug. 1944, when the city was attacked from the south by Allied forces, the bridge area was mined by the retreating Germans who continued resistance from the suburbs across the Arno. All the bridges, except the Ponte Vecchio, were blown up; around this bridge, two whole ancient districts were destroyed, north and south of the river. This irreparable loss could by no means be compensated by the modern rebuilding of the two districts, which took place from 1946 to 1961. Four of the destroyed bridges were rebuilt anew, and a further one added in 1956. The famous Santa Trinita bridge (Bartolomeo Ammannati, 1571) was reconstructed exactly as it had been and was completed in Aug. 1957. In 1961, the missing head of "Spring," one of the four statues adorning it, was found in the river. The magnificent panoramic fortress of Belvedere was restored (1955–61) and opened to the public.

See further TUSCANY; ITALY: *History*. *See* also references under "Florence" in the Index volume.

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FLORENCE, a city of northwestern Alabama, U.S., on the north bank of the Tennessee river, in the fertile Muscle shoals district; seat of Lauderdale county. Just upriver is the Wilson dam; across the river are important chemical and metallurgical plants and the Tennessee Valley authority's fertilizer-munitions centre. The city has several manufacturing industries. It is the seat of Florence State college, established in 1872, the oldest state teachers college in the south.

Florence was founded in 1818 by the Cypress Land company and chartered in 1826. It was named for Florence, Italy. An early property holder was Andrew Jackson. Among the distinguished ante-bellum homes are the Forks of Cypress, Mapleton, the Simpson-Irvine home and Rogers Hall. During the American Civil War the town was raided several times by the Federal forces. For comparative population figures *see* table in ALABAMA: *Population*. (B. CR.)

FLORENCE, a city of northeastern South Carolina, U.S., about 80 mi. E. of Columbia; the seat of Florence county. It is an important sales, distribution and manufacturing centre for the tobacco-rich Pee Dee section of the coastal plain. The Clemson college experimental station, a University of South Carolina extension centre and the state industrial school for boys are located there. Sites of interest are a museum and library, the latter having extensive state historical material. There is a national cemetery and nearby is a Confederate prison stockade. Timrod park and the Henry Timrod School shrine display indigenous trees and flowers, and the Womack gardens and nursery are noted for azaleas and camellias. Florence was founded about 1856, chartered in 1871, incorporated in 1890. The city adopted the council-manager form of government in 1921. For comparative population figures *see* table in SOUTH CAROLINA: *Population*. (A. L. D.)

FLORES, JUAN JOSÉ (1800–1864), autocratic first president and long-time dictator of Ecuador, was born in Venezuela on July 19, 1800. At 15 he enlisted in the forces fighting the Spaniards and fought practically continuously for the next ten years, becoming one of Simón Bolívar's trusted senior officers. In 1826 he became commanding general of the southern region of the federation of Gran Colombia. He fought brilliantly at the battle of Tarqui, where the Peruvian attempt to wrest territory from Colombia was thwarted. In 1830 he took the lead in establishing Ecuador as a separate country and became its first president. He held office from 1830 to 1834, crushing several revolutionary attemps to unseat him. Following four years as army commander he regained the presidency in 1839, relinquishing it in 1845 after a liberal revolution. Exiled first to Europe and later to Argentina and Chile, Flores spent the next 15 years plotting to return to Ecuador. He finally accomplished this through Gabriel García Moreno, his son-in-law, who became president in 1861. Flores aided García Moreno militarily during the latter's term, beating off Peruvian attempts to seize Guayaquil. Flores died on Oct. 1, 1864, while engaged in putting down a revolt against García Moreno. His death closed a turbulent career, marked by revolution, invasion, corruption and oppression, characteristic of Ecuador's early years as an independent nation.

FLORES, one of the Sunda Ketjil or Lesser Sunda islands in West Nusa Tenggara province, Indonesia, is the last large island

of the chain which extends eastward from Java and lies about 190 mi. S. of Sulawesi (Celebes) between the Flores and Savu seas. Pop. (1961 est.) 803,000. Area 6,622 sq.mi.

Flores is a long narrow island extending 224 mi. from east to west and 37 mi. in width, with several deep inlets, the chief being Maumere or Geliting bay toward the eastern end of the north coast, in which lies Pulau Besar or Mangkure. On the north coast, too, are Terang bay, Sindeh bay and Hading bay; on the south coast Aimere and Ende bays; and on the east coast, Oka and Konga bays, two deep inlets, the former cutting through high mountains. The island is very mountainous, with the greatest heights in the western part where the peaks of the Mandasawu range reach more than 7,800 ft. There are a number of active volcanoes in the central and eastern parts of the island, and the western section has a few in the fumarole state. The interior has been little explored, but the existence of slates, chalk and sandstones, with eruptive rocks and volcanoes, indicates that geologically the island is similar in structure to others of the Lesser Sunda chain. The few rivers known run either northward or southward and do not seem to be navigable, with the exception of the Reo river for about a mile. In the northwest, where there is a considerable area of limestone, the rivers sometimes run underground. The mean temperature ranges from 25° to 26.7° C. (77° to 80° F.) and the average yearly rainfall is 46 in. The western end of Flores, off which lie the lesser islands of Rintja and Komodo, was formerly a haunt of the giant lizard *Varanus komodoensis* but includes, in the forests, coconut palms and the sapan, cinnamon and sandal tree. Most of the vegetation consists of either tropical deciduous forest or savanna.

The people are mainly of a mixed Malay-Papuan type, the so-called Alfur (*q.v.*) type. In the west they have more of the Malayan characteristics, while in the central and eastern parts they are more Papuan in appearance. In addition, there are settlers all round the coast from Makasar, Sumba, Sumbawa and the Solor isles; the inhabitants of Todo on the south coast are said to be descended from Menangkabau Malays, and on the Ende coast are descendants of shipwrecked Chinese. The indigenous population long remained heathen, but Christianity spread rapidly in modern times; almost all of the Christian population became Roman Catholic. The remainder is either Muslim, in the coastal areas, or still pagan. *Baju* and sarong, or even trousers, are worn generally in the east and south, and often sarong only in the west; ceremonial garments are very elaborate, and many ornaments are worn. The form of house varies greatly. In the western part the houses are built on terraces, often on piles, and they are neat and regular in arrangement and are surrounded by a hedge of bamboo; they may be on piles, round in form, with a conical roof reaching to the floor; they are divided into separate rooms for different families and a passage where unmarried men and strangers sleep. In the east the houses are smaller and inhabited by one family only, while in Ende they are square, roomy and well built. Each village has its barns and, generally, a *pemali* house, where pagan offerings are made and relics preserved. The ground is usually owned communally by the tribe, and the head man, *tuan tanah*, has great power.

Flores originally was tributary to princes of Sulawesi, including Makasar, and when their power was broken by the Dutch in 1667 the island became open to Dutch influence. However, Larantuka, in the east, together with some neighbouring islands, was claimed by Portugal, and in 1818 a commission confirmed Portugal's right. In that year the Dutch stationed an official at Ende bay to suppress piracy, but no impression was made until 1838, when the place was bombarded and seven chiefs journeyed to Kupang, in Timor, to apologize for their piratical activities. A treaty was then made with these and other chiefs of Ende. Trouble with the Portuguese authorities of Larantuka and the island of Solor in 1848 led to negotiations with Portugal when, in return for the remission of certain debts, the Portuguese government renounced all claims to Larantuka and the neighbouring islands. Though the treaty embodying this was not ratified until 1859, Dutch troops were sent to garrison the ceded districts in 1851. Later the troops were withdrawn and a civil official appointed to reside at Larantuka; for many years afterward there was considerable trouble there and at Ende because of slave raids and piracy. The rajah of Larantuka, a Christian, was the principal nuisance, and his banishment in 1905 led to peace. A treaty was concluded in 1874 with one of the principal chiefs of central Flores, but attempts to penetrate into the interior failed. Eventually, from Ende as a base, mounted police succeeded in penetrating and pacifying the whole of the inland region (1907) and civil government was established. Flores was formerly associated with the sultan of Bima, in Sumbawa. The Dutch only once interfered—to suppress a small rising in 1909. The other states of Flores were allowed some measure of self-government under Dutch supervision. Flores was occupied by Japanese troops during World War II and became part of the Republic of Indonesia in 1949.

Agriculture is mainly by shifting cultivation, sticks being used to turn over the soil. Maize (corn) and root crops are the staple foods. Coconuts grow along the coast, and copra is the main export. Frequent burning, for field plots and hunting, together with the semiarid climate account for the small area (3%) of genuine forest, the remainder being scrub or grass savanna. Large herds of roaming cattle, owned and prized by chiefs for their prestige value, impede cropland expansion. About 5% of Flores is in temporary fields and only a fraction of 1% in permanent wet rice fields, the latter in coastal settlements of Malay immigrants. Most inhabitants are chronically underfed. Minor exports are coffee, sandalwood, mother-of-pearl and trepang. Ende (government and mission centre), Aimere, Reo and Labuhanbadjo, in the central and eastern (somewhat more advanced) sections, are ports of call. A fair-weather motor road traverses the island from west to east. Airline services between Surabaja (Java) and Kupang call at Waioti airfield near Maumere. (J. O. M. B.)

FLORES, an island in Horta district forming part of the Azores archipelago. Pop. (1960) 6,617; area 55 sq.mi. Flores and the adjacent island of Corvo (pop. 683; area 7 sq.mi.) constitute the westernmost group of the Azores. It derives its name from the abundance of flowers. Cattle raising, dairying and whaling are the main industries. Its capital is Santa Cruz das Flores (pop. [1960] 1,898). In 1591 Flores was the station of an English fleet before the famous sea fight between the "Revenge" commanded by Sir Richard Grenville and a Spanish fleet of 15 vessels. (J. Ao.)

FLORES, a department in south-central Uruguay, named for Gen. Venancio Flores, leader of the Colorado party and president of Uruguay (1865–1868). Pop. (1962 est.) 44,071; area 1,745 sq.mi. Flores, like its neighbouring departments, is a great rolling pasture supporting concentrations of livestock—about 1,000,000 sheep and 250,000 cattle. Industrial crops, principally sunflower seeds and flax, are grown, as well as cereals and forage.

The departmental capital, Trinidad (est. pop. 24,000), is connected by railroad and highway to Durazno 29 mi. S.W.
(M. I. V.)

FLOREY, SIR HOWARD WALTER (1898–), Australian pathologist, born at Adelaide, South Australia, Sept. 24, 1898, was awarded the Nobel prize for physiology and medicine in 1945, together with Ernst Chain and Sir Alexander Fleming, "for the discovery of penicillin and its curative effects in various infectious diseases." He studied medicine at Adelaide and Oxford universities until 1924 and then undertook research work in Great Britain and the United States. After holding a fellowship and a lectureship at Cambridge (1927–31) and the professorship of pathology at Sheffield (1931–35), he became professor of pathology at Oxford in 1935.

Florey's contributions to experimental pathology were mainly concerned with fundamental phenomena of inflammation and later also with secretion of mucus by mucous membranes. The study of mucus roused his interest in lysozyme, a bacteriolytic enzyme, and work on this was continued with his colleagues until the enzyme was purified and its substrate characterized. This led to plans for a wide survey of naturally occurring antibacterial substances, of which many were known.

In this survey, which started in 1939, penicillin soon showed so much promise that other studies were dropped and research was concentrated on investigating and producing penicillin and even-

tually on bringing it into clinical use.

In 1943 Florey went with a research team to north Africa to investigate the possibility of using the penicillin then available on the wounded. In 1943–44 he visited Moscow with an Anglo-American scientific mission. In 1944 he visited Australia and New Guinea at the invitation of the Australian army. Later he was an adviser to the Australian National university in Canberra.

Florey was elected a fellow of the Royal society in 1941, and received many honours. He was knighted in 1944.

FLÓREZ, ENRIQUE (1702–1773), Spanish Augustinian monk, an outstanding historian and scholar, was born at Villadiego, July 21, 1702. A notable example of 18th-century erudition, his *España sagrada*, 29 volumes (1747–55; continued by others to 51 volumes; index by A. González Palencia, 1918), embodies the results of tireless research in many archives on the origins and growth of religious foundations in Spain; for transcriptions of documents and study of secondary materials (coins, medals, inscriptions, legends) it is an essential source book for the history of Spain. His biographical *Memorias de las reinas católicas* (1761) has charm.

Flórez died at Madrid on May 5, 1773. (R. F. B.)

FLORIAN (Florianus), **SAINT** (d. 304), a Roman army officer and martyr. He occupied an administrative post in Noricum, now part of Austria, and was martyred under Diocletian. His *Acta*, with little historical value, date from the end of the 8th century.

Florian is regarded as one of the patron saints of Poland, Linz and Upper Austria. His protection is often sought against fire, and his feast is kept on May 4.

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints*, vol. ii, pp. 230–231 (1956).

FLORIAN (Marcus Annius Florianus), Roman emperor 276 (April–July), was half-brother and praetorian prefect to the emperor Tacitus (*q.v.*). Proclaimed emperor by the army on Tacitus' death and accepted in the west, he was rejected by the army of the east, who proclaimed their own prefect, Probus (*q.v.*). When Probus' army approached Tarsus, Florian was killed by his own troops. (Jn. R. M.)

FLORIANÓPOLIS, a city and port of southern Brazil, and capital of the state of Santa Catarina (*q.v.*), is located about 450 mi. S.W. of Rio de Janeiro, on the western side of Santa Catarina Island (Ilha de Santa Catarina) which is connected to the mainland by a steel bridge having an over-all length of 2,788 ft. Pop. (1960) 74,323. This island city serves as the state administrative and commercial centre in spite of the difficulties involved in reaching the inland parts of the state from the coast. The Great Escarpment which marks the edge of the Paraná plateau is especially steep in Santa Catarina and the interior of the state is more closely connected to Pôrto Alegre and Curitiba than to the state capital. Florianópolis is linked with other coastal towns, such as Blumenau and Joinville, by all-weather highways. There are air services to the interior.

The central part of Florianópolis consists mainly of wharves, warehouses and business establishments. This older harbour district is encircled by a modern residential garden section known as Praia de Fora built on the surrounding hill slopes.

The first European settlement on Santa Catarina Island was made in 1542 by the Spaniards under Alvar Núñez Cabeza de Vaca, who proceeded to march inland over rugged terrain to Asunción in Paraguay. The Portuguese established their control of this southern part of the coast when they sent an expedition from São Vicente to occupy the island in 1675. The present city was established in 1700 as Desterro. In 1777 the island was occupied by a Spanish expedition, but it was returned in the same year to Portugal by treaty.

In 1893 the island was captured by revolutionists who opposed the government of Pres. Floriano Peixoto. When the revolution collapsed the city was named Florianópolis in honour of the president. (P. E. J.)

FLORIDA, officially the "Sunshine state" and often referred to as the "Peninsula state," lies at the extreme southeastern corner of, and is the most southern state of, continental United States. The peninsula is the visible part of the Floridian plateau that separates the depths of the Atlantic ocean from those of the Gulf of Mexico; the submerged area is as large as the part above sea level. It is bounded on the north by Alabama and Georgia, on the east by the Atlantic ocean, on the south by the Strait of Florida, which separates it from Cuba, and by the Gulf of Mexico, and on the west by the Gulf and by Alabama. The total area of the state is 58,560 sq.mi., of which 4,308 sq.mi. are water surface; it ranks 22nd in size among the states. Florida was admitted to the union on March 3, 1845, as the 27th state. The state capital is Tallahassee. The state tree is the palmetto, or sabal, palm; the state flower, the orange blossom; the state bird, the mockingbird.

PHYSICAL GEOGRAPHY

Physical Features.—Florida is situated approximately between 24° 30′ and 31° N. and 80° and 87° 38′ W. The topographical regions of the state include the coastal lowlands, which are generally less than 100 ft. above sea level; the higher, hilly western highlands; the Marianna lowlands; the Tallahassee hills; and the central highlands or the "ridge" of the peninsula proper. Islands, the Florida keys, stretch southward, like a string of beads, from Biscayne bay to Key West. The last group of keys, the Dry Tortugas Islands (*q.v.*), lie west of Key West. The state is 447 mi. long and 361 mi. wide at its northern boundary, but never more than 145 mi. wide below the panhandle.

The general coastline, which does not recognize all the details of indentations, is 1,197 mi. in length (Atlantic, 399 mi., Gulf of Mexico, 798 mi.). The shore line when all details of indentations —bays, sounds and other bodies of water to the head of tidewater— are included measures 8,426 mi. (Atlantic, 3,035 mi.; Gulf of Mexico, 5,391 mi.). No point in the state is more than 70 mi. from either the Atlantic ocean or the Gulf of Mexico. The coastlines are bisected by many rivers, some of which are navigable for long distances. The St. Johns on the east coast is one of the few rivers in North America that flows northward; it enters the Atlantic at Mayport, above Jacksonville. The large rivers in western Florida rise in Georgia and Alabama; the Perdido, Escambia, Choctawhatchee and Apalachicola were the chief arteries of trade in the steamboat era. The Suwannee rises in the Okefenokee swamp on the border of Georgia and Florida.

Water is one of Florida's major resources: the underground and surface supplies are exceeded by no other area of similar size on the continent. There are more than 30,000 natural lakes in the state and more than 1,400 in one county (Lake) alone; the largest is Lake Okeechobee, covering 700 sq.mi., the second largest (after Lake Michigan) body of fresh water in the U.S. The overflow of this lake every year spilled into the long inundated plain of the Everglades (*q.v.*) and gradually made its way 100 mi. southward to Florida bay. The overflow is now controlled (*see* Okeechobee, Lake), and the lake connects the Atlantic Intracoastal waterway with the Gulf via the St. Lucie canal and river on the east and the Caloosahatchee canal and river on the west. Of the 75 largest artesian springs in the United States, 17 are located in Florida; among the best known are Silver springs, Rainbow springs and Salt springs near Ocala and Wakulla springs near Tallahassee.

Climate.—A mild climate is one of the state's greatest assets; in winter there is more sunshine than in any other state east of the Mississippi. The annual rainfall of about 53 in., most of which falls from April to November, tempers the warm temperatures of the summer season. Although the average temperature is near 70° F. (21° C.), the state is subject to damaging cold waves. Hurricanes that form in the Caribbean sea frequently strike the state and cause great destruction of property and often loss of life.

Soil.—The soils of Florida vary from the highly fertile organic muck and peat of the Everglades to the poorest of sandy soils along the coastal dunes and beaches. The soils of the coastal lowlands and the western highlands are generally composed of sands of low fertility, except in the river bottoms and marshy areas where organic materials have been deposited. Much of the area of the Marianna lowlands and of the central highlands is underlain by Ocala limestone formations which, when mixed with the overlying sands, make fertile soils. The soils of the Tallahassee hills

are generally the most fertile in the state and contain large amounts of red clay and organic matter.

Plant Life.—The high and low hammocks, sand and clay hills, beds of organic soils and salt- and fresh-water marshes of Florida provide excellent habitats for native and imported plants, from large flowering trees to delicate orchids. Of the palms found in the U.S., 15 varieties are native to Florida, and they range in size from the small saw palmettos to the tall royal palms, the coconut palms and the sabal palmettos. There are more than 300 varieties of trees: pines, oaks, cypresses, palms and mangroves are the predominant native trees; magnolias, yews, hollies, and hickories are also native. The royal and coconut palms, mahogany and gumbo limbo trees are tropical; northern species that thrive in the state include the red maple, the sweet gum and the tulip tree.

The woods, prairies and marshes support more than 3,500 species of plants. Bladderwort, duckweed, hyacinths and water lettuce grow in the marshes; pitcher plants, lilies, milkwort and cactus in the sandy soils; and coontie (comfortroot, from which the Indians made flour) flourishes in the rocky pinelands of the southeastern section of the state. Spanish moss streams from the trees, and more than 80 other air plants (epiphytes), 25 of which are orchids, have been identified in south Florida. Many plants and trees have been imported—more than 400 varieties of bougainvillaea, hibiscus, oleander, and croton for ornamental plantings and poinciana, poinsettia, jacaranda and mountain ebony.

Animal Life.—Eighty-four species of land mammals are found in Florida, including wildcat, gray fox, deer, panther and all of the smaller animals that are native to the southern states. Commercial trapping has reduced the number of otter and mink, and the tiny Key deer of the keys is almost extinct. The manatee or sea cow is occasionally found in coastal waters and in the rivers of the far southern part of the state. More than 400 species and subspecies of birds have been recorded, and the natural rookeries around Lake Okeechobee, in the Big Cypress swamp and in the Everglades are world famous. The first national bird sanctuary, Pelican Island in the Indian river, was established by Pres. Theodore Roosevelt in 1903; since then numerous national sanctuaries have been created in the state. Among the water birds are gulls, pelicans, cormorants, ospreys and sandpipers found along the seacoasts; ibises, herons, egrets and gallinules (water hens) in the freshwater marshes and surface waters. The snowy egret, roseate spoonbill and flamingo have become relatively rare. Land birds include almost all of the birds common to the southern states. Turkey, quail, dove and duck are the game birds protected by law except during a short hunting season in the fall of the year.

The alligator, long associated with Florida's lakes and rivers and hunted for sport and hide, is now protected from hunting by law. The crocodile is still found from time to time along the east coast from Biscayne bay to Cape Sable. Of the 40 species of snakes native to the state four are poisonous: the diamondback and ground rattlers, the coral snake and the moccasin. Lizards, land turtles, water turtles and frogs are plentiful. More than 700 species of fish have been identified: 300 species along the Gulf coast, 174 along the Atlantic and 290 around the keys. The edible and commercially salable sea fish include mullet, drumfish, trout, mackerel, snapper, grouper and pompano; freshwater fish that are edible include bass, bream, perch and catfish. For sport fishing the tarpon, sailfish and marlin of the deep waters and the bonefish of the shallows are eagerly sought.

Parks and Forests.—Florida was the first of the eastern states in which a national forest was created, the Ocala in 1908. The Osceola National forest was created in 1931 and the Apalachicola in 1936. The three national forests have a combined area of 1,100,000 ac. There are four state forests: Blackwater River near Milton, Myakka River near Sarasota, Pine Log near Panama City and Austin Cary near Gainesville. The Everglades National park in extreme south Florida attracts thousands of visitors as do the national monuments: Castillo de San Marcos at St. Augustine, Ft. Matanzas south of St. Augustine, Ft. Jefferson in the Dry Tortugas Islands, Ft. Caroline at Jacksonville and the De Soto memorial near Tampa. The Everglades National park contains the only tropical wilderness in the U.S., and is one of the few parks in the national park system established for the conservation of exotic plant, animal and marine life. A number of state parks and historical memorials protect plant and animal life, geological formations and historical landmarks. Pennekamp Coral Reef preserve, the world's first underwater park, is a state-controlled area of 75 sq.mi. (nautical) established (1960) in the Atlantic ocean off Key Largo by the federal and state governments to preserve a portion of the beautiful multihued coral formations of the area. There are also more than 20 public and private gardens and more than 200 public and private scenic attractions that are open to visitors.

HISTORY

The romance and the tragedies of the early history of Florida give it a unique place in the annals of the American states. Within 20 years after the first voyage of Columbus to the new world in 1492, an expedition was being organized to seek for a fabulous fountain of youth and for riches in the new and inviting land. This expedition was followed by others seeking wealth or seeking to establish the Christian faith among the savages. In turn these were followed by French Huguenots who sought a place of religious freedom, but the zeal of the Spaniards soon brought an unhappy end to their search. Florida also has the honour of containing the oldest European settlement within the bounds of the United States, as St. Augustine was founded in 1565, 42 years before the English were successful at Jamestown. The Spanish Council of Indies claimed that after 1510 fleets and ships had gone to Florida, and Florida is shown on the earliest known map of the new world, the Cantino map of 1502.

Spanish Exploration.—In 1513 Juan Ponce de León (*q.v.*), who had been with Columbus on his second voyage and who had later been governor of Puerto Rico, obtained a royal grant authorizing him to discover and settle "Bimini"—a fabulous island believed to contain a marvelous fountain or spring whose waters would restore to old men their youth or, at least, had wonderful curative powers. Soon after Easter day he came in sight of the coast of Florida, probably near the mouth of the St. Johns river. From the name of the day in the calendar, *Pascua Florida*, the country was named Florida. Ponce de León seems to have explored the coast, to some degree, on both sides of the peninsula, and to have turned homeward fully convinced that he had discovered an immense island. He returned to Spain in 1514 and obtained from the king a grant to colonize "the island of Bimini and the island of Florida," of which he was appointed *adelantado* (civil and military governor); in 1521 he made another expedition, this one for colonization as well as for discovery. He seems to have touched at the Dry Tortugas Islands, so named because of the large number of turtles found there, and to have landed at several other places, but many of his men succumbed to disease and he was wounded in an Indian attack, dying soon afterward in Cuba. Meanwhile, in 1516, another Spaniard, Diego Miruelo, seems to have sailed for some distance along the west coast of the peninsula. The next important exploration was that of Pánfilo de Narváez. In 1528 he sailed from Cuba with about 600 men (soon reduced to less than 400); he landed early in 1528, probably near the present site of Tampa, and for six months remained in the country, he and his men suffering terribly from exposure, hunger and fierce Indian attacks. In September, his ships being lost and his force greatly reduced in number, he hastily constructed a fleet of five boats, re-embarked, probably at Apalachee bay, and lost his life when his boat was blown out to sea while off the coast of Texas. Only four of his men, including Alvar Núñez Cabeza de Vaca, succeeded, after eight years of Indian captivity and of long and weary wanderings, in finding their way to Spanish settlements in Mexico. Florida was also partially explored by Hernando de Soto (*q.v.*) in 1539–40. In the summer of 1559 another attempt at colonization was made by Tristán de Luna, who sailed from Veracruz, landed at Pensacola bay and explored a part of Florida and (possibly) southern Alabama. Somewhere in that region he desired to make a permanent settlement, but he was abandoned by most of his followers and gave up his attempt in 1561.

French Huguenot Settlers.—In 1562, Jean Ribault, with a

Miami Beach, a resort city in southeastern Florida

Annie Russell theatre (left) and Knowles Memorial chapel (right), Rollins college, Winter Park; founded in 1885

Brahman cattle on a farm near Ocala. Stock raising has become a leading industry in Florida

The Everglades, largest subtropical wilderness in the U.S.; about 2,860,000 ac. in area

The state capitol building at Tallahassee, capital of Florida since 1824

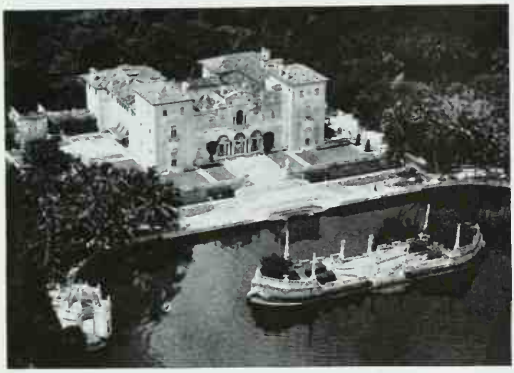
Fort Jefferson National monument (1846), on Garden Key of the Dry Tortugas. A military prison during the Civil War, it is now a bird refuge

SCENES IN FLORIDA

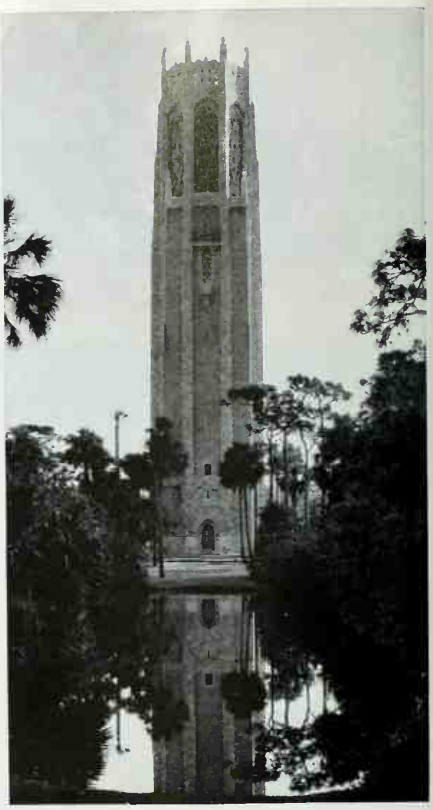
BY COURTESY OF (TOP LEFT) MIAMI BEACH NEWS BUREAU, (TOP CENTRE LEFT) ROLLINS COLLEGE, PHOTOGRAPHS, (TOP RIGHT) CHARLES J. BELDEN, (BOTTOM CENTRE LEFT, BOTTOM) H. ARMSTRONG ROBERTS, (CENTRE RIGHT) AUTHENTICATED NEWS

FLORIDA

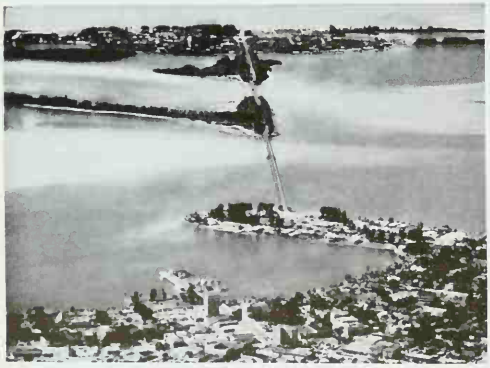
Wind-bent coconut palm trees, Miami beach



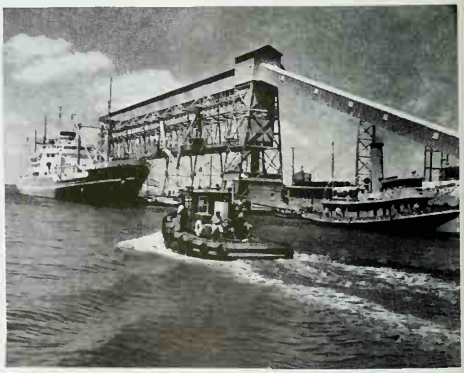
Vizcaya, James Deering estate resembling an Italian villa, on Biscayne bay, south of Miami



Bok Singing tower, in the Iron mountain bird sanctuary, near Lake Wales. Built by Edward William Bok (1863–1930), it has a carillon of 71 bells



Sarasota bay looking west across the John Ringling causeway toward the keys, offshore islands separating the bay from the Gulf of Mexico



Freighter in Port Tampa loading phosphate, one of Florida's principal mineral resources

VIEWS OF FLORIDA

BY COURTESY OF [illegible] SARASOTA COUNTY CHAMBER OF COMMERCE, (BOTTOM RIGHT) FLORIDA STATE NEWS BUREAU, PHOTOGRAPHS, (TOP LEFT) EWING GALLOWAY, (TOP RIGHT) BERGERT BROTHERS, (CENTRE LEFT) AUTHENTICATED NEWS

band of French Huguenots, landed first near St. Augustine and then at the mouth of the St. Johns river, which he called the River of May, and on behalf of the king of France claimed the country, which he described as "the fairest, fruitfullest and pleasantest of all the world"; but he made his settlement on an island near what is now Beaufort, S.C. In 1564 René de Laudonnière (d. *c.* 1586), with another party of Huguenots, established Ft. Caroline at the mouth of the St. Johns, but the colony did not prosper and in 1565 Laudonnière was about to return to France when (on Aug. 28) he was reinforced by Ribault and about 300 men from France. On the same day that Ribault landed, a Spanish expedition arrived in the Bay of St. Augustine. It was commanded by Pedro Menéndez de Avilés (*q.v.*), one of whose aims was to destroy the Huguenot settlement. This he did, putting to death almost the entire garrison at Ft. Caroline "not as Frenchmen but as Lutherans," on Sept. 20, 1565. The ships of Ribault were soon afterward wrecked near Matanzas inlet; he and most of his followers surrendered to Menéndez and were executed. Menéndez then turned his attention to founding a settlement which he named St. Augustine (*q.v.*); he also explored the Atlantic coast from Cape Florida to St. Helena and established forts at San Mateo (Ft. Caroline), Avista, Guale and St. Helena. In 1567 he returned to Spain in the interest of his colony.

The news of the destruction of Ft. Caroline and the execution of Ribault and his followers was received with indifference at the French court; but, according to a widely accepted story, Dominique de Gourgues (*c.* 1530–93), a friend of Ribault but probably a Catholic, organized an expedition of vengeance, not informing his men of his destination until his three ships were near the Florida coast. With the co-operation of the Indians under their chief, Saturiba, he captured Ft. San Mateo in the spring of 1568 and on the spot where the Huguenots of Ft. Caroline had been executed, he hanged his Spanish prisoners and inscribed on a pine tablet the words: "I do this not as unto Spaniards but as to traitors, robbers and murderers." Feeling unable to attack St. Augustine, De Gourgues returned to France.

Spanish Settlements.—The Spanish settlements experienced many vicissitudes. The Indians were hostile and the missionary efforts among them failed. In 1586 St. Augustine was almost destroyed by Sir Francis Drake, and it also suffered severely by an attack of Capt. John Davis in 1665. Not until the last decade of the 17th century did the Spanish authorities attempt to extend the settlements beyond the east coast. Then, jealous of the French explorations along the Gulf of Mexico, they turned their attention to the west coast, and in 1696 founded Pensacola. When the English colonies of the Carolinas and Georgia were founded, there was constant friction with Florida. The Spanish were accused of inciting the Indians to make depredations on the English settlements and of interfering with English commerce, and the Spanish were in constant fear of the encroachments of the English. In 1702, when Great Britain and Spain were contending in Europe, on opposite sides, in the War of the Spanish Succession (1701–14), a force from South Carolina captured St. Augustine and laid siege to the fort but, being unable to reduce it for lack of necessary artillery, burned the town and withdrew at the approach of Spanish reinforcements. In 1706 a Spanish and French expedition against Charleston, S.C., failed, and the Carolinians retaliated by invading middle Florida in various raids between 1702 and 1728. In 1740 Gen. James Edward Oglethorpe, governor of Georgia, supported by a naval force, made an unsuccessful attack upon St. Augustine; two years later a Spanish expedition against Savannah by way of St. Simon's Island failed, and in 1745 Oglethorpe again appeared before the walls of St. Augustine; but the treaty of Aix-la-Chapelle in 1748 prevented further hostilities. Pensacola, the other centre of Spanish settlement, though captured and occupied (1719–23) by the French from Louisiana, had a more peaceful history.

The Establishment of the Florida Provinces.—By the treaty of Paris in 1763 Florida was ceded to England in return for Havana. The provinces of East Florida and West Florida were now formed, the boundary of West Florida being 31° N. (when civil government was organized in 1767, the northern line was made 32° 28′ N.), and the western boundary the Chattahoochee and the Apalachicola rivers, the Gulf of Mexico, Mississippi sound, Lakes Borgne, Pontchartrain and Maurepas, and the Mississippi river. A period of prosperity began. Civil in place of military government was instituted; immigration began; and Andrew Turnbull, an Englishman, brought over a band of about 1,500 Minorcans (1767), whom he engaged in the cultivation of indigo at New Smyrna. Roads were laid out, some of which yet remain; in the last three years of British occupation the government spent $580,000 on the two provinces. Consequently, the people of Florida were for the most part loyal to Great Britain during the American Revolution. In 1776, the Minorcans of New Smyrna refused to work any longer on the indigo plantations; many of them removed to St. Augustine, where they were protected by the authorities. Several plans were made to invade South Carolina and Georgia, but none matured until 1778, when an expedition was organized which co-operated with British forces from New York in the siege of Savannah, Ga. In the following year, Spain having declared war against Great Britain, Bernardo de Gálvez (1746–86), the Spanish governor at New Orleans, seized most of the English forts in West Florida and in 1781 captured Pensacola.

By the treaty of Paris in 1783 Florida reverted to Spain and, no religious liberty being promised, many of the British inhabitants left East and West Florida. A dispute with the United States concerning the northern boundary was settled by the treaty of 1795, the line 31° N. being established.

Acquisition by the U.S.—The westward expansion of the United States made it highly desirable to have American ports on the Gulf of Mexico; consequently, the acquisition of West Florida as well as of New Orleans was one of the aims of the negotiations which resulted in the purchase of Louisiana in 1803. After the cession of Louisiana to the U.S., the people of West Florida feared that that province would be seized by Napoleon. They, therefore, through a convention at Buhler's plains (July 17, 1810), formulated plans for a more effective government. When it was found that the Spanish governor did not accept these plans in good faith, another convention was held on Sept. 26 which declared West Florida to be an independent state, and organized a government and petitioned for admission to the union. On Oct. 27, Pres. James Madison, acting on a theory of Robert R. Livingston that West Florida was ceded by Spain to France in 1800 along with Louisiana and was therefore included by France in the sale of Louisiana to the U.S. in 1803, declared West Florida to be under the jurisdiction of the United States. Two years later the U.S. congress annexed the portion of West Florida between the Pearl and Mississippi rivers to Louisiana (hence the so-called Florida parishes of Louisiana), and that between the Pearl and the Perdido to the Mississippi territory.

In the meantime war between Great Britain and the U.S. was imminent. The U.S. government asked the Spanish authorities of East Florida to permit an American occupation of the country in order that it might not be seized by Great Britain and made a base of military operations. When the request was refused, American forces seized Fernandina in the spring of 1812, an action that was repudiated by the U.S. government after protest from Spain, although it was authorized in official instructions. About the same time an attempt to organize a government at St. Mary's was made by U.S. sympathizers and a petty civil war began between the Americans, who called themselves "patriots," and the Indians, who were encouraged by the Spanish. In 1814 British troops landed at Pensacola to begin operations against the United States. In retaliation Gen. Andrew Jackson captured the place, but in a few days withdrew to New Orleans. The British then built a fort on the Apalachicola river, and from there directed expeditions of Indians and runaway Negroes against the American settlements. These expeditions continued long after peace was concluded in 1814. In 1818 General Jackson, believing that the Spanish were aiding the Seminole Indians and inciting them to attack the Americans, again captured Pensacola. By the treaty of 1819 Spain formally ceded East and West Florida to the United States; the treaty was ratified in 1821, when the United States

took formal possession, but civil government was not established until 1822.

The New Territory and Statehood.—Indian affairs became the most serious problem of the new territory of Florida. Immediately after the cession of Florida to the United States, pressure was brought to bear upon congress and the president to have the Seminole Indians removed and the country thrown open to settlement. The Indians, who had been allowed to occupy their lands in peace by the Spaniards, could not understand why they should be forced to move to new lands west of the Mississippi; but they consented, by the treaty of Ft. Moultrie in 1823, to live within certain limits. Conflicts followed, however, as the population increased, and a new demand was made to have the Indians removed. By treaties made at Payne's landing in 1832 and Ft. Gibson in 1833 the Indian chiefs agreed to exchange their Florida lands for equal territory in the western part of the U.S. But a strong sentiment against removal suddenly developed, and the efforts of the U.S. to enforce the treaty brought on the Second Seminole War (1835–42), which resulted in the removal of all but a few hundred Seminoles whose descendants continue to live in southern Florida. In 1845 Florida became a state of the United States.

The Civil War and Reconstruction.—On Jan. 10, 1861, an ordinance of secession, which declared Florida to be a "sovereign and independent nation," was adopted by a state convention, and Florida became one of the Confederate States of America. The important coast towns were readily captured by Union forces—Fernandina, Pensacola and St. Augustine in 1862 and Jacksonville in 1863; but an invasion of the interior in 1864 failed, the Union forces being repulsed in a battle at Olustee on Feb. 20, 1864. In 1865 a provisional governor was appointed by Pres. Andrew Johnson, and a new state government was organized. The legislature of 1866 rejected the 14th amendment to the federal constitution, and soon afterward Florida was made a part of the 3rd military district, according to the Reconstruction acts of 1867. Negroes were now registered as voters by the military authorities, and another constitutional convention met in Jan. and Feb. 1868. A factional strife in the dominant party, the Republican, threatened to break up the convention, but through the efforts of Gen. George G. Meade the differences were reconciled. A constitution was framed and ratified by the electors, and Florida passed from a quasi-military to a full civil government on July 4, 1868.

Before the American Civil War Jacksonville, St. Augustine and even Tampa had attracted tourists and invalids seeking respite from the colder winters of the northern states, but tourism only became a profitable business enterprise in the 1880s. Among later visitors were several northern capitalists who recognized possibilities for further development in Florida: Hamilton Disston, who bought 4,000,000 ac. of land in central Florida in 1881; Henry B. Plant, who bought several short-line railroads and built them into the Atlantic Coast Line system through central Florida to the west coast; and Henry M. Flagler, who built the Florida East Coast line into Miami and over the seas into Key West. The railroads brought not only winter visitors, but settlers who grew winter truck crops, planted citrus groves and mined phosphate. The population of the state doubled between 1870 and 1890; by 1900 there were about 500,000 residents and in each succeeding 20 years the population almost doubled.

The 20th Century.—The history of the state in the 20th century has been that of rapid expansion and is quickly told in the rise in population in 60 years from about 528,000 in 1900 to more than 4,000,000 in 1960. The population, which had been swelled during World War II by thousands of members of the several branches of the armed forces sent to the state for training, continued to increase after the war. Many new industries located or relocated in the state, a number of them providing products and services associated with the missile centre at Cape Canaveral, renamed Cape Kennedy. The annual state tourist influx approaches 10,000,000 persons. Agriculture remains an important part of the economy, but citrus crops and cattle raising have replaced field crops as the chief agricultural products. The growth of metropolitan and urban areas brought a decided shift of population and changed Florida's character from that of a rural state to that of a distinctly urban state. As in other states this shift resulted in a political fight on the part of the urban areas to secure better apportionment of representation in the state legislature.

Among the notable events in the 20th century were: the disastrous Jacksonville fire of 1901; the passage of legislation abolishing peonage (1909) and the convict lease system for prisoners (1923); the completion of the overseas railroad to Key West in 1912; the frantic land boom of the early 1920s; and the disastrous hurricanes of 1926, 1928, 1935 and 1960.

GOVERNMENT

The basis of Florida's government was laid in the constitution of 1885 (a document that was preceded by four earlier constitutions), to which about 100 amendments have been ratified. The amending process is simple: proposal by three-fifths of all of the members of both houses of the legislature and ratification by a majority of the voters casting their ballots for the proposed amendment at the next general election. The material that has been added by amendment comprises more than half of the constitution. There are a number of important constitutional prohibitions and tax exemptions, including prohibitions against an income tax, an inheritance tax and an ad valorem tax on real estate; the exemptions include three that relate to homesteads—immunity from forced sale unless alienated by the owner, $5,000 real-estate tax and $1,000 personal-property tax exemptions.

Governmental powers are divided between the legislative, executive and judicial branches with the usual system of checks and balances. The legislature is composed of a state senate and a house of representatives. Representation is apportioned among the 67 counties. A special session of the 1963 legislature increased the size of the state senate from 38 to 43 members selected from districts comprising one or more counties; the house of representatives was increased from 95 to 112 members. The constitution provides for reapportionment every 10 years, but the rapid population growth in the most populous counties has made this a difficult task. Regular sessions of the legislature are held biennially for 60 days; the sessions may be extended for 30 days by a three-fifths majority vote. Special sessions of 20 days may be called by the governor and the legislature itself may call a special session for 30 days by a three-fifths vote of the members. A legislative council, with a legislative reference bureau, was created in 1949; this agency, composed of nine senators and nine representatives, serves as an interim planning and study committee between sessions.

The executive power is vested in a governor and six elected administrative officers; these officers serve four-year terms, but a governor may not immediately succeed himself in office. Executive authority is highly decentralized among more than 150 officers, agencies, boards and commissions. The most important agencies are the 32 ex officio boards and commissions of which the governor and the six administrative officers (the so-called cabinet), in full or in part, are members, including the budget commission and commissioners of state institutions. The administrative agencies, established largely by statute, are supervised by officials appointed by the governor, including 22 examining boards for professions and vocations. Several agencies are under the control of the governor: the road department, industrial commission, racing commission, beverage department and motor vehicle commission. The heads of these departments are referred to as the "little cabinet." The only elective executive agency is the railroad and utilities commission whose three members are selected for four-year terms.

The judicial branch is composed of a supreme court of seven justices elected for six-year terms; the office of chief justice rotates among the members of the court. There are three district courts of appeals composed of three judges each, elected for six-year terms. There are 16 circuits of the circuit courts, with one circuit judge for every 50,000 inhabitants or major fraction thereof. To relieve the burden of litigation on the circuit courts, a number of courts of concurrent jurisdiction have been established in the more populous counties. There is a county judge in each county; lesser courts have been created in several counties.

*Florida: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total State	4,951,560	2,771,305	1,897,414	968,470	528,542
Arcadia	5,889	4,764	4,055	3,479	799
Auburndale	5,595	3,763	2,723	715	—
Avon Park	6,973	4,612	3,125	890	—
Bartow	12,849	8,694	6,158	4,203	1,983
Belle Glade	11,273	7,219	3,806	—	—
Boca Raton	6,961	992	723	—	—
Boynton Beach	10,467	2,542	1,326	—	—
Bradenton	19,380	13,604	7,444	3,868	—
Brownsville†	38,417	20,269	—	—	—
Carol City	21,749	—	—	—	—
Chattahoochee‡	9,699	8,473	7,110	—	—
Clearwater	34,653	15,581	10,136	2,427	343
Cocoa	12,294	4,245	3,098	1,445	382
Coral Gables	34,793	19,837	8,294	—	—
Crestview	7,467	5,003	2,252	500	—
Cutler Ridge	7,005	—	—	—	—
Dania	7,065	4,540	2,902	762	—
Daytona Beach	37,395	30,187	22,584	5,445	1,690
Deerfield Beach	9,573	2,088	1,850	—	—
De Funiak Springs	5,282	3,077	2,570	2,097	—
De Land	10,775	8,652	7,041	3,324	1,449
Delray Beach	12,230	6,312	3,737	1,051	—
Dunedin	8,444	3,202	1,758	642	113
Eau Gallie	12,300	1,554	874	507	172
Eustis	6,189	4,005	2,930	1,193	411
Fernandina Beach§	7,276	4,974	3,492	5,457	3,245
Fort Lauderdale	83,648	36,328	17,996	2,065	—
Fort Myers	22,523	13,195	10,604	3,678	943
Fort Pierce	25,256	13,502	8,040	2,115	—
Fort Walton Beach	12,147	2,463	—	—	—
Gainesville	29,701	26,861	13,757	6,860	3,633
Goulds	5,121	—	—	—	—
Gulfport	9,730	3,702	1,581	—	—
Haines City	9,135	5,630	3,890	651	—
Hallandale	10,483	3,886	1,827	—	—
Hayden	5,471	—	—	—	—
Hialeah	66,972	19,676	3,958	—	—
Hollywood	35,237	14,351	6,239	2,264	—
Homestead	9,152	4,573	3,154	1,307	—
Jacksonville	201,030	204,517	173,065	91,558	28,429
Jacksonville Beach	12,049	6,438	3,566	357	—
Key West	33,956	26,433	12,927	18,749	17,114
Kissimmee	6,845	4,310	3,225	2,722	1,132
Lake	9,465	7,571	5,836	3,341	4,013
Lakeland	41,350	30,851	22,068	7,062	1,180
Lake Wales	8,346	6,821	5,024	796	—
Lake Worth	20,758	11,777	7,408	1,106	—
Lantana	5,021	773	244	—	—
Largo	5,302	1,547	1,031	599	—
Leesburg	11,172	7,395	4,687	1,835	765
Live Oak	6,544	4,064	3,427	3,103	1,659
Marianna	7,152	5,845	5,079	2,499	900
Melbourne	11,982	4,223	2,622	533	131
Miami	291,688	249,276	172,172	29,571	1,681
Miami Beach	63,145	46,282	28,012	644	—
Miami Shores	8,865	5,086	1,956	—	—
Miami Springs	11,229	5,108	898	—	—
Miramar	5,485	—	—	—	—
New Smyrna Beach	8,781	5,775	4,402	2,007	543
North Miami	28,708	10,734	1,973	—	—
North Miami Beach	21,405	2,129	871	—	—
Oakland Park	5,341	1,295	815	323	—
Ocala	13,598	11,741	8,988	4,914	3,380
Opa-Locka	9,810	5,271	497	—	—
Orlando	88,135	52,367	36,736	9,282	2,481
Ormond Beach	8,658	3,418	1,914	1,292	595
Palatka	11,028	9,176	7,140	5,102	3,301
Palm Beach	6,055	3,886	3,747	1,135	—
Palmetto	5,556	4,103	3,491	2,046	569
Panama City	33,275	25,814	11,618	1,722	—
Pensacola	56,752	43,479	37,449	31,035	17,747
Perrine	6,424	2,859	—	—	—
Perry	8,030	2,797	2,668	1,956	—
Pinellas Park	10,848	2,924	691	134	—
Plant City	15,711	9,230	7,491	3,729	720
Pompano Beach	15,992	5,682	4,427	636	—
Quincy	8,874	6,505	3,888	3,118	847
Riviera Beach	13,046	4,065	1,981	—	—
St. Augustine	14,734	13,555	12,090	6,192	4,272
St. Petershurg	181,298	96,738	60,812	14,237	1,575
St. Petershurg Beach‖	6,268	1,722	398	—	—
Sanford	19,175	11,935	10,217	5,588	1,450
Sarasota	34,083	18,896	11,141	2,149	—
Sebring	6,939	5,006	3,155	812	—
South Miami	9,846	4,809	2,408	—	—
Tallahassee	48,174	27,237	16,240	5,637	2,981
Tampa	274,970	124,681	108,391	51,608	15,839
Tarpon Springs	6,768	4,323	3,402	2,105	541
Titusville	6,410	2,604	2,220	1,361	—
Valparaiso	5,975	1,047	221	—	—
Vero Beach	8,849	4,716	3,050	793	—
Warrington	16,752	13,570	—	—	—
West Miami	5,296	4,043	—	—	—
West Palm Beach	56,208	43,162	33,693	8,659	564
West Winter Haven	5,050	2,326	—	—	—
Westwood Lakes	22,517	—	—	—	—
Wilton Manor	8,257	883	—	—	—
Winter Garden	5,513	3,503	3,060	1,021	—
Winter Haven	16,277	8,605	6,199	1,597	—
Winter Park	17,162	8,250	4,715	1,078	366

*Populations are reported as constituted at date of each census. †Formerly Brownsville-Brent-Goulding. ‡Changed from River Junction in 1941. §Includes Fernandina and Fernandina Beach in 1950; previously known as Fernandina. ‖Pass-a-Grille Beach and St. Petershurg Beach consolidated since 1950; previously known as Pass-a-Grille Beach.

Note: Dash indicates place did not exist during the reported census, or data not available.

Each county elects a board of five county commissioners and at least eight administrative officers. An amendment to the constitution in 1956 excepted Dade county (the southeastern county which includes the Miami resort area) which adopted a county charter and a plan of metropolitan government (*see* MIAMI: *Metropolitan Government*). Municipal governments, generally chartered by special acts of the legislature, are provided for about 300 incorporated communities. Of the more than 600 units of government in Florida, about 200 are *ad hoc* district governments.

POPULATION

The population of Florida in 1850 (the first census after the state entered the union) was 87,445. Its population ranked last among the 31 states of the union and was classified as 100% rural. By 1900 the population had increased more than 500% to 528,542, ranked 33rd among the 45 states and was classified as 79.7% rural. In the succeeding decades the population increased 42.4% from 1900 to 1910; 28.7% from 1910 to 1920; 51.6% from 1920 to 1930; 29.2% from 1930 to 1940; 46.1% from 1940 to 1950; 78.7% from 1950 to 1960. At mid-20th century the population ranked 20th among the 48 states and was 65.5% urban. By 1960 it ranked 10th among the 50 states and was nearly three-fourths urban. After mid-20th century the population increased by about 220,000 new inhabitants per year. Of this total, about 60,000 represent natural increase, the excess of births over deaths. The net annual immigration to the state is about 160,000 arrivals per year or more than 3,000 per week. The population per square mile of land area in 1950 was 51.1, as compared with 42.6 for the nation as a whole. By 1960 the population per square mile had increased to 91.3 per square mile, as compared with 50.5 for the nation as a whole.

The five largest counties—Dade, Duval, Hillsborough, Pinellas and Broward (Fort Lauderdale)—contain slightly more than one-half of the total population. Eight standard metropolitan statistical areas (Fort Lauderdale-Hollywood, Jacksonville, Miami, Orlando, Pensacola, Tallahassee, Tampa-St. Petersburg and West Palm Beach) contain 67.1% of the total (1960 census).

More than half of the population of Florida comprises migrants from other states, but there are very few foreign-born residents. The distribution by colour and nativity, according to the 1960 census was as follows: 76.9% native white; 5.2% foreign-born white; and 18.0% nonwhite. Practically all of the nonwhite population is Negro.

FINANCE AND TAXATION

The state derives more than half of its total income from taxation and about one-eighth from the federal government. State tax revenues are derived from the following sources: sales and use taxes, gasoline taxes, beverage taxes, motor-vehicle licences, pari-mutuel fees and taxes, cigarette taxes, unemployment compensation taxes and intangible property taxes. There is no state income tax and no state property ad valorem tax. Most of the state's revenue comes from the excise taxes. The state disburses more than half of its income for operating expenses and about one-third of its income goes for aid to counties and cities. State aid to counties includes about $160,000,000 for public schools and school debt.

EDUCATION

In 1947, Florida established a Minimum Foundation program for public schools to enable each county, with the potential help of state funds, to offer adequate educational opportunities to all children. It provided that all schools have a term of 180 days, increased teachers' salaries and encouraged the training of new teachers. State educational scholarships for prospective teachers were doubled, provisions for kindergartens and junior colleges were made and many new school buildings were constructed. More than 1,000,000 students were enrolled in public schools by the 1960s. The school program provides a broad program of adult education, of diversified co-operative training enabling the student to work part-time and of driver education. The state university system of Florida consists of all the state-supported institutions of

higher learning and is supervised by an appointive board of control subject to the ex officio state board of education. One institution, the University of Florida (founded 1853), is located at Gainesville; two others are at Tallahassee—Florida State university (founded 1857), and Florida Agricultural and Mechanical university (founded 1887) for Negroes, a land-grant college. A few Negroes were admitted to other state universities in the 1960s. The University of Florida has colleges of medicine, nursing and health related services and the state also contributes to the support of the medical college of the University of Miami (founded 1925), a private institution. Older private institutions of higher education include Rollins college at Winter Park (incorporated in 1879 and opened in 1885), Stetson university at De Land (founded 1883) and Florida Southern college at Lakeland (founded 1885). The state also has a number of privately supported and public or community junior colleges.

HEALTH AND WELFARE

The public health program of Florida is directed by the state board of health and administered by county health departments. Under the state program clinics are provided for mothers and children, and visiting nurses instruct in child care and nutrition; sanitarians guard and test water supplies and inspect food establishments and handlers.

Immunization programs are provided and many counties require certification as to health conditions before issuing building permits; many of the counties provide guidance clinics to assist in the solving of behaviour and mental problems.

The state maintains hospitals for the treatment of tuberculosis and for the mentally ill; a rehabilitation centre for alcoholics has outpatient clinics in several cities of Florida. Training of doctors is supported by the state at the medical colleges of the Universities of Florida and Miami. The crippled children's commission has developed programs which have attracted both public and private funds.

The public-welfare program of Florida generally follows the federal program of social security and public assistance. Florida spends about $70,000,000 annually for aid to aged persons, the blind, dependent children and the disabled, and smaller amounts for unemployment compensation and other aids and for administration. The state maintains training schools for delinquent boys at Marianna and Okeechobee and for girls at Ocala. Schools for the mentally retarded are operated at Gainesville and Fort Myers. Correctional institutions are operated at Apalachee for first offenders while the state penitentiaries for men are at Raiford and Belle Glade and for women at Lowell.

THE ECONOMY

About four-fifths of Florida's labour force are nonfarm workers. Of the total number of employees in nonagricultural establishments about 30% are engaged in retail and wholesale trade; about 15% each in government, services and manufacturing; about 10% in construction trades; and less than 10% in transportation, communication and public utilities; about 5% in finance, insurance and real estate; and about 1% in mining.

The geographical distribution of employment varies with the economy of each section according to the development of tourism, agriculture and industry; agricultural employment is well distributed in the farm and grove areas from Pensacola to Miami; businesses and trades that cater to tourism and hence employ food handlers, maids and porters are concentrated along the major highways on the east and west coasts. The pulp and paper industry is largely in the northern sections; food canning and preserving in the central citrus section; the apparel industry chiefly in the Miami area; printing and publishing in the largest cities; chemicals in and around Pensacola; and mining in Polk county.

The population increased 76.3% from 1950 to 1960. The per capita income of Floridans rose from $1,228 in 1950 to about $2,000 by 1960, approximating the average for the nation as a whole. Extractive, processing and fabrication industries contribute about 20% of the total personal income; trades, services and related industries contribute about 40%; federal, state and local governments about 20%; and unclassified sources, about 15%. More than half of the state's income is derived from wages and salaries. Proprietors' income and property income each amount to about 15%.

Agriculture.—Florida is one of the few states in which agriculture is an expanding industry. The refrigerated freight car made practicable the long-distance shipment of perishable truck and citrus crops; quick freezing and the wholesale marketing of frozen foods increased market demands. The successful control of insect pests and the introduction of cultivated pastures promoted beef production; livestock receipts amount to almost 25% of total farm receipts. More than 100 meat-packing plants process Florida cattle, most of the beef being bought in 30 livestock auction markets.

Citrus fruits account for almost 35% of the state's agricultural production; Florida accounts for about two-thirds of the total U.S. production. Vegetable production is important; more than 60 vegetables are grown commercially, mostly for winter trade. Part of the 23,000,000 ac. of forest land in the state is privately owned, and timber is cut for lumber and pulpwood mills. The number of commercial farms in the state increased after mid-20th century, while there was a decline in other states. The production, processing and distribution of agricultural products is one of the three major sources of income payments.

The perfection of manufacturing processes for the concentration of citrus juices through a "quick-freeze" operation resulted in a major new food industry which consumes more than half of the citrus production of the state. Commercial fishing is an important industry, the annual catch being valued at about $30,000,000.

Manufacturing and Industry.—The most significant economic factor in the growth of Florida has been diversification: in agriculture with new processing for crops, in tourism through expansion to a year-round business and in industry through over-all expansion and development. Florida's industrial growth began with the 20th century; between 1899 and 1933, the value added by manufacture increased at a rate of 3% each year; after 1933 the rate of growth was more than 7% annually. Florida is not, however, a major industrial state, accounting for only about 1% of total U.S. industrial employment.

The broadening of the industrial base is illustrated by the great increases in metalworking and fabricated metal production and the establishment of an electrical machinery industry. Industry groups which doubled their employment in 1950–60 include apparel, furniture, paper, chemicals, stone, clay and glass, and nonelectrical machinery.

Food processing, including canning and preserving, was the state's leading industry after mid-20th century; it was followed, in order, by pulp, paper and paperboard; cigars; newspapers; and sawmills and planing mills. The most significant industrial development of the 1950s was the completion and opening of a natural gas line from Texas into the peninsula to serve all of the metropolitan areas. The state's leading power plants, industries and manufactured gas distributing systems were converted to the use of natural gas, assuring an ample supply of fuel for additional industries.

Beginning in 1956, several manufacturers of space missiles and jet engines established plants in Florida, and the national missile testing centre was established at Cape Canaveral (renamed Cape Kennedy in 1963). With nearby Patrick air force base, the centre employs 35,000 persons. There are more than 150 electronics firms, mostly in the Tampa-St. Petersburg area.

Minerals.—Although the extraction of minerals from the earth in Florida is behind other states in volume, the state leads in the production of phosphate rock and fuller's earth. Both aluminum and uranium have been extracted from Florida phosphate, enough of the latter to warrant the establishment of a recovery plant by the Atomic Energy commission. Among the newer minerals extracted in the state are titanium, zirconium and hafnium. The chemical industries include the production of textile fibres by chemical synthesis, organic chemicals, fertilizers, inorganic chemicals and plastics and resins. A fourth of the nation's supply of turpentine and wood rosin is manufactured in Florida.

Tourism.—Agriculture, industry and tourism constitute a three-way economy for Florida. The equable year-round climate and nearness to centres of population have made it a leading vacation land. In 1927, about 1,800,000 visitors spent approximately $201,000,000. Three decades later, about 8,080,000 visitors spent approximately $1,323,000,000 on vacations in Florida. After mid-20th century tourism was one of the state's three largest business enterprises. Before 1920, the state was a rich man's vacation spot, but the automobile and better roads made the luxury of a former generation a mass market.

Transportation and Communication.—There are about 4,700 mi. of railroads. There also are about 14,000 mi. of state-maintained paved roads and 28,000 mi. of paved roads maintained by counties and cities plus 20,000 mi. of improved but unpaved roads in Florida. International airports are at Miami and Tampa. Domestic and several foreign airlines operate from more than 100 commercial and municipal airports; there are more than 50 military airports and several private airports. The export-import trade through the state's 13 deepwater harbours regularly operating in foreign trade amounts to almost 10,000,000 tons, nearly balanced between imports and exports. There are more than 50 daily newspapers and about 150 weekly newspapers. About 175 radio stations, about 20 commercial television and 6 educational television stations broadcast in the state.

See also references under "Florida" in the Index.

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FLORIDA, a department in south-central Uruguay. Pop. (1962 est.) 121,607; area 4,675 sq.mi. In Uruguay, population, industry and intensive agriculture are concentrated in Montevideo and the adjacent departments of the south; ranching occupies the rest of the country. Florida is a border zone where agriculture and dairying have become important, while ranching predominates —in the early 1960s there were about 470,000 cattle and 1,500,000 sheep. The departmental capital, Florida (pop. [1962 est.] 16,362), centre of commercial and administrative activities, was the scene of Uruguay's Declaration of Independence on Feb. 28, 1811. There are rail and road connections with Montevideo. (M. I. V.)

FLORIDABLANCA, JOSÉ MOÑINO Y REDONDO, CONDE DE (1728–1808), Spanish statesman, who became identified with the reform program of Charles III and was the main force behind its operation, was born at Murcia on Oct. 21, 1728. He distinguished himself as a leading advocate in Madrid and was appointed fiscal of the council of Castile in 1766. Having cooperated in the expulsion of the Jesuits from Spain in 1767 and being known as a convinced regalist, he was sent as ambassador to Rome in 1772 with the purpose of procuring the general dissolution of the Society of Jesus. As a reward for his success in this mission Charles III gave him the title of conde de Floridablanca in 1773.

He replaced Jerónimo Grimaldi as first secretary of state in 1776. In office he attacked the problem of mendicity, sponsored vocational schools and workhouses, established public credit agencies to lend capital to farmers, and was involved in most of the reforming efforts of the government in trade, industry, agriculture and public works. Wishing to create a more efficient instrument of government, Floridablanca persuaded the king to establish (July 8, 1787) a *junta de estado,* or type of cabinet, which began regular joint meetings of all the royal ministers in order to discuss and co-ordinate policy and for which he himself drew up a program of action. In foreign affairs he improved relations with Portugal but could not prevent the intervention of Spain in the American Revolution.

Charles IV retained Floridablanca in office upon his accession (1789) but the minister's policy now changed. However much he had believed in enlightened progress and subscribed to the views of the French *philosophes,* he remained devoted to absolute monarchy. From 1789 events in France turned the progressive into an authoritarian, and a growing horror of revolution conditioned all his policy, led him to resuscitate the Inquisition, to impose a rigorous censorship and to disavow the ministers and institutions of the late king. Aristocratic resentment of his power and humble origin, together with his intransigent policy toward France which was thought to endanger the royal family there, led to his being replaced by the conde de Aranda in Feb. 1792. At first Floridablanca was allowed to return to his native Murcia, but he was arrested in July and confined in the fortress of Pamplona. When Aranda was dismissed and exiled in 1794 Floridablanca was released and permitted to retire to Murcia where he lived in seclusion until the French invasion of 1808. He was then nominated president of the supreme central junta. He died at Seville, probably on Dec. 28, 1808.

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FLORIDOR (JOSIAS DE SOULAS, SIEUR DE PRIMEFOSSE) (*c.* 1608–1671), French actor, of whom De Visé wrote that he acted "like a gentleman . . . whose bearing and movements were so natural that even without speaking he inspired general admiration." He was born at Brie early in the 17th century. After about five years at the Marais theatre in Paris he joined the Hôtel de Bourgogne in 1643 and there rose to the position of manager and *orateur,* that is, the speaker who addressed the audience when the next play was to be announced. As an actor Floridor seems to have been better suited for parts that required more dignity than warmth. Robinet commented on his "*air charmant*" and "*noble manière,*" and Louis XIV held him in particular esteem. When Racine cast him in the role of Nero in *Britannicus* (1669), the spectators had difficulties in reconciling the irreproachable actor with the wicked part he had been assigned to play. (A. M. N.)

FLORIN, the name of several coins of the continent of Europe and of two denominations struck in England at different times. The name is derived from a gold coin issued at Florence, Italy, in 1252. (A silver florin had been struck as early as 1189.) The gold

florin bore on the obverse a lily, from which it took the name *fiorino* meaning "flower"; on the reverse it bore the Latin name of the city Florentia, and for this reason it was also known as "florence." "Florin" and "florence" seem to have been used indiscriminately in English as the name of this coin. Because of its stable value, the Florentine gold florin was held in great commercial repute throughout Europe, and similar coins were struck in other parts of Italy, and in Germany, France and the Netherlands (*see* GULDEN). In effect, the Florentine florin became a means of international payment; its supremacy lasted until the 16th century.

The English gold florin was introduced by Edward III in 1344, half florins and quarter florins being struck at the same time. This gold florin weighed 108 gr. (in comparison with the 54-gr. weight of the Florentine florin) and was to be worth six shillings. It was found, however, to be overvalued relative to the silver currency and was demonetized the same year. The florin did not reappear in British coinage until 1849 when silver florins having a nominal value of two shillings were struck. In 1887 a double florin or four-shilling piece was issued, but its coinage was discontinued in 1890. The design of the British florin was frequently altered. After 1953 the reverse showed a central rose surrounded by thistles, shamrock and leeks. *See* also MONEY, MEDIEVAL; NUMISMATICS. (Jo. M. L.)

FLORIO, JOHN (GIOVANNI) (*c.* 1553–*c.* 1625), English teacher of Italian, lexicographer and translator of Montaigne, was the son of Michael Angelo Florio, a Protestant refugee of Tuscan origin. John, who was born in London about 1553, may have had some education at Tübingen, and had returned to England by 1576. In 1581 he matriculated at Magdalen college, Oxford. At Richard Hakluyt's instigation he translated, as *Navigations and Discoveries* (1580), Giovanni Battista Ramusio's account of the voyages of Jacques Cartier. Another translation, *A Letter Lately Written From Rome,* was printed in 1585. *Florio His Firste Fruites* (1578), consisting of a grammar and 44 lively dialogues in Italian and English, was followed by *Florio's Second Frutes* (1591), together with a collection of proverbs alphabetically arranged in *Giardino di Ricreatione.* Between 1583 and 1585 Florio was employed as tutor to the French ambassador's daughter. He was associated with Giordano Bruno, whose works Florio used freely as a lexicographer. By 1594, and possibly some years earlier, Florio had been appointed tutor to the earl of Southampton. His Italian-English dictionary, *A Worlde of Wordes* (1598), contains about 46,000 definitions, many amply informative, others racy and idiomatic. The second edition, *Queen Anna's New World of Words* (1611), was greatly enlarged.

In 1603 Florio produced his major translation, *The Essayes . . . of . . . Montaigne.* By modern standards of accuracy the freedom of this version is licentious; the style is uniformly elaborate where Montaigne is variously subtle or spare, but the book is rightly recognized as thoroughly good reading and was only temporarily displaced by Charles Cotton's version (1685). Florio revised it in 1613. From 1604 to 1619 Florio was groom of the privy chamber to Queen Anne. He was also her Italian tutor and probably taught Prince Henry. His last years were spent in poverty at Fulham, near London, still occupied with translations. Part 1 of *The New-Found Politicke* (1626) gives his rendering of Boccalini's *Ragguagli di Parnaso.* He died of the plague about 1625. His elaborate will is discussed by F. A. Yates, who identified two manuscripts in the British museum, *Giardino di Ricreatione* and an Italian version of King James's *Basilikon Doron.*

Florio left collections for the dictionary and ten dialogues which were apparently used by Torriano in his *Italian Tutor* (1640). H. G. Wright has made a good case for Florio's responsibility for the anonymous translation of the *Decameron* (1620). He is known to have had friendly connections with Sir Philip Sidney, Fulke Greville, Sir Edward Dyer, Matthew Gwinne, Barnabe Barnes, Nicholas Breton, Thomas Thorpe and Ben Jonson. He had his enemies too: John Eliot mocked him in *Ortho-Epia Gallica.* It has been supposed that Holofernes in *Love's Labour's Lost* was Shakespeare's gentler ridiculing of Florio's palpable pedantry and affectation; the most judicious consideration of this question is in F. A. Yates's *Study of Love's Labour's Lost* (1936). Florio was observant and critical of English manners and of the Elizabethan scene and indefatigably interested in words. He appears from his style as lively, learned, opinionated, fluent, industrious and, by his own epithet, the "Resolute John Florio."

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FLORIS (originally DE VRIENDT), **CORNELIS** (1514–1575) and **FRANS** (*c.* 1518–1570), Flemish artists, the former an architect, sculptor and medalist, the latter a painter, were brothers from a talented Antwerp (Belg.) family. Frans studied under Lambert Lombard in Liège, and early in the 1540s both brothers went to Rome, returning with their sketchbooks crammed with impressions. Those of Cornelis bore fruit in ornamental engravings (issued 1548–57) which introduced Netherlandic artists to an exuberant version of the Roman grotesque style. Of the drawings which Frans made from antique sculpture and from Michelangelo's paintings, many survive; he was one of the first northern artists to feel the impact of Michelangelo's "Last Judgment" (unveiled 1541).

Both brothers were soon at the head of flourishing workshops in Antwerp. Cornelis supplied, among other works, the choir screen of Tournai cathedral and the tombs of the Danish kings Frederick I at Schleswig, Ger. (1550–52), and Christian II at Roskilde, Den. (1568–75). Of his architecture, the most important example is Antwerp town hall (1561–65); its remarkable amalgamation of a Gothic gable front with a Florentine palace façade became the model for Netherlandic town halls. Indeed, the somewhat severe Renaissance style which Cornelis evolved dominated later 16th-century Netherlandic architecture, and its influence was felt in northern Germany, Denmark and around the Baltic coasts. He died in Antwerp, Oct. 20, 1575.

Frans's success was even more phenomenal, thanks to the fashionable modernity of his style, an astonishing facility of hand and the ability with which, like Rubens, he organized an efficient picture-producing factory. But his extravagant mode of life brought him into financial difficulties and he died (in Antwerp, Oct. 1, 1570) overwhelmed with debt. Paintings that bear his signature (a double or triple F) are in Antwerp; Arnstadt, Ger.; Vienna; Brussels; Stockholm; Florence and other cities.

Frans Floris' brilliant natural gifts seem obscured by his ill-digested borrowings from classical antiquity and from Raphael, Michelangelo, Tintoretto and others. His genius is best revealed in small details of his pictures, in his studies of heads and in such portraits as those of a falconer and his wife (1558; Brunswick, Ger.; Caen, Fr.). Here the bravura of the brushwork plainly foreshadows the painting of the Baroque. (D. KG.)

FLORUS, PUBLIUS ANNIUS (late 1st and early 2nd century A.D.), historian of Rome and poet, is important as the first of a number of African writers who, in the 2nd century, exercised considerable influence on Latin literature; he was also the first of the "new-fashioned" poets of Hadrian's reign, whose special characteristic was the use of lighter and more graceful metres (anapaestic and iambic dimeters), which had hitherto found little favour. He compiled, chiefly from Livy, a brief sketch of the history of Rome from the foundation of the city to the time of Augustus. The work, which some manuscripts call *Epitome de T. Livio bellorum omnium annorum DCC libri duo,* is a rhetorical panegyric of the greatness of Rome. Though almost valueless historically, it was much used in the middle ages. In the manuscripts the writer is variously given as Julius Florus, Lucius Annaeus Florus or simply Annaeus Florus; but from certain similarities of style he has been identified with Publius Annius Florus, who was also known to be the author of a dialogue *Vergilius orator an poeta,* of which a fragment of the introduction has been preserved. This states that he was born in Africa, and at an early age took part in the contest of poets instituted by Domitian in honour of Capitoline Jove. Having been refused a prize owing to the prejudice against African provincials, he left Rome and set up at Tarraco in Spain as a teacher of rhetoric. But he must have

returned to Rome, for it is agreed that he is the Florus who addressed the lines to Hadrian beginning "Ego nolo Caesar esse" ("I do not wish to be Caesar"), quoted with Hadrian's answer by Spartianus. Twenty-six trochaic tetrameters, *De qualitate vitae*, and five graceful hexameters, *De rosis*, are also attributed to him.

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(A. H. McD.)

FLOTATION PROCESS: *see* METALLURGY; ORE DRESSING.

FLOTOW, FRIEDRICH, FREIHERR VON (1812–1883), German composer known for his opera *Martha*. Born on April 26, 1812, at Teutendorf, Mecklenburg, he studied under Antonin Reicha in Paris, where he established his reputation with *Le Naufrage de la Méduse* (1839), written in collaboration with Albert Grisar and Auguste Pilati. Between 1840 and 1878 he produced 19 light operas in France, Italy and Germany of which the best known is *Martha* (Vienna, 1847), in its original form a ballet given at the Paris Opéra in 1844. Introducing the Irish song, "The Last Rose of Summer," and appealing by its melodic charm, *Martha* won a place in the operatic repertory. Flotow also wrote ballets produced at Schwerin, where he was director of the court theatre, and incidental music for Shakespeare's *A Winter's Tale*. He died at Darmstadt, Jan. 24, 1883.

See R. Svoboda, *Friedrich von Flotows Leben* (1892).

FLOTSAM, JETSAM AND LAGAN, in common law, goods lost at sea, as distinguished from goods which come to land, which are technically designated wreck. Jetsam (the same word as jettison) refers to the case when goods are cast into the sea and there sink and remain under water; flotsam where they continue floating on the surface; lagan where they are sunk in the sea, but tied to a cork or buoy in order to be found again. Flotsam, jetsam and lagan belong to the sovereign in the absence only of the true owner. Wreck, on the other hand (*i.e.*, goods cast on shore), was by the common law adjudged to the sovereign in any case, because it was said by the loss of the ship all property was gone out of the original owner. *See* SALVAGE.

FLOUNDER, a name given generally to flatfishes other than the sole (*q.v.*) and in England particularly to *Platichthys flesus*, which ranges from northern Europe to the Mediterranean, and often enters fresh water. The starry flounder (*P. stellatus*) of the Pacific coast of North America is a related species. In America the name is given to several species of flatfishes, *e.g.*, winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*) and gulf flounder (*P. albiguttus*). *See* also FLATFISH.

FLOUR, in general terms, is the fine, soft powder of any substance but the word usually means the finely ground meal of wheat. Flour for use as human food also is made from rye, barley, corn (maize), beans, buckwheat, bananas, rice, oats and potatoes; such flours, however, usually are known by a combination name, such as potato flour, to distinguish them from wheat flour which constitutes about 90% of the flour consumed in the U.S., western Europe and the British commonwealth and is the subject of this article.

Wheat flour is made primarily from the endosperm (food storage tissue) of the wheat grain, or kernel. The endosperm makes up about 85% of the kernel, the bran (husk) constitutes 13% and the germ (embryo plant) 2%. The endosperm consists of thin-walled cells containing mainly starch embedded in a matrix consisting principally of proteins, part of which form gluten (*q.v.*) when mixed with water. The exact chemical composition of the entire kernel and of the endosperm varies, however, according to the variety of wheat and the growing conditions, including type of soil and climate. The bran and germ are used chiefly as livestock feed but may be used in making certain types of flour.

The average composition of the entire kernel is carbohydrate 70%, protein 12.3%, water 12%, fat 2%, mineral matter (ash) 1.7% and crude fibre 2%. Vitamins also are present in small amounts, principally in the bran, aleurone and germ. The chemical composition of flour therefore varies according to the wheat variety, growing conditions, the parts of the kernel used and the degree to which the parts are separated in milling. The purpose of milling is to separate the endosperm from the bran and germ to the degree required for the type of flour being manufactured.

This article discusses types and grades of flour both as defined by government regulation and as used by bakers; properties and uses of flour; and the milling and treatment of flour. Related information will be found in the articles BREAD; FOOD PREPARATION: *Breads*; WHEAT.

TYPES AND GRADES OF FLOUR

U.S. Types.—In the United States, the federal government has established definitions and standards for wheat flour. The main points concerning the most widely used wheat flours are as follows:

White, Wheat or Plain Flour.—This flour is prepared by grinding and sifting cleaned wheat of some variety other than amber durum and red durum. Malted wheat, malted wheat flour, malted barley flour or any combination of two or more of them may be added to compensate for a natural deficiency of enzymes; the quantity of malted barley flour shall not exceed 0.25%. The amount of ash present from the bran coat, or bran coat and germ, shall not exceed the sum of 0.35% and 1/20 of the percentage of protein, calculated on a moisture-free basis. (Flour made from amber durum wheat is used to make macaroni, spaghetti and other paste foods; it will not make bread, rolls, biscuits or similar foods. Red durum wheats are used largely for livestock feed; their flours will not produce good bread and, because of their dark colour, are not suitable for macaroni and other paste foods.)

Enriched Flour.—White flour, as defined in the previous paragraph, is said to be enriched if each pound is supplemented so that it contains between 2.0 and 2.5 mg. of thiamine (vitamin B_1), between 1.2 and 1.5 mg. of riboflavin (vitamin B_2), between 16.0 and 20.0 mg. of niacin (nicotinic acid) or niacinamide (nicotinamide) and between 13.0 and 16.5 mg. of iron. Between 250 and 1,000 U.S.P. (U.S. Pharmacopoeia) units of vitamin D may be added. Between 500 and 625 mg. of calcium also may be added, but no maximum applies if the flour is acidified with monobasic calcium phosphate. Enriched flour may not contain more than 5% of wheat germ or partly defatted wheat germ by weight.

Bromated Flour.—This is white flour (usually a bread flour) to which has been added potassium bromate in an amount not exceeding 50 parts per 1,000,000 parts of finished bromated flour. The addition improves the baking qualities of the dough. Potassium bromate in this proportion may be added to other bread flours, *e.g.*, white enriched flours, whose baking qualities are improved by the addition.

Self-Rising White Flour.—This is a fine mixture of flour and baking powder. Baking powders can be substituted for yeast as a means of generating carbon dioxide when dough is leavened. The amount of baking powder may not exceed 4.5 parts to each 100 parts of flour. Self-rising flour may be enriched in the same way as white flour except that the calcium content may cover a wider range; *i.e.*, from 500 to 1,500 mg. per pound.

Whole Wheat (Entire Wheat or Graham) Flour.—This flour is prepared by grinding a variety of cleaned wheat other than amber durum or red durum so that not less than 90% passes through a No. 8 sieve and not less than 50% passes through a No. 20 sieve (U.S. standard wire sieves with openings of 2.38 and 0.84 mm. respectively). A deficiency of natural enzymes may be compensated by adding malted wheat, malted wheat flour, malted barley flour or any combination of two or more of these, but the quantity of malted wheat flour added may not exceed 0.5% and the quantity of malted barley flour may not exceed 0.25%. The moisture content may not exceed 15%. Whole wheat flour may be bromated by the addition of not more than 75 parts of potassium bromate per 1,000,000 parts of bromated flour.

Grades of Flour.—The weight of flour produced per 100 lb. of wheat milled is known as the flour yield or the percentage of extraction. An extraction of about 75% is usual for white flour; higher extractions, which produce dark flours, often are made during times of short wheat supply, such as during wartime. If all

the flour in an extraction is packed as one grade, it is called straight grade flour (U.K., straight run flour). If the total flour is subdivided into grades, their names and usual proportions are as follows: patent flour 82%; first clear 8%–12%; low grade 4%–6% of the total flour.

Patent flour, which is used to bake bread, biscuits (U.K., scones), cakes and similar white or light-coloured goods, is the whitest flour; it contains the least bran and germ and has an ash content of about 0.4%. The ash content is much lower in flour made from soft wheat flour than in hard wheat flour. First clear is used in the production of dark bread, such as rye bread; it is darker in colour than patent flour and its ash content varies from 0.7% to 0.8%. Low-grade flour, with an ash content between 1.0% and 1.3%, may be used to make dark cookies (U.K., biscuits).

British Types.—In Great Britain the government permits the milling of wheaten flour of any extraction rate, provided that the content of certain nutrients is not less than that required for "national" flour (which must be of 80% extraction rate). The nutrients referred to, with the minimum quantities required to be contained per 100 g. (following the recommendations made by the Conference on the Post-War Loaf in Britain in 1945), are vitamin B_1 (thiamine) 0.24 mg., nicotinic acid (niacin) 1.60 mg. and iron 1.65 mg. In Britain the miller has to add to all flour (except 100% whole meal) a highly purified form of calcium carbonate (*creta præparata*) at the rate of 14 oz. to the sack (280 lb.).

Whole-meal flour, in Great Britain, is flour of 100% extraction, prescribed in 1945 by British government regulation as "flour obtained by milling clean wheat from which nothing has been abstracted."

Flour By-Products.—The feed portion remaining after extraction of the flour can be made into the following by-products: bran 60%, shorts (U.K., fine wheat feed, pollards, middlings) 38%, germ 2%. All three are used mainly as animal feed. The germ has a protein content of between 25% and 33%, about equal to the protein content of dried milk and meat. The oil in the germ can be extracted and used as a human nutritional supplement to furnish vitamin E and unsaturated fatty acids. Oil-free germ is used as an ingredient of some breakfast foods and soups.

PROPERTIES AND USES OF FLOUR

The baker in the U.S. can choose from flours made from a wide range of wheat varieties, basing his choice on the type of baked goods he wishes to produce. The three main varieties of wheat, as distinguished by their properties, are: (1) soft wheat, (2) hard spring wheat and (3) hard winter wheat. The baking characteristics of their flours differ since the chemical contents of the wheats differ, chiefly in protein and mineral content.

Soft wheats are lower in protein and ash content than are the hard spring and winter wheats. Soft wheats are grown in the northeast (*e.g.*, New York and Pennsylvania) and the Pacific northwest of the U.S. Hard wheats are grown in the Great Plains areas of the U.S. and Canada. Winter varieties of hard wheat are planted in the autumn and harvested the following summer, while varieties sown in the spring are usually grown in regions where the winters are too severe for the winter varieties to survive.

When flour is mixed with water to make dough, the protein in the flour is hydrated to form what is called gluten, and this forms a continuous network throughout the dough. The strength of this network is dependent on the protein content of the flour, and when the latter is used for breadmaking it is necessary that the protein content be sufficiently high so that the gluten network has adequate strength to retain the carbon dioxide generated in the dough during fermentation. When the dough contains sufficient gluten so that the gas retention is good, the dough bakes into large loaves with soft, smooth-textured crumb.

For sponge cakes and other baked goods that have a light porous structure it is desirable that the flour should have a low-protein, high-starch content as the swelling of the latter during the cooking of the cake batter is of primary importance. Best results are obtained with flours of low protein content and fine granularity as these can be used with recipes containing high percentages of sugar and milk.

The mineral (ash) content of flour is used in the U.S. as an indication of the amount of bran in the flour, as bran is a source of ash. However, the ash content is also somewhat directly related to the protein content. The mineral matter consists principally of phosphates, sulfates and chlorides of potassium, magnesium, sodium and calcium.

Soft Wheat Flours.—These flours are used in making cakes, cookies (U.K., biscuits), pie crusts, crackers, doughnuts, ice box cookies and other pastries. The protein content ranges from 7.5% to 10% and the ash content from 0.32% to 0.48%.

Hard Wheat Flours.—Flour made from hard red spring and hard red winter wheats is used in making white pan (U.K., tinned) bread (both sponge and straight dough), speciality and variety breads, hamburger and similar buns, yeast-raised sweet goods, soft rolls, yeast-raised doughnuts, hard rolls and hearth bread. The protein content ranges from 12.5% to 15.5% and the ash content from 0.42% to 0.74%.

Dark Flours.—These flours include rye and whole wheat. Rye flour customarily is produced by blending rye flours with a good, first-clear, white flour from wheat to obtain the colour and flavour of bread desired; such breads as pumpernickel, rye graham and Swedish rye are made by using unblended flours. Whole wheat flour may also be blended with a good first clear; it is made from spring or winter wheat of the highest protein content.

In Britain, home-grown wheat is mostly soft wheat of low protein content, suitable for cakes and biscuits (U.S., cookies) but not for breadmaking. Consequently, British millers generally blend home-grown wheat with imported strong wheat, such as Canadian Manitoba wheat, and with "filler" wheats, such as Plate, U.S., and Australian, for milling breadmaking flour.

THE MILLING OF FLOUR

The modern milling process may be divided into two main parts: (1) cleaning and conditioning (tempering) the wheat; (2) separating the bran layers and germ from the endosperm and then pulverizing the endosperm. After the flours are milled they usually are blended and treated.

Cleaning and Conditioning the Wheat.—When wheat arrives at the mill, it contains unwanted materials, such as chaff, straw, soil, stones, weed seeds and grains of other cereals. These impurities are removed before the wheat is processed. The removal methods are based on physical differences between the wheat and the impurities; *e.g.*, differences in size, shape, specific gravity and magnetic properties. Friction, such as abrasion combined with impact, is most effective in removing impurities that adhere to the wheat kernel. Impurities that are either wider or narrower than the wheat can be removed by oscillating sieves; impurities longer or shorter than wheat grains can be removed by revolving cylinders or disks, the surfaces of which are covered with suitable-sized indentations. Chaff and other lightweight impurities are carried away by currents of air passed through streams of wheat.

Wheat is conditioned according to its type and the type of flour desired. The moisture content and the physical properties (and the chemical properties as well) of wheats grown in different parts of the world vary considerably. Wheats from India and Manitoba are vitreous, hard and dry; other wheats, such as those grown in Great Britain and France, are mealy, soft and less dry at harvest time. Water must be added to dry wheat and removed from damp wheat to bring the wheat into the condition in which the endosperm can be separated most effectively. If the process of removing or adding water is done at moderately high temperature, the process is called warm or hot conditioning. Conditioning does not lower the baking quality of the flour, unless the temperature is too high, and may improve it. An additional reason for drying damp wheats is to prevent deterioration during storage.

Separating the Endosperm.—*Purpose.*—The main objective of milling white flour is to separate the endosperm in as pure a state as possible and to grind it into flour that is free from bran and germ. The kernel (fig. 1) consists essentially of three parts: (1) the bran, which is made up of layers called the epidermis, epicarp, endocarp (these three constituting the pericarp, or fruit coat), testa (seed coat), nucellar layer and an aleurone cell layer

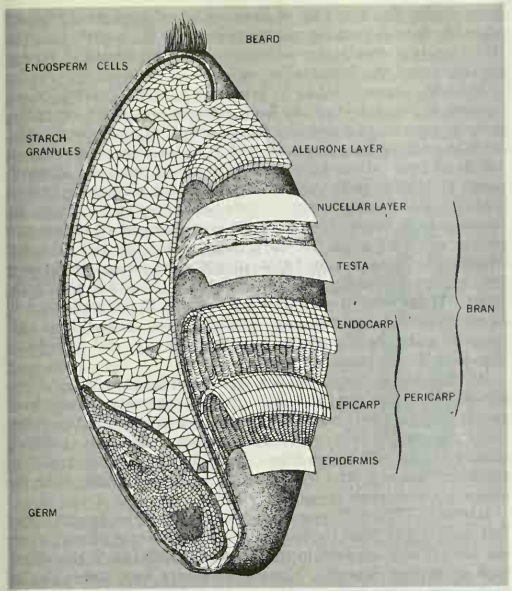

FIG. 1.—LONGITUDINAL SECTION OF A WHEAT KERNEL SHOWING BRAN LAYERS

(botanically, the outer layer of the endosperm); (2) the scutellum and the germ, which is the embryo of the future plant; (3) the endosperm, which is composed chiefly of starch, protein and cellulose cell walls, with small amounts of sugars, lipids, gums and other matter. Since the wheat kernel consists of approximately 85% endosperm, it would appear that an 85% extraction of flour consisting entirely of endosperm could be obtained; this is never achieved, however, because separation of endosperm from bran and germ is imperfect and is complicated by the existence of a deep furrow or crease that extends into the middle of the kernel on the ventral side. Admixture of bran particles with the flour during milling darkens its colour and affects baking qualities adversely. Inclusion of germ in the flour lowers baking performance and reduces storage life because of the presence of oil in the germ.

Figure 2 shows a simplified diagram of the flow of stock in a small modern flour mill. The process shown can be carried out continuously since the equipment in most mills is driven by electricity and is automatic. The equipment for milling flour consists essentially of roller mills, sifters and purifiers connected together into a continuous system by inclined spouts (tubes), horizontal conveyors and vertical bucket elevators or pneumatic lifts. Flour, bran and shorts (U.K., wheatfeed) are taken off at different points on the break roller-sifter-purifier line, while germ and additional flour and shorts are taken off the set of reduction roller mills and sifters shown across the bottom of the diagram. A flow sheet for a large mill would be much more elaborate with several machines operating in each step instead of only one as shown in fig. 2.

Flour mills usually occupy buildings with three to six floors. All the machines of one type are grouped on one floor as far as possible. One or two floors may be occupied solely by roller mills; other floors may be occupied completely by sifters or purifiers. The machines are grouped in this way so that stocks can flow from machine to machine by gravity whenever possible.

The Break System.—In the break rollers the wheat kernels are split open and the endosperm is scraped off the bran coats. The endosperm is released gradually by passing the kernels through a series of four to six breaks, the clearance between the rolls being progressively deceased from first to last breaks. A small additional amount of endosperm may be separated after the last break by impacting, beating or brushing the bran in specially designed machines.

A break roller consists of two parallel-mounted corrugated iron rolls that work as a pair but at different speeds; at their point of contact the rolls move in the same direction; the speed differential is $2\frac{1}{2}$ to 1: that is, the speed of the fast roll is $2\frac{1}{2}$ times that of the slow roll. Sawtooth-like grooves spiral around the surface of each roll; the corrugations become progressively finer (from 10 per in. to 24 per in.) from first to last breaks. The fineness of grinding can be adjusted by increasing or decreasing the gap, or clearance, between a pair of rolls.

After the stock leaves the first break rolls, it is sifted on the first break sifter and is divided into several portions according to particle size. The coarsest stock (bran coats) goes to the second break rolls, and the next two coarsest stocks are graded on purifiers; the finest stock is taken off the first break sifter as flour. The clean stock passing through the first (least coarse) cover of the first purifier is middlings; the throughs of the next coarser cover are sizings (U.K., semolina); throughs of the last (coarsest) cover are chunks (U.K., scratch stock). The chunks are ground on the chunks rolls (U.K., scratch rolls). The break work on the coarsest stock is repeated on the other break rolls, sifters and purifiers. The flours from the sifters are grouped according to their purity.

Sifting (Bolting).—Sifters basically are sieves that separate according to particle size or shape. The sifters (U.K., plansifters) move in a gyrating fashion and are equipped with one or more flat, horizontal sieves arranged in a vertical nest. Most sieves are rectangular; they are kept clean by various devices such as rubber balls and web belt cleaners that roll or ride under the cloth.

After each break the released endosperm is first sifted on cloth made of wire, silk or man-made fibres (*e.g.*, nylon); some of the cloths have meshes as fine as 12,000 per square inch.

The stocks, after being separated in the sifters, are divided into several grades, which in a large mill are named as follows: (1) coarse, medium and fine sizings (the coarsest particles; U.K., semolina); (2) coarse, medium and fine middlings (medium-size particles); (3) break flour (finest particles).

Purifying.—The purifiers make it possible to remove free bran particles from the break chunks, sizings (semolina) and middlings. These machines employ an oscillating sieve in conjunction with air currents that rise vertically through the sieve. For the most efficient purifier operation the sizings and middlings must be graded on sifters into several size classifications, each of which contains a relatively narrow range of particle sizes, and each grade must be purified separately.

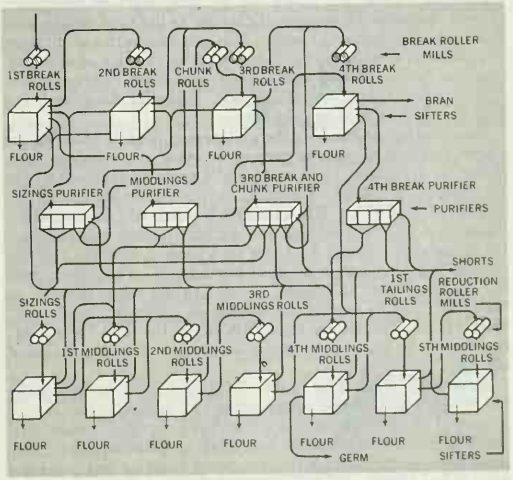

FIG. 2.—FLOW SHEET OF A SIMPLE FLOUR MILL OF SMALL CAPACITY

Each long, narrow purifier sieve is divided into several consecutive sections covered with wire, silk or nylon; the mesh of each section becomes progressively coarser from head to tail. The lightest impurities (the bran particles) are lifted upwards by the vertical air currents or are held suspended in the air by air currents until they reach the end of the sieve section and are drawn off. The sizings and middlings drop through the openings of the sieve.

Reduction System.—The graded and purified sizings (semolina) and middlings are ground into flour by a group of roller mills called the reduction system. These roller mills are similar to the break roller mills except that most of the rolls have a smooth or finely scratched surface and turn at a lower speed ratio (*i.e.*, 1½ to 1 in the U.S., 1¼ to 1 in U.K., instead of 2½ to 1). The stock is passed through reduction rolls either until the stock achieves flour quality, as judged by passage through a sifting cloth, or until the rejected stock, called shorts or tailings (U.K., fine wheatfeed or middlings) and germ, no longer contains enough endosperm to warrant further reduction.

Treatment and Blending.—The streams of flour from the various sifters in both the break and reduction systems are blended to make the various grades before being matured and bleached chemically. Flour is treated (*i.e.*, matured and bleached) in order to improve its baking qualities and appearance. Similar improvements can be brought about through natural processes but the results are more variable, more expensive and much more time consuming. Some flours also are treated by adding enzymes to them.

Bleaching.—The use of chemicals to bleach flour was introduced about 1900, approximately 20 years before chemical maturing agents were first used. Nitrogen peroxide was the first chemical used as a flour bleach; it was favoured because it gave flour an attractive appearance, free from grayness. At first it was produced chemically but later was made by passing an air current through an electric arc.

Chlorine gas is unequaled for treatment of cake flours, especially those to be used with large amounts of sugar, but for treatment of bread flours it was replaced in the early 1920s by nitrogen trichloride, a much more effective bleaching and improving agent. The use of nitrogen trichloride was discontinued, however, after 1949 when it was shown that in large doses it might cause canine hysteria.

Benzoyl peroxide was introduced as a bleaching agent about the same time as nitrogen trichloride. This reagent is an efficient whitening agent on all types of flour but does not improve baking quality. It is used at the rate of 1 part to about 30,000 parts of flour; the reaction time is about 48 hours.

Chlorine dioxide gas, which has no toxic effect on laboratory animals, has replaced nitrogen trichloride as the most widely used bleaching (and maturing) agent. It is just as effective as nitrogen trichloride as a maturing agent and 80% as effective as a bleach. Chlorine dioxide, which is used at the rate of about 3¾ g. per 280 lb. of flour, reacts almost instantaneously. It is used chiefly on bread flour but may be used on cake flour.

Bleaching agents intensify the whiteness of flour by oxidizing the yellow xanthophyll pigment present in wheat and in wheat flour. Patent flour contains between 1½ and 4 parts of xanthophyll per 1,000,000 parts of flour. Bleaching may reduce the amount of pigment by 90% to 97%. When the first research was done on wheat pigments it was believed that the pigment present was carotene, the precursor of vitamin A. Later work showed, however, that the pigment is xanthophyll or esters of xanthophyll. The milling trade has continued, out of custom, to refer to the wheat pigment as "carotene" and to express the amount of colour in "carotenoid" units. It has also become customary to use the term "bleaching" to refer to the action of maturing agents as well as the action of bleaches.

Maturing.—When flour is stored for six to nine months under the proper conditions of temperature and humidity, the natural process of aging causes certain physical and chemical changes that result in improvements in its breadmaking characteristics. Matured flour produces dough that has better handling properties and gives larger loaves with finer textured crumb. The changes that occur during the maturing of flour, or wheat, are not of benefit when the flour is used for making cookies (U.K., biscuits), and in this case best results are obtained when the wheat is freshly harvested and the flour freshly milled.

Maturing agents (U.K., "improving" agents) bring about changes in the protein of the flour, whereby the gluten of weaker flours is caused to behave like the gluten of stronger flours. If a straight grade of flour is treated with 1.3 g. of chlorine dioxide per 100 lb. of flour (about 3.7 g. per 280-lb. sack), the usual improvements in baking quality result. However, the different grades of flour, if used separately, require differential treatment. Thus, the patent portion (about 80% to 88%) would require treatment at a rate of about 0.5 g. per 100 lb. of flour (1.5 g. per 280-lb. sack), whereas the clear portion (12% to 20%) would require heavier treatment; *viz.*, 4 to 6 g. per 100 lb. of flour (11 to 17 g. per 280-lb. sack). Differential treatment is unnecessary if the grades are to be combined subsequently into a straight grade; nevertheless, differential maturing is customary milling practice, and differential bleaching is sometimes carried out.

Addition of Enzymes.—When flour is deficient in natural enzymes, the miller may add flour, rich in α-amylase, made from germinated (malted) wheat or barley. Alternatively, the baker may use preparations of fungal amylase. Diastatic enzymes usually are added only to bread flours, but proteolytic (protein-splitting) enzymes may be added to cookie (biscuit) flours to improve their dough properties.

History.—Milling is one of the oldest industries known. The first milling was done by hand, probably between a stone laid on the ground and one held in the hand; at least, this is the oldest type of process known. Many refinements were developed to make hand milling easier and to permit finer grinding of the meal. In a later refinement, large grooved horizontal millstones were used, one revolving against the other. Various means of power were developed; first the stones were turned by hand, then by animals and later by water power, by air (windmills) or by engines or motors. The purifier was developed in the early 19th century and many improvements were made to it subsequently. Roller mills were developed in Hungary in the latter part of the 19th century and have since been much improved. A recent development was the fine grinding of flour and classification (by air or other means) of particles by size. Such classification produces some fractions of very low protein content (chiefly starch) and others of high protein content, as well as fractions of intermediate protein content. The fractions may go into special uses or may be recombined in the proper proportions to give flours of desired characteristics. The main aim of each improvement in flour milling has generally been to obtain a whiter flour that will give a whiter, lighter textured loaf of bread, and, more recently, to increase the number of uses to which the flour may be put.

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FLOUR BEETLE, a term commonly applied to certain species of beetles, of the family Tenebrionidae, that inhabit grain, flour and patented cereal foods. They are cosmopolitan in distribution but are more common in warm regions. The most important, and the most studied, are two species of the genus *Tribolium:* the confused flour beetle (*T. confusum*) and the red flour beetle (*T. castaneum*), both of which are serious pests in flour mills. It is thought that, originally, these insects fed on broken grain in the fields but that, with the cultivation and storage of grains by man, they readily invaded such indoor supplies where they enjoyed an abundance of food and favourable conditions for breeding. That these beetles have long been pests is indicated by the fact that the remains of *Tribolium* have been found in a grain jar in an Egyptian tomb dating back to about 2500 B.C.

The life cycle of the various species of *Tribolium* is similar. The adults are small, elongated, red-brownish insects about ⅛ in.

long. The females can lay as many as 1,500 eggs during their lifetime. The small, milky-white eggs are deposited in flour and in cracks containing flour dust; they hatch into slender, locomotory, yellowish larvae. The latter grow by progressing through a series of stages (instars). Prior to pupation the larva is about $\frac{3}{16}$ in. long. The total life cycle from egg to adult can be completed in four weeks but generally requires longer, depending on such conditions as temperature, moisture and available food.

The beetles are difficult to control in flour mills because of their small size and rapid development. In the opinion of R. T. Cotton and G. B. Wagner, the mills generally become infested in six principal ways: (1) through entrance of the beetles with the grain stream; (2) from infested flour used in blending operations; (3) from infested flour returned to the mills from grocers, warehouses, etc.; (4) from infested second-hand flour bags; (5) from infested second-hand machinery; and (6) from infested feed stored in the mill near the milling machinery. The principal measures employed for control are fumigation or sterilization of incoming grain, frequent repair of flour sifters, cleaning and fumigation of conveyors and general fumigation of the mill with toxic gases such as hydrocyanic acid gas, chloropicrin and methyl bromide. Supplementary control measures consist of spraying neglected corners, woodwork, etc., with pyrethrum and thiocyanate sprays, rebolting (resifting) of flour that is being reconditioned, diversion of infested returned stocks, proper handling and storage of finished flour and fumigation and proper construction of warehouses. In homes, dry cereals should be kept in tight containers. Heavily infested food should be sterilized in a hot oven and then disposed of.

BY COURTESY OF U.S. DEPARTMENT OF AGRICULTURE

CONFUSED FLOUR BEETLE (TRIBOLIUM CONFUSUM)

Other common flour beetles are the broad-horned flour beetle (*Gnathoceros cornutus*), the small-eyed flour beetle (*Palorus ratzeburgi*) and the long-headed flour beetle (*Laetheticus oryzae*). These are widely distributed forms generally similar in habits to *Tribolium*.

Extending beyond their infamy as "pests," the flour beetles have a positive virtue: they are important experimental animals in modern biological research. *Tribolium*, especially, has been used extensively in the laboratory analysis of population ecology (*q.v.*), and, to a lesser degree, in studies of heredity and behaviour. These beetles adapt to such studies because they can be husbanded in large numbers under a wide array of chosen experimental designs.

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FLOURENS, GUSTAVE (1838–1871), French revolutionary, one of the most colourful figures of the Commune (*q.v.*) of Paris, was born in Paris on Aug. 4, 1838. Trained by his father, the physiologist Marie Jean Pierre Flourens, he had a brilliant scientific career until his father's death in 1867, when the Collège de France, to which his evolutionary theories and his republican opinions were equally distasteful, refused to appoint him to his father's chair of natural history. Flourens left France and went to Crete, where he joined the insurgents against Turkey. He gained his main military experience in hard guerrilla warfare and acquired such prestige among the Cretans that he was chosen president of the delegation elected by Crete in 1868 to sit in the Greek parliament. The Greek ministers, however, dared not recognize this delegation and solved their difficulties with the help of the French consul by kidnaping Flourens and sending him to France, while they turned his colleagues back to Crete. He then went to Naples and carried on republican propaganda there till he was imprisoned. On his release he returned to France and continued his propaganda. He was dangerously wounded in a duel with Paul de Cassagnac (Aug. 5, 1869). At Victor Noir's funeral (Jan. 12, 1870) Flourens attempted with his usual impetuosity to lead an insurrection but was thwarted by his principal associates. He next attempted a rising on Feb. 7, but this collapsed on the spot and he was condemned to imprisonment. Set free, he proved his ardent patriotism during the siege of Paris in the Franco-German War and commanded first five battalions raised at Belleville and then a corps of *tirailleurs*. Together with 23 other battalion commanders he attempted a *coup d'état* in Paris on Oct. 31, 1870, but government troops prevented this and Flourens gave in after negotiation. On the outbreak of the Commune Flourens was elected on March 26, 1871, for the 19th and 20th *arrondissements* and was made a temporary general by the revolutionaries. On April 3, in the course of a sortie from Paris, he was surprised by mounted gendarmes at an inn at Chatou and killed by a sabre blow.

See "Philhellène," *Gustave Flourens et l'insurrection crétoise, 1866–68* (1893); Charles Prolès, *Gustave Flourens* (1898).

FLOURENS, MARIE JEAN PIERRE (1794–1867), French physiologist who first demonstrated that gross areas of the brain are essential to certain body functions, was born at Maureilhan, near Béziers. After taking his doctor of medicine degree at Montpellier he went to Paris, where, at the Collège de France, he conducted his experimental studies on the vertebrate brain, using chiefly pigeons. His results were published in 1824 in a paper entitled *Recherches expérimentales sur les propriétés et les fonctions du système nerveux dans les animaux vertébrés*. He distinguished three main areas of the brain: the cerebral hemispheres, the cerebellum and the medulla. When he removed the hemispheres from pigeons they were deprived of all senses of perception but not of the sense of equilibrium. When he removed the cerebellum, the pigeons lost their equilibrium. When he sectioned the medulla the pigeons died. He therefore recognized the hemispheres as the organs of the higher psychic and intellectual abilities, the cerebellum as the regulator of all movements and the medulla as the site of vital centres, especially of respiration. Since extirpation of portions of the hemispheres did not interfere with perception, Flourens concluded that in every psychic action the whole hemisphere must be involved. Consequently he became the most prominent opponent of the phrenology theory of F. J. Gall. He also was the first to recognize (1824) the role of the semicircular canals of the inner ear in the maintenance of equilibrium and co-ordination and the relationship of the *corpora quadrigemina* to the optical pathway. Flourens became professor of comparative anatomy at the Museum du Jardin in 1832 and professor of natural history at the Collège de France in 1855. He died at Montgeron, near Paris, on Dec. 6, 1867. (F. Wn.)

FLOWER, SIR WILLIAM HENRY (1831–1899), English biologist who made valuable contributions to structural anthropology and to the comparative anatomy of mammals, was born at Stratford-upon-Avon on Nov. 30, 1831. He took his M.B. (bachelor of medicine degree) at London university in 1851, and went to the Crimea as assistant surgeon. On his return he became a member of the surgical staff of the Middlesex hospital, London, and in 1861 curator of the Hunterian museum of the Royal College of Surgeons. In 1870 he also became Hunterian professor, and in 1884 was appointed to the directorship of the natural history department of the British museum at South Kensington. Flower, cognizant of the teaching function of museums, greatly influenced museum display. He died in London on July 1, 1899.

His chief publications are: *Diagrams of the Nerves of the Human Body* (1861); *The Osteology of the Mammalia* (1870); *Introduction to the Study of Mammals, Living and Extinct* (1891); *Essays on Museums and Other Subjects* (1898).

See C. J. Cornish, *Sir W. H. Flower* (1904); R. Lydekker, *Sir William Flower* (1906).

FLOWER, a blossom, the association of more or less leaf-like organs of a plant which are concerned with the production of

seed. As popularly used, the term is especially applicable when part or all of this structure is distinctive in colour and form.

The flower has been a universal symbol of beauty in the civilizations of the world. Confucius included its cultivation among the arts that were essential to a man of culture. The Romans paid homage to Flora, goddess of flowers, with an annual festival, and in the luxurious times of the emperors men of wealth scattered roses lavishly about their reception rooms—a custom borrowed from the Greeks, who in turn had adopted it from the Egyptians.

The cramped European economy of the middle ages had comparatively little room for flowers; they were cultivated as a partly ornamental, partly practical supplement to herb gardens, and many of the flowers prized today for their beauty were grown for their supposed medicinal value or to be dropped into the kitchen pot as herbs. However, flowers retained their aesthetic and mystical significance, and they were regularly cultivated in monastery gardens to be placed on the altars of churches.

The gardens of the Renaissance again emphasized flowers. Their culture, along with horticulture in general, received a new stimulus from the settlements in the new world, which brought an interchange of plants between the gardeners of the colonies and those of Great Britain and western Europe.

In their range of colours, numbers and arrangement of constituent parts and relative positions on the plants that produce them, flowers present a seemingly endless variety of combinations. They range in size from the minute blossoms of the duckweed (*q.v.*), an inconspicuous plant found floating on ponds throughout the temperate zone, to the grotesque giant fleshy bloom of the monster flower (*Rafflesia* [*q.v.*] *arnoldi*) of Malaya, reported to measure up to three feet across. In some plants, such as poppy, magnolia, tulip and petunia, each flower is relatively large and showy and is produced singly and at some distance from other flowers on the plant. In other plants, such as aster, snapdragon, calla lily and lilac, the individual flowers, which may be very small, are borne in a more or less crowded cluster (see *Inflorescence*, below). Regardless of this range of variety, all flowers have a uniform function, the reproduction of the species through production of seed.

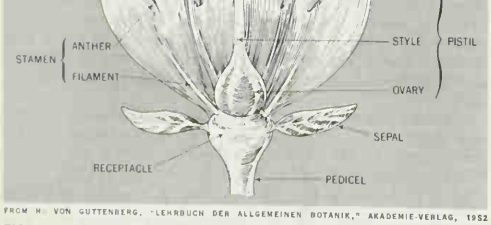
The flower is the characteristic structure of the evolutionarily highest group of plants, the angiosperms (*q.v.*), or flowering plants. In botanical classification the angiosperms were formerly grouped with the gymnosperms (*q.v.*) as the seed plants (Spermatophyta); technically, however, they are as different from the gymnosperms as they are from the ferns. (*See* PLANTS AND PLANT SCIENCE: *Classification of Plants.*)

In the following sections the flower is discussed first from the botanist's point of view, then from that of the commercial flower grower. For general information on the culture of flowering plants for the home garden and for indoor display, *see* HORTICULTURE; HOUSE PLANTS.

BOTANY

KINDS AND ARRANGEMENT OF FLOWER PARTS

Structure of a Generalized Flower.—Basically, each flower consists of a floral axis upon which are borne the essential organs of reproduction (stamens and pistils) and usually accessory organs (sepals and petals), which may serve both to attract pollinating insects and to protect the essential organs. The floral axis is a greatly modified stem; unlike the vegetative stems, which bear the leaves, it is usually contracted, so that the parts of the flower are crowded together on the stem tip, the receptacle. The flower parts are usually arrayed in whorls (or cycles) but may be disposed spirally, especially if the axis is elongate. (*See* fig. 1.) There are commonly four distinct whorls of floral parts: (1) an outer calyx composed of sepals; within it, the parts alternating with those of the calyx, is (2) the corolla of petals; next, alternating with the parts of the corolla is (3), the androecium, the group of stamens; and in the centre is (4) the gynoecium, the collective term for the pistil (or pistils).

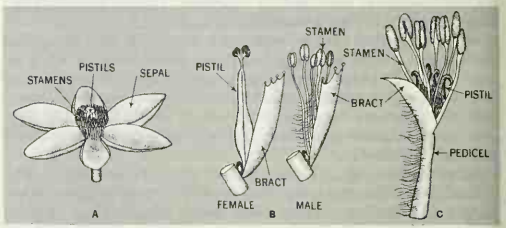


FROM H. VON GUTTENBERG, "LEHRBUCH DER ALLGEMEINEN BOTANIK," AKADEMIE-VERLAG, 1952

FIG. 1.—GENERALIZED FLOWER WITH PARTS IN GROUPS OF FIVE, DISPOSED IN WHORLS ON THE RECEPTACLE (SOME PARTS ARE REMOVED HERE)

The sepals are usually greenish and often resemble reduced leaves; the petals are usually showy. Together, the calyx and corolla are known as the perianth, or floral envelope. (In many monocotyledons, such as lilies and tulips, where the sepals are similar in size, form and colour to the petals, the individual parts of the perianth are technically called tepals.) Each stamen usually consists of a stalk, or filament, and an anther, which is composed of sacs containing pollen. The pistil comprises the ovary (the basal part that contains the ovules destined to become the seeds), the more or less elongate style and, atop the style, the stigma, or receptive tip, which receives the pollen.

Complete and Incomplete Flowers.—The generalized flower just described is called complete, because all four kinds of floral organs are present; specific examples of complete flowers are those of the snapdragon, rose, iris and petunia. With reference to the presence of the calyx and corolla, a complete flower is said to be dichlamydeous. But there are many kinds of flowers in which either the calyx or the corolla is absent (monochlamydeous) or both are missing (achlamydeous, or naked). If a monochlamydeous flower lacks petals, as in the marsh marigold (fig. 2[A]), it is said to be apetalous; if it lacks sepals, asepalous. Examples of naked flowers are seen in willows (fig. 2[B]) and in the lizard's tail flower (fig. 2[C]).



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 2.—INCOMPLETE, IMPERFECT AND PERFECT FLOWERS

(A) Apetalous, bisexual flower of marsh marigold (*Caltha palustris*); (B) naked, unisexual flowers of willow (*Salix*); (C) naked, bisexual flower of lizard's tail (*Saururus cernuus*)

Perfect and Imperfect Flowers.—Stamens and pistils are not present together in all flowers. When both are present the flower is said to be perfect, or bisexual (fig. 1; 2[C]). All complete flowers are obviously also perfect. When only one kind of essential organ is present, the flower is termed imperfect, or unisexual (fig. 2[B]), and is either staminate (male) or pistillate (female). When the same plant bears unisexual flowers of both sexes, it is said to be monoecious (*e.g.*, tuberous begonia, hazel, oak, corn); when the male and female flowers are on different plants, the plant is dioecious (date, holly, cottonwood, willow); when there are male, female and bisexual flowers on the same plant, the plant is termed polygamous.

Numerical Arrangement and Symmetry.—Usually the successive whorls of the flower, disposed from below upward or from without inward upon the floral axis, are of the same number of parts or a multiple of the same number of parts, those of one whorl alternating with those of the whorl next to it (fig. 1). When a flower consists of parts arranged in whorls or circles it is cyclic

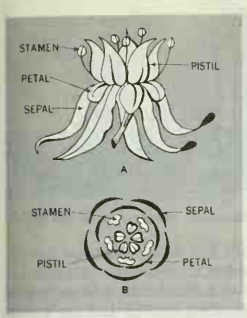


FIG. 3.—EUCYCLIC ARRANGEMENT OF FLOWER PARTS: (A) ENTIRE VIEW OF PENTAMEROUS FLOWER OF RED STONECROP (SEDUM RUBENS); (B) FLORAL DIAGRAM

(most flowering plants), and if the whorls have an equal number of parts and are alternate it is eucyclic (fig. 3). In contrast to the cyclic arrangement are flowers in which the parts are arranged in spirals (acyclic, as in the magnolia). Flowers that are cyclic at one portion and spiral at another (as in many species of the buttercup family, Ranunculaceae) are hemicyclic. In some cases the stamens of the outermost whorl are opposite the petals rather than alternate with them.

A flower is symmetrical when each whorl consists of an equal number of parts or when the parts of any one whorl are multiples of that preceding it. Thus, a symmetrical flower may have five sepals, five petals, five stamens and five carpels, or the number of any of these parts may be a multiple of five. The stamens, especially, are likely to occur in multiples of the basic number. The floral envelopes (calyx and corolla) are rarely multiplied. Flowers in which the number of parts in each whorl is the same are isomerous; when the number in some whorls is different the flower is anisomerous.

The number of parts in the pistillate whorl is frequently not in conformity with that in the other whorls, but in such cases the flower is still called symmetrical, provided that the other whorls are normal. A flower in which the parts are in twos is dimerous; in threes, fours or fives, trimerous, tetramerous or pentamerous, respectively. Trimerous symmetry (fig. 4[A]) is the rule in the monocotyledons; pentamerous (fig. 3[B]), the most common in the dicotyledons, although dimerous and tetramerous (fig. 4[B]) flowers also occur in the latter group.

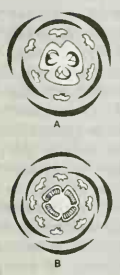
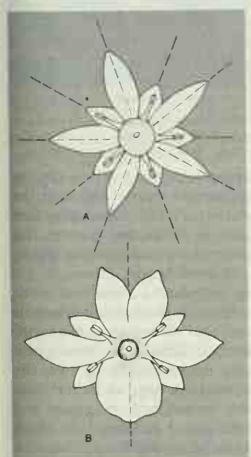


FIG. 4.—FLORAL DIAGRAMS SHOWING DIFFERENT ARRANGEMENTS OF FLOWER PARTS: (A) TRIMEROUS; (B) TETRAMEROUS

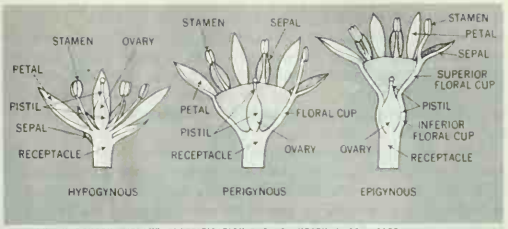
When the different members of each whorl are alike, the flower is regular, actinomorphic or radially symmetrical (fig. 5[A]), as in the petunia, buttercup and wild rose. Differences in size or shape of the parts of a whorl make the flower irregular (as in the canna). When a flower can be divided by a single plane into two equal parts it is zygomorphic, or bilaterally symmetrical (fig. 5[B]), as in the snapdragon, orchid and sweet pea.

Attachment to the Receptacle.—In the generalized flower the floral parts are attached separately to the receptacle (*see* fig. 6), and the series of organs follow in regular succession, culminating in the gynoecium. This arrangement is hypogynous, and since the sepals, petals and stamens are attached beneath the ovary, the ovary is said to be superior, as in the snapdragon and morning glory. In other cases the floral organs spring from a cup, or tube (floral tube), around the ovary. The flower in this case is perigynous and the ovary is still superior. In the most evolutionarily advanced conditions the floral parts are epigynous, inserted above the ovary, which is now termed inferior. In some Saxifragaceae there are intermediate (half-inferior) forms.



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 5.—FLORAL SYMMETRY: (A) RADIAL, AS IN THE WILD ROSE, MILKWEED AND PHLOX; (B) BILATERAL, AS IN THE SWEET PEA, ORCHID AND SNAPDRAGON



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 6.—ARRANGEMENT OF FLOWER PARTS WITH REGARD TO THE OVARY. HYPOGYNOUS AND PERIGYNOUS FLOWERS HAVE THE OVARY SUPERIOR; EPIGYNOUS FLOWERS, OVARY INFERIOR

Receptacular Theory.—The nature of the inferior ovary has long been a disputed question, and two chief interpretations have been advanced. The first, based upon ontogenetic studies, is that the tube to which the floral parts are attached is receptacular in nature, produced by the upgrowth of the receptacle around the gynoecium or by invagination (infolding) of the tip of the floral axis. Following invagination or upward growth, the receptacle in many forms became fused to the ovary wall. This, termed the receptacular theory, has been widely advocated.

Appendicular Theory.—The second, or appendicular theory, supported by evidence from vascular anatomy, conceives the tube surrounding the pistil to be the product of the fusion of the bases of the sepals, petals and stamens; from an evolutionary viewpoint these have become progressively fused with each other and then to the ovary wall. In some flowers (rose, *Calycanthus*) it is true that the (perigynous) cup surrounding the pistils is partly receptacular, partly appendicular, and in the inferior ovary of *Darbya* (Santalaceae, or sandalwood family) the cup is receptacular almost to the insertion of the floral organs. Other similar cases are known. In most forms investigated by the anatomical method, however, the tissues of the inferior ovary outside the ovary wall are appendicular and composed of the fused bases of the floral organs. This is true of most Ericaceae and Rosaceae; in the apple, for example, the bulk of the flesh is appendicular, not, as was earlier believed, receptacular.

Arrangement in the Bud.—The arrangement of the accessory parts (sepals, petals) of the flower in the bud is called aestivation and distinctive terms are applied to the various arrangements exhibited, both by the members individually and in their relation to each other. Only the latter are considered here, since these relationships are most frequently mentioned in technical descriptions of species or other groups. (*See* fig. 7.)

When the parts of a whorl are in an exact circle and are applied to each other by the edges only, without overlapping or folding, the aestivation is valvate, as in the sepals of the mallows. When the members overlap in the bud, two arrangements are possible. In the first, the convolute condition, the parts are rolled or wound together, covering each other completely, or the petals or other segments may cover each other partially; in which case the edge

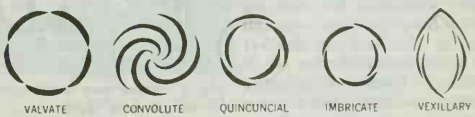


FIG. 7.—TYPES OF ARRANGEMENT (AESTIVATION) OF SEPALS AND PETALS IN FLOWER BUDS

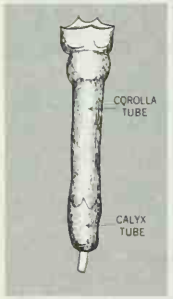
of one petal is overlapped by the one before it, while the outer edge in turn overlaps the next segment. The petals, as seen in cross section, resemble curved spokes in a wheel—this may be seen in the phlox family. In the second type, imbricate aestivation, an outer member overlaps the margins of the inner segments on both sides or on one side only, as shingles on a roof; an example is found in the petals of linden.

When the parts are five—quincuncial aestivation—as in many dicotyledons, there may be two parts external, two internal and a fifth that partly covers one of the inner parts by its margin and in turn is partly covered by one of the external parts (calyx of the rose). Vexillary aestivation may be seen in the pea family (Leguminoseae), with the banner (vexillum) often large and folded on the others.

Floral Envelope (Accessory Organs)

In many plants the floral envelope is showy and conspicuous, serving to attract pollinating insects; in others, where pollination is brought about by other agencies (wind, water, etc.), it may be inconspicuous or absent. Since neither the calyx nor the corolla is necessary for reproduction, these structures are also termed accessory organs.

Calyx.—The sepals are sometimes free (distinct) from each other, sometimes united (coalescent) to a greater or lesser extent; in the first case the calyx is polysepalous, in the second synsepalous, or gamosepalous (fig. 8). Sepals are generally oval, elliptical or oblong, with blunt or acute apices. They are usually greenish (herbaceous), but sometimes are white or coloured (petaloid) as in the buckwheat, anemone and clematis. The vascular bundles sometimes form a prominent midrib, at other times several ribs. The venation is useful in determining the number of sepals in a gamosepalous calyx. The sepals are occasionally of different forms or sizes. The number of members in a gamosepalous calyx is usually marked by divisions at the apex, which may be simple projections or may extend down as fissures, the calyx then being three-cleft, five-cleft, etc., or they may reach nearly to the base.



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 8.—COALESCENCE OF SEPALS AND PETALS IN TREE TOBACCO (NICOTIANA GLAUCA). SHOWING THE SYNSEPALOUS AND SYMPETALOUS CONDITIONS

The union of parts is in some cases complete, when the calyx is entire. Occasionally the sepals are enlarged to form a nectar spur, as in the nasturtium and garden "geranium" (*Pelargonium*). The sepals may be dry and scaly, as in the rush family (Juncaceae), or greatly reduced, as in many genera of the madder family (Rubiaceae). In the composite family it is generally stated that the pappus—composed of bristles, hairs or scales (fig. 9[A]) and projecting beyond the seedlike fruit—is a prolongation of the calyx. The calyx sometimes is caducous, *i.e.*, falls off before the flower opens, as in the poppy (fig. 9[B]); or it may remain after flowering (persistent), as in the mint family (Labiatae).

Sometimes a persistent calyx encloses the fruit without being incorporated with it, becoming large, inflated or bladderlike, as in the Chinese lantern plant (fig. 9[C]) and campion.

Corolla.—The corolla is the inner floral envelope and usually the most conspicuous whorl. As a rule the petals are white or highly coloured, the colouring matter being contained in the cell sap (in blue and red flowers) or in chromoplasts (in yellow flowers). Petals are generally glabrous (smooth), but in some instances hairs are produced. Coloured hairs occur on the perianth of iris. Normally thin and

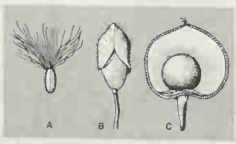
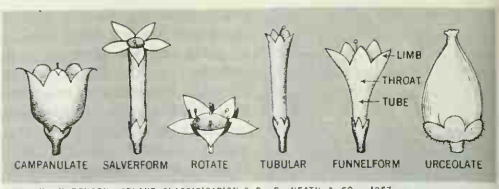


FIG. 9.—VARIATIONS IN CALYXES

(A) Hairlike calyx (pappus) of fruit of groundsel (*Senecio vulgaris*); (B) caducous calyx of poppy (*Papaver*); (C) bladderlike calyx of fruit of Chinese lantern plant (*Physalis*)

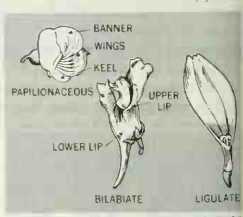


FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 10.—REGULAR SYMPETALOUS COROLLAS: VARIATIONS IN SHAPES

delicate, petals occasionally are thick and fleshy (monster flower, *Rafflesia*), dry (heaths) or hard and stiff (*Xylopia*). Each petal often consists of two parts, a lower narrow claw and an upper broad lamina or limb. The claw is often missing and the petals are then sessile. The limb may be flat, concave or hollowed. In the hellebore the petals become tubular; in aconite some of the petals resemble a hollow, curved horn, supported on a grooved stalk; in the columbine and pansy one or all petals are prolonged as spurs. In the snapdragon the corolla is swollen on one side. These spurs, tubes and sacs serve as receptacles for nectar. The corolla may be composed of separate petals (choripetalous, or polypetalous) or the petals may be united (sympetalous, or gamopetalous [fig. 8]). During the evolution of the union of petals, the fusion has tended generally to take place at the base and extends toward the apex, but in *Vitis* (grape) the petals are separate at the base and coherent at the summit.

In a sympetalous corolla (fig. 10) the lower portion usually forms a tube, the upper parts a common limb, the point of union being the throat. The number of parts is determined by the divisions (teeth) on the limb edge or, when (rarely) the corolla is entire, by the venation of the united petals. The union may be equal or some parts may unite more than others. Among regular polypetalous corollas may be noted that of the rose family, usually composed of five petals (except in horticultural varieties); the caryophyllaceous corolla, as in the pinks, in which there are five clawed petals; and the cruciform, having four petals in the form of a cross, as in the wallflower. Of irregular polypetalous corollas, the most marked is the papilionaceous form (fig. 11), as in the garden pea, where one petal is upstanding (banner or standard), two are lateral (wings) and two are ventral and united (keel).



FROM C. H. M. LAWRENCE, "TAXONOMY OF VASCULAR PLANTS", REPRINTED WITH PERMISSION OF THE PUBLISHER, © 1951 BY THE MACMILLAN COMPANY

FIG. 11.—IRREGULAR COROLLAS

Regular sympetalous corollas (fig. 10) may be (1) campanulate or bell-shaped, as in the bellflower; (2) salverform, the corolla tube being long with a shorter limb at right angles to it, as in the primrose; (3) rotate, as in the flower of the potato, with a very short corolla tube, otherwise much like the salverform; (4) tubular, as in the disc flowers of a daisy; (5) funnelform, as in the four-o'clock and morning glory; and (6) urceolate or urn-shaped, as in some heaths.

Some of these forms may become irregular as a result of some parts developing more than others; thus, in the foxglove there is a slightly irregular campanulate corolla. Other irregular sympetalous corollas (fig. 11) include the bilabiate or two-lipped, having two divisions of the limb, the upper usually of two, the lower of three, united petals, separated by a gap, as in the mint family. When the upper lip is much arched and the gap is distinct, the corolla is ringent; when the gap is reduced to a chink (as in snapdragon) it is personate. In *Calceolaria* the lips become much hollowed out and puffed. When a tubular corolla has a flattened strap-shaped extension, it is ligulate, as in many of the ray flowers of the composites (aster, dandelion, etc.).

Petals are sometimes suppressed and at times the whole corolla is absent; the latter condition is termed apetaly. In *Amorpha* (pea family) only the standard is present. In the buttercup

family some members (*e.g.*, crowfoot) have both calyx and corolla; others (anemone) lack the petals but have petaloid sepals.

The term nectary includes those parts of the flower that secrete a honeylike substance, as the glandular depression on the petal of the crowfoot. The nectar serves to attract insects and, while gathering nectar, they convey pollen to the stigma.

Petals are attached to the axis usually by a narrow base at the foot of the claw. When this attachment is articulate, or jointed, the petals fall off either shortly after expansion (caducous) or after fertilization (deciduous). A sympetalous corolla falls off in one piece.

Essential Organs (Sex Structures)

Since there exist functional naked flowers having no parts but stamens and pistils, these structures, concerned with the production of seed, are termed essential organs—essential in the sense that the continuation of the species is largely dependent on them. The pollen-bearing stamens are the "male" sex organs, and the pistils are the "female" sex organs. The ovules (potential seeds) are formed within the ovary of the pistil.

In comparative morphology these organs are termed sporophylls (spore-bearing leaves). The stamen, or microsporophyll, bears microsporangia (spore cases) in which are developed numerous microspores (potential pollen grains); the pistil, or megasporophyll, bears ovules, each enclosing an egg cell. When the microspore germinates (see *Pollen*, below) it is known as a pollen grain. Following fertilization the egg cell becomes an embryo and the ovule develops into a seed. In many gymnosperms the microsporophylls and ovulate scales are associated in separate cones, to which the term "flower" has been applied loosely (more correctly, flowers are borne only by angiosperms).

Stamens.—The stamens, collectively constituting the androecium, arise from the receptacle within the petals, with which they generally alternate, forming one or more whorls. Sometimes they adhere to the petals (epipetalous) or to the pistil, so as to form a column (gynandrous). Stamens vary in number from one to many, even hundreds. When the stamens are greater than 20, they are said to be numerous, represented by the symbol ∞. When there is only one whorl, the stamens are usually equal in number to the sepals or petals. In some flowers (mint and figwort families) the stamens are four in number and in two pairs, one pair longer than the other, a condition termed didynamous (fig. 12[A]). In the mustard family (Cruciferae) there are six stamens, two shorter than the other four, a condition called tetradynamous (fig. 12[B]). Stamens sometimes become sterile and frequently antherless, and are then termed staminodes.

Filament.—The filament is usually threadlike and cylindrical or slightly tapering toward the summit, but it may be thickened and flattened in various ways and may become petaloid, as in the water lily (*see* fig. 21 below). Though usually of sufficient rigidity to support the anther in an erect position, the filament is sometimes delicate and hairlike, so that the anther is pendulous (*see* fig. 18[C] below), as in the grasses. The filaments may cohere to a greater or lesser extent, the anthers remaining free. Thus, all the filaments may unite to form a tube around the pistil, the stamens being monadelphous (fig. 12[D]), as in the mallows, or they may be arranged in two groups, a condition termed diadelphous (fig. 12[E]), as in the pea, where nine filaments unite, the tenth being free.

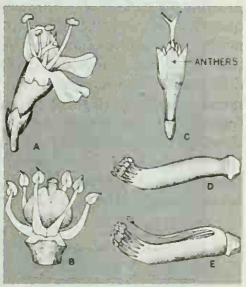


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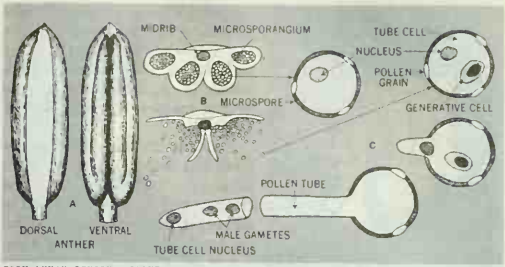
FIG. 12.—VARIATIONS IN STAMENS: (A) DIDYNAMOUS; (B) TETRADYNAMOUS; (C) SYNGENESIOUS; (D) MONADELPHOUS; (E) DIADELPHOUS

Anther.—The anther (fig. 13) consists of pollen sacs containing the pollen grains, which, at maturity, are released through an opening (see *Anther Dehiscence*, below). There is a double covering to the anther: the outer exothecium, actually the epidermis, often bearing stomates; and the endothecium, one or more subepidermal layers bearing fibrous bands. These fibrous-banded layers apparently function in the dehiscence of the anther. The endothecium generally becomes thinner toward the part where the anther will open out, and there gradually disappears. During the development of the anther a nutritive layer (tapetum) of the anther wall, surrounding the spore-bearing tissue, is present, but later breaks down and disappears. At maturity the anther may contain all four pollen sacs (quadrilocular, fig. 13[B]) derived from the four original microsporangia. Commonly, however, the walls between the two sacs on either side break down, to give a bilocular anther. Among exceptions to the above are unilocular anthers, as in the mallows, and numerous cavities in the anther, as in the mistletoe. Stamens may cohere by their anthers, becoming syngenesious, as in the composites (fig. 12[C]).



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

FIG. 13.—ANTHERS AND POLLEN: (A) ENTIRE VIEW OF AN ANTHER; (B) CROSS SECTIONS (TOP) BEFORE AND (BOTTOM) AFTER DEHISCENCE; (C) MICROSPORE AND GERMINATION STAGES OF POLLEN GRAIN

Connective.—The anther lobes are united by the connective, which is either continuous with the filament or articulated with it. When the filament apparently ends at the base of the anther, the anther is said to be basifixed. When the filament is attached to the back, the anther is dorsifixed (fig. 13[A]). If the attachment is so narrow that the anthers are movable they are said to be versatile, as in the lilies and grasses (*see* fig. 18[C] below). The connective is sometimes extended backward and downward, as in the violet, to form a nectar-secreting spur.

Anther Dehiscence.—The opening, or dehiscence of the anthers, resulting in the release of pollen, takes place by clefts, pores or valves. The anther may dehisce longitudinally by clefts through the pollen sacs (fig. 13[B]). If these clefts face outward, the dehiscence is extrorse; if inward, introrse. In other cases the opening is confined to the base or apex, each sac opening by a single pore, as in nightshade. In the barberry and other plants each lobe opens by a valve on the outer side of the anther (valvate dehiscence). Anthers dehisce at different periods during the process of flowering, sometimes in the bud, but more commonly as the flower opens. They may dehisce simultaneously or in succession, these variables being related to the type of pollination in the particular plant.

Pollen.—The pollen grains (fig. 13[C]) consist of small cells, developed from the large, thin-walled mother cells formed within the microsporangia. Two divisions (collectively termed meiosis) occur in each mother cell to form the four cells that are the microspores. The pollen grain results from the division of the microspore nucleus (germination of the microspore) followed by an increase in size and differentiation of the cell wall into an outer (exine) and an inner (intine) layer. The exine may be smooth and thin or ornately sculptured and exceedingly durable. It is generally yellow in colour and may be covered with a viscid or oily matter. The intine is uniform, thin, transparent and extensible. In some aquatic plants (*e.g., Zostera*) only one covering exists.

The mature pollen grains form a powdery mass. Usually the microspores separate from one another, but in some plants (most

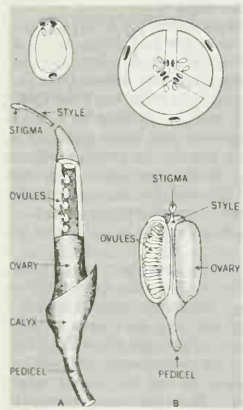
FROM R. D. GIBBS, "BOTANY: AN EVOLUTIONARY APPROACH," MCGRAW-HILL BOOK COMPANY, INC.

FIG. 14.—CENTRAL PORTION OF MILKWEED FLOWER (ASCLEPIAS SYRIACA) SHOWING POLLINIA

heaths, for example) they adhere in groups of four (tetrads). In the milkweed family and in many orchids all the pollen in each anther is aggregated into one or several masses, the pollinia (fig. 14).

Pollen grains vary in diameter from less than $\frac{1}{2,500}$ in. to more than $\frac{1}{100}$ in. They are most commonly spherical, but may be oblong and curved, polyhedral or nearly triangular in section. Symmetrically arranged furrows and pores in the exine allow for changes in volume of the grain and provide exit ports for the pollen tube during germination. A single furrow is characteristic of the monocotyledons, primitive gymnosperms and primitive angiosperms; the number of furrows in dicotyledons is usually 3 but may vary from none to approximately 40. Within the pollen grain is granular protoplasm with oily particles and occasionally starch. The mature pollen grain usually contains a tube cell and a generative cell that later divides to form two male cells, or sperms. (*See* POLLEN GRAINS.)

Pistil.—The pistil (or pistils) occupies the centre of the flower and is surrounded by the stamens and, when present, the floral envelope (fig. 1). It consists of an enlarged basal portion, the ovary, surmounted by a thinner style, at the top of which is the stigma. The pistil constitutes the innermost whorl of flower parts, which after flowering is changed into the fruit and contains the seeds. It is composed of one or more carpels that have been compared to highly modified leaves. When a pistil consists of a single carpel, it is simple (fig. 15[A]); when composed of several carpels, it is compound (fig. 15[B]). In some cases a flower contains a number of simple pistils (fig. 3), but more commonly the carpels are fused to form a compound pistil. If a number of simple pistils are present, these may be arranged at the same height in a whorl, or at different heights in a spiral. The union in a compound pistil is not always complete; it may take place by the basal parts of the carpels alone, or by the basal parts and the styles, only the stigmas being free (fig. 1). Frequently the stigma is solitary, the product of the fusion of the stigmas of many carpels. When separate, the number of styles and stigmas is a guide to the number of carpels composing the ovary.



FROM LYMAN BENSON, "PLANT CLASSIFICATION," D. C. HEATH & CO., 1957

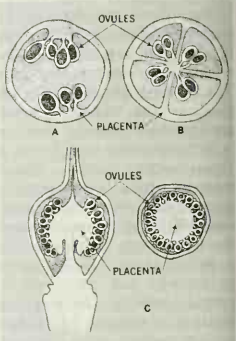
FIG. 15.—TYPES OF PISTILS

(*Top*): diagrammatic cross sections and (*bottom*) entire views of: (A) simple pistil (one carpel) of Spanish broom (*Spartium junceum*); (B) compound pistil (three fused carpels) of yucca (*Yucca whipplei*)

Placenta.—The surface of the carpel to which the ovules are attached is known as the placenta. The placenta is usually located in a region corresponding somewhat to the margins of a leaf, but is actually submarginal in position. In a simple pistil there may be separate placentas at each margin, or the margins may be fused to such a degree that the placenta is double. In such a pistil the placenta is said to be borne on the inner or ventral suture, the outer or dorsal suture corresponding to the midrib of a leaf.

The placentation, or arrangement of ovules within the ovary, is frequently of taxonomic value—useful in the classification of a given species or larger group. The placentation is usually submarginal (fig. 15[A], top) in a simple pistil. Other types of placentation are as follows: In a compound pistil two or more carpels are fused in various ways (fig. 16). If the carpels are united by their adjacent margins, the placentation is parietal; in such cases the ovary is said to be one-celled, or unilocular. In the melon family the fused margins of the adjacent carpels project into the cavity (locule) of the ovary as a single large placenta bearing two rows of ovules, each row belonging to a different carpel. On the other hand, the carpels may be folded inward, so that the margins meet in the centre of the ovary—the placentation is then axile. The ovary is then divided by partitions into cells (locules) corresponding to the number of carpels. In some groups, *e.g.*, Caryophyllaceae (pink family) and Primulaceae (primrose family), the partitions have been lost, leaving a central column composed of the fused margins of the carpels and bearing as many double rows of ovules as there were original carpels. This placentation (derived from the axile type) is termed free central.

Further reduction has led in some cases to the disappearance of the column and most of the ovules; the remaining ovule (as in Polygonaceae) or ovules therefore appear to arise from the bottom of the locule. This is basal placentation. Finally, in a few families, *e.g.*, water lily (Nymphaeaceae) and flowering-rush (Butomaceae), the ovary is composed of numerous carpels with the ovules scattered over their surfaces (laminar placentation).



(A, B) FROM W. W. ROBBINS AND T. E. WEIER, "BOTANY, AN INTRODUCTION TO PLANT SCIENCE," 1950, JOHN WILEY & SONS, INC. (C) FROM J. B. PRIESTLEY AND L. I. SCOTT, "AN INTRODUCTION TO BOTANY," LONGMANS, GREEN & CO.

FIG. 16.—THREE COMMON TYPES OF PLACENTATION: (A) PARIETAL; (B) AXILE; (C) FREE CENTRAL

Ovule.—The ovules (fig. 17) are essentially potential seeds (see *Fertilization*, below). The individual ovule may be sessile, but most commonly is attached by a stalk, the funiculus, which may become much elongated after fertilization. The scar left on the surface of the seed (as in the bean) after the seed separates from the funiculus is called the hilum.

The ovule first appears as a small projection from the placenta. The cells then multiply and form an enlarged ovate body, composed of a one-to-several-layered nucellus, sometimes considered to be the megasporangium wall. The nucellus then becomes enveloped by the integuments, which appear first as rings at the base, then gradually grow over the surface. In some forms only one integument is formed, in others a second one is developed subsequently, covering the first completely except at the apex, where neither integument invests the nucellus but leaves an opening, the micropyle. In most angiosperms a single spore mother cell is differentiated within the nucellus. This cell undergoes the usual meiotic divisions to form an axial row of four megaspores (linear tetrad). One megaspore, usually that farthest from the micropyle, develops into an embryo sac (megagametophyte) and produces the egg cell; the other three degenerate. Only vestiges of the nucellus may remain in the mature ovule. In many species, then, the ovule, when the egg is ready for fertilization, consists of the mature em-

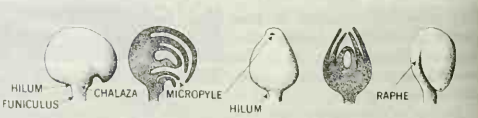


FIG. 17.—TYPES OF OVULES (SHADED FIGURES ARE LONGITUDINAL SECTIONS)

Flamingo flower (*Anthurium*), a tropical American herb of the arum family, Araceae

Calla lily (*Zantedeschia*), a South African tuberous-rooted plant of the arum family, cultivated in gardens and greenhouses

MONOCOTYLEDONS

Flowering plants are divided into two basic groups: the monocotyledons and the dicotyledons. Both groups are further subdivided into orders, and the orders, in turn, into one or more families. The two basic groups of flowering plants differ as follows: the embryo of the monocotyledons has only one seed leaf while that of the dicotyledons has two; the petals and sepals of the monocotyledons occur in three or multiples of three, whereas in the dicotyledons they occur in four or five or in multiples thereof; the monocotyledons have simple stems, the dicotyledons stems with secondary thickening

Spiderwort (*Tradescantia*), one of a number of species of the spiderwort family, Commelinaceae, of common herbs

Queen's tears (*Billbergia*), a tropical American member of the pineapple family, Bromeliaceae

Hohenbergia, a subshrub of the American tropics, belonging to the pineapple family

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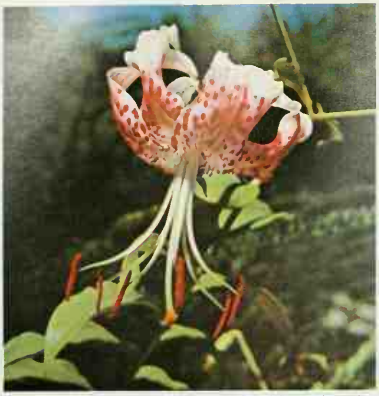

Showy Japanese lily (*Speciosum*), a reflexed flowered member of the lily family, Liliaceae

South African belladonna lily (*Amaryllis*), a bulbous plant of the amaryllis family, Amaryllidaceae, widely distributed as a garden and house plant

Lily of the valley (*Convallaria majalis*), a low woodland herb of the lily family, native to Europe and Asia

Crocus, a popular ornamental plant of the iris family, Iridaceae, from Eurasia

Mariposa lily (*Calochortus*), a western American plant of the lily family that grows from corms

Narcissus, a genus of bulbous, chiefly spring-flowering plants of the amaryllis family, native of central Europe and the Mediterranean region

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Iris, a popular herb of the iris family, favoured for decorative uses

Gladiolus, a genus of tender, cormous plants of the iris family. Most species are native to South Africa

Bird-of-Paradise flower (*Strelitzia*), a South African plant of the banana family, Musaceae

Flame flower (*Kniphofia*), an unusual autumn-blooming plant. It belongs to the lily family and is a native of Africa

Tulip, most popular of the bulbous spring flowers of the north temperate zone. It belongs to the lily family

Phalaenopsis, an epiphytic species (or "air plant") of the orchid family, Orchidaceae

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Telopea, a genus of fleshy-flowered Australian shrubs of the protea family, Proteaceae. These flowers are often cultivated in botanic gardens

Rose moss (*Portulaca*), a hardy, low-growing plant of the Portulacaceae, or purslane family

Columbine (*Aquilegia*), a spring-flowering perennial plant of the buttercup family, Ranunculaceae

Cockscomb (*Celosia*), a popular herbaceous annual plant, native to the tropics, belonging to the Amaranth family, Amaranthaceae

Water lily (*Nymphaea*), typical of its family, Nymphaeaceae, of aquatic plants

Lotus (*Nelumbium*), sacred to the Hindus and formerly found in Egypt. Water lily family

DICOTYLEDONS

Indian pink, or campion (*Silene*), a short herbaceous perennial plant of the pink family, Caryophyllaceae

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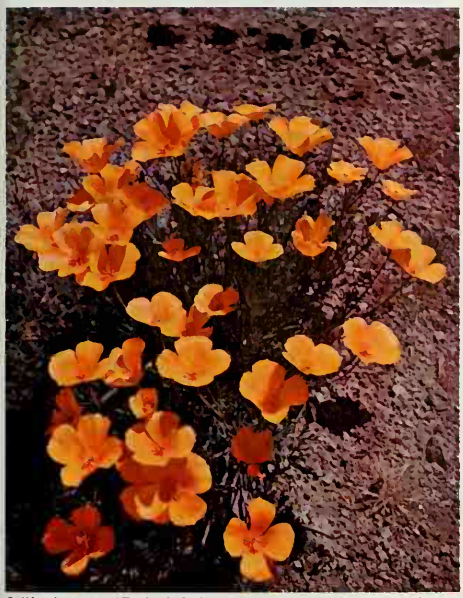
Persian, or turban, buttercup (*Ranunculus asiaticus*), native to Asia and belonging to the buttercup family

Hepatica, a plant of the buttercup family. Natives of open, rich woodlands, they bloom in very early spring



California poppy (*Eschscholtzia*), an annual plant widely grown in gardens, belonging to the poppy family, Papaveraceae

Bleeding heart (Dicentra), a popular hardy perennial plant of the fumitory family, Fumariaceae

Spiderflower (*Cleome*), a tall annual plant of the caper family, Capparidaceae

Buttercup (*Ranunculus repens*), the type of its family, originally native to Eurasia and now widely distributed in North America

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FLOWER

Powderpuff (*Calliandra*), a tropical American species of the pea family, Leguminosae

Mountain locust (*Robinia*), a hardy plant of the pea family, grown for decorative purposes

Everlasting pea (*Lathyrus*), a perennial plant popular for general garden use

Rose (*Rosa*), one of the most popular of garden flowers. Family Rosaceae

Blue flax (*Linum*), found in temperate regions. Linaceae, or flax family

Geranium (*Pelargonium*), one of a family, Geraniaceae, of flowers grown mostly for ornemental purposes

Lupine (*Lupinus*), a tall, herbaceous plant of the pea family

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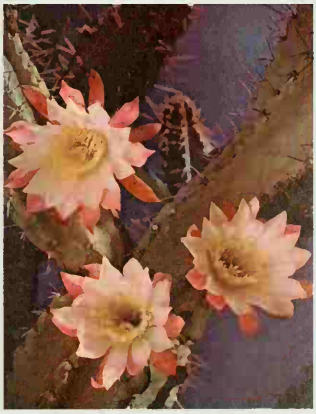
Swamp rose mallow (*Hibiscus*), a native Old World perennial plant of the Malvaceae, or mallow family

Passionflower (*Passiflora*), a genus of tendril-climbing vines. It is the principal member of the passionflower family, Passifloraceae

Camellia, broad-leaved evergreen shrubs belonging to the tea family, Theaceae, and native to Asia

Begonia, succulent plant of the Begoniaceae, or begonia family, growing in moist tropical climates

Pansy (*Viola*), a favourite garden flower belonging to the violet family, Violaceae



Cereus cactus, a native of desert regions of California and Arizona. Cactus family, Cactaceae

Fuchsia, a member of the evening primrose family and a popular house and garden plant

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FLOWER

Rhododendron, a hardy, showy flowering plant of the heath family, Ericaceae

Cyclamen, a perennial herb belonging to the primrose family, Primulaceae, native to the mountains of central Europe and the Mediterranean region

Primrose (*Primula*), low-growing perennial plant typifying its family

Shooting star (*Dodecatheon*), small American perennial plant of the primrose family

Dogwood (*Cornus*), a hardy, spring-flowering, ornamental wood plant. Dogwood family, Cornaceae

Ginseng (*Panax*), a herbaceous plant of the Araliaceae, or aralia family

Closed gentian (*Gentiana*), popular as wild-garden flower. Gentian family, Gentianaceae

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Salpiglossis, a half-hardy annual plant of the nightshade family, Solanaceae

Scarlet sage (*Salvia*), a hardy subshrub of the mint family, Labiatae

Foxglove (*Digitalis*), of the snapdragon family, Scrophulariaceae. It is a native of Europe and Asia

Bee balm (*Monarda*), also known as horsemint, a coarse aromatic herb of the Labiatae

Pumpkin flower (*Cucurbita*), a member of the Cucurbitaceae, or gourd family

Morning-glory (*Ipomoea*), the typical member of its family, Convolvulaceae, and a popular garden flower

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FLOWER

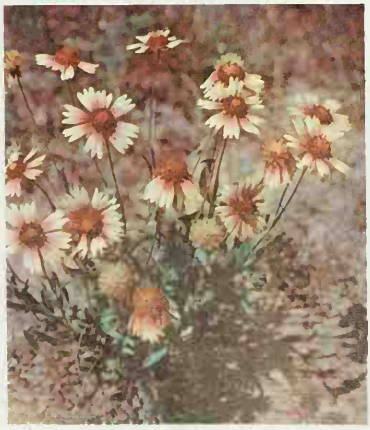
Dahlia, a herbaceous perennial plant of the Compositae, or composite family

Harebell (*Campanula*), of the bellflower family, Campanulaceae

Blue lobelia, a sturdy perennial plant of the composite family

New England aster (*Aster novae-angliae*), a common American composite

Garden aster, a popular ornamental composite flower



Gaillardia, a hardy annual member of the composite family

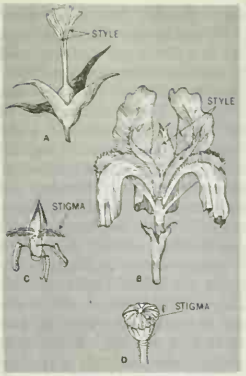
Sunflower (*Helianthus*), a tall, coarse annual plant belonging to the composite family

PHOTOGRAPHS: (TOP LEFT) NICHOLAS—PHOTO RESEARCHERS, (TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON, (CENTRE LEFT, CENTRE) JOHN GERARD, (CENTRE RIGHT, BOTTOM RIGHT) NICK IMPENNA—PHOTO RESEARCHERS

bryo sac and one or two integuments.

The true base of the ovule, the point of attachment of the funiculus, is called the chalaza. When the chalaza is at the hilum and the micropyle is opposite, the ovule is orthotropous. When by more rapid growth on one side than the other the micropyle approaches the hilum, the ovule is campylotropous. In an anatropous (inverted) ovule, the most common form in angiosperms, the apex with its micropyle is turned toward the point of attachment of the funiculus to the placenta, and the funiculus coalesces with the ovule to form the raphe. Forms intermediate between these types occur.

Style.—The style arises from the summit of the ovary and may be simple or branched. When branched, the number of branches is usually a guide to the number of carpels composing the pistil (fig. 18). The styles of a compound pistil, when separate, alternate with the partitions within the ovary. In the iris the style is divided into three flattened petaloid branches arching over the stamens (fig. 18[B]). In some plants the style is so short that the stigma is said to be sessile. In corn (*Zea mays*) on the other hand, the silk, functioning as both style and stigma, attains a length of 12–18 in. The pollen tube passes down the centre of the style, which in some species contains a stylar canal, in others the style is solid. In solid styles the pollen tubes are able to grow between the cells by the action of enzymes that dissolve the intercellular substance. In some cases, because of more rapid growth of the inner side of the ovary, the style may be lateral rather than terminal; sometimes this is accentuated so that the style appears to arise from the base. Several such styles may unite, as in the Boraginaceae, to form a single basal style.



FROM LYMAN BENSON, "PLANT CLASSIFICATION." D. C. HEATH & CO., 1957

FIG. 18.—TYPES OF STYLES AND STIGMAS

(A) Four-branched style of mock orange (*Philadelphus*), indicating that four carpels compose the pistil; (B) three-branched petaloid style of iris, indicating that three carpels compose the pistil; (C) feathery stigma of the grasses; (D) sessile stigma of the poppy

Stigma.—The stigma terminates the style and may be obviously enlarged or scarcely distinguishable from the style. Often it may be recognized by the presence of a viscid secretion present at the time of pollination. The lobes of the stigma may be flat and pointed, fleshy and blunt, smooth or granular, or feathery, as in many grasses (fig. 18[C]). In the poppy (fig. 18[D]) the stigmas are sessile and radiate on a disc at the summit of the ovary.

Production of Seed

Pollination.—When the pollen sacs are ripe, the anther dehisces and the pollen is shed. Fertilization can occur only if the pollen grains are transferred from the anther to the stigma, a process known as pollination. This is of two chief kinds: (1) self-pollination, the pollination of a stigma by pollen from the same flower or from another flower on the same plant; and (2) cross-pollination, the transfer of pollen from the anther of a flower of one plant to the stigma of the flower of another plant of the same or related species. Self-pollination occurs in many species, but in the others, perhaps the majority, it is prevented by such adaptations as the structure of the flower, self-incompatibility and the maturation of stamens and pistils at different times. Cross-pollination may be brought about by a number of agents, chiefly insects and wind. Wind-pollinated flowers generally can be distinguished by their lack of colour, odour or nectar. The pollen of these plants tends to be small, light and dry and is usually produced in enormous quantities. The pollen grains of insect-pollinated flowers are commonly large, heavy and sticky—the stickiness permits adherence to the body of an insect visitor. Insect-pollinated flowers are commonly adapted to insect visits by structure, colour and the production of scent and nectar; such adaptations long have been regarded as among the most remarkable aspects of the world of living things. (*See* Pollination.)

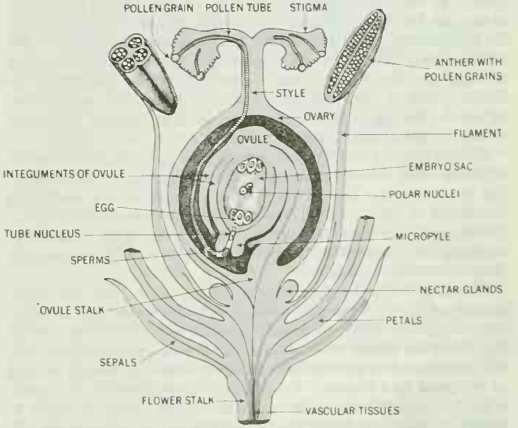
Fertilization.—After a pollen grain has reached the stigma, it germinates, and a pollen tube protrudes through a pore (fig. 13[C]). The tube, containing two male gametes (sperms) and a tube nucleus, grows through the style and enters the micropyle of the ovule (fig. 19). The apex of the tube penetrates the apex of the embryo sac, the male gametes are discharged into it and fertilization follows. Normally many pollen grains fall on the stigma; they all may germinate, but only one pollen tube enters any one ovule.

Following fertilization, changes begin in the embryo sac that result in the formation of the embryo plant, and the ovule is on its way to becoming a seed. Usually at this time also the ovary enlarges to form the fruit, often incorporated with other parts of the flower, such as the floral tube or receptacle. *See* also Angiosperms; Fruit; Seed.

Position of Flowers on the Plant

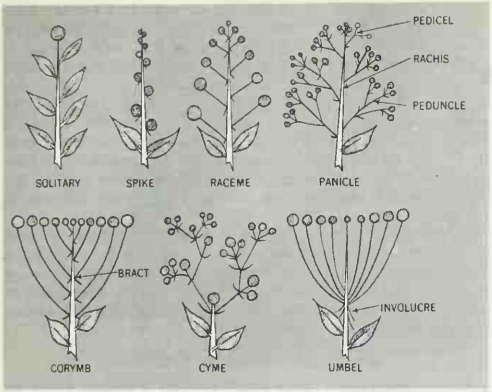
As mentioned above, some plants produce a solitary flower on each floral axis, whereas others produce a cluster of flowers (an inflorescence) as a result of repeated branching of the primary floral axis.

Association With Bracts.—Flowers, except terminal ones, are usually produced in the axils of leaves. When these leaves are reduced in size or are of different form or character they are called bracts. "Bract" is properly restricted to the leaf from which the primary floral axis arises, while leaves—commonly even more reduced—that arise between the bract and the flower are called bracteoles. Flowers do not always arise in the axils of bracts. At the base of the main inflorescence (general umbel) in the carrot family (Umbelliferae) is often a whorl of bracts, the involucre, while involucels are commonly found at the base of the umbellets. In the composite family (Compositae) the head of flowers is surrounded by a conspicuous involucre, the bracts here being termed phyllaries. A sheathing bract, or spathe, enclosing one or several flowers, is common among the monocotyledons (lilies, narcissuses, palms, grasses, etc.), and may, in some palms, reach 20 ft. in length and enclose 200,000 flowers. The spathe sometimes serves as a means of allurement to pollinating insects; it may be coloured, as in *Anthurium* species, or white, as in calla lily (*Zantedeschia aethiopica*). In grasses (*q.v.*), the outer scales (glumes) of the spikelet are sterile bracts; *i.e.*, they do not directly envelope flower parts. As a last example may be noted the coloured or white involucre of bracts that surrounds the flower cluster of poinsettia



FROM H. FULLER AND O. TIPPO, "COLLEGE BOTANY," HOLT, RINEHART AND WINSTON, INC., 1954

FIG. 19.—LONGITUDINAL SECTION OF A COMPLETE, HYPOGYNOUS FLOWER AT TIME OF FERTILIZATION. A POLLEN TUBE IS APPROACHING THE EMBRYO SAC



FROM J. S. MAHLSTEDE AND E. S. HABER, "PLANT PROPAGATION" REPRODUCED BY PERMISSION OF JOHN WILEY AND SONS, INC., 1957

FIG. 20.—COMMON TYPES OF INFLORESCENCES

and some species of dogwood (*Cornus*), the components of which are popularly, but mistakenly, called petals.

Inflorescences.—The term inflorescence, while generally referring to a flower cluster, more specifically denotes the arrangement of flowers on the floral axis (fig. 20).

Only the chief kinds of inflorescences are described here. It should be realized that the type of inflorescence is commonly used in the taxonomic and other descriptions of flowering plants, for it may be characteristic of species, genera and even of entire families, as the Umbelliferae and Compositae.

The primary axis of the inflorescence may be termed the rachis; its branches, when present, are peduncles, which in turn may give rise to pedicels. A flower having a stalk is pedicillate; one with no stalk is sessile. It is common to speak of the rachis as the primary floral axis, the peduncles as the secondary floral axis and so on. The peduncle may be simple, bearing a single flower (the remaining member of an inflorescence) or branched. A leafless peduncle, bearing one or many flowers and arising from a basal cluster of leaves, is known as a scape—examples may be seen in *Cyclamen* and hyacinth. Adhesions occasionally take place between the peduncle and the bracts, as in *Tilia* (linden).

Classically, two general types of inflorescences have been recognized. In one, the primary axis ends in a single flower, but lateral axes arise from the axils of bracts and repeat the process, the development of each lateral axis being stronger than that of the primary axis beyond its point of origin. The flowers are thus terminal and the inflorescence is determinate. In the other, the flowers arise as lateral shoots from a primary axis, which continues to elongate, and the lateral shoots do not exceed the length of the primary axis. Such an inflorescence is indeterminate.

Determinate Inflorescences.—In determinate inflorescences the upper or inner flowers open first; in indeterminate inflorescences the lower or outer flowers open first. But there is considerable variability in this order of flowering and the classification of inflorescences into these two groups is retained more because of tradition and common usage than on the basis of the existence of fundamental differences.

Classified with the determinate inflorescences are the cyme, umbel and head. A cyme in its simplest form consists of a terminal flower together with two flowers terminating pedicels inserted at the first node below. Commonly, the branching is repeated, *i.e.*, the laterals below the terminal flower continue to branch instead of maturing into flowers. Frequently a cyme appears as a somewhat flat-topped compound cluster of flowers, with the order of flowering from the inside to the outside (*e.g.*, Viburnum). In the dead-nettle (*Lamium*) the flowers arise in the axis of each foliage leaf and appear as if arranged in a whorl, a central flower expanding first and from its axis spring secondary axes bearing single flowers. The inflorescence is thus a highly reduced cyme.

When the secondary axes arise from a common point, each ending in a flower, an umbel is produced. A compound umbel results if each secondary axis becomes a peduncle, giving rise to flower-bearing pedicels. Each secondary umbel is then an umbellet. Umbels may be determinate or indeterminate. When the primary axis is greatly contracted and bears numerous sessile or nearly sessile flowers a head is formed, as in many acacias and clovers and members of the composite family. In the latter group the conical or flattened terminal part of the axis to which the flowers are attached is termed the receptacle. The head in plants such as the sunflower and chrysanthemum is popularly called a flower, but it really consists of a cluster of flowers.

Indeterminate Inflorescences.—Indeterminate inflorescences include the raceme, spike, catkin, spadix, corymb and panicle (fig. 20). If the primary axis is elongated and gives off pedicels ending in a single flower, a raceme is produced, as in the hyacinth, stock and toadflax. Reduced cymes may simulate racemes, as in the forget-me-not. If the pedicels of a raceme are wanting, so that the flowers are sessile or essentially so, the result is a spike, as in the verbena. If this bears unisexual, apetalous flowers, it is a catkin, or ament. Such an inflorescence is borne only on woody plants and falls as a unit after flowering. When the spikelike axis of an inflorescence is fleshy and surrounded by a spathe, as in the arum family, it is termed a spadix. In Jack-in-the-pulpit, "Jack" is the spadix and the "pulpit" is the spathe. The spadix may be simple or branched, as in many palms. If the lower flower stalks are developed more strongly than the upper, and thus the flowers are at about the same level, a corymb is formed, as in the cherry and candytuft, which may be simple or branched. A panicle is a loosely branched compound inflorescence terminated by pedicillate flowers, as in the yucca.

The biologic significance of inflorescences may be the attainment of showiness comparable with that of the large, brilliantly coloured single blossom, *i.e.*, conspicuousness. Species with very small flowers grouped together in large clusters gain prominence and thereby become more attractive to pollinating insects.

Evolutionary Aspects of the Flower

Fundamental Nature.—The writings of Goethe (1790) and Pyrame de Candolle (1813) are chiefly responsible for what has come to be known as the classical theory of the fundamental nature of the flower. According to this theory, as usually stated, the flower is a highly modified and abbreviated shoot, determinate in growth, and the floral parts are derived from leaves. The sepals are held to be modified leaves and the carpels greatly reduced and infolded leaves bearing ovules along their margins. Differences of opinion have been expressed concerning the nature of the petals: on the one hand they have been considered modified sepals, on the other metamorphosed and sterile stamens (fig. 21). The latter point of view has been accepted more generally. The classical theory has been accepted almost universally as an instrument of description in taxonomic and morphological studies. An important modification of this theory was suggested by A. Arber in 1937. According to this, leaves on the one hand, and stamens and carpels on the other, are to be regarded as homologous; that is, the carpel should not be regarded as an infolded foliage leaf, but the essential organs, carpels and stamens, together with the leaf, should be viewed as the products of parallel evolution from a common ancestral structure. The carpel may then be compared to a foliage leaf, but is not literally to be regarded as such.

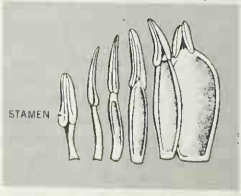
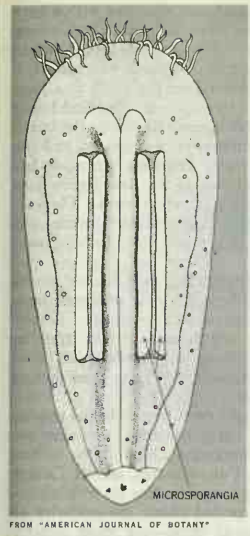


FIG. 21.—TRANSITION OF PETALS FROM STAMENS IN THE WATER LILY

Evolutionary Trends.—The fossil record of the angiosperms has provided few or no clues to classification or to evolutionary trends within this great group. Any attempt to construct an evolutionary scheme of classification is therefore restricted to the study of living forms, and much weight naturally is given to the structure



FROM "AMERICAN JOURNAL OF BOTANY"

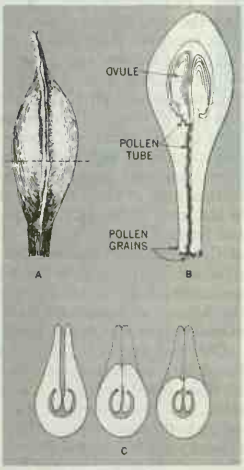
FIG. 22.—MICROSPOROPHYLL OF A PRIMITIVE WOODY RANALES (DEGENERIA, FAMILY DEGENERIACEAE)

of the flower itself, although other features are also taken into consideration.

With respect to evolutionary trends in the flower it is generally held that (1) bisexual flowers preceded the unisexual condition; (2) flowers with numerous parts (notably stamens and carpels) are more primitive than those with few parts; (3) flowers with petals preceded those with petals absent; (4) flowers with distinct and free parts are more primitive than those in which fusions occur, *i.e.*, petals fused into a corolla tube, stamens attached to petals, carpels fused into a compound pistil; (5) regular (radially symmetrical) flowers preceded irregular or zygomorphic ones; (6) the spiral arrangement is more primitive than the whorled; (7) hypogyny is the most primitive, followed by perigyny and epigyny.

Primitive Type.—Based upon the discussion above, the primitive type of flower is assumed to be composed of a perianth, androecium and gynoecium, with parts spirally arranged and distinct. The perianth is regular. The stamens are numerous; the gynoecium is superior, and composed of numerous simple pistils. Any departure from this arrangement indicates an advanced condition, the result of evolutionary change.

Beginning about 1942 important studies of the characteristics of the primitive flower were made by I. W. Bailey and his associates at Harvard university. In accordance with the general principles of comparative morphology, information on the structure of the essential floral organs—stamens and carpels—of primitive living angiosperms should provide clues to the nature of these organs in ancestral and now extinct angiosperms. It is generally held that the most primitive living angiosperms are to be found in the order Ranales, and it is in this order, notably in the woody families Magnoliaceae, Degeneriaceae and Himantandraceae, that presumably primitive microsporophylls were found. In a number of species of these families the stamens are not differentiated into filament and anther but are relatively unmodified three-veined microsporophylls. The two pairs of elongated microsporangia are located on either the inner or outer surfaces of the sporophylls (fig. 22). Important advances leading to the stamen typical of most angiosperms include a narrowing of the sporophyll, development of a filament, reduction in number of veins from three to one and change in size and position of the sporangia. The narrowing of the upper part of the sporophyll has resulted in the migration of the pairs of sporangia to the margins.



FROM "AMERICAN JOURNAL OF BOTANY"

FIG. 23.—CONDUPLICATE CARPEL

(A) Ventral view of primitive conduplicate carpel; (B) transverse section at cut marked on A, showing ovules and the penetration of a pollen tube from the margin. (C) Transverse sections of carpels, showing development from primitive conduplicate type (left) to enclosed carpels (right)

Very primitive types of carpels also were found in the woody Ranales; *e.g.*, in the Winteraceae, Degeneriaceae and other families. In these the carpels are conduplicate; *i.e.*, the halves are folded upward lengthwise along the midrib. A good example of such a carpel is found in certain species of the genus *Drimys* of the Winteraceae (fig. 23[A,B]). The ovules are not marginal but attached in two linear rows between the midrib and the margins (modified laminar placentation). A style and stigma are absent, and the pollen grains fall upon glandular hairs that extend along both of the unsealed margins from the base to the apex of the folded lamina. Developmental stages showing how the style and stigma probably originated were found in other members of the order. The usual position of the ovules on the margins of the carpels (as in extant plants) is regarded, on the basis of these studies, as derived rather than primitive. This is assumed to have come about phylogenetically by the retraction and infolding of that portion of the conduplicate carpel extending beyond the ovules (fig. 23[C]). However, all forms of carpels may not have been derived from the conduplicate type: carpel closure may also have occurred in other ways. (C. L. Wn.)

COMMERCIAL FLOWER GROWING

History.—Flowers were sold in the markets of classical Athens and Rome. In the time of Nero, the growing of flowers for the Roman luxury trade was a thriving industry; the emperor was said to have spent a fortune on roses from Paestum to adorn the banquet rooms at one of his parties. Roman patricians believed that flowers added elegance even to their food; chopped violets might be among the ingredients of a salad at a dinner that was topped with stewed roses for dessert.

Among the stimuli to commercial floriculture in England and western Europe after the doldrums of the middle ages was the importation of tulips from Turkey in the late 16th century. In the Netherlands, a wave of speculation in bulbs that began in 1634 became so wild that the word "tulipomania" was coined. The boom lasted three years and before its collapse single bulbs were selling for as much as 2,600 guilders.

However, until the industrial revolution the growing of cut flowers and potted plants for sale was an insignificant business. Increased urbanization combined with a general rise in living standards resulted in rapid growth of the industry on a per capita basis during the late 19th and early 20th centuries.

The founders of the industry were trained mainly in royal gardens, in gardens of great estates and in public horticultural gardens in England and western Europe. During the 19th and early 20th centuries these gardens continued to be the main source of trained personnel for the commercial flower-growing business. However, by the 1950s royal and estate gardens were severely reduced in number, and the main sources of trained personnel, in both Europe and the United States, were the government-owned agricultural training schools and colleges.

Associated with the change in the source of personnel was a change in methods of production. Starting about 1925 scientific research methods were applied to the production of commercial flower crops. In the 1940s and 1950s intensive research resulted in better and more efficient production; commercial flower-growing became more of a science than an art.

Economics.—Retail florists' sales indicate the relative size, if not the importance, of the flower-growing industry to a country. In the United States since 1909 the per capita purchase of flowers has been about one-quarter of a cent per dollar of expendable income. In 1935—a depression year—expendable income was about $57,000,000,000 and florists' sales were $142,000,000. By the 1960s expendable income was more than $300,000,000,000 and florists' sales more than $700,000,000. Thus, whether expendable income is high or low in the United States a fixed per cent of it (about 0.2%) is spent for flowers.

There is considerable economic stability in the flower producing and selling business. This stability is undoubtedly the reflection of the fact that most flowers are purchased in Europe and the United States for reasons other than the buyers' aesthetic appreciation. Flower giving is among the most popular of social ameni-

ties: as much as 80% of all flowers sold serve as tokens of respect for those deceased; as decorations at weddings and other ceremonies; as cheering gifts to shut-ins; as expressions of thanks to hostesses and of affection for friends and loved ones.

Production.—Most of the flowers that the public buys are grown in greenhouses. These are not standardized structures and the trend has been from narrow, wooden-framed structures to wider, metal-framed houses that allow the maximum amount of light to enter.

When potted plants are grown under glass it has been a general rule that in well-managed ranges no more than one man is employed per 5,000 sq.ft. under glass. On the other hand, from 8,000 to 10,000 sq.ft. of glass per employee is not unusual where cut flowers are produced. As might be expected, however, there is wide variation depending on the crop, modernness of equipment and cost of labour.

Despite the fact that figures on area per person employed would seem to set a minimum size for a successful flower-growing operation, businesses are operated in as little as 1,000 sq.ft. under glass. Rarely full-time businesses, these small units produce specialty items such as fern sporelings, fanciers' varieties of African violets, or they are part of a retail store. On the other hand, some ranges cover as much as 1,000,000 sq.ft. under glass. While there are fewer large ranges than small ones, the large ones sell most of the flowers. About 10% of the greenhouse firms produce 90% of the flowers sold. Furthermore, a general trend has been toward fewer but larger flower-growing establishments. In general the yearly gross income for these ranges—large and small—is about equal to the worth of the capital investment.

Facilities.—The greenhouse is symbolic of the flower-growing industry. Originally these houses were made with glass sash attached to a wooden framework and low narrow houses resulted. By the 1950s these houses had developed along two distinct lines: One was toward larger, more substantial houses with steel frames, aluminum sash bars and built-in automatic heating, ventilation and humidity controls for a minimum of maintenance. On the other hand, houses constructed with a light wooden framework and covered with inexpensive sheet plastic proved especially useful in mild southern climates to protect crops from wind and rain. The plastic-covered house has added flexibility to flower-crop production.

Modern Methods.—With time, changes in production methods have made crop production more certain, eliminated labour and increased quality and quantity of production per unit area.

Perhaps one of the most important findings was that soil could be treated with steam or chemicals so that it could be used again and again without risk of crop loss from soil-borne disease organisms (pathogens). Coupled with this discovery was the finding that only pathogen-free plants should be grown in this partially sterilized soil, for if pathogens are introduced into treated soil they spread more rapidly than they would in nontreated soil.

Other contributions were the devising of scheduled liquid fertilization and the formulation of environmental and chemical treatments for use in propagating, growing and timing horticultural crops. With these advances commercial flower production has become much more predictable and uniform. (*See* also PLANT PROPAGATION; PLANTS AND PLANT SCIENCE.)

The vastly improved insecticides and acaricides (mite-killers), available after the 1940s, are another boon to the flower grower. Evidence shows that the use of acaricides has resulted in as much as a 25% increase in rose production per unit area.

Marketing.—Through the years a distinct marketing channel has been developed for flowers. Usually, the flowers are sold through wholesalers to retail florists. There are a number of variations of this general method, including direct sale to the consumer by the producer and the auction sale.

A European Auction.—Sale of flowers at the great auction market at Aalsmeer in the Netherlands is most interesting. During the night preceding the auction, flowers arrive (mainly by barge) at the auction warehouse. These flowers, in lots, are open to inspection by the prospective buyers at the auction prior to the sale. As the starting time of the auction approaches the buyers assemble in the sales room; each has an assigned seat equipped with a button to stop the single hand of a large clocklike meter (with prices on its dial) at the front of the room. Flowers are wheeled before the buyers; the lot number and description of the flowers are given by an attendant. The auctioneer, having set the clock at a high price, starts the hand moving toward lower prices. The first buyer to push his button stops the clock; his number flashes on the board and a record is made of the lot number, price indicated and the purchaser's number. Immediate money transfers are made between the account of the buyer and that of the flower grower as the next lot of flowers is wheeled into the auction room. The auction goes fast—buyers collect their purchases, fill their orders and send them off quickly, with many of the flowers sold to consumers less than 24 hours after picking.

Wholesale Merchants.—The majority of cut flowers grown throughout the world pass through the hands of a wholesale merchant in the marketing chain from grower to consumer. Wholesalers are of two types: either they buy flowers outright from the grower or they handle the growers' flowers on a commission basis. Frequently one person acts in both capacities, buying some flowers and handling others on a commission.

Grower-Retailer Sales.—The direct sale of flowers to the retailer by the growers is not uncommon. For cut flowers these sales are consummated primarily at stall markets such as those in Los Angeles and San Francisco in the United States, and at Covent Garden in London. In effect the grower becomes his own wholesaler in these transactions. With potted plants the majority of sales—especially for holiday peaks of trade—are made directly between the retailer and the grower.

Cut Flowers.—Most cut-flower crops are of the long-stem varieties, which makes them useful for all kinds of floral decoration. Among this group are carnations, chrysanthemums and roses. However, some short-stemmed cut flowers have a more specialized use for personal adornment; *e.g.*, orchids, camellias, gardenias and stephanotis. Each of these crops has some peculiar cultural requirements and, for the most part, is grown by a specialist who raises no other crop.

Carnations.—The growers of Europe, the United States and Canada agree probably more closely on the general cultural practices for carnations (*Dianthus caryophyllus*) than for any other crop. Furthermore, growers from Denmark to California largely grow the same varieties. Carnations are a cool-house crop (50° F., night temperature). Because they are difficult to time for bloom exactly, carnations are grown in successive plantings so flowers will be available to meet a particular holiday demand such as that at Christmas or Easter. Cut carnations store well at low temperature (31° F.) and are frequently stored for several weeks preceding a time of anticipated increased trade. A good production of carnations is 25 high-quality blooms per square foot of bed area. Carnations were produced mainly in northern Europe, the northeastern part of the United States, Colorado and California, but in the early 1960s spread rapidly to Italy, Spain, South Africa and South America. A mild Mediterranean climate such as that of California allows production throughout the year in unheated structures such as cloth houses and plastic-covered houses. A specialized form of carnation is grown in quantity outdoors in the Riviera section on the Mediterranean coast. These are used in the cut-flower trade and in the perfume industry.

Chrysanthemums.—Perhaps no other crop can be grown and timed with as much exactitude as the chrysanthemum (*Chrysanthemum morifolium*). Because the chrysanthemum, like poinsettia, is a short-day plant, *i.e.*, it sets flower buds only when the daily photoperiod (period of light) is shorter than 13–14 hours, it blooms naturally in the fall of the year (*see* PHOTOPERIODISM). Chrysanthemums, originally flowered commercially only during the autumn, became associated with this season by flower consumers. However, when in 1931 it was found that the plants could be flowered during the summer if light were excluded for part of the day by covering them with black cloth, it became a commercial practice to produce chrysanthemums throughout the year. Commercially the black cloth covering is applied at about 5:00 P.M. and is removed at 8:00 A.M. whenever it is desirable to induce flowering

CONTEMPORARY FLOWER ARRANGEMENTS

Flowers of climbing plants. Passionflowers, purple and green cobaeas, variegated kale and a single magnolia flower. In a gless vase on a wine-red and gilt stand

Spring flowers. Daffodils, daisies, primroses and pasque-flowers arranged with moss and heath in a frame of bracket fungus

Late summer flowers. An arrangement of seed heads of gladiolus, torch lilies, pine-apple-flowers and hydrangea in shades of yellow and cream contrasted with bright yellow leaves, blue-green kale and rust peony foliage and stonecrop

BY COURTESY OF (TOP AND BOTTOM) CONSTANCE SPRY LIMITED, PHOTOGRAPH (CENTRE) "THE GARDENERS' CHRONICLE," CONSTANCE SPRY LIMITED

FLOWER ARRANGING

JAPANESE FLOWER ARRANGING

Zenei-bana (avant-garde) arrangement. Sogetsu school, founded in 1926 by the master Sofu Teshigahara

Moribana arrangement. Ohara school, established during the early 20th century by the master Unshin Ohara

BY COURTESY OF (TOP) SOFU TESHIGAHARA, (BOTTOM) UNSHIN OHARA

of the plants. Vegetative growth, necessary before flowering is induced, occurs normally during the long days of spring and summer. Artificial long days are used to assure vegetative growth during the short days of winter. If days are no shorter than eight hours, a period of four hours of lighting during the middle of the night with electric lights will cause the plants to respond with vegetative growth. The light intensity need be only five foot-candles at plant level. By judicious lighting and black-clothing of varieties whose response is known, growers produce chrysanthemums accurately timed to date of bloom throughout the year.

Chrysanthemums, a warm-house crop (60° F., night temperature), can be grown over most of Europe and North America. In Europe, England is a large producer. In the United States the large, outdoor winter production in Florida is noteworthy. Hundreds of varieties representing a great range of forms and colours, are grown commercially. They are prized as cut flowers for their excellent staying qualities, and are widely used in bouquets, corsages and floral sprays. In general two distinctly different types of chrysanthemums are produced. Of greatest importance in Europe is the large, one-flower-per-stem type, usually called a standard or disbud. There is also the smaller, many-flowers-per-stem type, usually called pompon or spray chrysanthemums; these are as important in the United States as are the standards.

Roses.—No flower has more sentimental appeal than the rose. Roses are grown in greenhouses with a warm temperature (60° F., night temperature). While rose ranges are located over a wide area in Europe, the United States and Canada, they are best in areas that have a large amount of winter sun and cool summers. When grown at high temperature, greenhouse roses tend to be too small.

Roses can be timed fairly accurately to produce at specific times; this is particularly fortunate since the flowers have a short life and cannot be stored very long at low temperature. Aside from accurate temperature control the single most important cultural practice is proper cutting of the flowers. Improper cutting methods result in unthrifty plants that produce weak-stemmed, small flowers. Growing fine roses consistently requires more skill than that necessary for successful production of most other cut-flower crops.

Although the Balkan area supplies a great portion of the commercial essence attar of roses (*q.v.*; extracted from the damask rose, *Rosa damascena*), a special rose flower industry has been developed in southern France (the Riviera) where the flower essence is extracted (from the cabbage rose, *R. centifolia*) for use in perfumes (*q.v.*).

Gladioli.—Almost all gladioli are grown outdoors. Winter and spring flowers are produced from corms (a bulblike structure) forced in warm southern climates—particularly Florida in the United States. As the warm season progresses, corms are forced in more northerly latitudes. The corms will force in as little as 60 days during warm weather; however, if grown cool—but not freezing—as in southern California in winter, the corms may not force in less than 120 days and many of the flowers will blast (die in bud) before they bloom. The plants and corms are tender and will not live through heavy frost.

Bulbous Crops.—So many tulip, Dutch iris and hyacinth bulbs are grown in the Netherlands that these are frequently known as Dutch bulbs. Commercially, they are forced during the late winter and spring months for cut flowers. Since these bulbs are an important export commodity of the Netherlands, the research stations there have made a concentrated effort to understand and control the growth and flowering of these crops.

Information is available, for instance, on the exact temperatures and growing conditions necessary to force tulips into earliest bloom. One of the most interesting generalizations on the forcing of the Dutch bulbs is that they all need a storage period at relatively low temperature (35°–50° F.) before they can be forced successfully at higher temperature.

Another bulbous crop that requires a low temperature treatment before it will force rapidly is the Easter lily (*Lilium longiflorum*)—an important cut-flower and potted-plant crop in the United States. The bulbs to be forced for the Easter season are produced by specialty growers particularly in the northwestern and southeastern parts of the United States as well as in Japan.

Flowering Potted Plants.—The potted-plant industry is smaller than the cut-flower industry and more widely scattered. One factor causing this distribution is the high cost of shipping potted plants long distances. Furthermore, there are strong local preferences for flowering plants, which means that a species that is popular in one location may hardly be known in another. For example, poinsettia, an important Christmas potted plant throughout the United States, is scarcely known in the Scandinavian countries. On the other hand Christmas begonia—popular in the Scandinavian countries—is grown in only limited quantities in the United States. Part of the reason for these differences is that most crops cannot be grown successfully in all locations. Poinsettias do not grow well with the small amount of winter light available in Norway and Sweden. Christmas begonias are difficult to grow where the summers are warm, as in most of the United States.

A list of the more important potted plants of the United States includes: poinsettias (*Euphorbia pulcherrima*), Easter lilies (*Lilium longiflorum*), chrysanthemums (*Chrysanthemum morifolium*), azaleas (*Rhododendron* hybrids), African violets (*Saintpaulia* hybrids), hydrangeas (*Hydrangea macrophylla*), tulips (*Tulipa* hybrids) and hyacinths (*Hyacintha* hybrids). A list for northern Europe includes: azaleas, hydrangeas, tulips, hyacinths, cyclamen (*Cyclamen indicum*) and Christmas begonias (*Begonia socotrana*).

See also references under "Flower" in the Index volume.

(H. C. K.)

FLOWER ARRANGING, the art of arranging flowers as decoration. In 1907 the appearance of a book, *Flower Decoration in the House*, greatly influenced the development of what today is widely practised as an art; the author was Gertrude Jekyll, already notable in the gardening world. For a long time, in big houses, flowers had been the charge of the head gardeners or of florists in town; it was customary in smaller houses for the mistress of the house to do the flowers. In any case, arrangement was done with varying degrees of skill and little guidance. But now the idea that flower decorations could be planned and designed in such a way as to heighten the quality of a room came to be widely accepted. Interior decorators added their specialized knowledge to the practical expression of this view. A marked development of ideas concerning more individual arrangements of flowers came about in the 1930s and a knowledge of the practical ways of doing them became widespread. After World War II flower arrangement clubs and societies were formed and helped to spread information.

In flower arranging a great variety of materials may be used, including branches, berries, leaves, colourful fruit and even decorative products of the vegetable garden. Among the possibilities are some kinds of growing things that, after being cut, are dried or preserved by one means or another. Their value in the arrangement is in their shape, size, colour, texture or a combination of these qualities. In selecting flowers for the house consideration should be given to fragrance as well as to appearance.

There are a few basic matters which, if understood and practised, simplify the application of this art. These are carefully explained in many of the growing number of books on this subject. One or two of the points may usefully be mentioned below as of general importance.

Preliminary Care.—Flowers can with advantage be picked some hours before they are arranged, placed in deep tepid water and left in a cool place, preferably overnight. Before they are placed in the water the stems should be prepared in one of the following ways: for hard-wooded stems, the tips should be crushed, for example by light hammering with a mallet; soft stems should be split about half an inch with a sharp knife or scissors. Flowers such as the Lenten hellebores and poppies and the soft-leaved kinds are greatly helped if the extreme tips of the stems are held a few seconds in boiling water. (The heads must be protected from steam, by paper or a cloth.) Such treatment is also helpful in reviving flowers that have begun to wilt. Wild flowers in particular suffer from too long exposure to air after picking; sometimes a drink in hot water will revive them, but the boiling water treatment may be more effective. It should be remembered that really hot water will damage

leaves and will spoil soft stems; a long woody leafless stem, that of some lilac, for example, will stand hot water, but the soft stem of a tulip may perish. After arrangement the vases should be inspected at intervals and kept filled with water. It is not generally necessary to change the water frequently.

Mechanics of Arrangement.—A useful all-round effective flower holder may be made of crumpled, two-inch mesh wire netting, carefully fitted in a vase; this makes it possible for stems to be kept in position at any required angle. The netting must be fitted in such a way as to stay firmly in place, and it should not be visible in the completed arrangement. Pin-holders, a commercial commodity, are useful for flowers with thick stems and for use in shallow bowls.

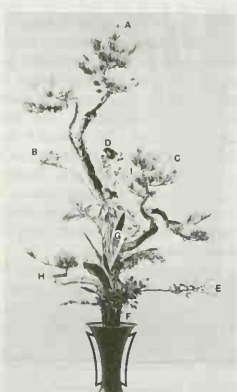
It is important to consider carefully the suitability of flowers to their vases and of both to their setting. Vases have assumed a greater importance now than in the days of a more limited taste for cut crystal and silver; pottery, china, metals of many kinds, marble, alabaster and wood are used.

A study of certain flower pictures of the great Flemish and Dutch flower painters can be of help; their contrast of form and the use of highlights and, in the smaller pictures, an informed simplicity are sources of inspiration. (C. Sp.)

Japanese Flower Arranging.—In Japan the arrangement of flowers is an elaborate and unique art form, with highly developed conventions and complex symbolism. The oldest studied form of this art, developed from the custom of offering flowers to the Buddha, was introduced into Japan early in the 7th century by Ono-no-imoko, Japanese ambassador to China and, in Japan, founder of the first and oldest school of floral art, called the Ikenobō. All the later masters of the Ikenobō school are descendants of the founder. Most important among the earliest styles was the *mitsu-gusoku*, an arrangement of an incense burner flanked by a candlestick and a vase of flowers, usually displayed before pictures of the Buddha or of founders of Buddhist sects.

Early styles were known as *tatebana*, standing flowers; from these developed a more massive and elaborate style, *rikka* (which also means standing flowers), introduced by the Ikenobō master, Senkei, around 1460. The early *rikka* style symbolized the mythical Mount Meru of Buddhist cosmology. *Rikka* represented seven elements: peak, waterfall, hill, foot of the mountain and the town and the division of the whole into *in* (shade) and *yō* (sun). (In Chinese the characters for *in* and *yō* are read *yin* and *yang*, the passive or female and the active or male principles of oriental philosophy.) Formal *rikka* is arranged out of nine main branches and some accessory ones (*see* fig.). Three branches, *shin* (truth), *soe* (supporting) and *nagashi* (flowing), are placed so that their tips form a scalene triangle. From this pattern all later styles of Japanese floral art developed.

In the early 18th century a three-branch, asymmetrical style, *shōka*, evolved from the *rikka* and was cultivated by the Ikenobō school. *Shōka* is written with Japanese characters meaning living flowers. These characters can also be read *seika* and *ikebana; seika* is the preferred reading by some schools, while *ikebana* today is the general term applied to any style of Japanese floral art. Up to the advent of *shōka* all styles of arrangements other than *rikka* had been known as *nageire*, meaning to throw, or fling into. This term was confined to arrangements in tall vases, and *heika*, vase flowers, is preferred to *nageire* by some schools. *Shōka* utilized three main branches, *shin*, *soe* and *tai* (substance), and emulated the natural growth of plant life. By the late 18th and early 19th centuries the *shōka* style had supplanted the *rikka* in popularity and many new schools flourished, including Enshūryū, Koryū, Kōdōryu and Mishōryū. All these new schools utilized the three-branch form but adopted different nomenclatures for them, such as *ten* (heaven), *jin* (man), *chi* (earth).



BY COURTESY OF SENEI IKENOBO

RIKKA FLOWER ARRANGEMENT, IKENOBO SCHOOL

(A) *Shin*, truth; (B) *Soe*, supporting; (C) *Uke*, receiving; (D) *Shoshin*, perfectly true; (E) *Nagashi*, flowing; (F) *Maeoki*, anterior; (G) *Do*, body; (H) *Hikae*, waiting; (I) *Mikoshi*, overhanging

Western flowers were introduced into Japan following the Meiji restoration (1868). The master Unshin Ohara who established the Ohara school (early 20th century) devised for them a new container, based on low bowls used for dwarfed plants. This new style, known as *moribana*, heaped-up flowers, permitted greater freedom in the choice and placement of materials. In 1930 a group of art critics and flower masters proclaimed a new style of floral art called *zenei-bana* (avant-garde flowers), free of all ties with the past. Foremost in this group was the master Sofu Teshigahara, who had founded the Sōgetsu school in 1926. The new style emphasized free expression, placing Japanese flower arranging on a par with the formative arts. *Zenei-bana* utilized all forms of plant life, living and dead, and previously avoided elements such as bits of iron, brass, vinyl, stone and scrap metal.

Until 1868 Japanese flower arrangement was generally a man's avocation, engaged in primarily by Buddhist priests, warriors and the nobility. Following the Meiji restoration and particularly after the beginning of the 20th century, it was taken up by large numbers of women; however, men still head most of the principal schools.

The total number of schools throughout Japan is believed to number from 2,000 to 3,000, varying in size from several thousand to millions of adherents. Each school has its own style of arrangement; however, all styles are based on the asymmetrical placement of three principal branches or flowers of unequal lengths, placed at varying angles in a three-dimensional composition. The material used in Japanese floral arrangements is held in position by various artifices, the most popular of which are the *matagi*, forked twig, and the *kenzan*, needlepoint holder.

Japanese flower arranging has influenced that of the West considerably, particularly in the second quarter of the 20th century. Many popularizations of the art have flourished in the United States. However, these influences abroad have rarely been as elegant or vigorous as the Japanese art at home. (N. J. S.)

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FLOWERPECKER (Midget), common names for many species of tiny, often brilliantly coloured songbirds of the family Dicaeidae. Their greatest centre of abundance is in the Indo-Malayan region, extending east to the Solomon Islands and south across Australia. They are mainly three to four inches long, with short tails and fairly short wings. The male is usually more brilliantly coloured than the female, often with crimson or orange, black or dull blue, and gray. The bill is thick, short, triangular, slightly down-curved and finely serrated at the tip. Flowerpeckers feed in tree tops and bushes along forest borders and gardens, on tropical mistletoe berries and insects and spiders.

The nest, with four or five white eggs, may be a tiny cup of fibres and down suspended from a twig, or may be placed in a natural cavity of a tree or tunneled burrow in the ground. The nest of the species known as pardalotes, or diamond birds, confined to Australia, is in the ground, one species even digging its burrow in the desert plains of the southwest interior. (G. F. Ss.)

FLOYD, JOHN BUCHANAN (1806–1863), U.S. politician, cabinet member and Confederate general during the American Civil War, was born in Montgomery county, Va., on June 1, 1806. After graduation from South Carolina college, he practised law, was a member of the Virginia general assembly and governor of the state (1849–52). During these years he was a states' rights Democrat but an opponent of secession. President Buchanan appointed him secretary of war in 1857. Floyd opposed sending reinforcements to the Federal troops in Charleston harbor and withdrew from office because of his growing belief in secession. At the same time, charges of financial irregularities in his office had

led the president to request his resignation. These charges were never substantiated, nor were the charges that as secretary of war he transferred arms to the southern states in excess of their normal requirements.

With the outbreak of the Civil War, Floyd was appointed a brigadier general by Pres. Jefferson Davis and served first in western Virginia. In 1862 he was in command of the Confederate forces at Fort Donelson in Tennessee but fled before its surrender to Federal troops. For this action Floyd was relieved of his command but was later chosen as major general of Virginia troops by the Virginia assembly. He died at Abingdon, Va., Aug. 26, 1863.
(E. E. R.)

FLUDD (FLUD), **ROBERT** (ROBERTUS DE FLUCTIBUS) (1574–1637), English physician and mystical philosopher, son of Sir Thomas Fludd, paymaster to Queen Elizabeth I's forces in France and the Low Countries, was born at Milgate, Kent. After studying in St. John's college, Oxford, he traveled for six years in Europe, where he became acquainted with the writings of Paracelsus. Returning to Oxford, he entered Christ Church, took his medical degrees (1605) and ultimately became a fellow of the College of Physicians (1609), practising his profession in London. His writings represent the culmination of the occult, as distinct from the scientific, tendencies of the 17th century. Deriving his ideas from such diverse sources as the story of the creation of Adam in Genesis, Paracelsus, the Cabala and the general tradition of alchemy, astrology, sympathetic magic and chiromancy, Fludd was mainly concerned to establish in detail the parallelisms between man and the world, both of them images of God. God created the world by first withdrawing himself from part of his substance—which then appears as darkness or matter. Expanding again—as light or mind—into matter, he thus gave rise to all substances of the world. As a mixture of light and darkness, everything has the same nature, and everywhere there are secret antipathies and sympathies which science can unravel; medicine, in its attempt to understand the functioning and the malfunctioning of the human body, can find its clues either in very general parallelisms such as that between the mind of man and the light of the sun, or in the special analogies revealed by astrology, numerology and the like. Although experimental observations are scattered through Fludd's works, their general tendency is wholly opposed to the growing rationalism of his time. He was attacked by Marin Mersenne (1623) as an "evil magician" and, at Mersenne's request, Pierre Gassendi wrote a lengthy critical examination of Fludd's occultism. He was an ardent defender of the Rosicrucians: Thomas De Quincey saw in his voluminous and obscure writings a principal source of the symbolic ideas of freemasonry. Fludd died in London on Sept. 8, 1637.

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FLÜGEL, JOHANN GOTTFRIED (1788–1855), German lexicographer, best known for a German-English, English-German word book, was born at Barby near Magdeburg, on Nov. 22, 1788. Emigrating to the United States in 1810, he made a special study of the English language. He returned to Germany in 1819, and in 1824 was appointed lecturer in English at the University of Leipzig. In 1838 he became U.S. consul, and subsequently representative and correspondent of the Smithsonian institution at Washington, D.C., and several other leading U.S. literary and scientific institutions. He died at Leipzig on June 24, 1855.

His *Vollständige Englisch-Deutsche und Deutsch-Englische Wörterbuch* (1830) had an extensive circulation in Germany, England and the U.S. In this work he was assisted by J. Sporschil, and a new and enlarged edition, edited by his son, Felix Flügel (1820–1904), was published at Brunswick (1890–92). Flügel also published in the English language: *A Series of Commercial Letters* (1822), and a *Practical Dictionary of the English and German Languages,* two volumes (1847–52).

FLUGEL HORN: *see* BUGLE.

FLUID MECHANICS: *see* MECHANICS, FLUID.

FLUKE, a common name for certain flatworm (*q.v.*) parasites that constitute the class Trematoda of the phylum Platyhelminthes. Flukes have soft, bilaterally symmetrical, unsegmented bodies; are covered with a secreted, noncellular cuticle; and possess a digestive cavity. Adult trematodes are parasitic in all classes of vertebrates (and in some invertebrates) and frequently injure or kill their hosts. Larval trematodes of the orders Digenea and Aspidobothria are parasitic in invertebrates—the former almost exclusively in mollusks and one genus of Aspidobothria in lobsters.

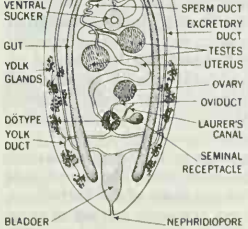
Economic and Medical Importance.—Thirty-six or more species, representing ten different families of trematodes, have been reported as parasitic in man. Incidents of infection range from a few specimens recovered from a single patient to massive infections with one or more species in millions of human beings. Endemic (local) centres are world-wide, but heavy infections occur especially in the far east, in Africa and in tropical America. Many species are ingested as cysts (metacercariae) in uncooked food; *e.g.,* the lung fluke *Paragonimus westermani,* in crayfish and crabs; the intestinal flukes *Heterophyes heterophyes* and *Metagonimus yokogawai* and the liver fluke *Opisthorchis sinensis,* in fish; and the intestinal fluke *Fasciolopsis buski,* on plants. Free-swimming larvae (cercariae) of blood flukes penetrate the human skin directly. In man these parasites, and others listed below, cause much misery and death.

Bilharziasis (or Schistosomiasis) is a major human disease caused by three species of the genus *Schistosoma,* known collectively as blood flukes. Africa and western Asia (*e.g.,* Iran, Iraq) are endemic centres for *S. haematobium; S. mansoni* also is found in these areas as well as in the West Indies and South America. In the far east *S. japonicum* is the important blood fluke. Blood flukes and their eggs occur in the veins draining the bowel and bladder. Ulceration and hemorrhage of these organs and liver damage commonly ensue in chronic cases. (*See* SCHISTOSOMIASIS.)

Human beings infected with trematode parasites are treated with a variety of medicines containing antimony compounds (tartar emetic and Fuadin for blood flukes), hexylresorcinol, tetrachlorethylene, carbon tetrachloride and others. Control of certain flukes through the eradication of their mollusk hosts has been attempted but without universal success.

Among domestic animals the sheep liver fluke (*Fasciola hepatica*) may cause debilitating and fatal epidemics ("liver-rot") in sheep. These animals become infected by eating metacercariae encysted on grass. Monogenea are common pests on fish confined in hatcheries and home aquariums. Wild animals are commonly infected with one or more species of flukes.

Structure and Function.—The body of a fluke is usually small, ranging from a fraction of a millimetre to about 10 cm. (4 in.), and flattened and leaflike or ribbonlike, but may be stout and circular in cross section. Concave, muscular suckers (on the ventral surface), hooks and spines are used for attachment. There are usually one or more suckers anteriorly (surrounding or near the mouth) and one or more posteriorly or near the midbody region. Flukes of the order Monogenea are parasitic on the outside of their hosts (are ectoparasites); customarily, they have an expansive posterior region beset with multiple suckers, hooks and spines. The two remaining orders, Aspidobothria and Digenea, are parasitic inside their hosts (are endoparasites); Aspidobothria have a single, large, ventral complex sucker, whereas Digenea usually have one or two simple suckers, or none. The number and complex-

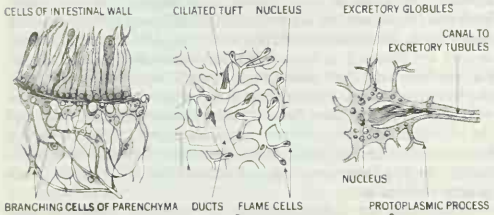


REPRINTED WITH PERMISSION FROM A. C. CHANDLER AND C. P. READ, "INTRODUCTION TO PARASITOLOGY," 1961, JOHN WILEY & SONS, INC.

FIG. 1.—DIAGRAM OF A GENERALIZED FLUKE TO ILLUSTRATE PRINCIPAL MORPHOLOGICAL CHARACTERISTICS

ity of attachment devices are correlated with sites of attachment and difficulties of clinging. The cuticle, often ornamented with spines, covers muscular layers responsible for locomotion and change in body shape; other muscles operate the hooks and spines. Suckers are composed chiefly of radial muscles and work on the vacuum principle. Embedded in the skin are gland cells whose secretions function in attachment and for softening and digesting host tissues. As in all flatworms the body is solid and filled with a spongy connective tissue called mesenchyme, which surrounds all organs of the body. A circulatory system is absent, but may be foreshadowed in some of the larger species by a lymph system containing free cells and fluid.

Flukes subsist on tissues, fluids and exudates ingested from the host. The blind-ending intestine consists of a simple sac with



(A) AFTER KERBERT, IN "ARCHIV FÜR MIKROSKOPISCHEN ANATOMIE," FRIEDRICH COHEN; (B, C) FROM LANKESTER, "TREATISE ON ZOOLOGY," A. & C. BLACK

FIG. 2.—CELLS OF DIGESTIVE AND EXCRETORY SYSTEMS OF A FLUKE. (A) SECTION THROUGH BODY WALL OF PARAGONIMUS; (B) PORTION OF EXCRETORY SYSTEM SHOWING BRANCHING DUCTS ENDING IN FLAME CELLS; (C) SINGLE FLAME CELL MORE HIGHLY MAGNIFIED

an anterior or mid-ventral mouth, or a two-branched gut with an anterior mouth; an anus is usually lacking, but a few species have one or two anal pores. Between the mouth and the intestine are often a pharynx and an esophagus lined with inturned cuticle and receiving secretions from glands therein. The intestine proper, lined with digestive and absorptive cells, is surrounded by a thin layer of muscles that effect peristalsis. In many larger flukes lateral intestinal branches (diverticula) bring food close to all internal tissues. Undigested residues are egested through the mouth.

The excretory system is of the protonephridial type and consists of tubes, often regionally ciliated, emptying externally at one or more pores (nephridiopores) variously placed, and connecting internally with terminal flame cells (or flame bulbs). A flame cell is provided with a conical, ciliated tuft, the motions of which give the appearance of a flickering flame; the tufts are directed into a funnel-shaped expansion of the duct. Pulsatile bladders may intervene between excretory ducts and the nephridiopores.

The nervous system consists of a pair of anterior cerebral ganglia (the brain), lying dorsal to the esophagus or pharynx, and usually three pairs of longitudinal cords (dorsal, lateral and ventral). The separated ventral pair of cords is usually prominent and, as in the free-living flatworms (class Turbellaria), has a series of cross branches that give the system a ladderlike appearance. Although sensory receptors in flukes are less diversified and less numerous than in Turbellaria, tactile bristles, often surmounted on elevated papillae, are prevalent on the oral and posterior suckers and on the general body surface. Eyes are absent in adult Digenea and Aspidobothria, but may occur as pigment cups (ocelli) in larval Digenea and in larval and adult Monogenea; larval stages often exhibit pronounced responses to light (phototaxes).

Flukes are hermaphroditic except in the family Schistosomatidae and sporadically in the family Didymozoonidae. The complicated male and female systems are fashioned on those of the Turbellaria, but variations on the basic pattern are numerous and are of taxonomic importance. Usually two compact, elongate, lobed or deeply branched testes connect by sperm ducts to an intromittent organ (penis or cirrus), which is housed in a muscular and glandular organ, the cirrus sac. The latter opens to the surface usually midventrally, laterally or posteriorly at a gonopore. The single ovary may be shaped like the testes. Yolk glands (vitellaria) lie in groups, often in close association with the intestine, and join by small tributary ducts, the paired transverse common yolk ducts, which discharge yolk material into the oviduct. After eggs are fertilized by sperm, contained commonly in a seminal receptacle, they pass into a shell gland, the oötype, where ovum and yolk cells are encapsulated. The egg capsules may be ovoid or stalked and are sometimes provided with a lid (operculum). Capsules move into and along the uterus, which is either short or long and tortuous, occupying much of the posterior body region. The external end of the uterus, the metraterm, is commonly muscular and serves in copulation and in expulsion of egg capsules through a gonopore that may end in a common atrium with the male system. Eggs may be discharged uncleaved or fully embryonated and escape from the surface of the host or in the host's urine, feces or sputum.

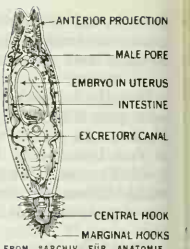


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FIG. 3.—VENTRAL VIEW OF GYRODACTYLUS ELEGANS (AFTER WAGENER), A PARASITE OF FISH

Copulation occurs in Monogenea through single or paired vaginae, which open laterally and connect internally to the oviduct. In Digenea copulation may occur via the metraterm or through Laurer's canal, which latter originates from the oviduct and opens by a dorsal pore.

In some flukes Laurer's canal ends blindly (*e.g.*, Aspidobothria) and insemination occurs via the uterus only. Although cross-fertilization is common, it is not obligatory, since single flukes can

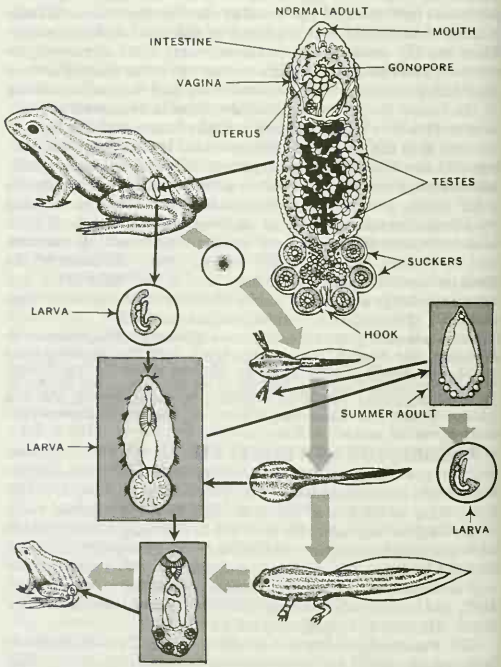

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FIG. 4.—POLYSTOMA, A MONOGENETIC TREMATODE PARASITIC IN FROGS, WITH A DOUBLE LIFE CYCLE

"Normal" adult (upper right: detail of *Polystomium integerrimum*) lives in the urinary bladder; the "summer" adult on the gills of the tadpole. Both give rise to larvae

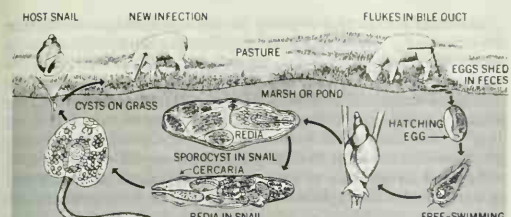

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FIG. 5.—LIFE HISTORY OF THE DIGENETIC LIVER FLUKE OF SHEEP, FASCIOLA HEPATICA (LARVAL STAGES GREATLY ENLARGED)

produce fertile eggs.

Life History and Development.—Eggs of Monogenea are deposited into the water or are attached to the host. Ciliated larvae hatch from eggs and swim to new hosts or commence feeding on the host to which the eggs are attached. Many variations occur in monogenetic cycles. In *Gyrodactylus*, parasitic on the gills of fresh-water fish, the embryology is remarkable in that a single egg within the parent develops into an embryo, and, within the first embryo, other embryos are produced before birth. In *Diplozoon* young larvae (called Diporpae) attach to a fish host, fuse in pairs, and remain in permanent copulation throughout life. In *Polystoma* young swimming larvae either attach to the gills of tadpoles and promptly attain sexual maturity or migrate by way of the intestinal tract to the urinary bladder, where maturity is delayed for a year or two.

The rather complicated development of Digenea involves a minimum of two hosts. Egg capsules, deposited in water or on land, hatch as free-swimming larvae called miracidia or are eaten by intermediate hosts (mollusks) in which the miracidia are released. Miracidia invade the deeper tissues of mollusks and transform into saclike mother sporocysts. Mother sporocysts produce daughter sporocysts or rediae, wormlike larvae with a mouth and a simple intestine. Each redia in turn produces another kind of larva called a cercaria, which emerges from the mollusk and swims briefly in the water. Cercariae are somewhat tadpole-shaped and are of many sorts. Most have a trematodelike forebody and a tail; the latter may be small or large, forked or unforked, and is used in swimming. Although the cercariae may directly penetrate the final host, they usually penetrate, or are eaten by, a vector host in which the cercariae transform into encysted, quiescent, larvae called metacercariae. Some vector hosts are blinded or bloated by metacercarial infestation. They also may be neurologically disturbed when tumorlike metacercariae develop in the brain and spinal cord. In the cycle just depicted the final host becomes infected by eating the infected vector. In other cycles metacercariae remain viable through metamorphosis of the host (*e.g.*, insects) and can infect the insect-eating final hosts.

Leucochloridium has an interesting modification of the cycle described above. Snails, chiefly *Succinea*, eat fluke eggs contained in the droppings of infected birds. After the usual early larval stages, daughter sporocysts containing metacercariae push into the tentacles of the snail. Then, bright-coloured bands, which are thought to act as lures, develop in the snails' tentacles. Birds become infected by pecking the tentacles or by eating sporocysts that rupture the tentacles and fall to the ground.

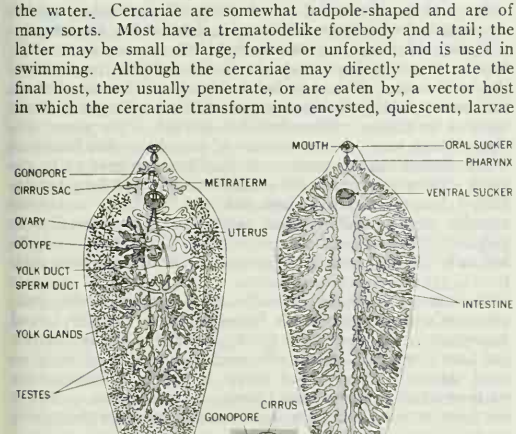

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FIG. 6.—ORGAN SYSTEMS OF A DIGENETIC TREMATODE, THE LIVER FLUKE (FASCIOLA HEPATICA): (A) REPRODUCTIVE SYSTEM; (B) DIGESTIVE SYSTEM; (C) CIRRUS SAC REGION

CLASSIFICATION

The class Trematoda, based on the classifications of L. H. Hyman and of B. Dawes, is divided into three orders: Monogenea, Aspidobothria and Digenea.

Order Monogenea.—This order comprises mostly ectoparasitic forms found on the gills and skin of cold-blooded vertebrates, and on crustaceans, cephalopods and mammals. Some exhibit endoparasitism, being found in the nasal, oral and pharyngeal cavities and in the urinary system of fish, amphibians and reptiles. Monogenea, as the name implies, have only one generation; the life cycle therefore is direct, *i.e.*, involves only one host. The body usually is divided into two main regions: an anterior part, in which occur the main internal organs; and a posterior region, which may be a single sucking disc or an expanded area containing multiple suckers, hooks or spines. The order consists of 16 families, important among which are the Gyrodactylidae, Dactylogyridae, Polystomatidae and Capsalidae.

Order Aspidobothria.—This order is characterized by a large ventral sucker divided by partitions into one or more longitudinal series of depressions, the alveoli. Members of the order occur in the mantle, pericardial or renal cavities of mollusks, and in the intestine and bile ducts of fresh-water and marine fish and reptiles. The life cycle may be direct (*Aspidogaster*) or may involve two hosts (*Lophotaspis, Stichocotyle*).

Order Digenea.—Adult digenetic trematodes are numerous and important endoparasites of vertebrates. Many species have been described, but attempts to organize them into families (more than 60) have not been universally accepted. All Digenea have complex life histories involving alternation between the sexual stage (in vertebrates) and asexual stage (in various invertebrates). The Digenea generally have a sucker surrounding the mouth, anteriorly placed in all except the family Bucephalidae, and a ventral imperforate sucker behind the mouth. The reproductive system lacks a separate vagina, and the uterus is often crammed with eggs. In all except one genus the excretory system has a single posterior nephridiopore.

Adult Digenea occur chiefly in the intestinal tract, from the mouth to the cloaca or anus, and in various organs associated with the gut, such as the liver, pancreas, lungs, bile duct, pancreatic duct and gall bladder; they also occur in the excretory system, circulatory system, coelom and skin (as cysts), and in the air sacs of birds. Digenetic trematodes are considered important parasitic worms of man and such of his domesticated animals as chickens, sheep and cattle.

Among the most important families may be mentioned the Paramphistomidae, Allocreadiidae, Plagiorchidae, Dicrocoeliidae, Opisthorchidae, Heterophyidae, Fasciolidae, Echinostomatidae, Strigeidae and Schistosomatidae.

See also PARASITOLOGY.

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(C. G. G.)

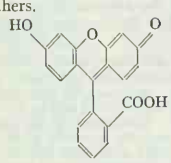
FLUORESCEIN, a synthetic colouring matter, was discovered in 1871 by A. von Baeyer, who prepared it by fusing phthalic anhydride and resorcinol at temperatures between 180° and 200° C. The chemical formula of fluorescein is $C_{20}H_{12}O_5$. Its name follows from the fact that the deep-red solutions of its sodium or potassium salt exhibit an intense yellowish-green fluorescence so strong that it can be seen in dilutions as high as 1:40,000,000.

Because of its very high tinctorial power the sodium salt of fluorescein, a dyestuff sold under the name of uranine, is used as a water tracer and a water marker. Millions of pounds of

the product were used during the years of World War II for marking spots on the surface of the ocean. Eosine, a bright scarlet dyestuff, used mostly for the manufacture of a brilliant red pigment, is made by brominating fluorescein to its tetrabromo derivative.

Likewise erythrosine, somewhat bluer in shade than eosine, is tetraiodofluorescein. Rose Bengal, once an important colouring matter for dyeing wool and silk in rich, dark-red shades, was made by condensing tetrachlorophthalic anhydride with resorcinol and then iodinating the resulting tetrachloro fluorescein. The product, no longer of commercial importance, was tetraiodotetrachloro fluorescein.

Structure and Preparation.—Fluorescein is resorcinolphthalein, and is usually considered to have the quinoid structure I, although there is positive evidence that in solution it consists of an equilibrium mixture of I and the benzenoid form II. Moreover, derivations of both forms have been made, particularly the esters and ethers.



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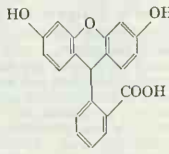

II

Commercially, fluorescein is of considerable importance and is made by heating resorcinol, phthalic anhydride and zinc chloride together at temperatures between 180° and 190° C., the latter agent hastening the reaction between the other two compounds. The melt is extracted with hot water whereby most of the zinc chloride is dissolved out. The remaining mass is then dissolved in dilute caustic soda, the solution is filtered and the fluorescein is precipitated with acid. By repeating the extraction and precipitation process several times, fluorescein can be obtained in a comparatively pure form. It is a yellow amorphous powder, insoluble in water, but soluble in alcohol from which it crystallizes in dark-red nodules. (J. H. Ss.)

FLUORESCENCE: *see* LUMINESCENCE.

FLUORINE is the most electronegative and most reactive of all known chemical elements. The applications of its compounds range from the use of sodium fluoride as a water additive to the process by which uranium hexafluoride separates and concentrates uranium isotopes in atomic energy installations.

Fluorine is a pale greenish-yellow gas with an irritating odour resembling that of hypochlorous acid. Inhalation of the gas is dangerous except in very low concentration. In the liquid state fluorine is clear yellow and the solid becomes colourless at −252° C.

Fluorine stands at the head of the halogen family in the periodic table (atomic weight 18.9984, atomic number 9, chemical symbol F). There is only one stable and naturally occurring nuclear species of fluorine, F^{19}, but radioactive isotopes with mass numbers 17 (half life 70 sec.), 18 (112 min.) and 20 (10.7 sec.) have been prepared. Additional properties are listed in the table. The element was first isolated in 1886 by H. Moissan who obtained it by the electrolysis of anhydrous hydrogen fluoride containing dissolved potassium fluoride. He used a U-shaped platinum apparatus including an anode made of platinum iridium alloy, and this classical research brought final success to 75 years of scientific effort.

Numerical Properties of Fluorine

Molecular formula	F_2
Outer electron configuration	$2s^2, 2p^5$
Boiling point	−188° C.
Melting point	−223° C.
Density relative to air	1.32
Density of liquid	1.108 g. per c.c.
Atomic volume of solid	14.62 c.c.
Ionization potential	17.42 v.
Electron affinity	4.13 eV
Covalent radius	0.72 Å
Radius F^- in crystals	1.36 Å
Standard potential $F \rightleftarrows \frac{1}{2}F_2$ e	2.85 v.

The chief source of fluorine is the mineral fluorspar or calcium fluoride, CaF_2, which is widely distributed geologically. It also occurs in cryolite, Na_3AlF_6, fluorapatite, $CaF_2.3Ca_3(PO_4)_2$, as well as in sea water, bones, nails and teeth in small amounts.

When fluorspar is distilled with concentrated sulfuric acid, essentially anhydrous hydrogen fluoride is liberated, which boils at 19.5° C. and dissolves in water to form hydrofluoric acid. Hydrogen fluoride is available in large commercial quantities, and is used widely as a solvent, as a versatile catalyst in organic chemistry and as a reagent for the replacement of chlorine by fluorine in organic compounds.

Elementary fluorine is prepared both commercially and in the laboratory by electrolysis of solutions of potassium bifluoride, KHF_2, in anhydrous hydrogen fluoride. The electrolytic cells or generators are constructed of steel or monel metal with especially treated carbon anodes and usually operate at moderate temperatures (about 100° C.). The process is efficient and the product, which is also available in cylinders under pressure, is of high purity. However, a jet of fluorine under pressure can be dangerous, since it instantly inflames organic matter, many metals and numerous other substances. Both hydrogen fluoride and the corresponding acid, which attacks glass and is used for etching, are corrosive and toxic.

In inorganic chemistry, the highly reactive fluorine combines readily with nearly all the other elements except the inert gases. It reacts with all metals forming a large number of single, double and complex salts, and also with most of the nonmetals. Because of the small size of the fluoride ion, it forms many stable complexes with positive ions; for example, SiF_6^{2-}, AlF_6^{3-}.

Elements having variable valences usually show their several oxidation states in combination with fluorine; *e.g.*, the sulfur fluorides S_2F_2, SF_2, S_2F_{10}, SF_4 and SF_6, the latter being the most stable. Many of these compounds have found significant use in the laboratory or in industry.

Boron fluoride, BF_3, and antimony fluoride, SbF_3, as well as hydrogen fluoride are important catalysts for organic reactions; cobaltic fluoride, CoF_3, and chlorine trifluoride, ClF_3, are good fluorinating agents; sulfur hexafluoride, SF_6, is used as a gaseous insulator; and uranium fluoride, UF_6, to separate uranium isotopes. Also sodium fluoride, NaF, is used in the treatment of dental caries and is often added to otherwise deficient water supplies (fluoridation) to reduce tooth decay in children (*see* DENTISTRY).

In the field of organic chemistry fluorine has become increasingly important. On account of the small size and great reactivity of the fluorine atom, elementary fluorine reacts with hydrocarbons to form corresponding fluorocarbons in which all hydrogen has been replaced by fluorine. These may be regarded as the parent substances from which a large number of completely fluorinated, or perfluorinated, organic compounds may be considered to be derived. These compounds are usually characterized by great stability, chemical inertness, high electrical resistance and other valuable physical and chemical properties. They may also be prepared by treating organic compounds with cobaltic fluoride, as well as by the new commercial process of electrolyzing their solutions in anhydrous hydrogen fluoride.

Unsaturated fluorocarbons and their derivatives readily yield polymers and plastics such as Fluon or Teflon $(CF_2CF_2)_x$ and fluorothene or Kel-F $(CF_2 = CFCl)_x$, which are highly resistant and have found considerable commercial application. Closely related substances have found usage as resistant incombustible water-repellent lubricants and coatings. Fluorocarbon chemistry has come to be regarded as a significant subdivision in the organic field.

Another method for introducing fluorine into organic compounds consists of the replacement of nonaromatic chlorine, bromine or iodine by fluorine through the action of hydrogen fluoride, antimony fluoride or other inorganic fluorides as the fluorinating agents. These reactions have been extensively studied, and perhaps the most important commercial application is the large-scale production of dichlorodifluoromethane, CF_2Cl_2 (Freon 12), the stable nontoxic coolant used in most household refrigerators. A whole series of related substances (Freons, Genetrons) are also

widely used as refrigerants and propellants, while the nontoxic compound CF_3Br is an excellent fire extinguisher.

Trifluoroacetic acid, CF_3COOH, can be made from the corresponding chlorine compound by this method as well as by the electrolytic process, and is available in commercial quantities along with related perfluorinated acids, which are also the source of many derivatives.

The stable $-CF_3$ group has been introduced as a side chain into aromatic compounds, and fluorine may be substituted directly on the aromatic nucleus by the diazo reaction. Such products have found use in the dye and pharmaceutical industries and also as insecticides. Finally, the $-CF_3$ group has been combined with many other elements, both metallic and nonmetallic, such as magnesium, nitrogen, phosphorus, arsenic and sulfur, and the products have been employed in organic synthesis and in other ways.

See also references under "Fluorine" in the Index volume.

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(L. A. B.)

FLUORITE (FLUORSPAR) is a common mineral composed of calcuim fluoride, and is the principal fluorine mineral. The name is derived from its low melting point and its use in metallurgy as a flux and comes from the Latin *fluere*, "to flow." The term fluorescence was derived from the behaviour of fluorite. Most varieties fluoresce strongly under ultraviolet light or other radiations. It may phosphoresce upon heating or after exposure to ultraviolet light. A variety called chlorophane emits a green light upon heating. (*See* LUMINESCENCE.)

Fluorite is used as a flux in the manufacture of open-hearth steel and in the making of aluminum fluoride and artificial cryolite, used in the production of aluminum (*q.v.*). It is used in opalescent glass, iron and steel enamelware, in the production of hydrofluoric acid, in the refining of lead and antimony and as a catalyst in manufacturing high-octane fuels (*see also* FLUORINE). Clear colourless fluorite of optical quality is used for apochromatic lenses because of its low index of refraction and low dispersion. A variety known as Blue John from Derbyshire, as well as other types has been used for ornamental vases and other articles.

Fluorite is common in hydrothermal veins, sometimes being the chief mineral, and sometimes the gangue mineral with various metallic ores such as silver, lead and copper. It is found in pneumatolytic deposits associated with cassiterite, topaz, tourmaline and quartz. It is also found in sedimentary rocks such as limestone and dolomite.

A few of the important occurrences are at Cumberland, Yorkshire, Derbyshire and Cornwall in England; Saxony and Hartz mountains, Germany; the Austrian, Italian, Swiss and French Alps; northern Norway and the Kola peninsula, Russia (yttrium variety); Ontario and British Columbia, Canada; Mexico; and in the United States in Illinois, Kentucky, Montana, New Mexico and Colorado.

Fluorite crystallizes in the cubic system. The commonest form is the cube but octahedrons are sometimes found. Composite crystals have been found, made up of an aggregate of tiny cubes in the shape of an octahedron. Penetration twins of two cubes are common.

The octahedral crystals, usually light coloured, have been attributed to high-temperature formation, and the darker cube forms to low-temperature formation. Twinned crystals in the form of interpenetrating cubes are common. A large number of additional forms have been observed in combination, including those with crystal indexes of 110, 210, 310, 211, 311, 221, 331, 123 and 124 (*see* CRYSTALLOGRAPHY).

The structural arrangement of fluorite consists of calcium ions at the corners and face-centres of the cubic cell, with the fluorine ions at the centres of the eight small cubes into which the unit cube may be divided by the principal planes of symmetry.

Fluorite is no. 4 in Mohs' scale (*q.v.*) of hardness. It has an excellent octahedral cleavage. It is usually in crystals or in cleavable masses but it is rarely columnar or fibrous. The specific gravity is 3.18, but it may be as high as 3.5 for yttrium and cerium varieties. It is usually transparent or translucent, with a vitreous lustre.

There is a wide range of colours; when pure it is colourless and clear, but commonly it is green, blue, yellow, purple, brown or blue-black; rarely pink or red. The colour may vary irregularly, and sometimes is in zones parallel to crystal faces. There may be a difference in the colour of the transmitted and the reflected light.

The formula is CaF_2, and it is usually quite pure. In certain localities it is found with the rare earths yttrium or cerium replacing calcium in amounts up to 15% to 20%. Dark coloured fluorite from Bavaria contains free fluorine and calcium ions released by radiation. When ground to a powder, this gives an odour of hydrogen fluoride and ozone.

Fluorite may contain minute cavities filled with water, bituminous matter or gas. Inclusions of tiny chalcopyrite crystals are sometimes found.

See also references under "Fluorite" in the Index volume.
(L. S. RL.)

FLUSHING (Dutch VLISSINGEN), a port of Zeeland province in the southern Netherlands, is situated on the south coast of Walcheren island at the mouth of the Western Scheldt estuary 55 mi. S.W. of The Hague. Pop. (1961) 29,381. Despite damage in World War II several ancient buildings remain, including St. Jacob's church (1308), the Prisoners' Tower (15th century) part of an old city gate, the exchange (1635), the house of the Lampsins family (1641), the house with the statues (1730) and the town hall (1733). In the municipal museum are objects and pictures relating to Adm. Michel Adriaanzoon de Ruyter (*q.v.*), a native of Flushing. A memorial was unveiled in 1952 to the British no. 4 (army) commando, which landed on Nov. 1, 1944. Flushing is the terminus of a railway which links with the main Netherlands system. It is an important port, a coaling station and has much fishing; it is also a Dutch naval base and a seaside resort. Shipbuilding and engineering are carried on.

Flushing grew up as a trading town with emphasis on herring fishery, but its importance lay in its position controlling the approach to Antwerp. The emperor Charles V fortified it. It was the first town to throw off the Spanish yoke in 1572 and it became the headquarters of the insurgents' navy (the Sea Beggars). The liberation of the Netherlands brought great prosperity to Flushing but it declined in the 18th century. Occupied by the French from 1795 to 1814 the port did not recover until the establishment of a shipbuilding yard in 1875. (J. DEN H.)

FLUSHING, former township and village of Queens county, N.Y., U.S., on Long Island, at the head of Flushing bay; after 1898 a part of the borough of Queens, New York city. Settled in 1644 by English nonconformists who had probably been living at Flushing, Holland, it was the country seat of many rich New Yorkers and colonial officials before the American Revolution. Flushing Meadow park was the site of the 1939–40 New York World's fair and from 1946 to 1949 served as temporary headquarters for the United Nations general assembly.

FLUTE, a wind instrument. The term is employed generically for all wind instruments that are edge-vibrated as well as specifically to denote the wood-wind instrument described here. *See* also MUSICAL INSTRUMENTS: *Classification of Instruments;* WIND INSTRUMENTS: *Flutes.*

The modern, or Boehm system, flute is a cylindrical tube of wood (cocuswood or blackwood) or metal (silver or cheaper substitutes) that is 26½ in. long and has a bore of about ¾ in. The bore runs through the three sections of the flute which are: (1) the head joint, (2) the body or middle joint and (3) the foot joint. The second and third joints, sometimes made in one piece, have the note holes, which number at least 13 and are controlled by an interlocking mechanism of padded key plates hinged on longitudinal axles. All eight fingers and the left thumb are used in operating the keys; the right thumb is used only for support. The bore narrows in the head joint which contains the mouth hole, or embouchure hole, and is closed just above the hole by a cork

or fibre stopper. The bore is open at the foot end.

The flute is held sideways to the right of the player, who forms his lips to make an aperture and directs his breath stream across the mouth hole and onto its farther edge, where it breaks up into eddies that alternate regularly above and below this edge and so excite the air column of the flute into vibration. Stability of the notes in the various registers and at different loudnesses is achieved by control of lip aperture, angle of breath impact and breath force. The compass is three octaves and one note upward from middle C, though some continental instruments have an extended foot joint to give the B below.

The flute with lateral mouth hole, or transverse flute, appears in history about the 2nd century B.C. when Theocritus mentions the herdsmen's *plagiaulos,* "cross pipe," and a flute player is shown on an Etruscan urn. It is recorded next in India, then in China and Japan, and has remained a leading wind instrument in these countries just as in Europe where it is first depicted about A.D. 1100. Up to the 17th century the western flute, bored in wood, retained the cylindrical bore of its Asiatic bamboo relatives, and it is still so made as a folk instrument in such places as the Eastern Alps and the Carpathians. For musical consorts in the 16th century the tenor flute, with lowest note D, corresponded in pitch with the modern instrument, while descant and bass sizes, respectively a fifth higher and deeper, were also available, all typically of boxwood with six finger holes and no keys, the semitones made by cross-fingering. These were superseded late in the 17th century by the one-keyed conical flute, probably conceived by the celebrated Hotteterre family of makers and players in Paris; a conical flute is built in separate joints, of which the head is cylindrical but the others contract toward the foot. In the 18th century the body usually comprised two joints, of which the upper was supplied in three or more lengths for tuning purposes. The flute's early solo and orchestral repertory is associated with this design, the instrument at this period being described as *flauto traverso, traversa* or German flute, in distinction from the common flute (recorder). (For a discussion of end-blown flutes *see* RECORDER.) From 1760, in order to improve various semitones that lacked strength with cross-fingering, three chromatic keys in addition to the original E flat key began to be used after being introduced in London, possibly by the maker Florio. Their acceptance was gradual; Mozart's solo works for flute are clearly for the one-keyed instrument, but by the end of the century the typical orchestral flute had the extra keys and also the lengthened foot joint to C, making six keys altogether. Two more keys produced the eight-keyed flute, which preceded the modern instrument and which lasted, with various auxiliary keys (Meyer system, etc.), in some German orchestras into the 20th century.

Although the finest players of the eight-keyed system drew from it a voluminous tone—especially with Charles Nicholson's model with enlarged finger holes—and possessed a fluent technique in tonalities previously denied to the flute, Theobald Boehm, the Munich flute player and inventor, set out to rationalize the instrument, creating his new conical model in 1832. He replaced the traditional layout of the holes with one based on acoustic principles and improved the venting by replacing closed chromatic keys with a system of open-standing keys, devising for their manipulation his system of ring keys on longitudinal axles. This conical Boehm flute was superseded by Boehm's second design (1847) which, with its experimentally evolved cylindrical bore (with contracting or parabolic head), is the flute since used. The chief modification to this, apart from refinement of manufacture, has been the wide abandonment of Boehm's open G sharp key in favour of the closed G sharp (*i.e.*, with this key sprung to remain closed) which was introduced by Paris makers soon after the 1847 invention. In England various other mechanisms fitted to Boehm's cylindrical bore have included the 1867 model made by Rudall, Carte and Co. (distinguished by the two small plates for the first finger of the right hand), now little used. The metal construction, introduced by Boehm himself, was for some time rare outside France but later became everywhere more common than the wooden construction and is standard in the U.S. where flute making has been brought to a very high level. Metal is also suited to the mass production of low-priced flutes for students. With the replacement of the old conical flute by the cylindrical Boehm, a certain depth of tone and intimacy of effect have been lost, but the gain has been enormous. Through the influence especially of the French school, the newer instrument inspired a splendid repertory of solo and chamber works in which evenness of the notes, their complete expressive control throughout the compass at all dynamic levels and an almost limitless technical flexibility were brilliantly exploited.

ANTHONY BAINES; BY COURTESY OF FABER & FABER LTD.

MODERN FLUTES (LEFT TO RIGHT): ALTO FLUTE IN G; FLUTE; PICCOLO; BASS FLUTE IN C

The piccolo, standing an octave above the flute (but lacking the foot joint), sounds an octave higher than the written notes. Boehm piccolos are made of wood or metal with a conical bore, though cylindrical piccolos enjoy increasing popularity. The *flûte d'amour* in low A hardly survived the 18th century. The larger flutes of the 20th century include the following two, both of them cylindrical Boehms of metal: (1) the alto flute (in England generally termed bass flute), 34 in. long, is in G, sounding a fourth below the written notes; its symphonic use has not been extensive but it enjoys great favour in light broadcasting and recording orchestration. (2) The bass flute (or contrabass) in C is pitched an octave below the flute. This is made with a coiled head for manageability and is used mainly in flute ensembles.

A special range of flutes is used in military (*see* FIFE) and civilian flute bands. By their most widely used nomenclature each flute is described by the note sounded by the fingering that on the orchestral flute sounds C. An A flat flute thus denotes the instrument that sounds a sixth above the orchestral flute, and its music is transposed accordingly; but by the old English nomenclature it is a B flat flute, each instrument being named a note higher because the orchestral flute is "in D." This, the principal instrument of flute bands, is generally made with a conical bore and up to six keys. Above it is the D flat piccolo and below it are the E flat flute, the D flat flute (formerly used in military bands to avoid flat-key tonalities on the eight-keyed flute) and the A flat bass flute, pitched a third below the orchestral flute. Occasionally deeper bass flutes, in E flat and D flat, are used; they necessarily employ some finger-plate mechanism, Boehm system or otherwise.

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FLUX, in metallurgy, a substance introduced in the smelting of ores to promote fluidity, and to remove objectionable impurities in the form of a slag. The substances in commonest use are: —lime or limestone and dolomite, to slag off silica and silicates, fluorite, calcium and barium sulfates and calcium phosphate, and silica for removing basic substances such as limestone. Other substances are also used, but more commonly in assaying than in metallurgy. Sodium and potassium carbonates are valuable for fluxing off silica; mixed with potassium nitrate, sodium carbonate forms a valuable oxidizing fusion mixture; "black flux" is a reducing flux composed of finely divided carbon and potassium carbonate. Borax is very frequently employed; it melts to a clear liquid and dissolves silica and many metallic oxides. (*See* also SOLDERING: *Fluxes.*) Potassium bisulfate is useful in the preliminary treatment of refractory aluminous ores. Litharge and red lead are used in silver and gold assays, acting as solvents for silica and any metallic oxides present. The word is derived from Lat. *fluxus,* "a flowing."

FLUXIONS, a form of the calculus developed by Sir Isaac Newton (*q.v.*), beginning in 1665. The word fluxion, as used by him, denoted the rate at which a variable (flowing quantity, fluent) increases or decreases at a given instant of time. If x and y were taken to be the flowing quantities (fluents) $y = x^3$, then it could be shown that $\dot{y} = 3x^2\dot{x}$. In modern differential notation this would be $dy = 3x^2dx$. *See* CALCULUS, DIFFERENTIAL AND INTEGRAL.

FLY, a common name used in a restricted sense by entomologists for any two-winged insect belonging to the order Diptera (*q.v.*), and more loosely as part of the common names of many other insects that are not true flies. Thus, stone flies belong to the order Plecoptera; green fly, black fly, white fly and lantern flies to Hemiptera, suborder Homoptera; May flies to Ephemeroptera; dragonflies and damsel flies to Odonata; alder flies to Neuroptera; scorpion flies to Mecoptera; caddis flies to Trichoptera; butterflies to Lepidoptera; sawflies and ichneumon flies to Hymenoptera; and fireflies to Coleoptera.

The name fly is also used to distinguish the winged adult stage of many insects; *e.g.*, ant lions are voracious larvae whose winged adults are called ant lion flies. It may also be applied to any small, abundant, probably noxious insect, as in the farmers' name turnip fly for the turnip flea beetle. Flies used in fly-fishing (*see* FISHING) are designed to imitate the aquatic insects that have bred in the water and that are snapped at by fish when they hatch out as winged adults at the surface (mostly May flies, stone flies and caddis flies).

JOHN H. GERARD

FIG. 1.—BLACK HORSEFLY (TABANUS ATRATUS); ABOUT NATURAL SIZE

Without other qualification "fly" popularly indicates the housefly (*q.v.; Musca domestica*) or other true flies of generally similar build (fig. 1). "Fly" used as a collective noun ("the horses went down with fly") refers to disease-carrying, biting flies, and especially to attacks by the tsetse fly (*q.v.; Glossina*). "Fly-blown" means contaminated with the eggs and larvae (maggots) of blowflies; figuratively, it has also come to mean in a state of chronic neglect. The true flies, Diptera, are the subject of this article; for information on other so-called flies *see* titles under their common names, as ALDER FLY; BLACKFLY; CADDIS FLY; DRAGONFLY; etc.

INTRODUCTION

Importance of Flies.—Estimates of the total number of known species of true flies in the world range from 60,000 to 85,000. Nearly every study of any group results in the discovery of new species and often of new genera. Probably most completely known are the tsetse flies, confined to tropical Africa. The mosquitoes, of the family Culicidae, have attracted many more workers than any other group of insects, yet even in this family there are groups, of no special medical importance, that are comparatively poorly known (*see* MOSQUITO). The pomace fly or small fruit fly, *Drosophila melanogaster,* has been laboratory bred for many years and intensively used in genetics studies (*see* DROSOPHILA).

Flies probably affect human welfare in more different ways than any other insects. These may be summarized as follows: direct transmission of specific diseases such as malaria, where the fly (in this case the mosquito) is an essential link in the chain; fortuitous or mechanical transmission, for example, through the contamination of food by houseflies; myiasis, or invasion of the human body by larvae of certain flies; infections or infestations of farm stock or draft animals; damage to cultivated plants by the feeding of the larvae of flies. (*See* ENTOMOLOGY: *Applied Entomology.*)

Characteristics.—The true flies are among the most highly evolved insects, and share a common ancestry with the orders Neuroptera, Mecoptera, Trichoptera and Lepidoptera, forming the so-called Panorpoid complex of R. J. Tillyard. The two most characteristic features of true flies are the modification of the hind wings into balancing organs and the structure of the proboscis in relation to feeding habits.

Wings of Flies.—True flies never have more than one pair of wings, which are on the second thoracic segment (mesothorax), and which correspond to the forewings of butterflies and to the elytra, or wing covers, of beetles. The hind wings, on the third thoracic segment (metathorax), have become modified into stalked organs like drumsticks, known as halteres, which are used to maintain stability in flight. The halteres vibrate in a fixed plane, and if the fly pitches, rolls or yaws in flight, nerve cells at the bases of the halteres are excited, producing impulses that affect the musculature in such a way as to make the necessary corrections in balance. This is similar in principle to the automatic pilot of an airplane.

The veins, or stiffening ribs, of the wing follow a definite pattern, which is remarkably constant in each genus and even in each species and thus proves of great value in classification. All flies have strong veins supporting the leading edge of the wing, as is shown in the examples illustrated in fig. 2. Some, like the horseflies (*Tabanus*), have most of the veins that were present in the hypothetical primitive insect; others, as shown, have fewer and weaker veins over much of the wing. These variations undoubtedly affect the functioning of the wing in flight, but exactly how remains to be explained. Also to be determined is whether a correlation exists between wing venation and observable differences in flight among flies.

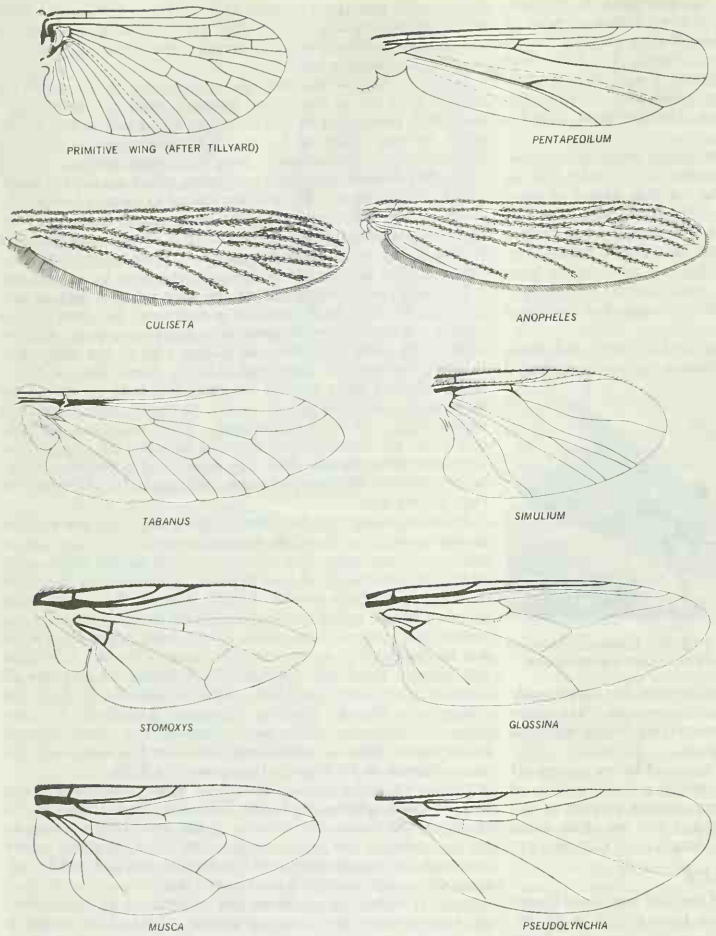
There are many flightless flies in which the wings are reduced in size, peculiar in shape, or missing altogether. A few species have functional wings that are used for the nuptial flight, after which they are broken off near the base. Flightlessness in certain flies may generally be associated with a parasitic life or with isolation on a remote island, on a high mountaintop, in a cave or in any habitat that is so restricted that a winged insect might easily stray and be unable to make its way back again. Yet this is not the whole story: the family Nycteribiidae, parasitic on bats, are all wingless; the family Streblidae, equally restricted to bats, are mostly fully winged. Flightless flies occur sporadically in many different families and, while some advantage can usually be seen in the loss of wings, it would seem that other flies can live in the same situation and still retain their powers of flight.

Despite the reduction or absence of wings, wingless flies can be recognized as belonging to the Diptera by the structure of the thorax, which always retains some of the modifications suited to the possession of one pair of wings. The dorsal, or upper, aspect of the thorax consists mainly of the dorsally enlarged middle segment, or mesothorax, which has evolved to accommodate the huge muscles of flight; the prothorax and metathorax, by comparison, are insignificant. The lower, or ventral, aspect of the thorax is much more equally divided into three segments, to each of which a pair of legs is attached.

Mouth Parts and Feeding Habits.—Adult flies feed upon fluids, which they draw up through a tubular proboscis. The component parts of the proboscis, when they are all present, are the same as those of grasshoppers or of beetles, which masticate solid food: labrum, or upper lip; a pair of mandibles; a pair of maxillae, with maxillary palps; a hypopharynx; and a labium, the lower lip. In flies these mouth parts are combined in various ways to form two distinct tubes (fig. 3), saliva being expelled through one and liquid food drawn in through the other.

Flies can be broadly divided into those that "mop-up," or sponge, liquid food from an exposed surface and those (erroneously called biting flies) that pierce the skin of another insect or of a vertebrate animal in order to suck blood.

Flies With Spongelike Mouth Parts.—The basic food of both sexes of most flies is carbohydrates, mostly in the form of nectar and pollen, and, of course, water and perhaps mineral salts. To get these substances, flies frequent flowers, pools of water, fresh dung, and most damp, rotting or fermenting matter. The great majority of living flies do not pierce skin or suck blood, but satisfy themselves with liquid food mopped up by the labium. The tip of the labium is divided into two lobes, called labella, the inner faces



FROM HERMS, "MEDICAL ENTOMOLOGY"; BY PERMISSION OF THE MACMILLAN CO., PUBLISHERS

FIG. 2.—WINGS OF DIPTERA

of which are lined with tiny, branching, open tubules, the pseudotracheae (fig. 3).

In normal use these tubules act as a fine sieve, allowing only liquids and the most minute solid particles to enter the proboscis. They are modified in various ways to suit the feeding habits. In many flies the labella has become a huge, spongelike organ, as in the housefly (fig. 4).

Flies With Piercing Mouth Parts.—The basic carbohydrate diet suffices to provide the adults of most flies with energy for flight and mating, but the females of some species need proteins to provide nourishment for the eggs. The habit of bloodsucking, interpreted as a way of obtaining this extra protein, was therefore primitively confined to female flies. This situation persists in such families as mosquitoes (Culicidae), black flies and buffalo gnats (Simuliidae), sand flies (Psychodidae), biting midges (Ceratopogonidae) and horseflies (Tabanidae).

At least some of these bloodsuckers can lay one batch of eggs without a blood meal, but all require blood before they can ripen a second batch. According to J. A. Downes (1958) the ancestral flies were apparently bloodsuckers. The mandibles and maxillae are drawn out into lancet blades, or stylets, which, by means of a combination of sharpened edges and backwardly projecting teeth, are suited for piercing the skin of vertebrates and lacerating capillaries. The released blood is drawn up into the food channel of the proboscis.

Some flies that earlier evolved spongelike mouth parts, losing the stylets, have secondarily developed piercing adaptations, associated with the return of these species to a bloodsucking habit. Thus robber flies (Asilidae) and dance flies (Empididae) have the hypopharynx, which bears the salivary duct, sharpened at its tip, and use it like a bradawl against their insect prey. Many flies with big, spongy labella are able to turn these back to expose a pair of prestomal "teeth," with which they can rasp through the skin of other insects (*e.g.*, in Dolichopodidae) or even vertebrates and man (in *Musca crassirostris*).

The really efficient bloodsuckers of this group, such as the tsetse fly (*Glossina*), its relative the stable fly (*Stomoxys*) and the parasitic Hippoboscidae, Nycteribiidae and Streblidae, have hardened the labium and reduced the spongy labella, while retaining prestomal teeth, so that the proboscis becomes a sort of miniature hollow drill. In all flies that have redeveloped the bloodsucking habit this modification of the proboscis has been adopted by both sexes.

STRUCTURE

Size.—Flies have a tremendous range of size. The smallest midges are about 1 mm. long, and are difficult to see, except when a swarm is caught by sunlight and appears as a cloud of dancing specks. The largest robber flies (Asilidae) may be almost 3 in. (75 mm.) long, with a 2- to 3-in. wing span; the bulkiest flies, Pantophthalmidae, and some Asilidae, are not quite so long, but may be about 50 mm., their bulk exceeding that of the tiny midge by about 125,000 times.

Shape.—Flies vary from slender, elongate insects, like the crane flies (fig. 5), to thickset, bristly flies like the housefly and bluebottle. Nearly all have a large, mobile head, a great part of which is occupied by the compound eyes. Male flies of many species are holoptic, the eyes meeting in the middle line and almost obliterating the rest of the head; females are almost invariably dichoptic, the eyes being separated by a strip called the frons. Where this difference is present, the sexes are easily distinguished, but in Asilidae and in many families of the Acalypterae (*see* below) both sexes have separated eyes. In the family Diopsidae and in a few genera in other families, the eyes, held far apart at the end of long stalks, have the appearance of some sort of range finder.

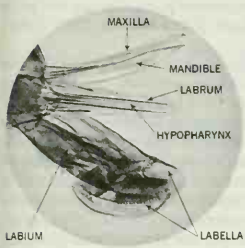
Simple eyes, ocelli, believed mainly to perceive intensity of light rather than to make an image, are found in many flies as a group

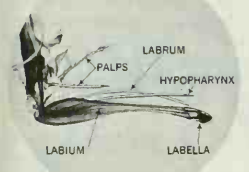
of three at the top of the head (vertex). Ocelli are clearly not essential, since flies without them seem in no way handicapped.

Body Parts.—The relative size and shape of the eyes and antennae among various families of flies vary considerably (fig. 6). As in other insects the antenna is composed of three parts: the basal segment, or scape; the second segment, or pedicel; and the remaining end portion, called the flagellum, which though superficially subdivided is one long compound segment. The long-horned flies, suborder Nematocera (literally, "thread-horn"), are so-called because nearly all the members have a long, threadlike flagellum consisting of a number of similar divisions. In the rest of the Diptera, the short-horned flies, the flagellum is much shorter, and constitutes a complex third segment that is variously modified but generally carries some of its divisions in the form of an appendage called either a style or an arista, according to its length and point of attachment.

The mouth parts have already been discussed. The maxillary palps are generally prominent, but only rarely take on a distinctive shape.

The thorax is always remarkable for the great development of the middle segment (mesothorax), but otherwise does not vary very greatly. Occasionally it bears spines of unknown function (*e.g.*, in Stratiomyidae and some Diopsidae). The posterior section of the mesothorax is the scutellum, a shield-shaped structure that seems to play an important part in flight mechanics. Occasionally the scutellum is enlarged: in Thyreophoridae it is abnormally long and triangular, and in Celyphidae it covers the abdomen dorsally, making these flies look like beetles.





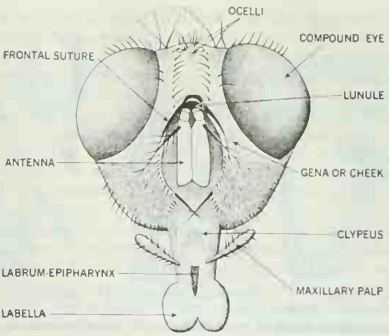
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

FIG. 3.—THE TWO TYPES OF PIERCING MOUTH PARTS OF BLOODSUCKING FLIES (GREATLY MAGNIFIED)

(Above) Mouth parts of a horsefly (*Tabanus*), showing bladelike mexilla and mandible, and spongelike labella; (below) mouth parts of a stable fly (*Stomoxys*), showing the reduced maxilla and mandible, the palps and the thin, hard labium and labella produced as the piercing organ

The legs have all the segments well developed: coxa; trochanter; femur; tibia; and five-segmented tarsus. The legs are generally bristly, and in predaceous flies (*e.g.*, Asilidae, Empididae, Ephydridae) the femur and tibia of one or more pairs are often enlarged and equipped with strong spines or bristles that aid in seizing prey. Often the male may have the legs specially adapted to grip the female during pairing, and in some species (notably in Dolichopodidae) the tarsus and sometimes the tibia are broad and bear conspicuous tufts of hair or scales, white or brilliantly coloured, which are used in a courtship display. The tip of the tarsus ends in a pair of claws, particularly strongly developed in parasitic flies; beneath each claw there is generally a pad called a pulvillus and centrally an empodium, which may be either a similar pad or a fine bristle.

The abdomen may be long and cylindrical or short and barrel-shaped, but nearly always the segmentation is clearly shown. Usually from four to seven segments are clearly visible, and constitute the abdomen proper, or preabdomen; the eighth to eleventh segments make up the postabdomen, which provides the organs of copulation in male flies and the ovipositor, or egg-laying apparatus, in females. The male postabdomen is very flexible and may be rotated round its longitudinal axis through anything up to 360°, in correlation with differences in the attitudes of the two partners during pairing. The shape and structure of the ovipositor of the female is directly adapted to the method of egg laying. If the



FROM A. D. IMMS, "GENERAL TEXTBOOK OF ENTOMOLOGY," METHUEN & CO.

FIG. 4.—HEAD AND MOUTH PARTS OF A FLY OF THE FAMILY MUSCIDAE (GREATLY MAGNIFIED)

eggs are merely dropped onto the ground, the ovipositor is very simple, but if they are laid inside the heads of grasses and in similar places, the ovipositor may be a bladelike organ. Flies that penetrate plant tissue, including fruit flies (Trypetidae or Tephritidae) that pierce the rind of young fruit, have a telescopic ovipositor; those laying eggs in sand or loose earth may have spiny or bristly ovipositors that assist in excavation.

LIFE HISTORY

Early Stages.—Flies are holometabolous insects; that is, they hatch from the egg as a larva that is quite different from the adult insect in shape and in habitat. At the end of larval life the insect passes through a quiescent pupal stage during which a complete metamorphosis occurs, the larva being transformed at one step into the adult fly, which emerges from the puparium in its final form. After a few hours the newly emergent adult has hardened fully and developed its full size and colour (fig. 7, 8). Contrary to popular belief, small flies never grow into big ones.

Egg.—The eggs of most flies are spindle-shaped and smooth (only rarely with external structures); the eggs of some anopheline mosquitoes are supported in water by air floats, whereas the eggs of some Drosophilidae and some Muscidae have respiratory "horns" or lobes that, according to H. E. Hinton (1959), ensure a supply of oxygen to such eggs, which are liable to be submerged in rain water. The egg-laying female nearly always lays eggs where the larvae will be able to find its food at hand.

Larva.—The larvae of a very large number of flies feed upon decaying matter, either of vegetable or animal origin. That is why this order of insects has acquired an unsavoury reputation, though in fact these larvae are doing an invaluable service in breaking down organic material and redistributing its elements. Thus compost heaps and all natural media of this nature, including leaf mold, rotting seaweed and the like, are the breeding places of great numbers of flies. Other fly larvae live in carrion and in animal flesh of varying stages of decay. Dead bodies pass through a sequence of stages as the processes of putrefaction go on, and there is a corresponding succession of larvae, each group of flies laying its eggs at such a time that their larvae appear when conditions of temperature, humidity and acidity are best for that species. Larvae living inside growing plant material and causing damage and loss of crops include those of gall midges (Cecidomyiidae), frit flies (Chloropidae) and large fruit flies (Trypetidae).

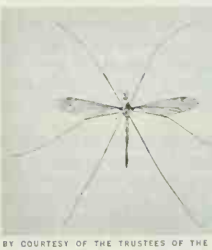


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FIG. 5.—CRANE FLY (TIPULA FULVIPENNIS); ABOUT NATURAL SIZE

As among larger animals there are herbivores and carnivores

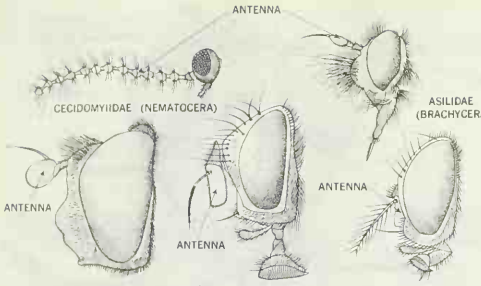


FIG. 6.—HEADS OF FLIES OF CERTAIN FAMILIES, SHOWING DIFFERENT TYPES OF ANTENNAE (MAGNIFIED)

or their equivalents. In a mass of dung, for example, there are larvae that feed upon the dung itself or upon the molds that grow on it; these are the primary feeders, which themselves are preyed upon by other dipterous larvae. According to D. Keilin, many Muscidae begin life in the first group, but as the larvae become larger and more rapacious they start to prey on their fellows. On vegetation, in the soil and in rotten wood are carnivorous larvae, notably of Syrphidae, Tabanidae and Stratiomyidae, that apparently roam about devouring anything they come upon. Many of them live in wet soil or in mud beneath water. The truly aquatic dipterous larvae also are divided into primary and secondary feeders.

Simuliidae, most Chironomidae, mosquitoes (Culicidae) and some Syrphidae feed on minute organisms, which they sweep into their mouths with mouth brushes; some mosquitoes, Stratiomyidae, Tabanidae and Ephydridae have exclusively carnivorous aquatic larvae. Larvae of Ephydridae may lead a predaceous existence in most inhospitable media, including brine pools and even pools of crude petroleum round oil wells (the "petroleum fly" of California).

Dipterous larvae never have true, segmented legs such as are seen in, say, larvae of beetles. They often have other appendages, however: gills for breathing under water; telescopic siphons for reaching to the open air; prolegs, or fleshy swellings with spines, which are used to get a purchase when crawling or for clinging to underwater vegetation; or lateral fringed processes that may increase the surface area and help to keep the larva from sinking in a very liquid medium.

Larvae of the more primitive families of the suborder Nematocera generally have a well-developed head, with chewing mouth parts and conspicuous mandibles. Their bodies, usually rather elongate and often with spiracles or breathing apertures on the thorax and on each abdominal segment (*e.g.*, fungus gnats, or Mycetophilidae), have a fairly characteristic form in each family. In the more advanced families, especially in the Cyclorrhapha (*see* below), the larvae are either grublike or maggotlike; they have no head capsule, and their mouth parts are "mouth hooks," visible through the transparent skin.

The head end of a maggot is pointed, and the posterior end is bluntly truncate; there is one pair of inconspicuous spiracles on the prothorax and a larger, more obvious pair at the posterior end. The shape of these larger spiracles is often the only good structural character that can be used for identification of various larvae.

The larvae of Nematocera can usually be named to the family and sometimes, as in mosquitoes, even to the species; among the maggotlike larvae of the higher Diptera such a small proportion have ever been matched with their adults, and the differences between them are so slight, that identification becomes inspired guesswork, based as much upon where the larva was found as upon its systematic characteristics.

The length of larval life varies very considerably. The flies that are of practical importance as medical or agricultural pests are generally those that have several generations a year, and so are able to multiply rapidly during a favourable season. Such flies require about three weeks to proceed from egg to adult, of which time the egg may occupy about two days and the larva and pupa about nine days each. This duration, however, is much affected by temperature and humidity, and larval life may be greatly prolonged under unfavourable conditions. In cold weather a housefly may spend a much longer time as a larva, and many flies have only one generation a year, passing the winter either as larvae or as pupae.

A few flies may have a larval life of two years or even longer. This is particularly true of larvae of Tabanidae, which are predatory on other soil-living insects and which must often go for long periods without meeting any suitable prey.

Pupa.—Most larvae of flies leave their food material when they are fully fed and ready to pupate. Some aquatic groups, notably mosquitoes and the rat-tailed larvae of Syrphidae, have an aquatic pupa that remains in the water; but other groups, such as horseflies (Tabanidae), move to the muddy margins of ponds or streams to pupate. Most larvae that feed either in plant tissues or in rotting materials move out to pupate in the soil or in a dry, sheltered place, often some distance from their larval habitat.

The pupae of the more primitive families reveal externally the structures—head, antennae, legs, wings, etc.—of the developing adult (fig. 7). In addition they may have other structures peculiar to the pupal stage, *e.g.*, the powerful spines in Asilidae and Bombyliidae, which are used by the pupae to move to a more convenient place before the emergence of the adult. The pupae of the Cyclorrhapha are entirely enclosed in a puparium, a protective case formed from the skin of the last larval stage. Such puparia are barrel-shaped and generally brown, red or black. The structures that show through the puparium are anterior and posterior spiracles and bands of spicules of the larvae; no adult structures can be seen externally. A cocoon, on the other hand, is a pupal shelter made from extraneous materials such as soil, sand, silk, etc.

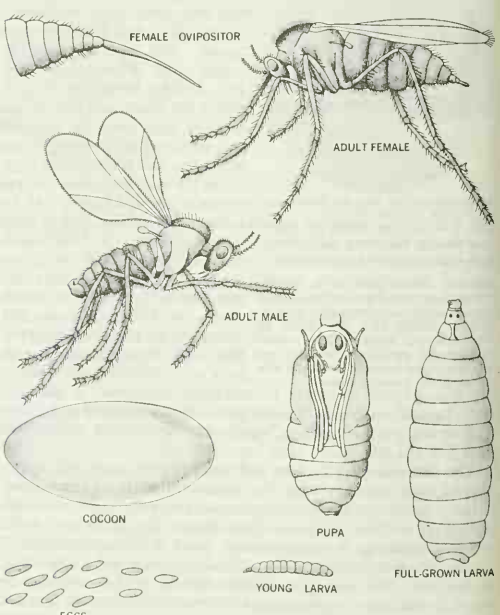


FIG. 7.—LIFE HISTORY OF THE ROSE MIDGE (DASYNEURA RHODOPHAGA) (ALL VIEWS GREATLY MAGNIFIED)

Cocoons occur sporadically throughout the Diptera, when the circumstances of pupation call for extra protection.

CLASSIFICATION

True flies fall into three suborders, which are usually referred to as Nematocera, Brachycera and Cyclorrhapha. There have been two lines of evolution from the ancestral Diptera, one of them leading to the Nematocera, which first appear in Upper Triassic deposits (about 170,000,000 to 180,000,000 years ago); along the other line, those families that have remained fairly primitive from the Lower Jurassic (beginning about 160,000,000 years ago) onward constitute the Brachycera, whereas those of the Tertiary (beginning about 70,000,000 years ago) are the most advanced flies, the Cyclorrhapha, and appear to be in active evolution at the present time. Although there are about 90 families of flies, it is relatively easy to place almost any adult specimen in its family. Identification of larvae, as has been noted, is much more difficult.

The following outline is one of several taxonomic schemes applied to the Diptera:

Suborder Nematocera
" Brachycera
" Cyclorrhapha
Series Aschiza
" Schizophora
Section Acalypterae
" Calypterae

Suborder Nematocera.—As mentioned earlier the name refers to the threadlike flagellum of the antenna, composed of a number of similar divisions that are inaccurately called segments. The maxillary palps also have several segments, and droop instead of projecting forward. Flies of this suborder might collectively be called the midges and gnats. Most of them are tiny or fragile, or both.

Tipulidae are the slender-bodied crane flies (sometimes called "daddy longlegs" because of their resemblance to the spider so called), with long, thin legs that are easily broken off. The familiar crane flies are fairly big, but the majority of the family are small and not often noticed. About 10,000 species have been described. The larvae live in moist situations where there is plenty of decaying vegetable matter. Some are pale and fleshy, like many larvae that live inside food material that they need never leave; others, which feed at the roots of plants (including grasses) and which come out on the surface at night, have a tougher skin and are known as leatherjackets (*q.v.*). A few tipulid larvae are carnivorous.

Closely related are Tanyderidae, a small, primitive family; Ptychopteridae, which have an aquatic larva with a respiratory "tail"; Trichoceridae, the winter gnats, which prefer cool, shady places in summer, and which come out on quite cold days in winter to dance in the sunlight; and Anisopodidae (Rhyphidae), which have similar habits, but also breed in damp places indoors and often appear on windows.

Psychodidae are small, hairy midges, which are divided into the bloodsucking and the nonbloodsucking groups. The former, the Phlebotominae, are the true sand flies, though the name is often used for the Ceratopogonidae (*see* below). They occur in the drier tropical and subtropical areas, and transmit a number of diseases (*see* ENTOMOLOGY: *Medical and Veterinary Entomology*). The nonbiting Psychodinae, the moth flies, have broad wings covered with hair and scales. They breed in damp places in organic matter, and are common round drains and sewers. The larvae of some species are abundant in the filter beds of sewage works, where they play an active part in breaking down the sludge. Most houses have a few of them about.

Chironomidae are the familiar midges that dance over the water on summer evenings. Their larvae are mostly aquatic, and some that live in stagnant conditions have hemoglobin in their bodies and are called bloodworms. The adult midges are fragile, elongate flies, usually pale green; the males often have very bushy antennae. The behaviour of the swarms in relation to air currents and to moving objects is an interesting field of study.

Ceratopogonidae are tiny, bloodsucking relatives of the Chironomidae, and are called biting midges, and also "punkies," "noseeums" and often, inaccurately, sand flies. *Culicoides* is the best-known genus. The larvae live in damp, decaying vegetation. The adults bite most intensely early and late in the day. Some genera attack other insects, sucking fluid from the wing veins.

Blepharoceridae are an aquatic family, the larvae of which have special suckers with which they cling to boulders in rapid streams; the adults have a characteristic network of fine wing veins. Deuterophlebiidae are closely related. Thaumaleidae (Orphnephilidae) are another aquatic family, with larvae similar to those of Chironomidae.

Simuliidae are the black flies, turkey gnats or buffalo gnats, the last name aptly describing their humpbacked appearance. The adult flies suck blood from man and other mammals and from birds. They cause extreme annoyance to and loss of blood from their victims, and in some tropical countries carry onchocerciasis, a disease caused by a nematode worm that parasitizes the flies. Many cases of blindness arise from this infection. The larvae of Simuliidae live in water that is rich in oxygen, either rapidly flowing water or water supporting a great deal of aquatic vegetation. The larvae attach themselves to rocks or plants by a posterior sucker and filter food from the water with mouth brushes. The pupae are also aquatic, and have respiratory filaments.

Bibionidae are shining flies, mostly blackish, with a hairy covering and the legs armed with elaborate spurs. *Bibio marci*, St. Mark's fly, is conspicuous about the Feast of St. Mark (April 25), while *Dilophus febrilis* (undeservedly called a "fever fly") often occurs in great numbers, especially on blossoms, in spring. The larvae are sometimes found in great numbers at the roots of plants, which they may damage. Scatopsidae are superficially very similar but have no tibial spurs, and the eyes form a bridge over the antennae. They breed in decaying material and excrement, and sometimes appear on windows.

Mycetophilidae, or fungus gnats, are very small, fragile, dull black insects, soft-bodied and with filamentous antennae. They are common in all cool, moist places, and their larvae are believed to feed on molds and fungus growths. Some breed directly in fungi and may be a pest to growers of mushrooms. The Sciaridae used to be placed in the same family, but are now separated: they have the eyes meeting in a bridge over the antennae, like the Scatopsidae. The larvae of some Sciaridae, which migrate in columns, are called army worms.

Cecidomyiidae, gall midges, are very fragile flies that are little-known as adults. Many of their larvae live in plants and cause them to form galls, but a number are free living in decaying materials or are predatory or parasitic on other small insects. The larvae are remarkable among Nematocera in having no head capsule, and indeed almost no structure, except for a clove-shaped "breastbone" that is a useful aid to recognition. The larva of the Hessian fly, *Phytophaga destructor*, causes the stems of winter wheat to break. The genus *Miastor* is able to reproduce by paedogenesis; *i.e.*, its larva may be seen to be filled with a mass of daughter larvae, which consume their parent before she has metamorphosed toward the adult stage.

Finally, the family Culicidae comprises three subfamilies. The largest of these is the subfamily Culicinae, the mosquitoes (*q.v.*); the other two subfamilies are much smaller. Chaoborinae are much like mosquitoes as adults, but their larva is different. The phantom larva of *Chaoborus* (*Corethra*) has two conspicuous air sacs that help to adjust the larva's density to match the water in which it lives; it is carnivorous. The Dixinae have adults rather like small crane flies, but their larvae are like those of anopheline mosquitoes.

Suborders Brachycera and Cyclorrhapha.—With very few exceptions, all flies other than Nematocera are "Brachycera" in the sense that they have shorter antennae, with the divisions of the flagellum fused into a compound third segment. They can be divided into Brachycera-Orthorrhapha, in which the adults emerge from the pupa by making a straight or a T-shaped slit; and Brachycera-Cyclorrhapha, in which a circular slit opens a cap in the puparium. It is convenient to shorten these terms to Brachycera and Cyclorrhapha respectively, particularly since the shape

of the slit is not a characteristic that can be used in practical identification. In practice all the families are placed in a generally accepted order, starting with the most primitive. M. L. Aczél (1954) proposed the names Orthopyga and Campylopyga for these two suborders. This scheme, based upon the position of the postabdomen with regard to the preabdomen, is controversial; its chief interest is that it moves the family Dolichopodidae from the Brachycera to the Cyclorrhapha (*see* below).

Brachycera.—The first group of the Brachycera is the Homeodactyla, with three equal pads (pulvilli) on the foot and no strong bristles between them. Stratiomyidae, the soldier flies, are flower-loving flies, brightly coloured, generally found near water; they often have aquatic, carnivorous larvae. The discal cell (large cell at the base of the wings) is greatly contracted.

Rhagionidae (Leptidae) are primitive in most structures except antennae, and much resemble Anisopodidae of the Nematocera. The adults are furtive (*e.g.*, the downlooker fly). A few suck blood. The females of *Atherix ibis* and *A. variegata* die in clusters over their eggs on waterside vegetation. Larvae of the subfamily Vermileoninae live in pits like ant lions.

Tabanidae include horseflies, gadflies, clegs and deer flies. All male tabanids, and the females of some genera, feed from flowers, but females of the best-known genera, especially of *Chrysops, Tabanus* and *Haematopota*, are fierce bloodsuckers. Their larvae live in moist earth, wet sand or mud, and many, but not all, are carnivorous.

Allied to these three families are a number of primitive genera that lie close to the stem of evolution of the Brachycera: various families have been proposed for these, such as Coenomyiidae; Xylophagidae; Xylomyiidae; Rhachiceridae; Pelecorrhynchidae and Pantophthalmidae. The last-named family includes giant flies (2- to 3-in. wing span), confined to tropical America; their larvae live in wood. Nemestrinidae, with complex wing venation, have larvae that parasitize beetles. Acroceridae (Cyrtidae) are globular little flies whose larvae parasitize spiders.

The group Heterodactyla have only two pulvilli on the foot, with a bristlelike empodium between them. Scenopinidae, window flies, are small and smooth-bodied but have a relatively large carnivorous larva, like a small worm, which is often found in carpets.

Therevidae are hairy, dusty-looking flies, with a larva very much like that of *Scenopinus*. Asilidae, robber flies, are a big family of fiercely predaceous flies; armed with a strong proboscis and protected by many bristles, they will attack even wasps bigger than themselves, catching them in flight and sucking them dry. Apioceridae and Mydaidae are related families, smaller and little-known.

Bombyliidae, bee flies, are covered with hairs and scales, and hover over flowers like bees, or dart in flight like wasps (*Systropus*). Many have a long proboscis. Their larvae are parasites or scavengers in the nests of bees and wasps; they also parasitize the egg pods of locusts and the larvae of moths.

The Empididae are a large family of predaceous flies which are rather like the Asilidae but are recognized by the more spherical head, sharper proboscis and different wing venation. They seem to replace the Asilidae in temperate regions. Males of *Hilara* spin silk from glands in the fore tarsi, and make a bundle, with or without prey, which they offer to the female during mating.

Dolichopodidae, long-legged flies, are bristly and usually metallic blue or green; they are abundant on damp vegetation, and prey on other insects, which they envelop in the labella of the proboscis and tear open by means of prestomal teeth. These mouth parts foreshadow those of Cyclorrhapha and support the view of Aczél, who excludes the Dolichopodidae from the Brachycera; yet the larvae cannot be certainly distinguished from those of Empididae.

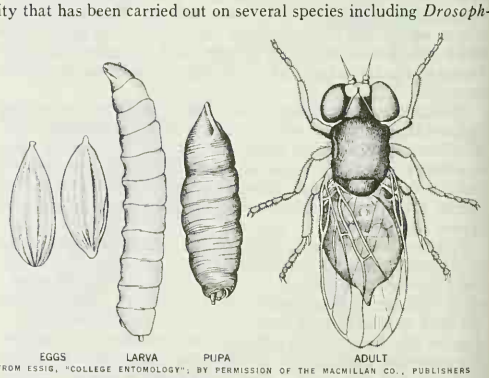
Cyclorrhapha.—*Series Aschiza.*—The first division, series Aschiza, have the small frontal lunule shown in fig. 4 but no frontal suture dividing the frons from the face. The five families included are highly individual, and seem to be evolutionary offshoots at the base of the Cyclorrhapha.

Syrphidae (hover, or flower, flies) are a large family of conspicuous insects. They are smooth, bristleless, shining flies, often large and bulky, with an amazing ability to hover in one place with very rapidly beating wings. Nearly all adult Syrphidae feed from flowers, but the larvae inhabit almost every kind of possible food material. The beneficial ones devour aphids. The rat-tailed larvae live in stagnant water and have a telescopic breathing tube.

Platypezidae, with peculiar flattened tarsi, live as larvae in fungus; Pipunculidae, with a curious almost spherical head, have larvae parasitic upon plant bugs. Phoridae are tiny black flies with a characteristic wing venation: one or two strong veins near the leading edge and the rest weak and running parallel to each other across the wing. The larvae live in almost any decaying animal matter in a dry or even mummified state. Some live with ants or with termites, and are sometimes separated as a family, Termitoxenidae. Lonchopteridae, in contrast, are small flies with pointed wings; only a few species exist.

Series Schizophora.—Cyclorrhapha of this group have a frontal suture, or more properly ptilinal suture, from which is pushed out an inflated sac, called a ptilinum, when the adult fly is breaking out of the puparium, making its way out of the soil. The air in the ptilinum is used to inflate the crumpled adult body to full size, the ptilinum being drawn into the body in the process. The series is divided into two sections, the Acalypterae and the Calypterae.

Section Acalypterae are so-called because the calypter, a flap at the base of the wing, is small and inconspicuous. This is a complex assemblage of species, nearly all small ($\frac{1}{4}$ – $\frac{1}{3}$ in.), that appear to be in active evolution, since so few clearly defined groups exist. Conopidae are an exception; they are large flies, wasplike, with larvae that are parasitic on adult bees, wasps and Orthoptera. Among other conspicuous families are Trypetidae, the large fruit flies, which include the Mediterranean and the Queensland fruit flies, and others that are dangerous enough to have legislation directed against them (*see* FRUIT FLY). Like the related Otitidae the large fruit flies often have patterned, or "pictured," wings. Chloropidae (fig. 8) include the frit fly (*q.v.*) of oats and the gout fly of barley as well as the eye gnats that carry conjunctivitis and the yellow swarming fly that invades houses in autumn. Agromyzidae include many species with leaf-mining larvae that tunnel in leaves and sometimes damage ornamental shrubs. Drosophilidae are world-famous for the intensive research into the laws of heredity that has been carried out on several species including *Drosophila melanogaster*. Many Ephydridae, shore flies, are powerful predators both as adults and as larvae; some are equipped with raptorial legs for this purpose. The petroleum fly, previously mentioned, belongs to this family. In all, there are more than 40 families of Acalypterae, of which a majority breed in many kinds of decaying materials.



FROM ESSIG, "COLLEGE ENTOMOLOGY"; BY PERMISSION OF THE MACMILLAN CO., PUBLISHERS

FIG. 8.—LIFE STAGES OF A CHLOROPID FLY (HIPPELATES PUSIO)

Section Calypterae.—These are structurally the most advanced of all flies. Representative of this group are the housefly and the bluebottle—short, stout, bristly, active flies. They generally have large calypters, except in the Cordyluridae. They also have a characteristic cleft in the second antennal segment. The species

are very numerous and difficult to classify, especially the females, since often the only obvious differences are in the male genitalia.

Only a few large families are recognized, and even these are subject to dispute. Oestridae are parasitic as larvae in the skin and in head cavities of mammals; the sheep nostril fly, *Oestrus ovis,* and the warble fly of cattle, *Hypoderma,* are well-known. These flies have virtually no mouth parts, and during their short adult life they do not feed.

The other Calypterae are divided according to the presence or absence of bristles on a chitinous plate (sclerite) on the side of the thorax, the hypopleural bristles: the families Muscidae and Cordyluridae have none; Calliphoridae and Tachinidae have them present. Cordyluridae, predatory flies with small calypters, are exemplified by the yellow dung flies that may be seen rising in a cloud from cow dung. Muscidae includes the housefly (*q.v.*) and its many allies, most of which feed on fluids by mopping them up. A number, however, including the tsetse fly, *Glossina,* and the stable fly, *Stomoxys,* have a hardened proboscis that can pierce skin.

Tachinidae are very bristly flies with larvae that are parasitic in a number of other insects, and consequently they rank as beneficial to mankind. Calliphoridae differ from Tachinidae in not having a strong convexity of the postscutellum, a chitinous plate of the thorax, and in their habits. Typically they breed in carrion, like the bluebottle, *Calliphora,* and play a useful part in disposing of animal remains. From this feeding habit many have progressed to infesting open wounds, then to attacking living tissues.

The sheep maggot fly, *Lucilia sericata,* and others, cause much distress to and loss of sheep. The Congo floor maggot, *Auchmeromyia luteola,* seems to be a specific parasite of man in its larval stage, whereas *Callitroga macellaria,* the secondary screw-worm fly, causes a great loss of tissue and mutilation in man and other animals. *Sarcophaga* and its allies are the flesh flies, remarkable for their habit of producing living larvae, which can begin to feed at once; they are sometimes placed in a separate family, Sarcophagidae.

Disputed Groups.—There remain a few groups of Cyclorrhapha, the position of which is in dispute. *Braula coeca,* a tiny, wingless, beetlelike fly clings to worker honeybees, and its larva lives on the wax of the honeycomb. According to A. D. Imms (1942) it is placed next to Chamaemyiidae in the Acalypterae.

Adults of Gasterophilidae have reduced mouth parts, and their larvae live as parasites in the intestines of mammals; *Gasterophilus,* in horses and zebra; *Gyrostigma,* in rhinoceroses; *Cobboldia,* etc., in elephants. Although this group seems so like the Oestridae, some authors have suspected mere convergence and removed them to Acalypterae; but F. Zumpt (1957) put them back next to the Oestridae.

Finally, there are three families of flies that are parasitic and bloodsucking as adults: Hippoboscidae, on mammals and birds, and Nycteribiidae and Streblidae, on bats. Adult females of these families nurture the larva until it is fully fed and drop it when it is ready to pupate. They have thus long been grouped together as the section Pupipara, and in spite of some criticism this still seems to be the best way to treat them. All Nycteribiidae are wingless, and so are some Hippoboscidae, including the sheep ked, *Melophagus ovinus.*

For a discussion of basic anatomy, function and evolution of flies and other insects *see* INSECT; for economic importance and control *see* ENTOMOLOGY.

See also separate entries on various flies under their common names.

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FLYCATCHER, a name used for two families of perching birds (order Passeriformes), in each case with reference to their habits of darting out from a tree perch after flying insects. The first family, Muscicapidae, sometimes called old world flycatchers, are songbirds (*q.v.;* suborder Passeres) closely related to the families of thrushes (Turdidae) and old world warblers (Sylviidae). These flycatchers, of which there are more than 400 species, are small (up to nine inches long) and typically have a broad flat bill and rather short legs. They live in wooded areas from Europe and Asia to Africa and Australia. Their colours and patterns vary widely; their biology is in general that of many other songbirds. The better known European species include the pied flycatcher (*Muscicapa hypoleuca*), with a black and white male, and the spotted flycatcher (*Muscicapa striata*), gray above and streaked on the breast. Both migrate to Africa for the winter.

JOHN MARKHAM

MALE PIED FLYCATCHER (MUSCICAPA HYPOLEUCA)

The second family of flycatchers are the tyrant flycatchers comprising the family Tyrannidae (suborder Tyranni), a new world family with most of its 365 species in the tropics. Tyrant flycatchers, so called from their pugnacity, are small- to medium-sized birds, ranging from 3 to 16 in. long. Although they are not true songbirds, but have a simpler syrinx or voice box, some have loud voices, even if not musical.

Tyrant flycatchers are mostly tree birds with broad flat bills and short legs, but a few South American species have longer legs and are ground living grassland birds. Their plumage is usually dull and plain, often in shades of gray, brown or olive. The nests vary greatly from simple cuplike structures placed in branches to more elaborate nests in tree holes, domed nests on branches or rocks and bulky pendant nests with side entrances.

Among the better known North American species, all of which migrate south for the winter, are the crested flycatcher (*Myiarchus crinitus*), olive and yellow with red-brown in wings and tail; the least flycatcher (*Empidonax minimus*), a gray and olive bird; the eastern kingbird (*Tyrannus tyrannus*), black, gray and white, with a concealed orange crest-patch and a white tipped tail; the eastern

phoebe (*Sayornis phoebe*); and the eastern wood pewee (*Contopus virens*). *See* KINGBIRD; PHOEBE. (A. L. RD.)

FLYING, COMMERCIAL: *see* AVIATION, CIVIL; TRANSPORT; *Air Transport.*

FLYING BOAT: *see* SEAPLANE.

FLYING DOCTOR SERVICES comprise a method for supplying medical service by airplane to areas where doctors are few and communications difficult. The plan for the first such service was conceived in 1912 by the Rev. John Flynn, superintendent of the Australian Inland mission of the Presbyterian Church. The large, isolated areas of the Australian outback which lacked highways, railroads and wire or wireless facilities for sending messages were imposing formidable hardships and retarding white settlement. Flynn's dream dawned into reality in May 1928 when the first base of what is now the Royal Flying Doctor Service of Australia began operating at Cloncurry, Queensland, under Dr. K. St. Vincent Welch. Flynn recruited an Adelaide electrical engineer, A. H. Traeger, to develop a low-powered, portable, pedal-driven, Morse radio transmitter-receiver with a range of 300 mi. This "transceiver," with the use of airplanes, made possible the world's first system of regular long-distance medical consultations and the flying of doctors to patients in emergencies. By 1962, 13 bases, run by state branches, covered two-thirds of the Australian continent and part of Tasmania. St. Vincent Welch traveled 20,000 mi. and attended 255 patients in his first year; by the 1960s doctors flew 500,000 mi. a year in 1,600 flights and conducted 10,500 radio consultations with patients at 1,300 outposts; the service also handled 250,000 radio messages annually. The Australian state governments contribute one-third of the finances; the rest comes from voluntary and outpost subscriptions and message charges. The flying doctor service is free.

Other parts of the world regularly use aircraft for the assistance of the isolated sick. In Canada the Saskatchewan Air Ambulance service was inaugurated in 1947; by the end of 1961 it had flown more than 15,000 patients to city hospitals. Newfoundland operates from the International Grenfell association at St. Anthony an air ambulance service, likewise begun in 1947, covering north Newfoundland and Labrador. The Royal Canadian Air Force operates a search and rescue service for Eskimos and Indians in the arctic.

In east Africa the African Medical and Research foundation, established in 1957 by joint British and American enterprise, was enabled in 1961 to begin a flying doctor service with a single airplane provided by private United States benefaction. In collaboration with this body, the Flying Doctor Service of Africa, Ltd., registered in the United Kingdom, planned a pilot scheme to be based on Gusau, northern Nigeria. (E. A. BE.)

"FLYING DUTCHMAN," a spectre ship believed to haunt the waters around the Cape of Good Hope. Its appearance is considered by sailors ominous of disaster. The commonest legend declares that the captain, Vanderdecken, was condemned for blasphemy to sail around the cape forever, unable to "make" a port. This legend was adapted by Wagner in his opera *Der fliegende Holländer* (produced 1843).

A German form of the legend alleges that the captain, called Von Falkenberg, is condemned to sail forever around the North sea, in a ship without helm or steersman, playing at dice for his soul with the devil. Sir Walter Scott's version, in *Rokeby*, is that the vessel was laden with bullion. A murder was committed on board and the plague broke out among the crew and closed all ports to the ship. The story has frequently been used in literature.

See G. Kalff, *De Sage van den Vliegenden Hollander. Naar behandeling, Oorsprong en zin Onderzocht* (1923).

FLYING FISH, a name applied especially to marine fishes of the family Exocoetidae (order Beloniformes or Synentognathi), but also to certain unrelated fishes that, like the former, are capable of what can be termed limited flight.

The exocoetid flying fishes do not fly in the sense of flapping their wing-sized pectoral fins, but actually glide. In preparing for flight, a typical, well-developed "four-winged" flying fish (of *Cypselurus* or a related genus) swims fast toward the surface of the sea, with its paired fins folded tightly against its streamlined body. On breaking the surface the fish spreads its enlarged anterior "wings" (very stiff pectoral fins) nearly at a right angle to its body. With the fish's head end thus held up, the strong lower lobe of the tail fin rapidly beats the surface, thus propelling the fish forward. When sufficient speed has been attained, the smaller, lower, posterior "wings" (pelvic fins) are spread, whereupon the tail fin is lifted and the fish is air-borne, gliding a few feet above the surface at a speed of about 10 m.p.h. The stronger fliers can span as much as 200 yd. in a single glide and can extend their flight by resuming the sculling motion of the tail fin when that fin droops to the water surface. Compound glides, timed as long as 43 seconds, may cover one-fourth mile.

About 100 species of flying fishes exist. They occur in all warm seas. In length they range from 6 to 18 in. They are preyed upon by such strong surface swimmers as the dolphins (both the mammal and the fish of that name), and their flight is primarily a means of escape from such predators.

HAROLD EDGERTON

CALIFORNIA FLYING FISH (CYPSELURUS CALIFORNICUS)

Other unrelated fishes capable of flight are the flying characins (Gasteropelecinae) of South American fresh waters, which have smaller wings that beat rapidly (in true but nondirectional flight). Flight has also been attributed to the little *Pantodon* of African fresh waters. Although the "flying gurnards" (Dactylopteridae) were earlier thought to be capable of flight, later evidence indicated that they do not and cannot fly. *See* also FISH. (C. L. HS.)

FLYING "FOX" (FOX BAT), any of the large, fox-faced, fruit-eating bats of the genus *Pteropus*, which includes more than half the family Pteropidae. This genus is confined to the tropics of Asia, Madagascar, Australia and from the East Indies east to Samoa. It comprises numerous species, a considerable proportion of which occur in the islands of the Malay archipelago. The flying "foxes" are the largest of the bats, the kalong of Java (*Pteropus vampyrus*) measuring about one foot in length and the wings measuring five feet across. Flying "foxes" are gregarious, nocturnal bats; toward evening they fly off in companies to the village plantations, where they feed on all kinds of fruit, doing much damage. During the day they hang head downward from the branches of trees, with their wings wrapped about them. They are good eating, tasting something like hare.

The flying "fox" of India (*P. giganteus*) is a smaller species, but is found in great numbers wherever fruit is to be had. *See* also BAT.

FLYING LEMUR, a name for two species of lemurlike gliding mammals (but not actually lemurs) of the genus *Cynocephalus* (or *Galeopithecus*), belonging to the primitive mammalian order Dermoptera, found only in the West Indies and certain of the Philippine Islands. They are called colugo (and other variant names) by the natives. *See* CYNOCEPHALUS.

"FLYING SAUCERS": *see* UNIDENTIFIED FLYING OBJECT (UFO).

FLYING SQUIRREL, the name applied to two very different groups of nocturnal, tree-dwelling rodents, in both of which a parachute-like expansion of the skin of the flanks enables them to take long gliding leaps. They all have large, dark-adapted eyes, and are omnivorous, berries, seeds, nuts and insects being the chief diet.

The first group, allied to the true squirrels (Sciuridae), comprises about 11 genera forming the subfamily Petauristinae and occurs from Scandinavia to Japan and the Malay region, and in North America from northern Canada to Honduras. The greater number of species occur in the Indian and Malayan regions; there some, *Petaurista* species, reach large size, more than a yard in total length, and may be foxy red, red spotted with white, or black in colour. The gliding membranes of these large species are more extensive than those of smaller forms; a fold connects the hind limbs with the tail. Flying squirrels glide from a position

ERNEST P. WALKER

NORTH AMERICAN FLYING SQUIRREL (GLAUCOMYS VOLANS)

high on one tree to a lower level on another tree or log, sometimes covering 200 ft. or more in a glide. Species of the North American genus *Glaucomys* are smaller buff-coloured sciurids (*see* RODENT).

The second group, called scaly-tailed "squirrels," is African and consists of certain members of the family Anomaluridae, some of which, however, have no parachute. The flying species differ from those of the last group in that the membrane is supported by a bone at the elbow joint instead of by a cartilage at the wrist. There are two flying genera, *Anomalurus* and *Idiurus*, each containing several species. They are all similar in habits to the previous group and, like them, are very squirrel-like in appearance.

The term "flying squirrel" is also applied to certain marsupials, but these are more properly called flying phalangers. *See* PHALANGER; MARSUPIAL. (J. E. HL.; X.)

FLYNN, JOHN (1880–1951), Presbyterian missionary of the Australian outback and founder of the Flying Doctor service (*q.v.*), was born in Moliagul, Victoria, Nov. 25, 1880. He was of mixed British descent, his father being a schoolteacher who emigrated to Australia in the late 1850s. Flynn attended primary and secondary government schools before entering the Victorian education service (aged 18–22). From 1902 to 1910 he was a staff member of the Presbyterian Home mission in Victoria. Moving to South Australia, he was ordained (1911) and became engrossed in the "dead heart" of central and northern Australia. In Sept. 1912 Flynn presented a brilliant report to the Presbyterian Church assembly on the hardships of these areas. The church thereupon established the Australian Inland mission, which Flynn directed until his death. Talented as a publicist, and able to impress very different types of people, "Flynn of the Inland" became a legend within his lifetime. He is most famous for having established in 1928 a Flying Doctor service throughout his territory; moreover, he inspired A. H. Traeger to develop an easily operated radio transmitter to facilitate communication between the service and people living in the bush. In 1932 Flynn married Jean Blanch Baird. He was given the Order of the British Empire in 1933, and elected moderator of the Presbyterian Church of Australia, 1939–42. He died in Sydney, May 5, 1951; his ashes lie near Alice Springs, where stands the John Flynn Memorial church.

See Vance Palmer, *National Portraits* (1954). (O. M. R.)

FLY RIVER, one of the major rivers of New Guinea, rises in the fantastic jumble of the rugged Victor Emanuel mountains (including the Star, Kaban and Hindenburg ranges) that constitute the central core of the island, and flows south and southeast into the Gulf of Papua. Debouching from the mountains, the Fly, with neighbouring rivers such as the Digoel (*q.v.*), has built up an immense plain bordering the Torres strait. Almost the entire river basin lies in the Australian-administered Papua territory, but for a short stretch of its middle course the Fly forms the boundary with Indonesian New Guinea. Its chief tributaries are the Strickland, Palmer and Alice. The upper and middle reaches of the Fly drain extensive areas of rain forest, but its lower course, where rainfall is lower and more seasonal, is through more open country whose savannalike aspect resembles that of northern Australia. The Fly plains contain many extensive swamps, and much of the country is inundated in the rainy season (October–April). Nipa-palm swamps border the river for about 20 mi. from its mouth, while the estuary, which attains a breadth of 40 mi., is bordered by dense stands of mangrove. The river is navigable by vessels drawing up to eight feet for more than 500 mi. at all seasons, but its value is limited by the economic backwardness of the area, which possesses but a few coconut plantations. Exploration for petroleum in many areas bordering the Gulf of Papua has revealed no commercial oil fields. There are no settlements of any size along the river apart from native villages, and even the native population is scanty. Sago palms, which grow in many of the swamps, provide the main source of diet for the indigenous population. The river was named by Capt. F. P. Blackwood of H.M.S. "Fly," who in 1842 explored the estuary. (D. W. F.)

FLYSCH is a term long used by geologists to denote a particular formation of Tertiary age (1,000,000 to 70,000,000 years) occurring in the northern Alpine region. The term is now commonly applied to similar deposits of other ages and other places.

Although flysch is said to mean "slippery earth" in the local Swiss-German dialect, it is applied by geologists to a sequence of gray shales rhythmically interbedded with thin, hard, dark gray sandstones of graywackelike character. The total thickness is commonly many thousands of feet; the individual beds, however, are thin, a few inches to a few feet in thickness. Fossils, notably rare, indicate marine deposition. The flysch facies is now generally believed to have accumulated in moderate to deep (up to 1,000 fathoms) marine waters. The deposition of coarse angular sands, commonly graded-bedded and locally conglomeratic, is attributed to turbidity flows—catastrophic incursions of debris-laden muddy waters. The extraordinary coarse conglomeratic mudstones found in some flysch are thought to be a product of submarine mudflows.

Flysch deposits characterize many ancient geosynclinal accumulations. Such deposits occur in old Pre-Cambrian formations of Canada, in the Lower Paleozoic of the Caledonian geosyncline in Great Britain, in the Late Paleozoic of the Armorican geosyncline of Europe and in the late Ordovician and in the later Devonian of the Appalachians, in the Alpine Tertiary, in the Tertiary of the Caucasus and the Himalayas and in the Tertiary beds of the Carpathian geosyncline.

For identification and discussion of periods, formations and terms *see* GEOLOGY.

See also ALPS.

See Z. L. Sujkowski, "Flysch Sedimentation," *Bull. Geol. Soc. Amer.*, 68:543–554 (1957). (F. J. P.)

FLYWHEEL, a relatively heavy rotating wheel attached to a shaft, whose principal purpose is to store kinetic energy while there is more energy coming onto the shaft than is departing, and to give up some energy when the energy leaving the shaft is greater than that received.

The amount of kinetic energy which can be stored in a flywheel or any rotating body is a function of the moment of inertia of the body and its angular speed. Thus a given flywheel stores energy only as its speed increases; it gives up energy as it slows down. Almost all reciprocating machines (for example, automotive engines) need a flywheel in order to run smoothly. This can best be understood by considering the operation of a single-cylinder engine. In a two-stroke cycle engine for a lawn mower or outboard motorboat, for example, the explosion occurs and the high gas pressures result in work being done as the piston moves down. Most of the work is done during the early part of the stroke and the amount gradually decreases. Moreover, on the return stroke of the piston, not only is no work done by the shaft but work has to be done on it to drive the piston to compress the gases for the next explosion. Since the law of conservation of energy says that energy is indestructible, the energy to compress the gases must be supplied from somewhere. This "somewhere" is the kinetic energy of the flywheel (and other rotating parts), and the flywheel got it from the excess work done while the pressure of the burned gases was high. Thus, the speed and energy of the flywheel increase while excess engine work is done; then, while the engine is

not producing enough energy to do the job, the flywheel supplies the necessary additional energy, slowing down in the process. This speeding up and slowing down is ordinarily not noticeable because it happens so quickly.

If a two-cylinder engine is used, so that the explosion occurs in one cylinder while compression takes place in the other, the work done is more uniform, but not constant. In this case, a somewhat smaller flywheel (same speed, speed variation, and power) will do the same job as before. The impulses overlap still more in an eight-cylinder engine, but a flywheel is nevertheless needed.

The size and weight of the flywheel depend not only on how constant the rate of work is but also upon the amount of speed variation that is permissible. If the speed must be nearly constant, as in driving an electric generator, a larger flywheel for a reciprocating engine is required than in most other situations. The larger and heavier the flywheel, the less will be the speed variation.

In such machines as punches and shears, the major part of the work, that is, the actual punching and shearing, is done in only a small fraction of an operating cycle. If a flywheel is used, the machine not only runs with less speed variation but the peak requirement of power from the motor is reduced. In these machines, the motor may be so small that the major source of energy during the cutting operation is the kinetic energy of the flywheel.

(V. M. F.)

FOÀ, EDOUARD GEORGES (1862–1901), French explorer whose travels increased the knowledge of west and central Africa, was born at Marseilles on Dec. 17, 1862. In 1886–89 he explored the interior of Dahomey, and in 1891–93 made two extended journeys in Nyasaland and the lower Zambezi valley. Finally in 1894–97 he crossed Africa from the Zambezi mouth to Libreville on the Atlantic coast, covering unexplored ground in the upper Congo basin. He died at Villers-sur-Mer, Calvados, on June 29, 1901. His works include *Le Dahomey* (1895); *Chasses aux grands fauves pendant la traversée . . . du Zambèze au Congo Français* (1899; Eng. trans. F. Lees, 1899); and *De l'Océan indien a l'Océan Atlantique* (1900).

See *Résultats scientifiques des voyages en Afrique d'Edouard Foà* (1908). (R. L. Hl.)

F.O.B., a contraction of "free on board," a commercial expression describing the terms of sale. Under f.o.b. terms the seller must load the goods on board a railroad car, ship, plane or other carrier at the location named in the contract. The named location is sometimes the city where the factory is, but it may be a port of export. In the United States, for example, the prices of automobiles are often quoted as "f.o.b. Detroit." Risks and expenses pertaining to the goods pass from the seller to the buyer at the moment of loading. Other common expressions include c.i.f. (cost, insurance and freight) under which the seller pays all costs of delivering the goods to a port in the country of destination, and f.a.s. (free alongside ship) under which the buyer must pay loading costs at the port of export. (J. P. Ca.)

FOCH, FERDINAND (1851–1929), marshal of France, supreme commander of the Allied forces on the western front at the end of World War I, was born at Tarbes (Hautes-Pyrénées) on Oct. 2, 1851, the son of a civil servant. His early education was largely in the hands of the Jesuits. In the Franco-German War of 1870 he enlisted in the infantry but saw no active service. The next year he entered the École Polytechnique in Nancy, where the Germans were still in occupation. He was commissioned in 1873 and the next year he joined the 24th artillery regiment. He distinguished himself in a course at the cavalry school both as student and as horseman and was promoted captain at the age of 26. His service before 1914 was humdrum by comparison with that of many contemporaries. While they saw the world and fought in desert or bush in north Africa and Indochina, he passed, as staff officer or commander, from one French garrison town to another. His promotion lagged after the Dreyfus case, when officers who went to Mass were put on a black list.

The military institution with which Foch became most closely associated was the École de Guerre. He attended it three times, as student in 1885, as lecturer in military history in 1895 and as director in 1908. This last appointment was made by Georges Clemenceau, a fierce anticlerical, and must stand to the credit of both. During the second period Foch delivered his celebrated lectures on 19th-century warfare, later published in two volumes as *Des Principes de la guerre* (fourth edition, 1917) and *De La Conduite de la guerre* (third edition, 1915). Some of his ideas were borrowed from earlier writers, but he was not lacking in originality, and his examination of Helmuth von Moltke's method of waging war is memorable. He was 61 when appointed in 1913 to command the crack XX corps on the German frontier, with headquarters at Nancy.

In Lorraine, at the outbreak of war in 1914, the Germans began by making a deep withdrawal, then suddenly struck back hard and won an important success in the battle of Morhange. The XX corps, which had been boldly—some critics say impetuously—led, behaved better and suffered less than the others engaged, but it was hard hit and was withdrawn behind the Meurthe river. Foch was, however, counterattacking successfully when on Aug. 28 he was summoned by Gen. J. J. C. Joffre to take over a new army. This, later numbered the 9th army, was then forming on the Aisne river in the midst of the retreat. In the first of the battles of the Marne it became very heavily engaged when the German left-wheeled to face Paris. It lost a considerable amount of ground but the determination of Foch's leadership impressed Joffre. On Oct. 4, after the pursuit to the Aisne and renewed fighting in Champagne, Joffre appointed Foch his assistant to co-ordinate the operations of French, British and Belgians in the north. It was an extraordinary position, since Foch was not authorized by any agreement to issue orders to the British and Belgians. His one lever was his control of French reserves, which played a notable part in the terrible battles of the Yser and of Ypres. His parsimony in committing reserves was first noted here. It infuriated commanders and often involved suffering for troops but it paid in the long run. The reputation of Foch stood very high by the end of 1914. Some of it was lost in 1915, which proved bitterly disappointing. He was now commander of the Northern army group, a task involving him in the notorious gas attack at Ypres, where even his drive and vituperative power could not compel a sluggish local French commander to take any steps to restore the front, so that virtually the whole burden fell on British shoulders. Foch also directed the spring and autumn offensives in Artois, neither of which fulfilled its promise.

In Dec. 1916 disappointment over the results of the battle of the Somme led to the replacement of Joffre by Gen. R. G. Nivelle. Foch, as army group commander, fell with his chief. He then performed valuable work in planning aid to Italy in case Germany strongly reinforced the Austrians in that theatre. When Nivelle's ambitious offensive broke down and he was replaced by Gen. Philippe Pétain, Foch was called on to succeed the latter as chief of the general staff (May 11, 1917). Before the end of the year 1917, Foch's planning in Italy bore fruit in the orderly flow of Allied reinforcements after the Central powers had inflicted a crushing defeat on the Italians in October. Meanwhile Russia had collapsed, and by Jan. 1918 German divisions were pouring westward to the French front. Foch strove to find for the new Supreme War council an international reserve to meet the threat, but neither Pétain nor the British general Douglas Haig would yield a battalion. Few soldiers would willingly suffer their troops to be commanded by committees.

The expected German blow was delivered on March 21, 1918. It proved even more deadly than had been feared. The prospect was that Pétain would fall back on Paris, Haig on the Channel ports and that both would be destroyed. Largely on the initiative of Haig, Foch was appointed generalissimo at Doullens on March 26, in which capacity he was shortly afterward recognized by the United States and Belgium. The German Somme offensive was not immediately stopped—in fact, the worst anxieties were to come—but his reorganization of the defense must be accounted the greatest feat of his life. It had to be repeated in the Lys offensive in April. There he doled out reserves so sparingly as to incur Haig's anger but the strategy smashed the final German thrust. The heaviest trial of all came when Foch was surprised—for the only time of his career—on the Chemin des Dames in May and Paris itself lay in

peril. This series of crises was ended on July 18 by a brilliant counteroffensive, with strong U.S. and some British aid, the second of the battles of the Marne (*q.v.*).

The Allied offensive proper, remembered as "the Hundred Days," began on Aug. 8 and never slackened while the enemy continued to fight. In this phase Foch again played an invaluable role of coordination but his influence was no longer quite what it had been while he was on the defensive. The remarkable striking power of the British army, extraordinary in view of its losses and fatigue, became an asset in the hands of Haig and enabled him to a great extent to dictate the strategy henceforth. On two important occasions where they differed the British commander in chief got his way. The first was when the generalissimo demanded that he should free the Béthune coal fields, an unimaginative objective; the second, when Haig, on the stiffening of German resistance, determined to break off the offensive from Amiens and strike farther north. However, Haig was not disloyal and in any case his views and those of Foch generally coincided. The directive issued by Foch on Sept. 3 was carried out to the letter and decided the final course of the war. The front of attack now extended from the Argonne to Ypres. A vital element was the U.S. 1st army which, after clearing the St. Mihiel salient, took on and finally succeeded in the great task of breaking through the Argonne forest and cutting the German communications south of the Ardennes at Mezières. Haig's private opinion at the time is known to have been that the chief contribution of Foch now, and a priceless one, was that of controlling Pétain, the French commander in chief. Foch conducted the business of the Armistice, and the British representative at his side was not Haig but the first sea lord of the admiralty (Hugo Charteris, 11th earl of Wemyss).

In Jan. 1920 Foch was appointed president of the Allied Military committee of Versailles to supervise the carrying out of the Armistice terms. Despite bitter Anglo-French quarrels over the Rhineland and the Ruhr, it was not, except intermittently, an arduous appointment, and he was able to spend upwards of half the year at his beautiful country home at Trofeunteuniou, in Brittany, and on his native Pyrenean slopes. He had received the baton of a marshal of France on Aug. 6, 1918, and been made a British field marshal on July 19, 1919; on May 3, 1923, he was also made a marshal of Poland. He had been elected to the Académie Française on Nov. 11, 1918.

Foch died in Paris on March 20, 1929. His body was placed under the dome of the Invalides, in company with those of Napoleon and Turenne. His career has aroused much controversy. Before World War I he laid himself open to attack by indiscreet phrases in support of the mysticism of the offensive then prevalent in the French army. Yet, in his role of teacher, he constantly emphasized the necessity of artillery support for the infantry. As for his leadership, he can afford to be judged by results. It is doubtful whether any other commander could have held the Allies together as he did in 1918 or recovered the initiative as speedily. The layman is often puzzled that the soldier should insist so much on "character" in assessing a leader. The career of Foch may provide an answer: Only a man richly endowed with that quality could have borne the weight that he carried. His war memoirs (left incomplete) were published in French and in English, two volumes, 1931.

See also references under "Foch, Ferdinand" in the Index volume.

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(C. B. FA.)

FOCŞANI, a town in the Galaţi region of Rumania, is situated at the southeastern elbow of the Transylvanian Alps about 50 mi. W.N.W. of Galaţi. Pop. (1960 est.) 29,492. The town lies on the Milcov river, which formed the frontier between the principalities of Moldavia and Wallachia until their unification in 1859. It is the administrative centre of the Focşani *raion* (district), which was famous even in the 15th century for its vineyards at Odobeşti, Panciu and Jariştea. Focşani has a large trade in wine and corn and its industries include tanning and the manufacture of food products, oil and soap.

FOCUS, a point at which converging rays meet, toward which they are directed or from which diverging rays are directed; in the latter case it is called the virtual focus (*see* LENS; MICROSCOPE; TELESCOPE). In geometry the word is used to denote certain points, such as the focuses of an ellipse or the focus of a parabola.

See ANALYTIC GEOMETRY; CONIC SECTION; ELLIPSE; HYPERBOLA; PARABOLA; PERSPECTIVE.

FODDER; *see* FEEDS, ANIMAL.

FOG. A cloud in contact with the ground, fog is usually the result of a condensation process taking place in air near and at the earth's surface, but at mountain-summit stations it may be merely the result of clouds formed in the free air and drifted onto the mountain slopes by the winds. (*See* CLOUD.)

Physical Characteristics.—A fog is a cloud of particles, usually water droplets (water fog) but sometimes of ice crystals (ice fog). There is no essential distinction between fogs and free-floating clouds in the atmosphere. Fogs seldom produce precipitation, if any at only very small rates; in this respect they are similar to many of the free clouds seen in the sky that are not giving precipitation. Fogs and those clouds which do not tend to develop precipitation are said to be colloidally stable; that is, there is no marked tendency within them for the size of some of the droplets to grow rapidly at the expense of the other drops. Clouds (fogs) of this type are characterized by relatively small-sized drops, predominantly much less than 100 μ in diameter (raindrops are 400–1,000 μ), and also their drop-size spectrum (more or less bell shaped in general) has a smaller range than found in colloidally unstable or precipitating clouds. But the size distribution, median and modal size, etc., of the drops in fogs vary greatly from case to case, according to the method of formation, history of the fog, its age, the wind, temperature and radiation conditions, thickening or thinning tendency, admixture of smoke or other "foreign" aerosols, effects of rain or snow falling into it from above, etc. Theory and certain experiments suggest that initially a fog formed by a simple adiabatic expansion should have a fairly uniform drop size, assuming sufficient uniformly effective condensation nuclei are present (often the case in nature). Since observations on fogs rarely show this uniform size, it must be assumed that considerable coalescence of droplets takes place with time, through collisions because of turbulence and the faster falling of the resulting larger droplets.

Normally water fogs form and persist at relative humidities of 100%, but many cases are reported with humidities between 95% and 100%, presumably because special nuclei effective somewhat below 100% are present, or because of pollution. However, salt particles deliquesce at about 70% relative humidity and this effect probably explains the fogs and hazes sometimes reported at sea with humidities from 75% to 95%.

The concentration of droplets in fog rarely exceeds 100 per cubic centimetre, and the liquid water contents are usually of the order of hundredths of a gram per cubic metre and less (whereas rain and many warm, unstable clouds have 0.1 to 3 g. per cubic metre). Fogs, however, often appear to be denser than any clouds because a large number of small drops is a more effective light-absorbing medium than a smaller number of larger drops.

Various theories of scattering and transmission of light have been applied to fogs, with conflicting results. Measurements show that the transmission is greatest in the visible spectrum, and the difference in transmission of visual colours is trivial.

There is a tendency for the climatological probability of fog formation to decrease at low temperatures, largely because of the very low water content of cold air masses and the unfavourable effects of snow cover and atmospheric circulation conditions where very low temperatures prevail. Fogs of waterdrops become rare at temperatures below 15° F. (−9.4° C.), and well inland practically none occur below −15° F. (−26.1° C.). Below −22° F. (−30° C.), however, ice-particle fogs frequently appear in the vicinity of towns and airfields when there is moisture given off from combustion of hydrocarbon fuels, and over water surfaces through evaporation. Ice fog has become a serious problem at some airfields in Alaska and northern Canada, where very low temperatures prevail for months each year. Otherwise in the polar night only a

very thin frost haze can form; it persists widely inland and over the arctic ice pack in winter.

The visual range in fog has been analyzed as an integral part of the general problem of visibility (*q.v.*) which has defied both satisfactory theoretical analysis and measurement. It is noteworthy that the routine observation of fog as a meteorological element has been confined, in all weather services and observatories, to recording (1) the observer's opinion as to whether or not true fog exists at or in sight of the station at the time of observation, and (2) the observer's estimate of the horizontal visual range, in general or in each direction, in terms of the distance to the remotest object that can just be distinguished. The latter is given in miles, yards, metres or in International Visibility or other code numbers. Until the 1929 International Meteorological code was generally adopted, many different codes for reporting the types and intensities of fog were in use, and as a result the older statistics given in terms of dense, thick, moderate or light fog, mist, haze, days with fog, etc., are often useless for climatological comparisons between stations or countries that used different codes. Significant distinctions have long been observed in some countries between ground fog, high fog, stratus, steam fog, ice-particle fog, smoke, dust, etc. These morphological categories are of meteorological value, particularly in connection with forecasts for air navigation, and most of them have been embodied as hydrometeors in the International Meteorological code. The code in the 1960s still defined various intensities of fog in terms of visual range. Careful observers will not file weather reports in which the hydrometeor indicated under "weather" is inconsistent with that indicated under "visibility." Nevertheless, it is a manifestly difficult task, often requiring arbitrary considerations, for an ordinary observer to decide whether he is enveloped in a thin water fog, or a light haze (British "mist"), or a light obscuration by smoke or dust. Even the dense fog reported in cities may be caused as much by smoke as by water (called a smog). Therefore, a good deal of circumspection is in order when analyzing fog-frequency and fog-intensity statistics. The use of estimated visual range as some kind of a measure of the density and constitution of a fog can be misleading, for the visual range, according to accepted approximate "laws," depends on a number of independently varying factors, such as the liquid water or solid-particle content, the size distribution, the type of particle, the type and intensity of illumination, the background contrast, the observer's eyes, etc.

Meteorology of Fog.—The treatment of fog phenomena from the point of view of synoptic meteorology or weather forecasting has proceeded along lines largely independent of the study of the physical and chemical constitution of fog. Observations of fog formation and morphology in relation to the wind direction and speed, pressure and temperature distribution, topographical relations, antecedent weather, etc., long ago revealed the basic processes which lead to saturation or fog dissipation. Sverre Petterssen has given the best summarization of the fog processes in the following table:

Fog-Producing Processes	*Fog-Dissipating Processes*
1. Evaporation from:	1. Sublimation or condensation on:
a. Rain that is warmer than the air (rain-area fog or frontal fog)	a. Snow with air temperature below freezing (excepting ice-particle fogs)
b. Water surface that is warmer than the air (steam fog)	b. Snow with air temperature above freezing (melting snow)
2. Cooling because of:	2. Heating because of:
a. Adiabatic upslope motion (upslope or orographic fog)	a. Adiabatic downslope motion
b. Flow of air across the isobars toward lower pressure (isobaric fog): effect negligible	b. Flow of air across isobars toward higher pressure (effect negligible)
c. Falling pressure (isallobaric fog; unimportant)	c. Rising pressure (unimportant)
d. Radiation from the underlying surface (radiation fog)	d. Radiation absorbed by the fog or the underlying surface
e. Advection of warmer air over a colder surface (advection fog)	e. Advection of colder air over a warmer surface
3. Mixing:	3. Mixing:
a. Horizontal mixing unimportant by itself, and strongly counteracted by vertical mixing	a. Vertical mixing (important in dissipating fogs and in producing stratus clouds)

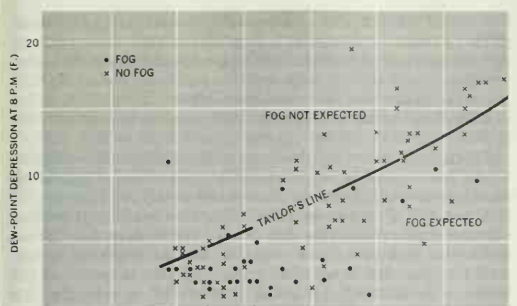
Source: Sverre Petterssen, *Weather Analysis and Forecasting*, vol. ii (1956).

It has been the fashion to classify fogs into types each identified with a single process supposed to produce it. While the logic and clarity of such a scheme has obvious advantages for didactic purposes, it is difficult to apply that sort of classification in a strict way to real cases or in the practice of weather forecasting because several of the processes enumerated are commonly operating together at the same time. The relative importance of the processes varies from case to case and with time in a given case; no two fogs are conditioned by precisely the same combination of factors. Often one of the processes is predominant, especially at sea (advection). Thus the forecaster must apply a great measure of judgment, acquired as much by experience as by theoretical understanding of the processes. There are in the standard textbooks many useful generalizations about the characteristics and favourable processes and antecedents for advection fogs, radiation fogs, upslope fogs, frontal fogs, etc., based on the general impressions of forecasters and a few detailed analyses. But it has remained for the studies of Joseph J. George and collaborators to show fully how complex the fog forecast-analysis problem is and how strikingly it differs from one air terminal to another. Previous studies were usually restricted to detailed analyses of isolated single cases and did not provide sufficient material for quantitative generalization. George's method—taking a cue from early work of G. I. Taylor—is to analyze a large number of past fog situations at each station, classifying them according to combinations of processes acting along the previous trajectory of the air fogging the terminal; probability diagrams are constructed to show the critical limits of the most dangerous combinations of factors. The general picture may be similar for all stations in a meteorologically homogeneous region, but for practical use by the forecaster the data must be worked up at each station, since the numerical values may differ considerably. George also showed that for aviation-forecasting purposes it is infeasible to attempt to distinguish between low stratus and fog, especially for the fog types (common to the southeastern U.S. where he worked) in which the ceiling gradually lowers to the ground during the development of the fog situation. He proposed what appears to be the first (but partial) classification of fog types that is practical for use by forecasters: (1) prewarm frontal and postcold frontal fog; (2) orographic (upslope) fog; (3) advection fog; (4) radiation fog; and (5) radiation-advection fog.

The preparation of a statistical (or so-called objective) system of fog forecasting for a given airfield or station involves the careful selection of the important parameters that will predict fog formation (or dissipation).

This is done a priori on basis of experience, known general principles and detailed analysis of past cases. The forecasting relationships of these parameters to the combined visibility and ceiling (*i.e.*, fog) conditions of aviation-operational concern are then determined by means of scatter diagrams. Pure radiation fogs are most amenable to such an approach, since usually only dew-point depression and temperature on preceding clear nights need be considered, as illustrated by the use of Taylor's well-known fog-prediction diagram (*see* figure). In case of the other types of fog, wind speed, trajectory of the air coming to the station, terrain and weather conditions along that trajectory, etc., must be added to the equation, and then a series of diagrams is required to express the prediction relationships. Forecasting by means of such procedures alone is not always sufficiently successful to justify their use: it is suggested by some workers that the inclusion of the vertical gradients of wind and moisture content may improve the results. There are limitations to the statistical method imposed by inadequacies of the weather observations available. Nevertheless, the application and development of this approach to fog forecasting is steadily gaining ground in the leading weather services. Only the complex California type of coastal stratus, which is involved in a sea breeze sort of air movement from the cold shore waters onto the coastal plains—formed at sea as advection fog and reinforced by nocturnal radiation over the land—has generally proved quite refractory to statistical attempts.

The geographical and seasonal distribution of fog is determined by the relative occurrences of each process or type of fog at given points over the earth. In general, the oceans of middle and high latitudes have a large maximum frequency of fog in the summer because of advection of warm air over cold water. A few advection



REDRAWN BY MOOK ("BULL. AMER. MET. SOC.," JUNE 1950)

TAYLOR'S FOG PREDICTION DIAGRAM FOR KEW, ENG.

The points plotted show all cases during 1900–05 when the wind at 8 p.m. was less than 5.5 m.p.h. and the sky was clear; if fog occurred by the next morning a dot was plotted, if no fog a cross. The line divides roughly the dots from the crosses. Below the line the chances were about equal that fog would form or not form if the line was used to forecast (for Kew)

fogs appear over the cold lands in winter. The continents are the home of radiation fogs, which tend to have a maximum frequency in autumn or winter in middle latitudes, in summer in high latitudes and in the rainy season in the tropics. Superimposed on these regimes characteristic of land *v.* sea is a tendency for frontal fogs to occur in the circumpolar belt of cyclonic storms, which pass through the middle latitudes in winter shifting to higher latitudes in summer. The annual march of fog frequency at most places in the world can be explained by one of or some combination of these basic fog-type regimes, as R. G. Stone demonstrated in a study of fog distribution in the U.S. The advection fogs are individually apt to be widespread, dense and deep, especially over the colder ocean waters. Radiation fogs are usually shallow though dense; the sky is often visible (ground-fog)—and they generally are restricted in coverage to valleys, marshes and low ground. However, the high (radiation) fogs of California and western Europe are extensive, deep, dense and persistent for days, whereas ground (valley) radiation fogs are usually nocturnal only. The frontal fogs with cold fronts are brief and infrequent, but the type formed under a warm front by falling rain is apt to be deep and extend for hundreds of miles, one of the most troublesome of all weather conditions hindering aviation.

Artificial Fog Dissipation.—Under discussion and experiment for many years, no practical use was made of artificial fog dissipation until World War II. Many proposed methods were unscientific or not practical. The feasible methods are of two basic types: (1) to evaporate the drops by heating the foggy air, or by injecting a drying agent into it, and (2) to remove the drops physically by some means such as inducing their precipitation. A practical heating method (FIDO; Fog Investigation Dispersal Operations) was developed by the British during World War II and was successfully used to clear aerodromes in England. Oil was burned in rows of jets arrayed around the field. The amount of heat required depends on the latent heat needed to evaporate the water in a unit volume of the fog and the amount of foggy air to be cleared in a specified time. Even with a moderate wind, the equipment used cleared a large field up to 100 ft. or more above the runways in a few minutes. Under windy conditions the equipment must have much more rapid heat output and a more flexible burner system so that the centre of heating can be shifted rapidly to the windward. Such developments were improved and further tested after the war, but high installation and operating costs ($1,000,000 to $2,000,000 for installation and $100 to $500 per minute for operation) precluded their general use. The heat of jet-engine exhausts offered a more economical alternative. These methods proved reliable and suitable for water fogs at temperatures above 25° F. (−3.9° C.).

Henry G. Houghton and William H. Radford successfully demonstrated the precipitation of fog by means of a vertical curtain of fine salt spray through which the wind drifted the fog, leaving a small runway clear to the lee. The use of chloride or other chemically active agents was not adopted for airfields, however, because of destructive effects on the aircraft and the installations, soil, etc. Precipitation by means of seeding with electrified particles, by passing the fog through an electrostatic (Cottrell) precipitator and by coalescing the drops by intense high-frequency sound have been demonstrated in laboratory experiments, and mechanical removal by fans, suction ducts or impaction on screens are sound in principle; but none were practical for large-scale application.

More promising were experiments in seeding of fog with dry ice, silver iodide, carbon black, water or calcium chloride spray, underway since 1955. Seeding with dry ice or silver iodide from an aircraft was found effective and practical on fogs in the temperature range −5° to −25° C. (about 20° to −14° F.). But fogs do not occur often in this range. The principle involved is to convert the waterdrops to ice particles, which grow by sublimation and then precipitate. The use of water or calcium chloride sprays or carbon black is theoretically applicable to warm fogs and some tests proved successful. The sprays accelerate the natural tendency for the droplets to coalesce into larger drops that can fall out. Carbon black, by absorbing solar radiation, may cause the temperature to rise enough to evaporate the fog.

Meanwhile air navigation interests concentrated on development of radio and radar beacons and powerful lights to make landing and take-off feasible and safe in all but the heaviest fog.

See also references under "Fog" in the Index volume.

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FOGAZZARO, ANTONIO (1842–1911), Italian novelist who opposed to the literary realism of his time an idealism stressing romantic feeling and minute analysis of psychological problems. Born at Vicenza, March 25, 1842, he was a pupil of the priest and poet Giacomo Zanella, whose religious spirit continued to inspire his work. A poetic romance *Miranda* (1874) was his first published work; *Malombra* (1881), *Daniele Cortis* (1885) and *Il mistero del poeta* (1888) established his reputation as a novelist. Popularity came with the great success of *Piccolo mondo antico* (1895), which was acclaimed, even by critics unsympathetic to his religious and philosophical ideas, as the best Italian novel since Manzoni's *I Promessi sposi* (1827). It tells the story of the contrasted love of Franco and Luisa and of the pathetic death of their little daughter, against a background of the struggle in Lombardy between the Italian nationalists and the Austrians. An even greater sensation was caused by *Il santo* (1906), condemned as unorthodox and placed on the *Index* for its presentation of a mystical modern reformer of the church and its satire of the clerical world of its time. Other successful novels were *Piccolo mondo moderno* (1900–01) and *Leila* (1911). Fogazzaro also wrote short stories, plays and poems. He became a member of the Italian senate in 1896 and died in Vicenza, March 7, 1911. Many of his novels have been translated into English.

Although Fogazzaro's literary importance lies in his idealistic portrayal of virtue and feeling, and his interest in the psychological problems of his characters, which was strongly opposed to the realism (*verismo*) of other writers of his time, he owed his contemporary popularity to his talent for describing domestic in-

teriors in aristocratic society and his intimate studies of the conflict between religious aspirations and sensual appetites. A liberal Catholic, he derived from Antonio Rosmini his sincere desire to revive the church (*see* ROSMINI-SERBATI, ANTONIO). This sometimes led him to accept modernist ideas, which he reluctantly abandoned in obedience to the church's condemnation. His position is made clear in *La parola di Don Giuseppe Flores* (published posthumously in 1920). A critical edition of Fogazzaro's works by P. Nardi was published in 14 volumes (1930–41).

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FOGBOW, a white rainbow, about 40° in radius. It has a reddish outer margin and an inner margin of bluish tinge, but the whole of the middle of the band is uncoloured. It occasionally accompanies fogs and its origin resembles that of the normal rainbow, but the smallness of the water drops (under 0.05 mm.) causes the colours to be mixed and the resulting band to be nearly white. *See* FOG.

FOGERTY, ELSIE (1865–1945), British teacher of voice production and dramatic diction, was the founder of the Central School of Speech Training and Dramatic Art in London. She was an actress at an early age and trained under Hermann Vezin and at the Paris conservatoire. In 1889 she became a teacher of elocution at the Crystal Palace School of Art and Literature and later at Sir Frank Benson's London School of Acting before founding her own school in 1906. This she directed until her death. Among her pupils were Dame Sybil Thorndike, Dame Peggy Ashcroft, Sir John Gielgud and Sir Laurence Olivier. She adapted and produced a number of classical Greek plays to support her advocacy of the study and use of choral speaking, and wrote several treatises, the best-known of which is *The Speaking of English Verse* (1923). She died at Leamington on July 4, 1945. (A. H. D.)

FOGGIA, capital of Foggia province in Puglia region, southeast Italy, is situated in the centre of the Puglia plains (Tavoliere di Puglia) 124 km. (77 mi.) by road W.N.W. of Bari and 170 km. (106 mi.) E.N.E. of Naples. Pop. (1961) 118,120. Partially destroyed by the earthquake of 1731, it is a town of modern appearance. The centre lies between the Via Arpi and Corso Garibaldi and contains the cathedral, begun by William the Good in 1170 and mostly early Romanesque despite baroque alterations. On the east side of the town is the Piano delle Fosse, a large square stretching to the railway station; the Villa Comunale is on Piazza Cavour. Only a door remains of the Swabian palace erected by Frederick II. The churches of S. Giovanni and of the Crosses and the Palazzo de Rosa with its elegant loggia are of interest. The municipal library archives include those of the sheep tax, which give an insight into the region's economic history. Foggia lies on the main railway from Bologna to Bari; another line crosses the Apennines to Naples. Agriculture is the main occupation and much land has been reclaimed in the locality. Vegetables, olives, grapes, fruit, tobacco and cheese are produced. Cellulose is extracted for papermaking. Foggia is a granary for southern Italy, wheat being stored in pits in the Piano delle Fosse.

A few miles north are the ruins of Arpi, founded according to legend by Diomedes and called Argos Hippion (its coins bore the figure of a horse), hence Argyrippa and finally Arpi. Ally of Rome in the Punic Wars, it passed to Hannibal after the battle of Cannae but was retaken by Quintus Fabius Maximus in 213 B.C., after which it declined. Foggia may have been named after the pits or cellars (Lat. *foveae*) of the Piano delle Fosse or from cisterns which supply drinking water for the flocks, still called *fogge*. The favourite seat of the emperor Frederick II, its fortifications were dismantled after it had supported the pope. It passed to Charles of Anjou, who died there in 1285. Alfonso I of Aragon made it the centre of the collection of the sheep tax on flocks moving between highlands and plains, later abolished. It remained a wool market. After the Restoration it became a centre for Carbonari (*q.v.*) revolutionary societies and took a vigorous part in the revolts of 1820, 1848 and 1860. The capture of the Foggia military airfields in the fall of 1943 was an important factor in consolidating the Allied position in southern Italy.

FOGGIA PROVINCE, with an area of 2,774 sq.mi. and a population (1961) of 632,332, comprises a large clayey plain (sheep raising, cereals) surrounded on three sides by the Apennines and the mountainous Gargano (*q.v.*). Aside from the provincial capital the chief towns are Cerignola, Lucera and Manfredonia. (M. T. A. N.)

FOG SIGNALS: *see* LIGHTHOUSES AND OTHER AIDS TO NAVIGATION: *Signalling Systems;* RULE OF THE ROAD AT SEA.

FOIL, solid metal that has been reduced to a leaflike thinness by mechanical beating or rolling. (For a discussion of the instrument known as a foil and used in swordsmanship *see* FENCING.)

A thin foil of copper-zinc alloy is used by jewelers as backing for paste jewels and inferior gem stones. When silvered, burnished and coated with translucent colouring, the foil heightens by contrast the colour and lustre of the gems. A Japanese variegated foil having a damascened appearance is produced by soldering thin sheets of various metals together in a particular order, hammering a pattern along the soldered edges and then beating or rolling the whole into a single sheet.

Foils of tin or tin alloys have long been applied in many fields including electricity, electrotyping, stereotyping and the protective wrapping of food and tobacco. Although toxicity prohibits the use of lead and some other metals as alloys in foil used in food and tobacco packaging, an alloy consisting of 91.35% tin, 8.5% zinc and 0.15% nickel has been proved safe to use for this purpose. Tin foil is produced by running ingots of the cast metal in a series of passes through a breakdown mill with large reduction gearing; the passes reduce the ingots to sheets which are wound on cores; a sheet is reduced to foil thinness by running it through a finishing mill, with the number of passes determining the degree of thinness. The hard steel rolls of the finishing mill, which are precision ground and buffed to a mirror finish, impart a bright polish to the finished foil. (*See* also TIN: *Uses.*)

In practically all its areas of usefulness, tin foil has largely been replaced by aluminum foil, which is produced in a similar manner. The reduction of sheet metal to foil, which is achieved principally through vertical pressure exerted by the finishing-mill rolls combined with horizontal tension applied through mandrels paying out and rewinding the foil stock, has been made more efficient in the aluminum-foil industry by mounting "backup" rolls above the work rolls of finishing mills to provide increased vertical pressure. These finishing mills are classified as being two, three or four rolls high; the choice of the type of mill to be used in any particular instance is dictated by the foil width and thickness required. Two sheets of aluminum are rolled together to produce very thin (light gauge) material. When finished, the double sheets of foil are parted and rewound individually by a separating machine. Rolling a double web of stock produces foil that is bright on one side and mat finished on the other. Aluminum foil may be coloured, printed or embossed, and to meet some end-use requirements it may also be bonded to other materials or coated with a plastic film.

See also ALUMINUM: *Alloys and Uses: Other Uses.*

(E. L. Y.)

FOIL FENCING: *see* FENCING.

FOIX, COUNTS OF, the heads of a feudal dynasty of southwestern France which, between the 11th and the 15th century, built up a quasi-independent power bounded by Languedoc on the north and on the east, by the territories of the counts of Roussillon and of the kings of Aragon on the south and by those of the counts of Comminges and of Armagnac on the west. The county thus corresponds approximately to the modern *département* of Ariège.

Counts of the First Line.—At the beginning of the 11th century the town of Foix, from which the county took its name, belonged to the counts of Carcassonne. In his will (1002), Roger I of Carcassonne (d. 1012) left "the land of Foix," Consérans (Cousérans) and some adjacent domains to his second son, Bernard (d. *c.* 1038), who was styled count of Consérans and lord of Foix. The first count of Foix was this Bernard's second son, ROGER I (d. *c.* 1064). Roger I's brother and successor, PETER (d. *c.* 1070), left the countship to his son ROGER II (d. 1124 or 1125), who took part in the first crusade but was later excommunicated for seizing ecclesiastical property and had to make rich donations to the church to rehabilitate himself. After Roger II's son and grandson,

ROGER III (d. *c.* 1149) and ROGER BERNARD I (d. 1188), the latter's second son, RAYMOND ROGER (d. 1223), became count. Having joined Philip II of France on his crusade and taken part in the siege of Acre (1190–91), Raymond Roger returned to Foix and distinguished himself as a troubadour and a patron of troubadours, but then set himself up as a protector of the Albigensian heretics or Cathari. After the battle of Muret (1213), in which Simon de Montfort defeated the protectors of the heresy, Raymond Roger forfeited his lands until he became reconciled to the Catholic Church. His son ROGER BERNARD II (d. 1241), however, continued to favour the Cathari and did what he could to help Raymond VII of Toulouse against the French, thus incurring excommunication twice. His son ROGER IV (d. 1265) left the countship to his son ROGER BERNARD III (d. 1302). This count was imprisoned for more than a year (1272–73) by Philip III of France for attacking royal officials but was chiefly important for his acquisition of the viscounty of Castellbò in Catalonia from the king of Aragon (1284) and for his marriage with the heiress of Béarn (*q.v.*), through which that lordship came into his hands in 1290. This began a long rivalry between Foix and Armagnac (*q.v.*). GASTON I (d. 1315), heir to Foix and Béarn, died in Normandy on his way back from Louis X's expedition against Flanders and was succeeded by his son GASTON II (d. 1343), who died at Seville in Spain, having gone to help the Christians in their siege of Algeciras.

GASTON III PHOEBUS or FÉBUS (1331–91), Gaston II's son, was the greatest of these counts. In the early years of the Hundred Years' War he fought for the French, but soon turned to quarreling with Armagnac for control over Bigorre. Incited by Charles II of Navarre, he refused to do homage for Béarn to John II of France, who arrested him in Paris. Set free after the battle of Poitiers (1356), he went to fight the pagans in Prussia, returned to France in time to save Meaux from the insurgents of the Jacquerie (1358), then withdrew to Foix, where he took the English side till France made a treaty with him at Pamiers (1360). Jean I of Armagnac organized a coalition against him, but Gaston Phoebus defeated this at Launac (1362) and held Armagnac to ransom for 300,000 florins. Between 1371 and 1381 he was involved in bitter disputes first with Armagnac, then with Jean de France, duc de Berry, for the lieutenancy general of Languedoc. A handsome man (hence his name Phoebus), he was renowned for the splendour of his courts at Orthez and at Pau, for his amours and for his love of hunting. He wrote a treatise on hunting and hawking and also wrote some poetry, and commissioned several fine manuscripts. Gaston Phoebus died at Orthez on Aug. 1, 1391.

The next count was MATHIEU (d. 1398), a great-nephew of Gaston II. Having in 1392 married Joan, daughter of John I of Aragon, he claimed Aragon on John's death (1395) and invaded Catalonia but was defeated and deprived of all his Aragonese fiefs.

Line of Foix-Grailly.—Mathieu's sister ISABELLE (d. 1426) was married in 1381 to ARCHAMBAULT DE GRAILLY (d. 1412). Their son JEAN (d. 1436) succeeded in restoring good relations with Aragon and finally deserted the English alliance for the French, for which he was made lieutenant general in Languedoc. His son GASTON IV (1423–72), after a dispute over his styling himself "count by the grace of God," served Charles VII of France against the English and was in 1458 made a peer of France, but was chiefly concerned in securing the kingdom of Navarre. Having been married in 1434 to Leonor (Eleanor) of Aragon, later queen of Navarre in her own right, he did much to persuade her father, John of Navarre (later John II of Aragon), to disinherit her brother Charles, prince of Viana. Louis XI of France, however, also had designs on Navarre. On the death of Gaston, prince of Viana (son of Gaston IV and Leonor), in 1470, he refused to acknowledge Gaston IV as guardian of Gaston of Viana's children. Gaston IV then joined the malcontents against Louis in Guienne (1471), but died in July 1472, on the point of intervening in Navarre.

The infant FRANCIS PHOEBUS (1467–83), son of Gaston of Viana and Louis XI's sister Madeleine, succeeded his grandfather in Foix (1472) and his grandmother in Navarre (1479). On his death his sister CATHERINE (d. 1517) inherited both countship and kingdom. Through her marriage, Foix, Béarn and Navarre passed to the house of Albret (*q.v.*). Jeanne d'Albret's marriage brought the inheritance to the Bourbons, who in 1589 succeeded to the French crown.

FOIX, a town of southern France, in the *département* of Ariège, lies in the foothills of the Pyrenees, 82 km. (51 mi.) by road S.S.E. of Toulouse. Pop. (1962) 7,106. It is situated 1,350 ft. above sea level, in the confluence fork of the Arget river with the Ariège, and is dominated by the medieval castle, which stands on a high rock site and offers a magnificent viewpoint. The castle withstood the assaults of Simon de Montfort during the Albigensian crusade. Foix was the capital of the counts of Foix (*q.v.*) and controlled the gateway into the central Pyrenees by the Ariège valley, leading to the crossing into Spain over the Col de Puymorens, the pilgrim route to Montserrat. Modern Foix is a market town and tourist centre and is the seat of a prefecture. The Gothic church of St. Volusien, dating mostly from the 14th century, incorporates a fine Romanesque doorway. In the old town are several medieval houses with wooden fronts. A noteworthy feature of the local museum is the collection of examples of paleolithic art gathered from the grottoes of the surrounding district. On summer evenings the history of Foix is presented in *Son et Lumière*. Nearby is the subterranean river of Labouiche with its stalactites and stalagmites, which can be explored by boat. Ironworking is carried on.

In World War II Foix was in German hands from Nov. 1942 to Aug. 1944. (AR. E. S.)

FOKINE, MICHEL (1880–1942), Russian-U.S. choreographer who exerted a profound influence on the theatrical dance of his time. Born April 26, 1880, in St. Petersburg, he trained in the Russian Imperial ballet, graduating in 1898. He entered the ballet of the Maryinsky theatre and quickly established a reputation as an excellent dancer in such classic ballets as *Raymonda* and *The Sleeping Beauty*.

Dissatisfied with the rigid classic tradition enforced there by Marius Petipa, Fokine believed that in ballet the dancing, mime, music, scenery and costumes should all contribute toward the dramatic expression of the theme.

For charity performances and pupils' recitals he staged his early ballets, *The Vine* (1906), *The Animated Gobelins*, later titled *Pavillon d'Armide* (1907), and *Chopiniana* (1908), revised as *Les Sylphides*. The latter, an evocation of the romantic ballet, is recognized as one of the finest works in dance repertoire. *The Dying Swan* (1905), composed for Pavlova, is another well-known early work.

As principal choreographer of the Diaghilev Ballet Russe, Fokine had the opportunity to put his theories into practice, creating such distinguished works as *Petrushka, The Firebird, Prince Igor* and *Scheherazade*. For Vaslav Nijinsky and Tamara Karsavina, brilliant interpreters of his work, he created *Le Spectre de la Rose*. His wife, Vera Fokina, danced in many of his ballets.

From 1919 Fokine taught in New York city, continuing to create new ballets and revive old ones for various companies. He died in New York city, Aug. 22, 1942.

See Cyril W. Beaumont, *Michel Fokine and His Ballets*, new ed. (1942). (LN. ME.)

FOKKER, ANTHONY HERMAN GERARD (1890–1939), Dutch-U.S. airman and pioneer aircraft designer and manufacturer, was born at Kediri, Java, on April 6, 1890. He was educated at Haarlem, Neth., and began his aviation career at the age of 20, obtaining his international pilot's certificate in 1911. As the Netherlands offered insufficient opportunities, he went to Germany and established a small aircraft factory at Johannisthal near Berlin in 1912, in which year he participated in a competition for the design of military aircraft at St. Petersburg. The German government became interested in his designs and he received orders for aircraft and a three-year contract for the training of pilots.

Shortly before World War I Fokker set up a factory at Schwerin, Mecklenburg, and many aircraft of his design played a part in that war. He perfected the interrupter gear which made it possible to fire a machine gun straight ahead through the propeller. After the war he left Germany and established the Fokker works at Amsterdam. He also founded aircraft construction firms in the United States, where he became a naturalized citizen. During the later years of his life, he concentrated on the design and development of commercial aircraft. He died in New York city on

Dec. 23, 1939. His autobiography *The Flying Dutchman* was published in 1931. (D. Cr.)

FOLARD, JEAN CHARLES, Chevalier de (1669–1752), French soldier and writer on tactical theory, was born at Avignon on Feb. 13, 1669. His military ardour was first awakened by reading Caesar's *Commentaries*, and he ran away from home and joined the army. He was almost continuously on active service, in Italy, in Flanders and, in 1714, under Charles XII of Sweden. Charles XII he regarded as the greatest captain of all time, and it was at Stockholm that Folard began to formulate his tactical ideas in a commentary on Polybius. On his way back to France he was shipwrecked and lost all his papers, but he set to work at once to write his essays afresh, and in 1724 appeared his *Nouvelles Découvertes sur la guerre dans une dissertation de Polybe*, followed (1727–30) by *Histoire de Polybe traduite par . . . de Thuillier avec un commentaire . . . de M. de Folard, Chevalier de l'Ordre de St. Louis*.

Folard spent the remainder of his life in answering the criticisms provoked by the novelty of his theories. He died friendless and in obscurity at Avignon in 1752.

Folard's military writings contain a great number of independent ideas, sometimes valuable and suggestive. The central point of his tactics was his proposed column formation for infantry. Struck by the apparent weakness of the thin line of battle of the time, he desired to substitute the shock of a deep mass of troops for former methods of attack and further considered that in defense a solid column gave an unshakable stability to the line of battle. Controversy at once centred itself upon the column. While some famous commanders, such as Marshal Saxe and Guido Starhemberg, approved it and put it into practice, the weight of military opinion throughout Europe was opposed to it. History justified this opposition, even though the French Revolutionary armies won several victories with infantry columns.

FOLD. In geology, folds are undulations or waves displayed by the stratified rocks of the crust of the earth. Stratified rocks

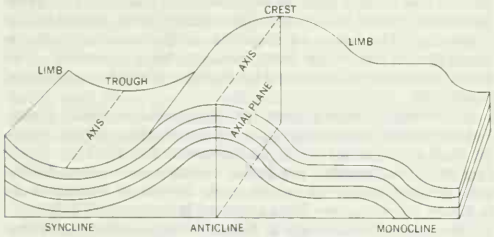

FIG. 1.—THREE FORMS OF FOLDS

are generally formed by the accumulation of material in horizontal and nearly horizontal sheets. Some stratified rocks are of sedimentary origin, deposited in rivers, lakes and seas; other stratified rocks are of volcanic origin, deposited as lava flows or as layers of fragmental explosive material. In many places the sheets or strata, as they are more appropriately called, are no longer horizontal but have been thrown into folds. Some folds are so gentle that the inclination of the strata is barely perceptible; other folds are so pronounced that the strata of the two flanks may be essentially parallel, either steeply inclined as in isoclines (*see* fig. 4) or lying nearly flat as in recumbent folds (*see* fig. 2).

Folds show a wide range in magnitude; some are miles or even hundreds of miles across; others, a few feet across, are visible in single outcrops; still others may be perceived only under the microscope. The tops of the large folds have almost invariably been removed by erosion so that only the truncated inclined strata can be seen (fig. 3).

For discussion of the significance of folds in the occurrence of oil and gas and in petroleum geology the reader is referred to the article Mine Prospecting and Development.

Origin of Folds.—The long linear folds, so characteristic of mountainous regions, are believed by many to result from compressional forces acting parallel to the surface of the earth and at right angles to the fold. Whether compressional forces are due to contraction of the crust of the earth or to the drag of subcrustal convection currents or to some other cause is not known. Some geologists believe that many folds are the result of strata sliding, under the influence of gravity, from a vertically uplifted area. The large folds that are essentially circular in plan are due to vertical forces of unknown origin. Many smaller domes, those one-half mile to two miles in diameter, are caused by the rise of masses of rock salt (salt domes) or by the injection of mushroom-shaped masses of magma (laccoliths). (*See* Salt Dome; Laccolith.)

The push exerted by an advancing glacier may throw weakly consolidated rocks into folds. The compaction of sedimentary

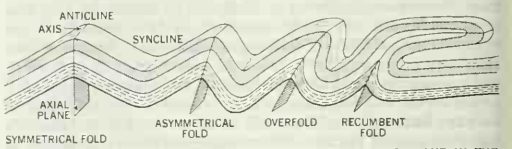

FIG. 2.—FOLDS, PROGRESSIVELY DECREASING FROM LEFT TO RIGHT IN THE INCLINATION OF THE AXIAL PLANE

rocks over buried hills results in gentle folds.

Geometry of Folds.—The axial plane or axial surface of a fold is the plane or surface that divides the fold as symmetrically as possible (fig. 1). The axial plane may be vertical, horizontal or inclined at any intermediate angle (fig. 2). An axis of a fold is the intersection of the axial plane with one of the strata of which the fold is composed (fig. 1, 2).

Although in the simpler types of folds the axis is horizontal or gently inclined, it may be steeply inclined or even vertical. The angle of inclination of the axis, as measured from the horizontal, is called the plunge. The folds illustrated in fig. 3 are plunging away from the reader at an angle of about 20°. The portion of the fold between adjacent axes forms the flanks, limbs or slopes of the fold (fig. 1).

An anticline is a fold that is convex upward (fig. 1). A syncline is a fold that is concave upward. An anticlinorium is a large anticline on which minor folds are superimposed. A synclinorium is a large syncline on which many minor folds are superimposed. A symmetrical fold (fig. 2) is one in which the axial plane is vertical. An asymmetrical fold (fig. 2) is one in which the axial plane is inclined. An overturned fold or overfold has the axial plane inclined to such an extent that the strata on one limb are overturned (fig. 2). A recumbent fold is one in which the axial plane is essentially horizontal (fig. 2). Isoclinal folds have the two limbs essentially parallel to each other and thus approximately parallel to the axial plane (fig. 4). In an area where the strata are generally horizontal, they may locally assume a steeper dip; a fold of this type, with only one limb, is called a monocline (fig. 1).

Many folds are distinctly linear; that is, their extent parallel to the axis is many times their width. But some are not linear

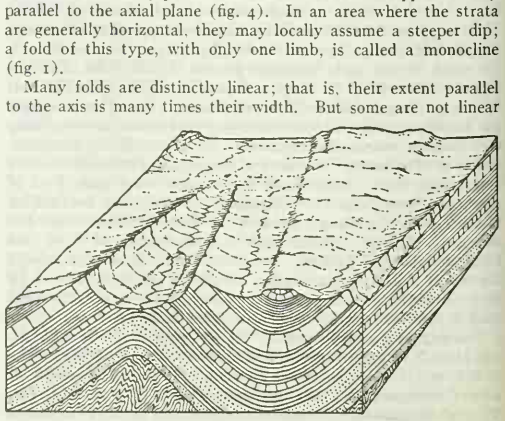

FIG. 3.—PLUNGING ANTICLINES AND SYNCLINES

FIG. 4.—STEEPLY INCLINED OR ISOCLINAL FOLDS

and are more or less circular in plan. A dome is such a fold that is convex upward (fig. 5); this means the strata dip outward from a central area. A basin is such a fold that is concave upward; that is, the strata dip inward toward a central area.

Examples.—Folded strata are characteristic of many of the mountain ranges of the world. In the Appalachian Valley and Ridge province of eastern North America, extending in a southwesterly direction from Albany, N.Y., to central Alabama, the folds are symmetrical folds, asymmetrical folds and overfolds (fig. 2); the axial plane dips southeasterly. Only the eroded stumps of these folds are now preserved (fig. 3, 4). The distance from the crest of one fold to the next is from one to ten miles, and the height of the folds—the difference in altitude of the same bed in the trough of a syncline and on the crest of an anticline (fig. 1)—is two to five miles.

Many of the folds in the Rocky mountains of western North America are similar to those in the eastern United States. But in the southern and central Rockies of Colorado and Wyoming

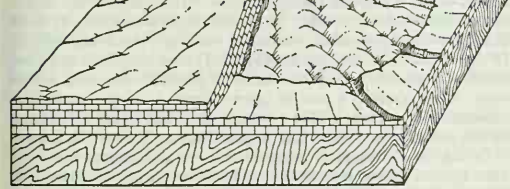

FIG. 5.—DOME. THE LEFT-HAND PART OF THE DIAGRAM REPRESENTS CONDITIONS BEFORE EROSION. THE RIGHT-HAND HALF REPRESENTS CONDITIONS AFTER CONSIDERABLE EROSION

the distance from the crest of one major anticline to the crest of the next is 10 to 50 mi.

The Jura mountains of Switzerland and France offer a classic example of symmetrical and asymmetrical folds. The crests of the anticlines are one-half to two miles apart, whereas the height of the folds is one-half mile. When they were being folded, the rocks of the Jura mountains slid northwesterly along the rigid basement, just as a rug on the floor might fold if one end were held stationary and the rest of the rug moved.

Recumbent folds, similar to those shown on the right-hand end of fig. 2, are common in the Alps. In places many recumbent anticlines and synclines are piled on top of one another. Some of the larger recumbent folds in the Alps are many miles across. *See* also GEOLOGY.

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FOLENGO, TEOFILO (GIROLAMO) (1491–1544), the most important of the Italian macaronic poets, who used an Italian vocabulary treated according to Latin rules of form and syntax, was born in Mantua, Nov. 8, 1491. In 1509 he entered the Benedictine order (taking the name Teofilo, by which he is known) and lived in the convents of Brescia, Mantua and Padua until he was 33. In 1525 he left the order, to which he was readmitted in 1534 after having lived as a hermit for a time near Sorrento. He died in a convent near Bassano, Dec. 9, 1544.

Folengo's masterpiece is the *Baldus*, a poem written in macaronic hexameters and published under the pseudonym of Merlin Cocai. Four versions of this poem (in 20 books) are known, published in 1517, 1521, 1539–40 and 1552 (mod. ed. by A. Luzio, *Le Maccheronee*, 1927–28). It narrates the adventures of Baldo, a descendant of Roland's cousin Rinaldo, in a comic style which avoids parody. The first 11 books deal realistically with the popular world of Cipada (birthplace of Baldo, near Mantua), while the last books contain a number of episodes which reveal the author's rich vein of fantasy. Folengo uses macaronic Latin in a masterly way, revealing a sound humanistic education, besides his familiarity with his native dialect. His minor works are of little literary value. The *Moschaea*, inspired by the *Batracomiomachia*, deals with the war between the flies and the ants; the *Zanitonella* describes the love of two peasants; the Italian poem *Orlandino* (1526) and the *Caos del Triperuno* (1527; written in Italian, Latin and macaronic language, partly in verse and partly in prose) have only autobiographical interest. Folengo wrote also two poems on Christ's life (*La Humanità del Figliuolo di Dio* and *Palermitana*) and a *sacra rappresentazione* (*Atto della Pinta*), of which only a very corrupt version is known. Of his three tragedies only the titles are known. Folengo's *Opere italiane* were edited by U. Renda in three volumes (1911–14).

See G. Billanovich, *Tra don Teofilo Folengo e Merlin Cocaio* (1948); E. Bonora, *Le Maccheronee di T. Folengo* (1956). (G. A.)

FOLGER, HENRY CLAY (1857–1930), U.S. lawyer and capitalist, was born in New York city on June 18, 1857. He attended Amherst college, Amherst, Mass., graduating in 1879, and studied law at Columbia university, obtaining his LL.B. in 1881. As a student he was employed by Pratt and company, a part of the Standard Oil group, and later became a director of the company. In 1908 he became a director of Standard Oil Company of New York and in 1911 became its president. The firm prospered under his direction and in 1923 he became chairman of the board. A devoted Shakespearean scholar, Folger built a fine Shakespearean collection and erected a library to house it in Washington, D.C.

(H. J. Sc.)

FOLIES-BERGÈRE. This Parisian music hall, variety-entertainment theatre, destined to become one of the major tourist attractions of France, opened in a new and spacious theatre on May 1, 1869, located in the rue Richer. Its designation was taken, after litigation over the originally chosen name of Folies-Trévise, from the nearby rue Bergère. The opening performance included two operettas, a pantomime featuring the famous Paul Legrand as Pierrot, and a variety of specialty numbers. During the siege of Paris the theatre became a hall for political meetings but at the conclusion of the war opened again under the management of Leon Sari. By the last decade of the 19th century, its repertory resembled that of a vast circus but without the equestrian numbers. Vaudeville sketches, playlets, musical numbers in great variety, ballets, eccentric dances, acrobats and balancing performers, tightrope walkers, magicians and sleight-of-hand artists, trained animal acts, elaborate choral numbers, spectacular and mechanical effects on a vast scale, operettas and musical comedies attracted Parisians and tourists alike. For other patrons the pursuit of gallantry, intrigue and affairs of love in the promenades and the refreshment rooms was the chief attraction.

Under the management of the Lallemands, their nephew, Edouard Marchand, introduced the first "girls" to the Folies. In 1894 the vogue of the strip tease seized the music halls of Paris and the Folies took it over and elaborated it to the extent that, in the 20th century, its reputation for *les girls* overshadowed its many other beautiful performances. During the period of World War I the exhibition of feminine pulchritude in the nude became and continued to be the most sensational aspect of a Folies show.

Most of the great entertainers and music-hall artists of France

have played at the Folies. The list includes, among many others, Fernandel, Colette, Yvonne Printemps, Raimu, Yvette Guilbert, Colette Fleuriot, Yvonne Menard, Maurice Chevalier, Mistinguett, of the beautiful and highly insured legs, and Josephine Baker. Charlie Chaplin began his career at the Folies in 1902 at the age of 14. The elaborate shows presented at the Folies require 10 months of planning and preparation, about 40 different sets, 1,000 to 1,200 individually designed costumes, in addition to the elaborate electrical and mechanical effects. The large and splendidly equipped stage, complete with elaborate machinery and extensive lighting apparatus, allows the management to stage sumptuous and grandiose spectacles.

Through touring the Folies-Bergère became widely known throughout France and in many other European and South American cities.

See Paul Derval, *The Folies-Bergère,* trans. by Lucienne Hill (1954). (H. C. Hr.)

FOLIGNO (anc. Fulginiae), a town and episcopal see in the province of Perugia, in Umbria, central Italy, is located on the Topino river 40 km. (25 mi.) S.E. from Perugia city by rail and 168 km. (104 mi.) N.E. of Rome. Pop. (1961) 48,684 (commune). Originally an Umbrian settlement, the present site is that of the Roman town, of which it reflects the regular street plan. The principal monuments are the Duomo (restored, but a fine south façade of 1133), the church of Sta. Maria Infraportas, and the Palazzo Trinci (1395–1407), now the civic museum. Raphael's "Madonna di Foligno," now in the Vatican, was painted for the church of Sta. Anna. The first edition of Dante's *Divina Commedia* was printed (1472) in the Palazzo Orfini.

The town at all times owed its importance to its position commanding the entrance of the principal pass between the Umbrian plain and the Adriatic coast. A powerful rival of medieval Perugia, it enjoyed great prosperity under the government of the Trinci family as semi-independent deputies of the Holy See (1305–1439). After their fall at the hands of Eugenius IV it remained part of the papal state until 1860, and its later history was uneventful. It was badly damaged by an earthquake in 1832, and again during World War II. A rapidly developing commercial and industrial centre, its principal products are sugar, spaghetti, building materials, textiles, paper and timber. (J. B. W.-P.)

FOLIOT, GILBERT: *see* Gilbert Foliot.

FOLK DANCE. A folk dance is by implication a dance of the people, but the word "folk," as used in connection with dance, song, lore, custom, etc., indicates characteristics that are distinctive from those associated with the word "popular." The French speak of *chansons populaires* as the English and Americans speak of folk songs, but the English word "popular" does not convey the concept of "folk" as used here.

This concept embodies two ideas: (1) that this form of dance was evolved over great stretches of time by communal practice; and (2) that the process of handing on through successive generations operates within a framework of natural selection and an unconscious choice of the more acceptable traits. Thus, the folk dances of a people, like folk songs, may reflect national character.

This description and partial definition of folk dance is not universally applicable. It serves for most of Europe but is not so appropriate among peoples whose dances are still an integral part of tribal custom, as in many parts of Africa, or in civilizations where the dances continue to have a religious content, as in many parts of India and Asia. For such religious dances the term "ethnic" is increasingly used, but between ethnic and folk dances there is no sharp dividing line. Even in Europe, where Christianity tended to purge the dances of their pagan religious content, many of the surviving folk customs exhibit traces of pre-Christian practice and belief.

Understanding of these surviving customs is helped by comparing them with analogous forms outside Europe and with folk dances carried abroad by colonists, as in North and South America. There are cases where a colony of settlers, prone to cling tenaciously to elements brought from the mother country, have preserved folk forms that have become extinct at home. An instance of this is the carole of the Faeroe Islands, a chain dance carried from Denmark, where it has long been forgotten traditionally. The folk-dance traditions of England, Ireland and Scotland have been enriched by the recovery of dances preserved by descendants of British emigrants living in Canada and the United States.

In North America the settlers and their descendants have tended to remain in fairly distinct communities and so have preserved their folk traditions comparatively unsullied. In Central and South America the elements of European folk culture have, to a certain extent, been assimilated with the indigenous cultures already established, but there are easily recognizable traces of Spanish and Portuguese ritual folk dances in Central and South American folk customs. Not only have the European dance customs become wedded to the native Indian ceremonies but later Negro-African traits and rhythms have invaded the dances and dance music. Thus folk traditions of very different sources have mixed and blended with one another and yet still exhibit distinctive traces of their centres of origin.

The European folk dances that were recorded and described in most European countries during the first half of the 20th century fall into two main groups: (1) the ritual-ceremonial; and (2) the social. The second group includes all those dances in which the unit is the man-woman couple with sex relationship as a dominant feature. The dances in the first group are, except in a very few instances, performed by men and there is almost invariably clear evidence of ritual ceremony.

Ritual-Ceremonial Folk Dances.—Apart from relatively few instances of women's ritual dances, associated mostly with seasonal customs such as harvest in Hungary, Poland and the Balkan peninsula, this type of dance is performed by men.

Derived from pre-Christian religious ceremony, the ritual dances are associated almost invariably with local annual customs, which can be grouped under seasons: winter, carnival, Easter, spring, May Day and Whitsuntide, midsummer. The customs may include some dance action together with ritual drama, such as Christmas mumming and carnival masquerading, or they may be composed wholly of dance, as in the English morris dance and other young men's dances of the European spring festivals. The dance drama represent a life-and-death conflict often covering the complete cycle of birth, growing up, combat, courtship, marriage, death and rebirth. In these ancient "plays" can be discerned traces of animal and plant fertility rites reflected in the antics of "green" men and animal men. Often there is a central figure—horse, bear or dragon—accompanied by a *corps d'élite* of young men who dance attendance on the creature but whose role is subsidiary to that of the animal.

In the ritual dances it is the characters and animal men who have become subsidiary and the *corps d'élite* are projected as dedicated medicine men whose dance magic is dispensed to the community; *e.g.,* curing sick babies and ensuring the fertility of the unmarried girls. The medicine men, in order to prepare themselves for their magic rite, undergo forms of initiation of which the dances themselves are a part. Frequently this initiation includes a flagellation that must always be painful, although the severity of the blows is often mitigated by the protective padding worn by the dancers, giving them a grotesque humpbacked appearance. This figure of a misshapen scapegoat actor can be traced down through folk tradition from the drama of classical Greece through the *commedia dell'arte* to the familiar Punch and Judy and the antics of the harlequinade. The medicine men also perform combats, when one side dances or battles against the other side, apparently reflecting the eternal conflict of life against death. The two sides are dressed differently—blacks against reds or blacks versus whites. In Spain, where these moriscos are still staged, the contest is between Moors and Christians. One interesting English example of a contest dance between medicine men is to be seen in early September in Abbots Bromley, Staffordshire. The dance consists of a procession of six "deer" men followed by the antique characters—the fool, the man-woman, the "horse" and the "hunter" with crossbow. Of the six "stags," three bear white horns and three black and these two sides of white and black, while they fight against each other, never mingle (*see* Morris-Dance).

The folk dramas such as are acted by the mummers at Christmas, by the soul-cakers in early November and by the pace-eggers at

Easter include a contest and a ritual murder but little dancing. An exception, however, has to be made in the case of the hilt-and-point sword dance as it survives in parts of Europe and the British Isles.

Even in cases where the dance seems to have ousted the drama there are easily recognizable clues to its dramatic origin. For instance, the dancers are often introduced, by a calling-on song, as actors; and the dance invariably includes the figure of the rose or lock, made of interwoven swords, that is placed over the head of a victim, who is "hanged" or has his throat "cut" by the swords. The sword in folk ritual would seem to be as much a symbol of life as of death. In certain dances the swords are brandished, or whiffled, with the apparent intention of clearing a way or making room so that the new life can enter in. Whifflers with great two-handed swords have been familiar figures in civic and guild processions in Britain for many centuries. Another property connected with the ritual folk dance is the pole—the maypole or maybush—and its smaller sister, the garland. Garlands and hoops are used in the linked-up dances in much the same way that swords are in the hilt-and-point dances. Sticks of all sizes also are used for clashing and beating in rhythm. Although separate terms are used to distinguish between stick dances, sword dances, garland dances, etc., there is no clear division between them nor can they be separated from the acting and mumming of the folk plays.

There are also famous solo dances of folk origin that have affected the progress of the art dance in ballroom or on the stage. In the British Isles individual jigs are danced over swords in the Highlands of Scotland, over broom sticks in Wales, over churchwarden pipes in England and over sticks, flails and other implements in different parts of Europe (*see* JIG).

Social Folk Dances.—These possibly originated when the young medicine men shared their magic making with the unmarried girls in a ceremonial fertility rite. Many examples of communal processions and chains survive in Europe in the farandole, carmagnole, saraband (*q.v.*), in the Cornish floral or furry dance and in the different types of maypole dance.

The forerunner of the European country dance, square dance and reel (*qq.v.*) is the carole (*q.v.*), the dance form popular in the middle ages. This chain dance was performed to the singing of the dancers themselves; the old dance form and its name survive in the choro, horo, hora, kolo and similar chain dances in the Balkans.

The English, Scottish and Irish country dances have evolved from the "long" dance processions and from the maypole rounds. Adapted through the centuries to indoor dancing, they attracted the interest and ingenuity of dancing masters and musicians, who composed on the old base a continuing stream of new dances for the social dancers in court and hall. This stream of folk-type dances overflowed their countries of origin to mix with and fertilize home-grown forms. One example is the importation into France and other European countries of the English country dance. Another is the evolution of the North American square dance out of the mixing of English, Irish and Scottish and French dances, carried by the early settlers, with later imported ingredients from Scandinavia and central Europe.

Couple folk dances are also of ancient origin with erotic content, as in the Spanish jota, the Italian saltarello and the somewhat more acrobatic displays of the man partner in the Basque *aurresku* and the "halling" of Norway.

Solo folk dances, mostly of ceremonial origin, have survived for exhibition and entertainment purposes and figure prominently among the dances of the eastern and the middle-eastern peoples. Moorish influences have probably affected certain Spanish solo folk dances; *e.g.*, in Andalusia.

A number of social folk dances traditional to particular countries have established themselves as cosmopolitan ballroom dances or have provided the basis for such dances. Besides the country dances that spread through Europe these include the Austrian waltz, the Czech polka, the Mexican tango (*qq.v.*) and various South American and North American folk forms. While the folk dance was influencing the cosmopolitan social dance, it was also affecting dances in public entertainment. Henry VIII imported peasant dances, possibly even rustic dancers, to add novelty and spice to his ingenious spectacle, the court masque. Later the Elizabethan theatre developed a special kind of epilogue called the jig, which was a song-and-dance act immensely popular with the groundlings because of its rustic familiarity.

Stage dancing, including the classical forms of ballet, constantly borrows and has borrowed from folk sources of many countries to enrich its content and techniques. Meanwhile the ancient country customs and the rustic revels persisted, often receiving reinforcement in the shape of a new step or rhythm or even a complete dance that had briefly been the rage in the fashionable dance world. But the persistent characteristics of folk dance have never been dependent on novelty or change; tradition has thrived, rather, on almost a monotony of repetition: an 18th-century writer recording her impressions of the traditional social dances summed them up as "these interminable hornpipes." Folk dances are dances to be enjoyed in performance rather than by being watched. Another feature that distinguishes folk dance from the various forms of art dance is that the folk-dance movement is one that the body itself directs, with as little as possible interference from the self-critical and self-conscious will. Nevertheless the conscious art dance cannot be clearly separated from the unconscious folk dance. In England the transition in the 17th century can to some extent be followed in the printed versions of the country dance, first published in John Playford's *The English Dancing Master* (1651), where the dances described bear rustic traces, but year by year the dances and dance airs became more sophisticated and less folk in character.

See also DANCE TEACHING: *United States: Folk Dancing.*

(D. N. K.)

FOLKESTONE, a municipal borough, seaport and seaside resort in the Folkestone and Hythe parliamentary division of Kent, Eng., 17 mi. S.E. of Canterbury by road. Pop. (1961) 44,154. Folkestone is an important port of the continental passenger service to Boulogne, France. The older part lies in a small valley which opens steeply to the Dover strait. To the north, the town is sheltered by hills 400 to 500 ft. high, on one of which, Castle hill, is an ancient earthwork. Along the cliff west of the old town a broad promenade with lawns and flower beds, nearly two miles long, called the Leas, extends west to Sandgate and is connected with the shore road and gardens below. On this cliff stands the parish church of St. Mary and St. Eanswythe, mainly Early English, built to receive the relics of St. Eanswythe. The original church, attached to a priory, was founded near the site of a convent built by Eadbald, king of Kent and father of Eanswythe, in A.D. 630, for his daughter. The town contains a public library and museum, a technical school, the Leas Cliff hall (a musical centre), a repertory theatre and the Royal Victoria hospital, built in 1889–90 and several times enlarged.

William Harvey, discoverer of the circulation of the blood, was a native of Folkestone and is commemorated by a memorial on the Leas. Sir Eliab Harvey, his nephew, founded the grammar school in 1674. Folkestone has its own court of quarter sessions.

Folkestone harbour has a deep-water pier, which, before World War I, was lengthened to 1,480 ft. and has berths for eight steamers, with a railway platform and lighthouse. The area of the inner and outer harbours is about 12 ac. There is a fishing industry, and in addition to passenger traffic a large general trade is carried on. The railway line to Dover (seven miles) passes through a series of cuts and tunnels in the chalk cliffs, by way of the Warren (on the east of the town overlooking East Wear bay) and Abbot's and Shakespeare's cliffs. In 1915 a serious landslide in the Warren closed the railway for four years. In 1920 the earl of Radnor presented the Warren and East cliffs to the town and they were developed as parks. The remains of a large Roman villa were excavated near the East cliff in 1924.

Folkestone (Folcantan) was among the possessions of Earl Godwin when he was exiled from England; at the time of the Domesday survey it belonged to Odo, bishop of Bayeux. From early times it was a limb (member) of the Cinque Port of Dover, and had to provide one out of the 21 ships furnished by that port for the royal service. It shared the privileges of the Cinque Ports, whose

liberties were exemplified at the request of the "barons" or burgesses of Folkestone by Edward III in 1330. The corporation, which was prescriptive, was entitled the mayor, jurats and commonalty of Folkestone. In 1629 the inhabitants obtained licence to build a port. By the end of the 18th century the town had become prosperous by the increase of its fishing and shipping trades, and by mid-19th century it was one of the chief health and pleasure resorts of the south coast. In 1805 the threat of invasion by Napoleon caused three Martello towers to be built, east of the town. It was an important embarkation point during World War I. In World War II Folkestone was damaged by enemy air raids and cross-channel bombardment.

FOLKLAND (*folcland*), a term found in certain Anglo-Saxon legal documents. In a law of Edward the Elder (I, ch. 2) it is contrasted with bookland in a way which shows that these two kinds of tenure formed the two main subdivisions of landownership: no one was to deny right to another in respect of folkland or bookland. By a charter of 858 Aethelberht, king of Kent, exchanged five hides of folkland for five hides of bookland which had formerly belonged to a thegn. He granted the latter for the newly acquired estates exemption from all fiscal exactions except the threefold public obligation of attending the fyrd and joining in the repair of fortresses and bridges. The king converted the former bookland into folkland when it came into his possession. Evidently folkland was not free from the payment of the king's "farm," from providing quarters for the king's men or from paying to the king all the profits of jurisdiction. In Ealdorman Alfred's will (*c.* 880) the testator left three hides of bookland to an illegitimate son, and the folkland, provided the king gave his consent.

Two principal explanations have been given to this term. John Allen, in his *Inquiry Into the Rise . . . of the Royal Prerogative in England* (1830) described folkland as the common property of the nation (*folc*), out of which the king could carve dependent tenures for his followers. Such estates remained subject to the superior ownership of the folk and of the king, who could eventually take them back, and whose confirmation had to be sought by every heir to a holder of folkland.

A theory proposed by Sir Paul Vinogradoff in 1893 considers folkland as landownership by folkright—at common law, as might be said in modern legal speech. In opposition to it bookland appears as landownership derived from royal privileges. Whereas folkland was shown in charters as subject to ordinary fiscal burdens and not freely devisable, bookland, or land held under a royal charter, was normally free from fiscal dues and could be bequeathed at will. This view has become generally accepted.

See F. M. Stenton, *Anglo-Saxon England,* 2nd ed. (1947), *The Latin Charters of the Anglo-Saxon Period* (1955). (P. Vi.; D. Wk.)

FOLKLORE, the generic name used to denote those traditional beliefs, superstitions, manners, customs and observances of ordinary people which have persisted from earlier into later periods and which, in fragmentary, modified or comparatively unchanged form, have continued to exist outside the accepted pattern of contemporary knowledge and religion, in some cases down to modern times. Folk tales, traditional ballads, folk songs and proverbs also come under this heading and, by a recent extension of meaning, certain aspects of material culture originally excluded by definition. (*See* also Ballad; Folk Music; Proverb.)

Origins and Development of the Study of Folklore.—The word folklore was introduced into English usage by W. J. Thoms in a letter written under the pseudonym of Ambrose Merton which appeared in the *Athenaeum* in Aug. 1846. In this he suggested that "a good Saxon compound Folk-Lore" could be more aptly used to describe "what we in England designate as Popular Antiquities, or Popular Literature. . . ." This suggestion was made only in passing, the main object of the letter being to arrange for the publication in the *Athenaeum* of notes concerning superstitions, customs, ballads, sayings and other traditional survivals "of the olden time" still existing in Britain. The word thus incidentally coined was quickly adopted and has since been absorbed into the languages of almost all the European and transatlantic countries where the science of folklore (now commonly spelled without a hyphen) is seriously studied.

Interest in what would now be called folklore had, of course, existed long before the subject acquired its modern name. The works of Herodotus, Livy and Pliny contain references to popular beliefs and practices in ancient Greece and Rome. In 16th- and 17th-century England, lively descriptions of traditional ceremonies, domestic and communal, occur quite frequently in books primarily concerned with other matters. Among these may be mentioned Philip Stubbes's *Anatomie of Abuses* (1583), Robert Burton's *Anatomy of Melancholy* (1621) and H. Misson's *Memoirs and Observations in his Travels over England,* first published in French in 1698 and translated into English by J. Ozell in 1719. John Aubrey recorded numerous superstitions and folk customs of his time in his *Remaines of Gentilisme and Judaisme* (a collection of manuscript notes compiled in 1686–87 but not printed in full until 1881) and in his *Miscellanies* (1696). Perhaps more than any of his contemporaries he had the true folklorist's curiosity about such matters, and he was quick to observe that parallels to many of the examples he gives had existed in antiquity. Henry Bourne's *Antiquitates vulgares; or, The Antiquities of the Common People* appeared in 1725. This little book is memorable because, though short and, by modern standards, unscientific, it was one of the earliest attempts at a general survey of the traditions and seasonal rites of the English peasantry. It was later expanded by John Brand into the now much better-known *Observations on Popular Antiquities* (1777). Among other early writings dealing with rural belief and custom were William Borlase's *Observations on the Antiquities, Historical and Monumental, of the County of Cornwall* (1754), Peter Roberts' *Cambrian Popular Antiquities* (1815) and William Hone's *Every-day Book* (1826–31) and *Year-Book* (1832).

The first recorders of British folklore were often men of leisure with an antiquarian turn of mind whose curiosity had been aroused by survivals of ancient thought and habit in particular localities. Such survivals were commonly explained as relics of classical or Druidic paganism, but this theory was rarely, if ever, checked by comparison with the folklore of peoples outside the range of those religious traditions. The early 19th century saw the beginnings of a more serious approach to the subject. The striking similarity of customs, ideas and popular tales in widely separated parts of the world then began to be realized for the first time, and the necessity for a more careful and detailed inquiry into the problem of their origins was recognized.

In Germany, Jacob and Wilhelm Grimm (*q.v.*) laid the foundations for the scientific study of folk tales and superstitions in their *Kinder-und Hausmärchen* (1812–14) and *Deutsche Mythologie* (1835; Eng. trans. by J. S. Stallybrass, *Teutonic Mythology,* 1883–88). Thomas Keightley's *The Fairy Mythology* (first published in 1828 and greatly expanded in 1850) included tales from the fairy traditions of almost every European country and a few from outside Europe, systematically arranged by regions and peoples. Unlike many of his predecessors, Keightley scrupulously adhered to oral tradition in the presentation of his material, avoiding any form of literary embellishment, and was concerned to discover the origins both of the word "fairy" and of the widespread fairy creed. Another notable British worker in the folklore field at this period was Thomas Wright who, in *Essays on Subjects connected with the literature, popular superstitions, and history of England in the Middle Ages* (1846), discussed, among other matters, the difficult problem of the movement, separate invention and literary borrowings of folk tales.

Folklore Societies.—By the middle of the 19th century a growing interest in folklore was becoming evident not only through the publication of serious works but also through the many contributions to the "Byegones" or "Folk-Lore" columns printed in various newspapers and magazines, including *Notes and Queries,* the journal founded in 1849 by W. J. Thoms. In 1876 a letter published in that paper urged the formation of a society which could undertake the collection and printing of "all the scattered bits of folklore which we read of in books and hear of in the flesh." Two years later, the Folk-Lore society was founded in London, with W. J. Thoms as its director and G. L. (later Sir Laurence) Gomme as its honorary secretary. The society's function was to publish

books and monographs dealing with folklore in general and to issue a periodical which, as the first prospectus stated, would contain "those scattered notes on the popular superstitions, legends and ballads, which are almost the only traces of the primitive mythology of our islands." This periodical first appeared in Feb. 1879 as an annual called *The Folk-lore Record* and, after passing through various changes, became a quarterly known as *Folklore*. Although the newly formed society was naturally deeply interested in the native traditions of Great Britain and Ireland, and particularly with those most threatened by the rapidly changing social conditions of the time, it had no definite British bias and was thus able to deal with foreign as well as British material.

This society was the first of its kind in the world, but it was soon followed by others in Europe and North America. In 1888 the American Folklore society was founded in the United States, with rules formed on the English model but with the inevitable difference that its studies were at first largely concerned with the traditions and beliefs of primitive North American Indian tribes. In the course of time, similar societies, or institutes, came into being in Germany, France, Spain, Scandinavia, Rumania, Turkey, South America and elsewhere. Some of these, unlike the pioneer British society, were associated from the start with local universities or with the government of the country concerned. Thus, the Swedish Institute for Folk-Life Research was set up by the Nordiska museum and the University of Stockholm. The Institute for the Investigation of Swedish Dialects, Folk-Lore and Folk-Life, which sprang originally from the voluntary work of teachers and students at Uppsala, later became part of the University of Uppsala, and the School of Scottish Studies, founded in 1952, is part of the University of Edinburgh. In 1959, the Nordic Institute for Folk Literature, which deals with material from all over Scandinavia and receives grants from Denmark, Finland, Norway and Sweden, began work in Copenhagen.

In Ireland, folklore studies were greatly stimulated by the strong cultural and linguistic revival that followed the political changes in that country after World War I. The Folklore of Ireland society was founded in 1926. Four years later, the Irish government set up the Irish Folklore institute, which was replaced in 1935 by the state-aided Irish Folklore commission. In some of the smaller European countries, the upsurge of national feeling during the first half of the 20th century greatly encouraged the study of local tradition and custom with the result that much valuable material was collected, particularly in regions (*e.g.*, in Yugoslavia and other Balkan countries) where the change-over from ancient peasant ways of life to those of modern civilization was still comparatively new.

Early Theories of the Origins and Nature of Folklore.—When folklore first began to be seriously studied, the distinction between it and social anthropology was not very clearly marked (*see* SOCIAL ANTHROPOLOGY). Both dealt with aspects of human culture, and both were affected by the evolutionary theories then in vogue. E. S. Hartland defined folklore as "anthropology dealing with the psychological phenomena of uncivilized man." Andrew Lang called it the science of survivals, using that term in the specialized sense in which Sir E. B. Tylor had first used it in his *Primitive Culture* (1871) to denote opinions and customs carried forward "by force of habit into a new state of society different from that in which they had their original home," and thus remaining "as proofs and examples of an older condition of culture out of which a need has arisen." An etymological hypothesis propounded by the philologist Max Müller (*q.v.*) was that mythology is a "disease of language," derived from ancient names and personifications of the sun and other natural phenomena and associated with what was then thought of as "Aryan culture." According to this theory, popular beliefs and folk tales existing among modern European peasants were vestigial relics of sun and nature worship once practised by an ancestral race from which all peoples speaking languages belonging to the Indo-European family were believed to be descended. Müller's ideas won considerable attention and support for a time, but his thesis was later shown to be unsound. It was attacked and demolished by Andrew Lang who, in his *Modern Mythology* (1897) and other writings, proved that analogies to the supposed survivals of "Aryan" culture could be found among primitive peoples almost everywhere, including those totally unconnected by blood or contact with countries using Indo-European speech.

Tylor's doctrine of "survivals" had a more lasting effect upon the trend of folklore studies. Laurence Gomme, Andrew Lang, Charlotte Burne, E. S. Hartland and other distinguished folklorists were profoundly influenced by it. So also was Sir James Frazer, in whose monumental work *The Golden Bough* (1890; 3rd, enlarged ed., 12 vol., 1907–15) innumerable examples of parallel beliefs and ritual from all over the world were assembled to show the existence in modern peasant tradition of survivals of a primitive vegetation cult. In the second half of the 19th century a belief in unilineal social evolution and the passage of all peoples through successive and similar stages of development was generally held by anthropologists and was not limited to them. For folklorists also, the culture of primitive or barbaric societies represented first steps in the evolution of human institutions and civilization. Existing folk beliefs, tales and customs were regarded as relics, still surviving among backward races or in the less advanced sections of modern civilized communities, of the life and thought prevailing in these lower levels of culture. The widespread distribution of similar or identical traditions was explained by the theory that all races had passed through the same stages of development and that human reactions to similar circumstances and environment tend, in similar states of evolution, to be the same everywhere.

This theory sometimes led to the overstressing of resemblances and to the neglect of differences that were often fundamental as well as to insufficient study of the effects upon native cultures of contact with other races, whether by invasion, trade or peaceful penetration. Later, this last consideration assumed great importance in the controversy between the diffusionists, who believed culture contacts to be the main explanation of peasant beliefs and customs, and the survivalists, who attributed them to the processes of folk memory and to oral tradition handed down through the ages.

Folk Tales.—The collection and interpretation of folk tales has always been an important part of folklore studies and at one time seemed likely to overshadow all other sections of the work. Here again, the problems of diffusion or independent creation, of age and of literary borrowings were fruitful sources of controversy. That some tales are very old and embody in their incidents conditions of an archaic state of society is obvious, but that such conditions actually prevailed in the regions where the tale is found at the time of its first telling is not so certain. The striking similarity of many stories found in different parts of the world suggests that they were carried from place to place by travelers, and J. Jacobs (in his article in *Folk-Lore*, vol. 5, 1894) pointed out that some of their more primitive elements may have been introduced into a particular country only after they had already become survivals. On the other hand, it has been argued that if men have passed through the same stages of development everywhere they are likely to have embodied the details of that development in stories that are essentially the same. In this, as in other parts of the folklore field, there is no single formula which can be used unfailingly for interpretation, and individual tales, like superstitions and folk customs, will only yield their secrets to detailed and scientific investigation.

The stories told by early peoples, handed down from generation to generation or carried by migrating tribes, merchants, sailors and other travelers from one country to another, fall into three main classes—those of myth, of legend and popular tales intended mainly for amusement. Myths are sacred narratives with a practical purpose. They deal principally with past events of cosmic and permanent significance, like the creation of heaven and earth or the coming of death into the world or with such everlasting mysteries as the struggle between good and evil or life beyond the grave. By recounting what is believed to have happened in primeval ages they provide supernatural sanction and precedent for existing rituals, traditional behaviour and custom and the accepted pattern of tribal society. In so far as they account for what now is by what was in the beginning, they have etiological signif-

icance, but the true function of a myth, for so long as it remains a living force, is not to provide explanations but to stabilize and unify the community or tribe to which it belongs. Its business, as R. R. Marett says in his *Faith, Hope and Charity in Primitive Religion* (Oxford University Press, 1932), "is not to satisfy curiosity, but to confirm the faith . . . cater, not for the speculative man with his Why, but for the practical man with his How if not thus?" (*see* MYTHOLOGY, PRIMITIVE).

Legends of the saga type, like those of Arthur or the Homeric heroes, and the many stories of lands overwhelmed by the sea can perhaps be best described as twisted and broken fragments of history. They preserve traditions of heroic personages and of real or supposed historical happenings and contain a nucleus of true fact, heavily embellished, as a rule, by magical or romantic accretions or by borrowings from similar tales told elsewhere. Since they are concerned with particular places or individuals, their central themes have a distinct character and may be supposed to have originated in the regions whence the tales were collected, but in their later embroideries they usually resemble saga-legends in other parts of the world. Heroes, for instance, are credited with attributes common to giants, fairies and supernatural beings in many different areas; floods and other disasters occur as the result of curses or tabu violations of a stock type or are attached to the wrong place or period and so on. (*See* also HERO; ARTHURIAN LEGEND; ALEXANDER ROMANCES; CHARLEMAGNE LEGENDS.)

The third and largest class of popular tales are those told purely or mainly for the entertainment of their hearers. Unlike legends and myths, they are not concerned with history, ritual practices, or explanations of the natural world but are simply good stories, the fiction of unlettered peoples. They deal with situations familiar to the listeners and sometimes reflect in the setting of their incidents conditions of life long since vanished, like matriarchy, primitive birth and marriage customs and old forms of inheritance. The fairy tales collected by Charles Perrault, the brothers Grimm, P. C. Asbjørnsen and J. E. Moe (*qq.v.*) and others from a variety of sources are of this nature. Their most usual theme is the triumph over difficulties, with or without supernatural aid, of the good or the oppressed and quite frequently of the merely cunning. Such ideas are, of course, common to almost all peoples and might occur to any storyteller anywhere, but the appearance of almost identical incidents, and even entire plots, in widely separated regions suggests diffusion rather than separate and independent invention. This is the type of story most likely to travel easily, and all the evidence points to its having done so from an early period. European folk tales also seem to have been influenced in some cases by Persian and Arabic translations of Indian literary collections of stories, first heard, perhaps, and repeated at home by crusaders and pilgrims to the Holy Land. (*See* also FABLE.)

Increased Scope of Folklore.—Any branch of study which is alive and deals with living material must change and expand with the passing years as knowledge and experience are gained. The scope of folklore has been widened in many ways since it was first lifted out of the hands of amateur antiquaries and casual observers. When Thoms first coined the word, he defined it as the lore (or learning) of the folk. By the latter term he meant the unlettered peasantry. The enthusiasm with which folklore studies were taken up in the middle and later 19th century was partly due to a sense of urgency arising from the changes then taking place in agricultural life and the consequent disappearance of age-old traditions. "Fast-perishing relics" was a phrase often applied to survivals of rural custom and belief, the recording of which was deemed to be urgently necessary before they vanished forever. For anthropologists and folklorists alike, "the folk" were synonymous with the more backward inhabitants of rural districts, and one of the twenty definitions of folklore in Funk and Wagnall's *Standard Dictionary of Folklore* (see *Bibliography*, below) is "the anthropology of peasants."

The recognition that superstitious beliefs and usages were not confined to simple countrymen but could be found among the educated also, and in towns as well as in isolated villages, was the first step toward an important change of views in this matter. The word "folk" was broadened to indicate a certain level of thought and practice, wherever found. The study of relations between different strata of society had its effect upon this problem. One school of thought, which includes writers like R. S. Loomis, Lord Raglan and A. H. Krappe, holds that folklore, far from originating with the ordinary people (who, according to Krappe, never create anything but can only re-create), represents forms of culture originally existing in the aristocratic and scholarly classes and later brought down to the level of the peasant and the artisan. A more generally held view is that the different classes in a single society do not so much imitate each other, consciously or unconsciously, as share, in greater or lesser degree, many beliefs and traditions common to their history and national way of life.

A further alteration of earlier views concerned the nature of folklore survivals. These had hitherto been regarded as undatable relics of a remote antiquity, preserved in the minds and memories of simple people and incapable of any change but that of disintegration and decay. This conception, with its strongly anthropological bias, was modified by the realization that not all survivals are of equal age, and that, far from being mere fossil remains, they survive precisely because they still have life and so are able to grow and change. In his presidential address to the Folk-Lore society in 1914, R. R. Marett pointed out that such things have more than antiquarian value and that "old-fashioned stuff though folklore may be, it belongs to the here and now, and may at any moment renew its youth."

For the modern student of the subject, folklore is a living and inextinguishable force, ebbing and flowing with the rhythm of social life and, while carrying into the present the traditions of the past, constantly adapting itself to the changing conditions of the times. Old customs disappear and superstitions vanish with new techniques and knowledge, but ancient forms of thought are continually reappearing in a new guise. Thus, beliefs which follow a well-established folk pattern have attached themselves to such modern objects as railways, airplanes, motorcars, "flying saucers" and atomic bombs. Similarly, with the spread of towns, the urbanization of what were originally rural practices can often be seen. Folklore material is no longer looked for solely in the country or in the records of the past. The products of the folk mind working under present conditions in urban as well as rural areas and the effect of modern ideas upon the birth of new folk traditions form an important part of the study today.

In addition, certain aspects of material culture formerly excluded from the folklore field are now accepted as an essential cognate study. Domestic utensils, tools, agricultural implements and other accessories of folk life formed no part of it in the earlier period, except in so far as they might affect beliefs or be associated with customs. Of late years, however, it has been appreciated that a knowledge of folk life in general, including its material background, is of great value in the interpretation of those traditions which are the true concern of the folklorist. An increased enthusiasm in the collection of folk life accessories and the rise of the modern folk museums in Scandinavia, Wales, Germany, Austria and elsewhere are indications of this change of viewpoint.

See also FOLKLORE (AMERICAN INDIAN).

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FOLKLORE (AMERICAN INDIAN). Indian folklore exhibits a wide range of topics touching every aspect of traditional life and including secular and religious myths, folk tales and historical legends, as well as a rich folk science in star, plant and animal lore. Much of it is sheer art, expressing the love of telling stories, posing riddles and playing games—the joy of poetry, music and the dance that may accompany ritual. The folklorist has been interested in the kinds of tales, how and when they are told, where found and what forms they take. This article is concerned only with the myths and folklore of North American tribes.

Plains Indians themselves distinguish two classes of tales: the supposedly real or historical and the fictional. Such differences may be noted from lead lines: "A tribe was settled. . . ," "Spider was traveling. . . ." The eastern woodlands Indians distinguish among events "which truly happened" (myths); adventures with supernaturals ("they-went-to-hunt-for-meat tales"); and tribal history. Animal stories are virtually universal. Perhaps the most striking aspect of Indian literature is the wide distribution of the tales of creation, the deluge, the "trickster" cycle, contest or ordeal stories, twin-hero and other myths.

Tales were traditionally told during the winter period of quiet "when the earth sleeps"; the storyteller filled an educational role, recounting night after night animal stories and trickster cycles to children. Creation myths and the origins of ceremonies were recited mainly in public to adult audiences. Definite rules governed the telling of stories—the host put up a feast, the narrator chose the topics and he continued so long as the children listened, stopping at the first sign of drowsiness. Myths and tales were widely disseminated from village to village and tribe to tribe. Warriors brought back "news" and captured bards from distant peoples. To this day, stomp-dance songs composed in Oklahoma reach New York and Ontario, and the pan-Indian gatherings in the southwest have spread the modern "hoop dance" to metropolitan Indians of Chicago and New York.

Remarkable concordances of language, myths and geographical region mark off certain folklore areas as follows: Eskimoan; northeast Algonkian; Iroquoian of the Appalachian uplands; and southeastern. The Plains, the far west and the southwest are more complex, however. Certain tales are common to the North Pacific and arctic coasts, another series spans the territory between the North Atlantic and the middle Pacific coast and a third extends along the Rocky mountains. The tale of the animal bringing up the earth from the bottom of the water is told over an enormous area; though at home in the watershed of the Great Lakes, its distribution includes the Mackenzie basin, the middle and South Atlantic coasts and a few isolated spots on the Pacific coast. An early connection has been inferred for the beautiful allegory of the loon's necklace, or the man who recovered his eyesight, which occurs both in Greenland and Oregon. Likewise, close relations obtain between Algonkin tales and those of the Pacific coast. Stories of the rabbit that tried to rival the ways of other animals are told of Longfellow's *Hiawatha* (Schoolcraft's "Nanabush"), and in Alaska they are told of the raven.

A story continental in distribution, lacking only in California and on the arctic coast, is that of the bungling host—a person who is fed by the magic powers of his host but fails ignominiously to imitate him. Legends of the stars have followed trade routes from the Great Plains up the Ohio and westward to the Pacific. An appealing plot is that concerning "Thrown-Away," an outcast orphan boy who is brought up magically to become a hero. Characteristically western are themes involving "Eye Juggler," an animal that plays ball with his eyes and finally loses them; an ascent to the sky by means of a ladder of arrows; and the contest between beaver and porcupine in which beaver invites porcupine to swim and porcupine invites beaver to climb. Migration legends form another pattern of distribution in the southwest and the Mississippi river basin.

A series of complicated Indian tales has old-world counterparts. Among the Samoyed of Siberia, as on the northwest coast of North America, children escape a pursuing cannibal by a magic flight. In Siberia a thrown whetstone becomes a ravine, a flint cast away is transformed into a mountain and a comb becomes a thicket; in America the whetstone becomes the mountain, a bottle of oil a lake, and the comb a thicket. Indian lore was enriched by contact: the French *voyageurs* traded oral literature with the ax and gun across Canada, and the Negro slave in the southeast introduced fairy and animal tales from Africa.

Material collected in different parts of the continent presents marked differences as to themes, actors, plot and formal structure. It is not the selection of themes or even the actors that permits recognition of certain types of stories as characteristic of certain areas but rather the fundamental ideas underlying the plots and composition or style. Elaboration of the tale may be extremely variable but the constant element is always some plot—such as "Thrown-Away" or the twins; "Turtle's War Party"; "Wisahka and His Brother" or "Tar Baby"—that characterizes the mythology of a particular area.

The majority of North American "test tales" have human heroes in a human setting and refer to social phenomena. In the southwest the quest for "long life" is a consistent theme of Apache mythology—an example that M. E. Opler cited in applying such themes to a characterization of the culture. In the trickster mythology, P. Radin saw the presence of a personage and motif having a permanent appeal and an unusual attraction from the beginnings of civilization, possibly reflecting universal psychic experiences of mankind. In part, the animals that appear in tales are determined by the particular fauna of each habitat. The same stories are told of all these creatures. Raven, the hero of a cycle in the northwest, is replaced farther south by the mink and then by the blue jay; the coyote ("Old Man Coyote") is the pornographic trickster on the plateau; the rabbit replaces him on the Plains and the spider in the southwest; a human trickster prevails among the Iroquois and Algonkin of the east. These tricksters are not to be equated with either animals or human beings but regarded, in Jungian terms, as the workings of a mythological imagination depicting man's struggle with nature and with himself.

Most myths of Indian origin deal with the transition from a mythological period to the modern age, usually brought about in a series of disconnected incidents by the act of a particular culture hero. Usually, the universe is assumed to be already present, and the plot is concerned with the discovery of elements, seasons, plants and animals that already exist or have been released on the earth for the use of mankind. Chaos does not precede the origin of the world. Four types of origin tales are noted: (1) accidental happenings (far north); (2) a decision by a council of animals (Plains and woodlands); (3) a contest between two beings, good and evil (California and east); and (4) the culture hero who travels about over the earth setting things right (east and northwest coast).

An absence of moralizing is offset by a high incidence of explanatory elements in the tales, particularly on the western plateau. Among the southern Caddoan tribes, an explanation of the stars predominates; on the plateau, animal behaviour is stressed; the Iroquois, Blackfoot and Kwakiutl have numerous tales relating to ceremonies; and the southern tribes tell a great number of cosmogonic tales.

Grouping of the tales into long episodes is characteristic and deliberate. The disconnected tales of the northwest present a striking contrast to such long and systematic origin myths of the east as the Iroquois myth of the holder of the heavens (the cosmology) and the Deganawidah epic (the origin of the Iroquois political system). The structure of southern Plains, Navaho and Pueblo myths is similarly complex and is built around the idea of emergence from the ground. Unlike the southeastern tribes, the northern Iroquois, and also the Cherokee, lack extensive migration legends such as the *Walam Olum* of the Delaware.

Such historic sources as the *Jesuit Relations* record fragments of cosmogonic myths, journeys to the land of the dead and legends of the origins of supernatural power, which establish the tales as pre-Columbian. But the absence of written documents relating to the trickster cycle throws the investigation back on methods of inferring history from distribution. Efforts to describe tribal culture from folklore sources, first on the northwest coast, then on the Plains and later in the southwest, demonstrated that myths are not always exact tribal autobiographies and quite often novelistic tales outweigh realism. But in the pueblos of the Rio Grande dependence on tilling the soil, the necessity of irrigation and authoritarianism are mirrored in the tales which afford instances of disciplinary action consistent with modern political organization. Cases in which individuals have introduced new rituals and myths in postcontact times are found; *e.g.*, among the Navaho, in the history of the ghost dance (*q.v.*) and in the careers of the native prophets.

Interest has been increasing in the contributions of the Indian

to American folk culture. Storytellers are still found among older reservation Indians and the growth of mythology continues in the beliefs held regarding tribal history, particularly treaties and relations with the federal government. Such traditions sometimes can be verified.

Music, poetry and the dance that comprise Indian ceremonialism have been collected since the mid-19th century. Musical scores have been printed and recordings are available on discs and tape for most areas. There is at least one successful attempt to render the native texts into English poetry. The choreography, which is inseparable from the songs and the ritual poetry, has been arranged according to the technique of Rudolf von Laban by modern students of the dance. The collected literature on the subject—much of it in native texts—is immense, but a comprehensive program of tape recording might yet rescue from oblivion style lost in transcription.

See also GHOST DANCE; INDIAN, NORTH AMERICAN; MANITO; MYTHOLOGY, PRIMITIVE; NATIVISTIC MOVEMENTS; PEYOTISM; PLAINS INDIANS; RELIGION, PRIMITIVE; SUN DANCE; TOTEMISM; *North America.*

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FOLK MUSIC has been defined in various ways according to the temper, time and particularly the territory of the investigator. A definition as serviceable as any is the one accepted in 1954 by the International Folk Music council: "Folk music is the product of a musical tradition that has been evolved through the process of oral transmission. The factors that shape the tradition are: (i) continuity which links the present with the past; (ii) variation which springs from the creative impulse of the individual or the group; and (iii) selection by the community, which determines the form or forms in which the music survives. The term can be applied to music that has been evolved from rudimentary beginnings by a community uninfluenced by popular and art music, and it can likewise be applied to music which has originated with an individual composer and has subsequently been absorbed into the unwritten living tradition of a community. The term does not cover composed popular music that has been taken over ready-made by a community and remains unchanged, for it is the refashioning and re-creation of the music by the community that gives it its folk character."

By that definition, mainly based on a formulation by Cecil Sharp in 1907, folk song in its natural state is poetry and music that is perpetuated not by writing and print but by oral transmission, and in order to remain satisfactory and memorable to the community a folk song must be founded on certain inflexible principles but constantly subjected to individual variation. Implicit in the definition is the vital dialectic of folk song creation, the perpetual struggle for synthesis between the collective and the individual, between tradition and innovation. While the International Folk Music council's definition may be employed as a rough guide to indicate what is and what is not a folk song, it must be said that not all scholars would accept its implications. Notably within the last few years, due in part to the advent of the tape recorder and to more candid contact between collector and informant, the quantity of folk song study data has enormously increased and its quality much improved. As a consequence, in the 1960s the frame of folk music studies was expanding at an almost disconcerting rate and old ideas were being drastically reconsidered in the light of new discoveries.

Origins of Folk Music.—The knottiest problems are those relating to the creation of folk music. In the 19th century lively dispute raged over the question: Is folk music communal in origin and created by a community or group rather than by an individual? Cases are attested in which a company of North American lumberjacks or Rumanian frontier guards may have whiled away a winter evening round the stove by the collective creation of a song text and even, though more rarely, a tune. However, this method of composition seems rather the exception than the rule. The modern state of studies indicates that a more usual role for the collective is not so much one of creation as of re-creation.

Hypothetically, the process might be illustrated thus: Under stress of emotion or to divert his mind from a dull task a man sets about making a song. He may take a ready-made tune as it stands, or he may adapt that tune, or he may make a melody that seems to him entirely new. To this tune he sets his words. And perhaps at evening, in the kitchen or the tavern, among congenial company, he tries out his song. Someone in the group may like the song and wish to take it into his own repertory. But when this second singer comes to reproduce the song, he may find that some passages are imperfectly remembered and he must somehow fill the gaps in text or tune. Moreover, he may feel that he can improve the song in certain details, and so he brings his individual fancy to the task. Thus his version comes to differ from the original. A third singer may learn the song from the re-creator and submit it to a similar process. So, in the course of time and transmission, many variants will come into being, some remaining close to the original while others differ from it to such a degree that they may be considered as quite separate songs. Inevitably, in this process of communal re-creation, some variants are improved while others are marred and "sung to tatters."

The foregoing may serve as hypothesis, but scientific information on the way in which folk music is created is weak and deficient, for the folklorists' experience with authentic song makers, though increasing, still is not extensive. So obscure is the process that Béla Bartók wrote: "Whether peasants are individually capable of inventing absolutely new tunes is open to doubt. We have no data to go on. And the way in which the peasant's musical instinct asserts itself encourages no such view." For folklorists of this school, variation is the key to the mystery, and Bartók's compatriot L. Lajtha puts the matter in these terms: "Folk music is *par excellence* an art of variation. The feeling for variation assures the strength, the capacity for evolution, the life of folk song, and it manifests itself as long as the folk song keeps its malleable and ductile qualities."

Some German scholars, notably Hans Naumann, have offered the theory that song, like every form of art, evolves among the educated classes and filters downward through the layers of society till it comes to rest among the lower classes, where it dwindles on as folk song, which is but the vague and sometimes distorted echo of a once-fashionable musical and poetic culture.

This theory of *abgesunkenes Kulturgut,* of a come-down cultural heritage, is fortified by the facts that songs written by troubadours (*q.v.*) of Provence 800 years ago still survive among Catalan peasants, that German scholars have been able to trace the bookish origins of hundreds of folk songs and that French traditional song is known to have been affected for centuries by the music and poetry of the courts and of the *bourgeoisie,* to say nothing of the influence of song books of urban origin, popular theatres, cabarets and the like. Indeed, the process is so marked in France that P. Coirault and other French folklorists hold the view that song may become folk song but is not so in the first place.

Similarly, urban influences have worked on folk song in Britain and the U.S., notably on the texts. Printed ballad sheets were appearing by the 1540s in England and were taken through the country districts by peddlers, while street singers and stall stationers distributed them in the towns. In North America ballad sheets containing either native compositions or copies of British texts were being printed in the 17th century, and, as in Britain, the production of these "broadsides" and "garlands" or "songsters"

continued vigorously through the 18th and 19th centuries before dwindling away during the early years of the 20th century. The extent to which town culture and print have worked on the predominantly rural and oral folk traditions of Britain and the U.S. has not been fully evaluated, but its general effect is doubtless considerable.

The traffic, however, has not flowed only in one direction. The troubadours themselves imitated folk music forms, the polyphonists of Tudor times employed in their works not only traditional song tunes but also street cries, while 20th-century composers, including some of the most advanced, have freely made use of what Bartók paradoxically called the "novelties" of the rural repertory.

From speculation about folk music origins other considerations arise concerning such factors as illiteracy and anonymity. Is illiteracy a necessary factor for the creation and survival of folk music? Whatever the case in the past, modern experience seems to show that education does not necessarily diminish the life of traditional song. Indeed, some U.S. collectors have found that illiteracy is a negative factor, particularly where ballad singing is concerned. As to anonymity, Sharp considered it an essential factor of folk song that the author should be unknown. Others deem this to be a mere accident. To those who maintain that folk songs are refashioned by so many generations of singers that the original author's composition is lost in a forest of variants, the answer is made that not all songs change to any great extent, nor are they necessarily of such antiquity; moreover, in some traditions—in Gaelic Ireland, for instance, and the northeastern woods of the U.S.—the names of the original creators are often known and are long remembered by the bearers of the songs. Two names that spring to mind are those of Blind Raftery of Mayo and the shanty boy song maker, Larry Gorman of Miramichi, N.B. Nevertheless, whether or not anonymity is *sine qua non* it is a usual condition of folk song.

In attempting to reach an objective view of the nature of folk music, theorists have been hampered by generalizations based on experience in western and central Europe, where the traditional repertory has shrunk through the loss of many of its ancient genres and has for centuries been hovering between two levels of art and between two societies, educated and unlettered, urban and rural. Furthermore, over much of this area the practice of folk music has diminished and its creation ceased; thus theory is sometimes based rather on speculation than on full evidence.

The folk traditions of southern and eastern Europe offer firmer ground for theorists, for, while these traditions have not remained unaffected by urban-educated influence, they are at once more complete in range of genres and more vigorously alive than their counterparts in the north and west. From a view offered by the Balkans, for instance, the scholar may plausibly reconstruct, at least in rough outline, the condition of folk music as it may have prevailed over most of Europe in the past. In countries such as Yugoslavia, Rumania, Bulgaria and to a lesser extent Greece, a large number of peasant rituals, magical or not, rural ceremonies and calendar feasts are occasions for folk music. Critical periods of the year and decisive moments in life—the winter and summer solstices, seedtime and harvest, funerals and weddings, etc.—have their prescribed musical repertory, often of great amplitude and importance. Besides the ceremonial songs other ritual pieces are still performed, such as musical charms to induce rain or to make a girl's hair grow beautifully. The shepherds' repertory also contains venerable survivals evoking an ancient pastoral civilization, including alphorn signals to celebrate the coming of spring and extended flute or bagpipe solos—doubtless once of magical intent—that are nothing less than folk tone poems describing the losing and refinding of beloved sheep. The range of functional music, of songs-for-a-purpose, extends far beyond field work, churning, cheese making and such. Pairing off (courtship) is also urged along by song, and a large array of apparently gratuitous lyrical pieces are associated with working bees and are designed to lighten such communal tasks as corn shucking, apple paring, sewing and embroidering. The rich treasury of dance music has its vital function too, for the week-end dances are of peculiar importance to many villages, providing prime opportunity for exchange of news with neighbours from outlying districts, for the enlistment of help with a job on hand and notably for courtship.

A folk music repertory of this kind, comprising a wide range of ceremonial and functional types and only a relatively small proportion of purely diversionary songs and instrumental tunes "for listening to," may be considered as "classical" and probably represents the general situation in Europe in past times. Along the Mediterranean, particularly in southern Italy and Spain, ritual and occasional items still comprise an important part of the rural musical fund, but elsewhere in western Europe the functional songs exist only as vestigial relics. In the U.S., apart from Christmas carols, there is an almost total absence of ritual songs; even the impressive work chants of Negro labour gangs that flourished until recently are rarely heard. As in western Europe, by far the greater part of folk music is now of diversionary and more or less gratuitous kind.

If functional songs are plentiful in southeast Europe, it should not be thought that the traditions there consist only of reflections of the past. On the contrary, 20th-century variations abound, and particularly since the end of World War II there has been a vivacious flowering of creation that was already in bud during the inter-war years. Specialists working in such fertile terrain are privileged, since fruits of knowledge that elsewhere are objects of speculation or legend grow there before the scholar's eyes and within his grasp. So, from local experience the eastern folklorist is able to confirm what many in the west had suspected: that in fact folk song may be created either by individual composition on the part of a member of the folk-singing community, or it may arise as a product of variation, or it may be received from an urban-educated source and digested into the tradition. All these processes are common enough, it seems. Variation is still the most familiar method by which the inventiveness of the folk shows itself, but in traditions where new songs are constantly arising, the process of variation may show itself in other ways than the oral transmission of a song over a considerable period of time, as is evidenced by the testimony of a Bulgarian peasant singer and song maker interviewed in 1954, who said in effect: "I have about 500 songs in my head. I take a bit from here, a bit from there, and so my new tune is made."

Some of the ancient stock of European music shows itself remarkably tough and durable, but with social advance the forms of folk song draw ever closer to art song. The process has been going on for centuries but is more noticeable in the 20th century as its pace accelerates. It seems that anonymity and perhaps orality too become less and less important as song makers living within the orbit of traditional music prepare written (perhaps even typewritten) copies of their texts and as literacy, sometimes even musical literacy, spreads in areas where folk song is still the dominant musical activity. Such developments, most noticeable in eastern Europe but affecting other parts of the continent and the U.S. also, indicate that the test of a folk song may lie neither in its origin, as was thought in the 19th century, nor in its evolution, as maintained by most 20th-century folklorists, but in the positive function it fulfills in a society; *e.g.*, it is still far closer bound to the material life of men than art music is, it is still capable of acting on the prime conditions of existence as in its ancient magical days and over a large part of the world common people still employ it as solace in dark times or as cheer to accomplish a hard task or as release for pent-up joys.

An extension of this social function is seen in the development of industrial folklore—the self-made songs of miners, textile workers, railway men, etc.—both in Europe and North America. Some of these have an epic quality that has served to encourage working men to almost superhuman effort, as Guy B. Johnson testified in his study (1929) of the ballad of the railway tunneler John Henry (*q.v.*). Industrial folk songs that convey an expression of protest have been used effectively in many countries, notably in the U.S. during the 1930s, for purposes of labour organization. The study of folk song began with the literary scholars; they yielded to the musicologists; in the mid-20th century, with living folk music running with outstretched arms toward art music and shedding its folkish appearance while retaining its folkish function,

it would seem that the musicologists in turn must give way increasingly to the specialists in social studies.

After about 1945 an urban folk music "revival" manifested itself in the U.S. and Britain, affecting particularly the middle-class youth of the large cities. Charles Seeger, noting that this tendency coincides with the tendency of many rural singers toward urban musical habits, describes the current development metaphorically as two alternate highways, the one leading from the comparatively authentic folk idiom to the comparatively authentic fine art idiom, the other following the contrary course. Thus, as Seeger wryly observes, some city performers of folk music, in their move toward rural habits of music making, pass country performers traveling in the opposite direction. The urban performers of "revived" folk music are only of marginal interest to the folklorist, since they are but visitors to that area of traditional culture of which the authentic folk singers (so long as they remain authentic folk singers) are the permanent residents.

Folklorists' attention centres on Europe and America, since the tendency has been to leave Africa to the ethnographers and Asia to the students of eastern classical music. In Europe, migrations, conquests and a diversity of material and social conditions have produced variegated markings on the map of musical folklore. In the southeast, folk song lives most vigorously and in its widest range from the oldest to the newest forms. Distinctive rural musics still flourish in parts of central Europe (Slovakia, Hungary, Croatia, Slovenia) and in the Mediterranean countries, but in Switzerland, France, Germany and Scandinavia the authentic performance of folk song is more rare and the repertories have long been influenced by town culture, though impressive relics of ancient music may still be heard here and there. In the British Isles, traditional music, though much shrunken, has remained distinct from art music to a greater degree than usual in western Europe, and by no means only in those outlying Gaelic areas where singers sometimes seem separated from the world of conventional music by 1,000 years or more. In America too, the folk song map shows differentiations of style and wealth. Both in Canada and the U.S. traditional music flourishes mainly in the east and diminishes sharply toward the west. Notable style areas are those of the northern seamen and woodsmen, the southern mountain farmers (among whom Sharp made his impressive collection of U.S. ballads of British descent), the Negro plantation workers (whose song belt extends from east of the Appalachian mountains in Virginia to Louisiana) and the western cowboys. The prevalent occupations in those areas have deeply influenced the songs, and not only with regard to the texts.

Even when smaller areas are under survey, the condition of folk music is far from homogeneous. In a single region, some villages may display a large amount of fine music while others in the same neighbourhood know only a few poor pieces. Nor are folk songs evenly spread inside the village itself, as Z. Kodály found in Hungary. The more prosperous villagers are likely to distinguish themselves from the poor even in their songs (often leaving the oldest and most beautiful items to the lowest classes), while farmers above a certain level of property ownership may feel that any kind of folk singing is unfitted to their dignity. Considerations of age and sex are of some weight too. Game songs usually remain the property of children nowadays, though they may once have been impressive items in the adult repertory. Funeral laments (where they still occur) and lullabies are sung exclusively by women; epic ballads are often deemed proper only to men and the female epic singer is looked on as abnormal, a "crowing hen." Rapid waves of social change involving, say, the advent of a bus service or the establishment of a cultural centre in a remote and backward settlement may result in the old people not knowing the middle-aged people's songs nor the middle-aged the songs of the youngsters, with each age group having its own distinctive style of performance.

Performance of Folk Music.—The idea that folk music is natural, spontaneous and produced as a bird sings on the bough does not bear close consideration. In many parts, the folk singer's voice is produced with an artifice that may differ from that of the *bel canto* singer but is quite as considerable. The more experience the folklorist gains with traditions in flower the better he realizes the part played by individual skill, taste, fantasy and diligence. The vast amount of data that has accumulated since the tape recorder came into general use has helped the specialist to understand that every Slovak shepherd or Congo canoe paddler does not necessarily have the same ability as his neighbour to display the musical treasures of his community. In the world of folk music, as of art music, there are performers with talent and others with no gifts; some have inventive imagination while others are passive imitators; some are great virtuosos, others are novices. Where the folk arts predominate, the average member of the community will join in music making to a much greater extent than his cousin in the towns, but outstanding performers are acknowledged and prized.

The qualities that make a performer important in his tradition are differently assessed in different places. Notably there are regional variations in admired ways of producing the voice. English folk singers like to pitch their voices as high as possible, whereas in Sardinia a guttural growl is practised that, in chorus, sounds like the roaring of musical lions; in southern Spain a squeezed, agonized voice is esteemed, while in the northwest region of that country a round rich voice is preferred. In the U.S., the song style of the whites—rigidly pitched, solo voiced, of limited colour, simple rhythm and with well-developed text—seems the antithesis of the relaxed, mainly choral song of the Negroes with its varied vocal colour, ingenious rhythms and fragmentary rambling texts, but in fact the two musics have greatly influenced each other, particularly in the more modern kinds of U.S. folk song.

Generally speaking, a deliberately melodious tone is seldom sought by folk singers and instrumentalists and, once started, each piece of music is produced impassively with little variation of volume, timbre or tempo (beyond a steady speeding up in some dance tunes). The expressive devices of folk song consist rather of tiny details of intonation, rhythm and ornament that may be far from obvious yet eminently flavoursome. However, in some folk music areas—for example, in the Balkans, Hungary and Spain—a measure of professionalism is found, especially among instrumentalists, and these performers, many of them gypsies, may resort to pathos and exaggerated dynamism.

The increase of rural professionalism has also greatly affected U.S. folk music, both white and Negro. The melodies have tended to gain impetus at the expense of their contour, and experimentation with the tonal and rhythmic possibilities of the fiddle, the five-string banjo and the guitar has often led to brilliant virtuosity but a lessening of musical expressiveness.

The educated ear is struck by many features of folk singing that do not correspond to the conventions of European music. Until recently most published folk music was based on skeletal notations taken down by hand directly from the informant, although as early as 1897 E. Lineva in Russia was demonstrating the importance of recording folk song by phonograph and by 1906 both Percy Grainger in England and Bartók in Hungary had accepted this idea almost as a *sine qua non*. In the U.S. their example was followed a few years later by John A. Lomax, though he was not concerned as the Europeans were with the painstakingly accurate transcription of the recordings. Today, the tape recorder provides a simple means of reproducing folk performance in all its nuances, though problems of transcription still remain, since staff notation, reasonably adequate for art music, is not able to describe clearly the deviant intonations and rhythms of folk song, much less its timbre, etc. The folklorist looks forward to an easily read and supple graphic notation, possibly produced with electronic aid.

Melodic and Rhythmic Patterns of Folk Songs.—The melodies of the oldest type of folk songs are generally restricted in range. Songs on a single note have been reported from Bulgaria, while those comprising two notes within the compass of a second or three notes within that of a third abound particularly among songs attached to calendar and funeral customs, not only in eastern Europe (*e.g.*, the English "Souling song," connected with a ritual for the dead, consists essentially of the series *re mi fa*). Likewise, songs consisting of four or five stepwise notes are found not only in the Slav countries but also in the west in such well-known songs as "The Keys of Canterbury." George Herzog stressed the importance of realizing that these restricted

note series form the scales of the tunes and are not to be considered as incomplete fragments of octave scales. "The scale of a folk tune is no more nor less than the series of notes used."

Scales of five notes within the compass of a fifth are called pentachordal. Those of five notes within the compass of an octave are pentatonic. Formerly these were considered to be characteristically Chinese, though it was early recognized that they also abounded in, for instance, Irish and Scottish music. Research shows the virtual universality of pentatonism, which is found, with or without semitones, not only in the British Isles and the far east but also in the oldest layer of Hungarian music and among the Russians, south Bulgarians, south Italians, Spaniards and Turks, to say nothing of its wide diffusion in Negro Africa and Andean America. The U.S. received this scale system from two sources, from British settlers and Negro slaves, and it occurs in many familiar Negro spirituals as well as in white folk songs as shown by Sharp's great Appalachian collection, where nearly 20% of the 969 tunes are pentatonic and a still greater proportion is in the hexatonic (six-note) system. Both pentatonic and hexatonic scales are sometimes called "gapped" scales, and it is commonly assumed that the normal heptatonic (seven-note) scales have evolved from these more fundamental forms by the process of filling in the gaps. Pentatonism is not necessarily a sign of antiquity, however, and many seven-note tunes are older than many in the "gapped" scales. *See* also SCALE.

Among the heptatonic scales or modes (*see* PLAINSONG) common in folk music are a number known to medieval church theorists. Besides these so-called "church modes"—a misleading appellation—are others unknown to medieval theory. One such is C D E F G A♭ B♭ C, occurring in Moravia and Hungary and, less commonly, in England and France. Another is a Rumanian scale found attractive by Bartók, combining the augmented fourth of the Lydian with the flat seventh of the Mixolydian, as C D E F♯ G A B♭ C. These are but a few specimens of the tonal riches of traditional music.

The rhythms of this music also show great resources. Apart from the huge corpus of melody performed in free *tempo rubato* that hardly permits the tune to be confined within bar lines, a wide range of *tempo giusto* rhythms are also heard, either binary or ternary or in compound. Chopin and Tchaikovsky are among 19th-century composers who derived unusual rhythms from their native folk music, and modern composers such as Stravinsky, Bartók and their successors have profited particularly from the discovery of the peculiar system sometimes miscalled "Bulgarian" rhythm. This system—which folklorists, borrowing a term from Turkish theory, now prefer to call *aksak*—was first noticed in Bulgaria but later was found to exist also in Turkey, Greece, Rumania, Yugoslavia and Albania, to name only the main European areas of diffusion. *Aksak* rhythms differ from classical ones in that the short and long units of duration, instead of being one-half or twice the value of each other, are two-thirds or one and one-half times the value. Thus, the bar is not made up of the play of, say, crotchet and minim (quarter note and half note) but of crotchet and dotted crotchet. In this system the eight quavers (eighth notes) of a $\frac{4}{4}$ bar do not fall into two groups of four, as with standard western music; the folk musician may subdivide them as 3 + 3 + 2, or 3 + 2 + 3, or 2 + 3 + 3. Similarly a $\frac{9}{8}$ bar would not consist of three threes, but of 2 + 2 + 2 + 3 or some other combination determined by placing the beat of three elsewhere in the bar. With this kind of rhythm unconventional time signatures such as $\frac{11}{16}$ or $\frac{13}{16}$ are often encountered. The resources of the system are large, and C. Brailoiu has tabulated 1,884 theoretical forms of *aksak* measure without claiming to have exhausted the possibilities.

Most folk music is monophonic, either solo or in unison. Nevertheless, polyphony is found to be more common and varied than was once imagined. Thus, in southern Albania alone, 32 different forms of part singing have been reported (by R. Sokoli in 1959), ranging from simple drone-based diaphony to complex four-part styles that yet owe nothing to classical European theory. In several parts of the continent ritual songs are performed antiphonally, and when, as often happens, the second group begins its response a little before the first group has finished its statement, an overlap occurs by which a more or less involuntary polyphonic effect may be momentarily achieved. It is not impossible that the origin of multivoiced music lies in accidents of the kind.

Two distinct kinds of polyphonic folk music are found in Europe, one based on a drone, the other not. Vocal drones are found in Switzerland (in the canton of Appenzell) and in northern Italy, but principally they occur in "islets" scattered across the map from Sardinia through southern Albania, Yugoslavia and Macedonia and across to the Caucasus. In the centre of this area—in southwestern Bulgaria and northern Greece—the form has generally shrunk to consist of a solo melody sung to the monotone bass of a group, but at either extremity—in Sardinia and particularly in the Caucasus—more complex part singing survives. A peculiar feature of drone-based polyphony is the frequent and much-admired clash of major seconds; indeed, in some parts of western Yugoslavia singing in parallel seconds without a drone is also practised.

The spread of "correct" harmony among folk singers is even more scattered, occurring in northwestern Spain, abounding in Germany, Austria, northern Italy and Slovenia, missing in Hungary but reappearing strongly among the Moravians, Slovaks, Ukrainians and particularly the Great Russians.

Instrumental polyphony shows itself in similar fashion. In its rudimentary forms, the accompanying instruments provide a fixed or moving drone, but in more advanced forms greater enterprise is shown—particularly in the case of the relatively recently evolved string bands in the south of the U.S., comprising fiddles, banjos, guitars and bass.

Folk Instruments.—Among the more rudimentary "sonorous engines" in use among European folk musicians are leaves (*e.g.*, in Ireland), slips of birch bark (*e.g.*, in southern Germany) and even, along the eastern Danube, fish scales inserted in the mouth and blown as a free reed. From any of these pseudo instruments the rustic virtuoso is capable of producing brilliant music. At the other end of the evolutionary scale, a number of modern factory-made instruments such as the violin, guitar, mandolin, cimbalom and (in western Rumania) saxophone are found in the hands of country players; folklorists are being forced to the opinion that any instrument may be classed as a folk instrument, depending on the way it is played.

Many instruments familiar in their evolved concert hall form are found among folk musicians in primitive condition: the shepherd pipe with or without fipple or finger holes; the rustic oboe (shawm) that is known in Yugoslavia as the *zurla*, in Persia as the *zurna* and in China as the *sona;* the rebec with or without sympathetically vibrating strings (*gusle, gudulka*, etc.); and many others. A folk instrument that has never graduated into the world of symphonic music is the widespread bagpipe, either bellows-blown or mouth-blown, which extends from Spanish Galicia to Russia and from Scotland to southern Italy. Another is the giant alphorn, sometimes 12 feet long, whose mournful bellow is still heard in the Alps and the Carpathians.

Over much of Europe, the violin has been the dominant folk instrument for several centuries, though of recent years its supremacy has been threatened by the accordion. Similarly in the U.S. the fiddle has been very popular for rural dance music. Many U.S. folk fiddlers still retain the old custom of bracing the instrument against their chests when playing; it is said that any fiddler worth his salt knows at least "the eight tunings" and perhaps a half dozen more. But in the U.S. also the fiddle has been yielding ground. Since the mid-19th century the five-string banjo has become enormously popular among white musicians in the south and east, and since the beginning of the 20th century prestige has attached to the guitar, an instrument that began to produce specifically North American sounds in the hands of Negro players at a time when jazz still resided in the orbit of folk rather than popular music.

See also BALLAD; FOLK DANCE; FOLKLORE; JAZZ; SONG.

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FOLK SONG, U.S. The folk songs of the United States have grown from imported traditions. English, Irish, Scottish and Negro songs are the roots of U.S. folk song, which has flourished with a variety and strength expressive of the young, diversified and rapidly changing American culture. Ranging from beautiful songs with delicate melodies to coarse and bawdy songs, from ancient songs carefully preserved to senseless scraps of forgotten songs lumped together, from droning or harshly unmusical songs to those with irresistible strong dancing beats, from gay lilting songs to almost intolerably sad and bitter ones, from gruesomely detailed songs of blood and violence to sweetly innocent songs, the rich body of U.S. folk song includes ballads (old and new), love songs, the blues, riddles, nonsense songs, spirituals (white and Negro), rhythm-setting work songs, occupational songs about various jobs and professions, lullabies, children's skip-rope and ball-bouncing songs, play-party and square-dance songs, street cries and many kinds of as yet unclassified songs in great numbers.

Definition.—The boundaries of U.S. folk song are not sharp and clear; the form overlaps into hymns, minstrel songs, sentimental favourites, hillbilly, rock 'n' roll and jazz. Moreover, the rigid definitions sometimes employed (as, for instance, that a folk song is always anonymous, and that it ceases to live as a folk song if it is published), however useful these may be in other countries, are not helpful here. (For a general discussion of the folk song *see* FOLK MUSIC.) U.S. folk song, *i.e.*, that which has developed in America, has a very short history. The composers of many songs are still known. Many songs have been interchanged between oral tradition and print, and some have even passed into oral tradition from phonograph records and radio broadcasts.

But although they have not been successfully defined, folk songs do constitute a definite tradition (or, more precisely, several definite traditions), so that they are usually recognizable by their characteristics. Folk song is built, traditionally, on melody and rhythm, not on harmony. ("Down by the Old Mill Stream" and "Love's Old Sweet Song," though they exist in oral tradition, are not in the folk song tradition.) Folk song employs various modes, not only the major and minor. Folk song, because it has persisted in oral tradition, changes, so that one song typically exists in more than one version.

Within the general tradition, there are several subtraditions, of which one of the most distinctive is the blues. Usually in 8 or 12 bars, with an AAB line pattern and built on a pentatonic scale, the blues employ many slides, trills and runs, have a heavy rhythm, allow great freedom in the length of word phrases, employ the guitar as if it were an equal partner to the voice and have a peculiar mood of bitter but humorous sadness. Many of the subtraditions of U.S. folk song have not been studied sufficiently for similar concise descriptions to be made, though they are recognizable to experienced ears.

Development.—The process by which new folk songs develop out of older ones is most interestingly evident in the U.S., where many British songs have been made over to express the experiences of a new country, and where rapidly changing conditions have continually provided new subjects. Familiar traditional tunes are often used with new words. The Irish folk tune that Thomas Moore used for "Bendemeer's Stream" is heard in the Cumberland mountains in a play-party song called "Hog Drovers." A song about the Irish rebellion of 1798, "Hurrah for the Men of the West," furnishes a tune for a ballad about the U.S. west, "Surrounded by Acres of Clams."

Sometimes the subject and narrative of a song are changed, but the new words echo the old. Thus the Irish street song "The Old Man Rocking the Cradle," with the lines "Ay ay ay, my darling lie easy,/It's my misfortune and none of your own," becomes a familiar cowboy song with the lines "Whoopie ti yi yo, get along little dogie,/It's your misfortune and none of my own." An English ballad about a young soldier dying of a venereal disease becomes the familiar cowboy lament "As I Walked Out in the Streets of Laredo," in which the cowboy, though dying of a gunshot wound, retains some of the symptoms of the soldier, is wrapped in white linen and requests a military funeral with fifes and drums.

An Irish song about an American utopia, "Canada Iho," becomes first a ballad about lumberjacks in Canada and then a wonderfully detailed ballad narrating the experience of a gang of buffalo skinners. An old British ballad with the chorus "Derry down down down derry down" was used during the Revolutionary War as "You Simple Bostonians," later as an Adirondack lumber camp ballad called "Blue Mountain Lake" and still later as a song of the Great Lakes sailors with the line "Bound away from Chicago for red iron ore." A hymn (still sung in the churches), "He's the Lily of the Valley, the True and Risen Lord," furnished the tune for an old minstrel-show song, "My Little Old Log Cabin in the Lane," which was later made over into "My Little Old Sod Shanty on the Plain." Another old hymn, "Follow the Risen Lord," became the well-known slave song "Follow the Drinking Gourd."

One of the most interesting U.S. folk song histories is that of the Casey Jones group. First came a varied group of hobo and railroad songs, the heroes of which are often Charlie Snyder or Hobo Jones. These songs, which include "Mama Have You Heard the News?" and "Jay Gould's Daughter," include many lines and narrative incidents that were later combined in the song "Casey Jones," which was commercially published, copyrighted and circulated by sheet music, records and radio. That song in turn gave rise to songs about Casey Jones the labour scab, Casey Jones the gold miner, etc., and to such songs as "Sidney Allen," which begins, "Come all you rounders, gather near,/And I'll tell you the story of a brave mountaineer." The many versions, the interplay of oral and published traditions, the tension between public domain and copyright, and conflicting claims of origin and authorship, all of which are associated with the Casey Jones group, are characteristic of U.S. folk song.

Influence of History and Geography.—The history and the regional geography of the U.S. are reflected in its folk song. Along the east coast, the British tradition was preserved and imitated. In the southern Appalachians it was preserved tenaciously in a relatively unchanging cultural island that also preserved old speech habits and folk customs. This region is perhaps the most prolific source of folk music in the country, adding to the old traditions banjo pieces, square-dance and play-party songs, and many new ballads.

The opening of access routes through the Appalachians to the midwest is celebrated in songs about the Cumberland gap and the Erie canal. The settling of the midwest is celebrated in songs about the new states, such as "The State of Arkansas," "The State of Illinois" and "Kansas Boys." The westward crossing of the Great Plains is described in such songs as "Sweet Betsey from Pike." The Gold Rush is described in "Days of '49," "The Banks of the Sacramento" and "What Was Your Name In the States?"

The Civil War produced a great many folk songs, as such a deep emotional upheaval was bound to do. All the U.S. wars produced folk songs, but only the Civil War produced such a profusion. After that war, folk songs reflect the great changes in the culture, the growing pains of modern America. The railroads, for instance, are memorialized in many songs, most of them, like "Casey Jones," emphasizing the dangers of early railroading. ("There's many a man been murdered by the railroad,/And laying in a low and lonesome grave.") "Paddy Works on the Railway," for example, contains the lines "Bad cess to the luck that pulled me through/To work upon the railway."

The brief era of the cowboys on the open range brought about the best-known group of folk songs produced in the U.S. The settlers of the plains, whose barbed wire ended the cowboy era, had their own songs, such as "Greer County Bachelor" and "Little Old Sod Shanty."

The influence of the Negro tradition was most strongly felt in the southern states, though that influence pervades almost all of

U.S. folk song. Three well-known groups of songs were produced by the U.S. Negroes. From work gangs in southern prisons and from labourers building the railroads come the rhythmic work songs such as "Told My Captain," "Rock Island Line" and "Another Man Done Gone." From the days of slavery come the famous spirituals in which the enslaved Negroes identified themselves with the Jews in bondage in Egypt. Some of the spirituals were used as signals and messages in the underground movement of escape from slavery; all of them are characterized by powerful emotion and deceptively simple structure. From the sharecrop farms and from the cities along the Mississippi river come the blues, also deceptively simple, which in turn were part of the origin of jazz.

The unrest that brought about social reform movements at the end of the 19th century and in the early 20th is reflected in songs of the Populists, such as "The Farmer is the Man That Feeds Them All." The growing labour movement of those times made a conscious use of folk song, changing old songs into parodies and satires such as "Pie in the Sky." During the depression of the 1930s, it was obvious that the folk song tradition was still active, as such songs as "Beans, Bacon, and Gravy" and "Nobody Knows You When You're Down and Out" demonstrate.

Revival and Study.—In the years after World War II, a combination of increasing collection by folk song scholars, the development of long-playing records and a wave of nostalgic interest in the country's history produced a popular interest in the U.S. folk song; the movement has been called the urban folk song revival. This movement encouraged the self-conscious learning of folk songs by many people to whom they were not traditional. It produced many uncritical published collections and many phonograph records of various degrees of authenticity.

The scholarly study of U.S. folk song developed tardily and long remained in a state of argument over basic methods and terms. In the 19th century, the study of ancient British ballads was made respectable by Francis James Child. Much effort was devoted, in the late 19th century and thereafter, to the collection of survivals in the U.S. of the standard British ballads.

In the 20th century, collection of folk songs on a wide scale developed, although the development took place slowly and was accompanied by great variation in method and in levels of exactness. John A. Lomax in the early 1900s, turned to the collection of songs previously considered not respectable. As field collector, as editor, publisher, popularizer, as the publicizer of the great Negro singer Huddie Ledbetter ("Leadbelly"), as a major contributor to the Archive of American Folksong in the Library of Congress, Lomax did much to set the tone for modern U.S. folk song study. A steadily increasing amount of U.S. folk song is available in books and on records. (The Library of Congress has more than 60,000 items in its collection.)

Scholars of U.S. folk song have tended to become more and more inclusive in both their definitions and their interests. As folk song scholarship becomes more systematic, a great deal more will become known, for the study is very young and the subject largely unknown. It will be noted that no mention has been made in this article of U.S. folk song in languages other than English. In the songs of other language traditions, as in so much of U.S. folk song, a great body of evidence waits for analysis, classification and description.

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FOLLEN, ADOLF LUDWIG (AUGUST ADOLF FOLLENIUS) (1794–1855), German political and romantic poet, was born on Jan. 21, 1794, in Giessen, Hesse. While studying there he founded the democratic *Deutsche Lesegesellschaft* (1814). Expelled for his political views in 1815 he went to Heidelberg where he helped to found the political student association *Teutonia*. Expelled again in 1817 because disputes with other associations had led to bloodshed, he took his degree at Giessen in 1818. Follen's political views were based on an idealized picture of the medieval Christian empire, and he aimed at incorporating the German states into a Christian, national, unitary republic; he and his brother Karl Follen (*q.v.*) formed the centre of the radical student group called the *Unbedingten* or *Schwarzen*, whose ideas were ultimately responsible for the assassination of August Kotzebue (*q.v.*) by Karl Sand. Their aims are shown in Follen's collection of songs, *Freye Stimmen frischer Jugend* (1819), and in their "Grossen Lied," shown only to a few under promise of secrecy.

In 1819 Follen became editor of the *Allgemeine Zeitung* in Elberfeld, intending to make it a leading republican newspaper, but he was arrested and committed for trial in Berlin. The poet E. T. A. Hoffmann, judge of the supreme court, judged the case mildly, but the police commission of inquiry objected and the case led to the evolution of the Prussian concept of treason which formed the basis for the numerous strict trials of liberals as "demagogues" until 1840. Follen was banished and in 1821 went to Switzerland, where he taught at Aarau, 1821–27. Later he lived at Zürich and at Hottingen. His political ideas had become more moderate and he opposed the atheism of the young Hegelian Arnold Ruge. In 1847 he bought an estate in Thurgau which he farmed himself. In 1854 he moved to Bern where he died on Dec. 26, 1855.

Follen's poetry is either political, like the *Freye Stimmen* and some of the *Harfen-Grüsse aus Deutschland und der Schweiz* (1823), or is moved by romantic enthusiasm for the middle ages as in his ballads on incidents from Swiss history, in his novel *Malegys und Vivian* (1829), in *Sigenot* (1830), in his epic poem *Tristans Eltern* (1857) and in *Siegfrieds Tod* (1843), which relates part of the *Nibelungenlied* in ballad style. He was also a distinguished translator, publishing a version of the Homeric hymns (1814) and of Tasso's *Gerusalemme liberata* (1818).

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FOLLEN, KARL (CHARLES) (1796–1840), German-U.S. educator, author and patriot, brother of Adolf Ludwig Follen (*q.v.*), was born at Romrod, Hesse-Darmstadt, on Sept. 4, 1796. He graduated from the University of Giessen as a doctor of civil and canonical law (1818), and between 1818 and 1824 taught for brief periods in the universities at Giessen and Jena in Germany and at Basel in Switzerland. His activity in revolutionary movements for German national unity and civic freedom precluded any extended academic career; suspected of repeated political intrigues, he forfeited the various university posts.

Seeking refuge, Follen went to the United States in 1824 and soon accepted an instructorship in German at Harvard (1825), becoming in 1830 Harvard's first professor of German language and literature. While at Harvard, Follen, an admirer of F. L. Jahn (*q.v.*), the father of German gymnastics, was instrumental in establishing the first U.S. college gymnasium. Follen was also a strong advocate of the new German educational theories of J. H. Pestalozzi and F. W. A. Froebel, except in higher education.

After nearly ten years, Follen's career at Harvard ended in 1835. The appointment as professor was not renewed, apparently because of his antislavery agitation, and rather than accept demotion Follen resigned and became a Unitarian minister. He died in the disaster of the steamer "Lexington," which burned in Long Island sound during the night of Jan. 13–14, 1840.

Follen was the author of several celebrated patriotic liberal songs, of which perhaps the best is "Horch auf, ihr Fürsten! Du Volk, horch auf!"

See E. L. Follen, *The Life of Charles Follen* (1844); George Washington Spindler, *Karl Follen: a Biographical Study*, with bibliography (1917). (J. M. Bk.)

FOLSOM, an early American Indian culture named after the town of Folsom, N.M., near which the first artifacts were found. There, in 1926, a stone point was discovered in direct association with the remains of a giant extinct bison (*Bison antiquus figginsi*, at that time classified as *Bison taylori*) by an expedition from the

Colorado Museum of Natural History, led by J. D. Figgins. The acceptance by archaeologists and paleontologists of this association of Folsom culture remains with an extinct Pleistocene bison required a new interpretation of the problem of the peopling of the new world. Previously the earliest Americans were thought to have arrived three or four millenniums prior to European contact. Early estimates of approximately 10,000 years for the age of the Folsom culture (which, however, by no means represents the earliest culture in the new world), based primarily on geological dating methods, are supported by later estimates based on the radiocarbon analysis of bone and shell samples from a site near Lubbock, Tex., containing Folsom artifacts.

The single type of artifact most characteristic of the Folsom culture is a thin lanceolate stone projectile point with a deeply concave base and a long narrow flake removed lengthwise from its two flat surfaces. This gives the Folsom point a fluted or "hollow-ground" appearance. Folsom points seem to represent a relatively late refinement of the fluting technique, which may have been in use in North America as early as 12,000 years ago. They are believed to have been used on a thrusting spear.

The Folsom culture is best known from excavations by a Smithsonian institution field party in 1934 and 1935, under the direction of F. H. H. Roberts, Jr., at the Lindenmeier site in northeastern Colorado. There a deeply buried Folsom campsite had been partially exposed by erosion. Excavation of the uneroded portion yielded an extensive inventory of nonperishable tools associated with hearths and the remains of extinct bison and camel. Characteristic stone tools from the Lindenmeier site include snub-nosed scrapers, end scrapers, side scrapers, drills, gravers and various types of knives. There are also sandstone shaft polishers and rubbing stones, some bone punches or awls and several bone fragments of problematical use decorated with engraved lines. The kinds of tools and the condition of the animal bone at the Lindenmeier site indicate that the Folsom people subsisted primarily by hunting large bison, and that they were not dependent to any great extent on wild plant foods. While Folsom remains have been found in localities as widely scattered as southern Alberta, Can., and southern Texas, the centre of activity of the Folsom culture was the southern high plains region, particularly the eastern portions of what are now Colorado and New Mexico. The distinctive culture of the Folsom hunters appears to have been replaced by the Plano hunting cultures before 8,000 years ago. *See* also ARCHAEOLOGY: *Prehistory: The New World Prior to Urban Civilization;* INDIAN, NORTH AMERICAN.

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FOND DU LAC, an industrial city, seat of Fond du Lac county, Wis., U.S., is located at the south end of Lake Winnebago in a dairy farming and resort region, 150 mi. N.W. of Chicago. Platted by speculators in 1835, Fond du Lac attracted many German immigrants. Sawmills and wood-product manufacturing prospered before the pine forests were removed. The town was incorporated as a village in 1847 and chartered as a city in 1852. A council-manager form of government was adopted in 1957. (For comparative population figures *see* table in WISCONSIN: *Population.*)

Principal products include machine tools, refrigerators and outboard motors. Recreation centres on the lake where motorboat races attract entries from many states. The Episcopal Cathedral Church of St. Paul, with its wood carvings from Oberammergau, is a famous institution. A vocational school and an extension of the University of Wisconsin provide education beyond high school. (W. D. W.)

FONDI (anc. FUNDI), a town in Latina province, Lazio (Latium), It., lies 19 km. (12 mi.) N.W. of Formia and 110 km. (68 mi.) S.E. of Rome by rail. Pop. (1957) 21,529 (commune). It is at the northern end of a low-lying coastal plain with the Lepini or Volscian mountains on three sides, and owes its historical importance to its control of the Appian way. The rectangular plan of the present town is that of the ancient city, the walls of which are still largely preserved. These are partly of polygonal masonry (late 3rd or early 2nd century B.C.) and partly of *opus incertum* or rubble masonry (1st century B.C.), and they include the north-east gate, with the inscription of the three aediles who built it. The main street is part of the ancient Appian way and the whole street plan closely follows that of the old Roman city. Of the many remains of Roman buildings the principal are those of a temple beneath the medieval church of S. Pietro, which was the cathedral until the see was united with that of Gaeta in 1818; it contains a fine altar canopy by the Roman marbleworker Giovanni di Nicolo (1286). The late Gothic church of S. Domenico, on the site of the ancient amphitheatre, contains a cell used by St. Thomas Aquinas. The castle (13th–15th centuries), with massive cylindrical towers and elaborately traceried windows, was sited beside the southeast gate and controlled passage along the Appian way. The Palazzo del Principe and the Castello were damaged during World War II along with much of the town.

Originally a Volscian town, Fundi in 338 B.C. received (with Formiae) limited, and in 188 B.C. full, citizenship. The family of Livia Drusilla, wife of Augustus, came from Fundi, and Augustus himself established a *colonia* there. The famous Caecuban wine was produced in the district. In the 5th century it was church property; a bishop of Fondi is recorded as early as 236. In 592 the town was sacked by the Lombards, and in 846 by the Saracens. Pope John VIII (872–882) ceded it to Gaeta. During the later middle ages it changed hands several times between the church and the kingdom of Naples, being held successively by the princely families of l'Aquila, Caetani, Colonna and di Sangro. There in 1378, under Count Onorato I Caetani, was held the conclave which elected the antipope Clement VII, giving rise to the great schism of Avignon. In 1534 and again in 1594 it was sacked by the Saracens, on the first occasion by the corsair Barbarossa, lured by the legendary beauty of the countess Giulia Gonzaga. Its position on the frontier of the papal state ensured it a lively part during the French Revolution and the events leading up to the unification of Italy. Otherwise its later history is one of steady decline. It is now an agricultural centre, notably for citrus fruits, being the northernmost point in Italy where they are regularly cultivated.

The Lago di Fondi (anc. Lacus Fundanus or Amyclanus), although partly silted up since antiquity and partly reclaimed in modern times, is still a considerable body of water (1,112 ac.). Until 1957, when a new and more direct road was opened along the coast between Terracina and Gaeta, all traffic had to follow the Appian way, skirting the northern shore. The lake takes its name from the short-lived Greek colony of Amyclae, destroyed by the Oscans in the 5th century B.C. The site now is occupied by the village of Sperlonga, which derived the name from the Roman *speluncae* ("the caves"). The grotto where Sejanus saved the emperor Tiberius, whose life was imperiled by falling rocks, was located nearby. From the largest of the caves, adapted as a nymphaeum, has come, since 1957, a remarkable collection of classical sculpture.

See S. Aurigemma, A. Bianchini and A. De Santis, *Circeo-Terracina-Fondi* (1957), with Italian bibliography; G. Jacopi, *I ritrovamenti dell'antro cosidetto di Tiberio a Sperlonga* (1958). (J. B. W.-P.)

FONSECA, MANUEL DEODORO DA (1827–1892), professional soldier and first president of Brazil, was born in Alagoas (Marechal Deodoro) on Aug. 5, 1827. The son of an army officer, Fonseca was trained from childhood for a military career. He distinguished himself for personal valour and military prowess in the Paraguayan war (1864–1870) and rose rapidly in the army thereafter. His rise to prominence occurred during a period of increasing political activity by army officers, many of whom favoured a republic. Although Fonseca was not an ardent republican, he defied the emperor, insisting that his fellow officers had the right to express their political views publicly even when they opposed the empire. The imperial government, severely weakened by other problems, could not withstand the direct military challenge to its authority. On Nov. 15, 1889, Fonseca led the bloodless *coup d'état* that toppled the empire and set up the republic. He served as provisional president until Feb. 1891, when he was elected president by the constituent assembly. Arbitrary

and autocratic, Fonseca lacked the capacity for political compromise. Unable to work harmoniously with his ministers or the congress, he resigned in Nov. 1891 and retired from public life. He died at Rio de Janeiro on Aug. 23, 1892.

Despite Fonseca's personal limitations as a political leader, his short regime established the institutional framework within which the republic functioned for nearly 40 years. Under his leadership a constitution patterned somewhat after that of the United States was issued (Jan. 1891); the highly centralized government of the empire was replaced by a federal system in which the states enjoyed almost complete political and economic autonomy; and the army was confirmed as a major element in the Brazilian political process. (R. E. P.)

FONSECA, GULF OF (Golfo de Fonseca), a sheltered inlet of the Pacific ocean in Central America, shared by Nicaragua on the south, by Honduras on the east and northeast and by El Salvador on the north and northwest. The gulf is about 50 mi. long and about 30 mi. wide at the mouth between Amapala and Cosigüina points; it is regarded as one of the world's finest natural harbours, being protected from the winds and waves of the Pacific by the islands of Conchagüita, Meanguera and the rocky Farallones. It is surrounded by volcanic shores with huge sugar-loaf islands, some of which are under cultivation, dotting the surface, and receives the Choluteca, Goascorán and Estero Real rivers and the Río Negro. The chief ports are La Unión (*q.v.*), Amapala and Puerto Morazán (on the Estero Real, Nicaragua).

The Gulf of Fonseca was discovered in 1522 by Gil González de Ávila and was named by him after his patron, Archbishop Juan Rodríguez de Fonseca, persecutor of Columbus. Under the Bryan-Chamorro treaty (1916) with Nicaragua, the U.S. acquired a perpetual option to the site of an interoceanic canal in Nicaraguan territory; at this time Nicaragua also granted the U.S. the right to establish a naval base in the Corn Islands if and when the Nicaraguan canal should be constructed. However, both Honduras and El Salvador protested to this latter grant, asserting that the waters of the gulf were not open sea but the joint property of El Salvador, Honduras and Nicaragua. (L. We.)

FONT, a basin holding the water of Christian baptism. Many types exist: pools or cisterns with edges at floor level; built-up pools with sides extending above the floor; basins hewn from the stone floor; basins set on the floor or raised on a pedestal. These types are the functional product of the corresponding development of the baptismal rite: immersion, partial immersion with infusion (pouring water over the neophyte's head); infusion alone; and finally aspersion, or sprinkling. The latter rite, requiring a small, elevated basin, is now the commonest Western form; it is not used by the Eastern churches. However, all other fonts are also found in both east and west.

The early pools had steps leading into the water for immersion. They generally did not exceed 2½ ft. in depth, with 8 in. of water. This type of font corresponds to the practice of partial immersion, used from early times. The later built-up pool allowed the neophyte to bend over it or the child to be held above it to receive the baptismal water by infusion. Pools large enough to accommodate several persons, which appeared with the basilicas of the 4th and 5th centuries, were housed in separate structures (*see* Baptistery). This practice of separating the font from the church was wholly adopted in the west until the 9th century, when western non-Mediterranean countries, probably because of the cold, began infusion; the smaller fonts required for this were placed in the church. Because of the subsequent use of less and less water, the northern countries by the 13th century came to practise baptism by sprinkling. In the 12th century, however, fonts for both immersion or simple infusion and some for both were still common in Italy.

FROM "LES FONTS BAPTISMAUX DE L'ÉGLISE ST. BARTHÉLEMY DE LIÉGE" BY JEAN PURAYE

EARLY 12TH-CENTURY BAPTISMAL FONT OF CAST BRONZE, DESIGNED BY RAINIER DE HUY FOR THE CHURCH OF ST. BARTHÉLEMY, LIÉGE, BELGIUM

The outside walls of the later pools and the basins of the middle ages became very decorative, with symbolic and geometric patterns in the stone (usually marble) or, occasionally, metal. Eastern fonts remained relatively simple. The shapes of the fonts were from the outset diversified. Most popular were the circular, then the octagonal, forms. Cruciform was commoner in the east than in the west.

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FONTAINE, PIERRE FRANÇOIS LÉONARD (1762–1853), French architect and decorator, who supervised work on the Louvre for many years, was born at Pontoise on Sept. 20, 1762, and died in Paris on Oct. 10, 1853. Several of his family were distinguished architects.

In 1779 Fontaine went to Paris to study under Peyre the younger, and won the second Grand Prix de Rome in 1785. With this grant he went to Rome. After the French Revolution he was employed by Napoleon for the restoration of the palace of Malmaison and thereafter executed the principal architectural works in Paris for Napoleon I, Louis XVIII and Louis Philippe. He was employed with his collaborator, Charles Percier, on the arch of the Carrousel, the restoration of the Palais-Royal, the grand staircase and several wings of the Louvre and the project for the union of the Louvre and the Tuileries.

The neoclassical Expiatory chapel (1815–26) in Paris is considered by many authorities the outstanding work of Percier and Fontaine. Together they published *Palais, maisons, et autres édifices de Rome moderne* (1802); *Descriptions de cérémonies et de fêtes* (1807 and 1810); *Recueil de décorations intérieures* (1812); *Choix des plus célèbres maisons de plaisance de Rome et des environs* (1809–13); *Le Parallèle des principales residences des souverains d'Europe* (1833). *L'histoire du Palais Royal* was published by Fontaine alone.

See M. Fouché, *Percier et Fontaine* (1905).

FONTAINEBLEAU, a town of northern France in the *département* of Seine-et-Marne, lies in the Forest of Fontainebleau 3 km. (nearly 2 mi.) from the left bank of the Seine and 60 km. (37 mi.) by road S.S.E. of Paris. Pop. (1962) 19,677.

The château, in the southeast of the town, is one of the largest royal residences in France. It is composed of many distinct buildings erected by different kings but mostly dating from the 16th century. It originated as a royal hunting lodge and was first mentioned in 1169. Louis VII built the chapel of St. Saturnin, and Saint Louis (IX) enlarged the buildings and added the dungeons, of which one tower still exists. Charles V established a library there (1363) which was later moved to Paris to form the nucleus of the national library of France. The chief creator of the château, however, was Francis I, who employed the best architects (including Sebastiano Serlio, Pierre de Chambiges and Gilles le Breton), sculptors and painters (including Niccolo del Abbate, Primaticcio and Benvenuto Cellini) of the period. Henry II continued the work and Henry IV contributed greatly to the embellishment of the château. The latter's son, Louis XIII, was born there. Le Vau designed the gardens for Louis XIV. Napoleon I enriched it with magnificent furniture.

The château is entered from the Place du Général de Gaulle from which a gateway leads into the Cour des Adieux, where Napoleon bade farewell to the Imperial Guard on April 20, 1814, after his abdication. Opposite the gateway is the "iron-horse" staircase (1634). The eastern side of the Cour des Adieux is joined by the Gallery of Francis I to the Cour Ovale, from which, on the north, extends the long and narrow Cour des Princes. Detached from the rest of the buildings to the east is the Cour des Offices. Among the special features of interest are the Gallery of Francis I, the

wing of the Cour des Adieux built by Louis XV which now houses a museum of American arts, the ballroom, the stairway of honour, the royal apartments and Holy Trinity chapel. The park covers about 200 ac. and is traversed by a canal dating from the reign of Henry IV.

Old houses cluster round the château, among them the pavilion of the Marquise de Pompadour, the villa Napoleon III and the Hôtel du Tambour. The town, with its large suburb of Avon, is mainly a residential and a tourist centre. It contains a museum of military uniforms. The chief festivals are the June festival (folklore), the patronal festival of St. Louis on Aug. 25 and St. Catherine's fair on Nov. 25. Two gastronomic specialities are grapes from the royal vine (grown in the Parc National), which are auctioned every September, and Fontainebleau cheese. Fishing, especially for carp, is a major activity.

The origin of the name Fontainebleau is unknown but the history of the town is intermingled with that of the château to which came many royal visitors from other lands. In World War II Adolf Hitler celebrated the fall of France at Fontainebleau, the town having been occupied by the Germans on June 15, 1940. It was the headquarters of the German Marshal Walther von Brauchitsch and, in 1943, of Marshal Erwin Rommel. Liberated by U.S. forces under Gen. George S. Patton on Aug. 23, 1944, Fontainebleau became the Western Allies' headquarters in 1945.

The forest of Fontainebleau is one of the most beautiful wooded tracts in France, with oak, beech, hornbeam, birch, coniferous and other trees. It has been painted by artists for generations and Barbizon, a small village on the edge of the forest, gave its name to a school of 19th-century landscape painters (*see* BARBIZON SCHOOL). It covers 42,000 ac., with a circumference of 56 mi., and nearly a quarter of it is of a rocky nature. The sandstone quarries supplied a large part of the paving of Paris.

See also references under "Fontainebleau" in the Index volume.

(S. LA.)

FONTANA, DOMENICO (1543–1607), Italian architect who worked on St. Peter's basilica and other famous buildings of Rome and Naples, was born at Melide (Mili) on Lake Lugano in 1543, and died at Naples in 1607. For Cardinal Montalto (afterward Sixtus V) he erected a chapel in the church of Santa Maria Maggiore and the Villa Negroni, Rome. On the election of Sixtus V, Fontana became his chief architect. Among his works were the Laleian palace, the palace of Monte Cavallo (the Quirinal), the Vatican library and other buildings, executed in the baroque style. With Giacoma della Porta he completed the dome of St. Peter's (1585–90) from Michelangelo's model.

In the course of building an aqueduct, Fontana came across remains of the ancient city of Pompeii (*q.v.*), which was excavated many years later. His most famous undertaking was the removal of the Egyptian obelisk (brought to Rome in the reign of Caligula) from its place in the circus of the Vatican and its erection in front of St. Peter's in 1586. Fontana was accused of misappropriating public money and was dismissed from his post in 1592 by Clement VIII. He then became architect at Naples to the viceroy, the count of Miranda, and built the royal palace. Fontana's projected new harbour and bridge were carried out after his death.

FONTANA, PROSPERO (1512–1597), Italian painter of the Mannerist school, was born in Bologna, and became a pupil of Innocenzo Francucci da Imola. He later worked for Giorgio Vasari and Perino del Vaga in Genoa, Florence and Rome. He has left a large quantity of work in Bologna where he lived after 1540. A representative work of his early period is the "Entombment" in the Bologna Pinacoteca, painted under the influence of his first master and comparatively careful in execution. To his later period belongs the "St. Alessis Distributing Alms," in S. Giacomo Maggiore at Bologna (1576), with many figures in architectural setting, in the mannered style of Vasari's pupils. He died in Bologna in 1597.

In portraiture Fontana was outshone by his daughter and pupil, LAVINIA FONTANA (1552–1614). She was greatly employed in Bologna and in Rome. She enjoyed the patronage of the family of Pope Gregory XIII and painted the likenesses of many illustrious personages.

FONTANE, THEODOR (1819–1898), German man of letters and one of the most successful realistic novelists, was born at Neu-Ruppin, Brandenburg, on Dec. 30, 1819. Trained as an assistant in a chemist's shop, after 1848 he found a way through journalism to a literary career. As English correspondent of two Prussian ministerial newspapers he wrote several books on British life, including *Ein Sommer in London* (1854) and *Jenseits des Tweed* (1860). From 1860 to 1870 he was on the staff of the arch-conservative *Kreuz-Zeitung*, and between 1862 and 1882 he published a series of volumes, often reissued, *Wanderungen durch die Mark Brandenburg*, describing the Prussian landscape and the seats of historic families and skilfully incorporating historical and anecdotal material. In his ballads (*Männer und Helden*, 1850; *Balladen*, 1861), which are stirring and became very popular, he celebrated heroic and dramatic events, including incidents from Prussian history.

In 1870 he became dramatic critic of the liberal *Vossische Zeitung* and, freed from the conservative attachment, produced his best work. At a remarkably advanced age he turned to the novel (his first, *Vor dem Sturm*, was published in 1878), and while his theme remains in general the Prussian nobility, to which he remained attached by sentiment, his work constitutes a sober and sympathetic criticism of its moral behaviour and foundations. His aim was, as he said, "the undistorted reflection of the life we lead," and in his realism he is one of the few German novelists to bear comparison with the great English and French novelists of his time. Though his letters show his mounting indignation in old age over the "Byzantinism" of the German court, the arrogance and anti-Semitism of the nobility, and a strong distaste for the money-making *bourgeoisie*, his depiction of these classes remains restrained and terse, relieved by an attractive humour to which he always had recourse when his indignation was too sharply provoked. He is a master of the conversation. The best of his novels are *Schach von Wuthenow* (1883), *Frau Jenny Treibel* (1892), *Effi Briest* (1895) and *Der Stechlin* (1898). In the last decade of his life he showed remarkable understanding of the art of the new Naturalistic dramatic school, particularly Ibsen and Gerhart Hauptmann. He is one of the most engaging of German letter-writers, and his autobiographical volumes are of interest (*Meine Kinderjahre*, 1894; *Von Zwanzig bis Dreissig*, 1898). He died on Sept. 20, 1898, at Berlin.

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FONTANES, LOUIS, MARQUIS DE (1757–1821), French man of letters who represented Catholic and conservative opinion in the public life of the first empire, was born at Niort, in Poitou, on March 6, 1757. During the Revolution, he drew up the protest of the people of Lyons against the repressive measures undertaken by J. M. Collot d'Herbois after their rising (Dec. 20, 1793). For this he had to go into hiding for a time. In 1795, however, he was made professor of literature in the École Centrale des Quatre-Nations, and he was one of the first members of the Institut, in which he resisted antireligious views. Proscribed by the Directory for his journalistic activity (1797), he went to London and there made friends with Chateaubriand, whom he later helped. Returning to France in 1799, he was commissioned by Napoleon to deliver a eulogy of George Washington in Feb. 1800. Thenceforward he became more prominent in politics. A member of the Corps Législatif from 1802 and its president from 1804 to 1810 (when he became a senator), he was made a count of the empire in 1808. As grand master of the University of Paris (1808–15), he eluded pressure to make it subservient to Napoleon and notably gave more encouragement to the clergy as teachers than Napoleon wanted. A supporter of monarchical government, he was at first enthusiastic for Napoleon, but went over to Louis XVIII in 1814 and was made a peer of France, minister of state (1815) and marquis (1817). He died in Paris on March 17, 1821.

His *Oeuvres*, edited by Sainte-Beuve, were published in 1839.

See A. Wilson, *Fontanes* (1928). (C. E. DU.)

FONTENELLE, BERNARD LE BOVIER DE (1657–1757), French scientist and man of letters, described by Voltaire as the most universal mind produced by the era of Louis XIV. Fontenelle was born at Rouen on Feb. 11, 1657, of middle-class parents, his father being an advocate and his mother a sister of Pierre and Thomas Corneille; he was educated at the local Jesuit college, proceeded to study law, made an unsuccessful start as a barrister and thereafter devoted himself to literature and philosophy. Two of his early publications were libretti for tragic operas (*Psyché*, 1678; *Bellérophon*, 1679), and despite later preoccupations he still wrote occasionally for the theatre in the 1730s and 1740s. Though he visited Paris in his youth he did not settle there until he had passed 30, by which time he had become famous. His literary activity during the six years 1683–88 won him a great reputation. The *Lettres galantes* (1683; expanded edition 1685) contributed to this, but the *Nouveaux Dialogues des morts* (1683; 2nd part, 1684) enjoyed a greater success and are more interesting to a modern reader. Conversations, modeled on the dialogues of Lucian, between such figures as Socrates and Montaigne, Seneca and Scarron, serve to place in circulation new philosophical ideas. The work of popularization was carried further by the *Histoire des oracles* (1686; critical edition by L. Maigron 1908; reprinted 1934), based on the Latin treatise *De oraculis ethnicorum* of the Dutch writer Anton van Dale (1683). Here Fontenelle uses a technique later to become popular with the 18th-century *philosophes:* it is to make criticisms of pagan religions in such a way that the reader will inevitably turn them against Christianity. The same antireligious bias is seen in his amusing satire *Relation de l'île de Bornéo* (published in the Dutch periodical *Nouvelles de la République des Lettres*, 1686), where the civil war between the princesses Mréo and Eénegu symbolizes the dissensions between Catholics (Rome) and Calvinists (Genève-Geneva).

Fontenelle had not abandoned belles-lettres. His *Poésies pastorales* (1688) contains an interesting "Digression sur les anciens et les modernes," in which he shows himself an unashamed supporter of the moderns, even to the extent of regarding many of Descartes's ideas (though not his method) as superseded. It was as a wholehearted Cartesian, however, that Fontenelle had published his most famous work, the *Entretiens sur la pluralité des mondes* (1686; critical edition by R. Shackleton, 1955). It is not an exaggeration to say that these charming and sophisticated dialogues were more influential than any other work in securing popular and fashionable acceptance of the Copernican system, still far from commanding universal support in 1686. Fontenelle's basis of scientific documentation was meagre: his main authority was Bishop John Wilkins' *The Discovery of a World in the Moone* (1638), and some of his figures were wildly erroneous even by the standards of his own day. He was unfortunate in the moment of his publication: the Cartesian theory of vortexes, on which his work was based, was refuted the next year in Newton's *Principia*. But the *Entretiens* were nevertheless exceedingly successful. Their author was elected to the Académie Française in 1691 and became perpetual secretary to the Académie des Sciences in 1697. He was also elected to the Académie des Inscriptions in 1701.

The secretaryship of the Académie des Sciences became in Fontenelle's hands a highly influential office and afforded him his main occupation for the rest of his life. It was his duty to publish the memoirs presented to the academy and to write its history, which he did (sometimes tendentiously) in his *Histoire de l'Académie royale des sciences*, covering the years from 1699 to 1740 in a series of volumes that appeared annually from 1702. His account of the earlier years, from the foundation of the academy in 1666, did not appear in the series till 1733; but his *Histoire du renouvellement de l'Académie* was published separately in 1708. Initially quite undistinguished as a scientist, he later became highly competent, though without ever being original. He frequently revised and amended his *Entretiens;* he kept abreast of new developments in all branches of science and corresponded with scientists in most European countries. He developed his talent for lucid popular exposition so that in some of his obituary notices read to the academy (notably those of Newton and Leibniz) it reached almost the point of genius.

Fontenelle lived meanwhile a gay social life. Having known the salon of Madame de Sévigné, he lived to grace that of Madame Geoffrin. He was a close friend of Montesquieu, whom he introduced into Parisian society. He was well known to Voltaire, who mocked him in his *Micromégas*. He was witty, good-humoured, inclined to cynicism and exceedingly cautious, perhaps as a result of having been denounced to Louis XIV's government as an atheist after the publication of the *Relation de l'île de Bornéo*. Many of the characteristic ideas of the Enlightenment are found in embryonic form in his works. His most original contribution is in his approach to historiography, shown in his *De l'origine des fables* (1724; critical edition by J. R. Carré, 1932), where he argues for the polygenesis of fables and tentatively addresses himself to comparative religion. He attended a ball at the age of 98 and died on Jan. 9, 1757, a month short of his century.

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FONTENOY, a village of Belgium in Hainaut province, lies 8 km. (5 mi.) by road S.E. of Tournai. Pop. (1955 est.) 684. Nearby was fought a famous battle during the War of the Austrian Succession, in which the French under Maurice comte de Saxe defeated an Anglo-Hanoverian force, supported by Austrian and Dutch contingents, under the command of William Augustus, duke of Cumberland. The object of the French was to cover the siege of the important fortress of Tournai; that of the British, who slowly advanced from the east, to relieve it. When fighting began, early on the morning of May 11, 1745, the French were able to put about 52,000 men into the line of battle to oppose an allied strength of 46,000. Attempts by the Anglo-Hanoverian cavalry to launch a flank attack on Fontenoy were irresolutely handled and gained nothing. At 9 A.M. Cumberland decided to make a frontal attack with his infantry, which advanced, under heavy enfilade fire from both sides, up to the French positions. Then occurred the celebrated incident in which, according to Voltaire, Lord Charles Hay invited the French, who declined, to fire first (Hay: "Messieurs les gardes françaises, tirez"; French commander: "Messieurs, nous ne tirons jamais les premiers; tirez vous-mêmes"). Hay himself, however, said that he merely toasted his opponents and called for three cheers from his men—to which the French responded in like manner. Successive volleys from the British enabled them to advance to the second line of the French positions, but there they came to a standstill and eventually, about 2 P.M., the combined effect of French artillery and cavalry attacks caused the Anglo-Hanoverian infantry square to break up and retreat. Losses among those forces actually engaged were extremely heavy, each side losing more than 7,000. The battle is commemorated by a granite cross.

FONTEVRAULT-L'ABBAYE (Lat. FONS EBRALDI), a town of western France, in the *département* of Maine-et-Loire, lies near the confluence of the Loire and the Vienne 16 km. (10 mi.) S.E. of Saumur by road. Pop. (1962) 1,286. The interest of the place centres in its abbey which was founded in 1099 by the Breton hermit Robert d'Abrissel. The establishment was a triple monastery containing separate buildings for religious, for monks and for nuns and there was also a hospital. The order was inspired by the Benedictine rule but the abbess was in complete authority. The nuns came mostly from the highest families and in the 12th century there were three houses belonging to the order in England, several in Spain and about 100 in France. In 1792 the abbey was suppressed and in 1804 Napoleon made it a convict prison, which was closed for restoration of the building in the 1960s.

The abbey church, consecrated in 1119, is a beautiful Romanesque building with a nave covered by four great cupolas. There are eight English Plantagenet royal tombs, those of Henry II and his wife Eleanor, Richard I and Isabella of Angoulême, wife of John, being the most remarkable. The chapter-house, decorated with frescoes, opens into the cloisters (all 16th century) and there is a curious 12th-century double octagonal kitchen with multiple chimneys. Near the abbey is St. Michael's church, built partly by

Henry II of England, which houses treasures from the monastery. There is also a 13th-century funerary chapel. (J. Po.)

FONTEYN, MARGOT (DAME MARGOT FONTEYN DE ARIAS) (1919–), English prima ballerina of the Royal Ballet, London, was born at Reigate, Surrey, on May 18, 1919. She studied as a child in Hong Kong and later in London with Serafima Astafieva and at the Sadler's Wells school. Her debut was with the Vic-Wells ballet in 1934. The following year she took over many classical roles from Alicia Markova, among them *Giselle*. In 1939 she danced Aurora in a revival of *The Sleeping Beauty*. Apart from the classical repertoire she created many roles in ballets by Frederick Ashton, among them *Horoscope*, *Symphonic Variations*, *Daphnis and Chloë*, *Ondine*, and has given outstanding performances in revivals of Fokine's *Firebird* and *Petrouchka*. Her dancing stands out for its exceptional musical quality; she is able to combine minute detail into a perfectly integrated whole. In 1955 she married Roberto Emilio Arias, Panaman ambassador to Great Britain. She was created dame of the British empire in 1956, and had become president of the Royal Academy of Dancing in 1954. (A. L. HL.)

FOOCHOW (FU-CHOU, MINHOW), former treaty port and the capital of Fukien (*q.v.*) province, China. Pop. (1957 est.) 616,000. It is located 35 mi. above the mouth of the Min Chiang near the head of an elongated, narrow delta, on the north bank of the river. The Min is the largest of the many Fukien drainage basins, and Foochow is the natural outlet for the area. The hinterland is rough and hilly with no good passes through its ranges and the Min is navigable by small boats only. Foochow is thus oriented to the sea, with a long history of coastal and foreign trade. The Foochow dialect is not intelligible beyond the Min river valley.

Foochow was one of the original five treaty ports and was opened in 1861. It became the chief centre of the China tea trade during the mid-19th century, and exported the noted black *bohea* tea which was grown inland. The former foreign settlement of Nan-t'ai was established on an island in the river, and is linked to the south commercial riverside suburb by the Wanshow ("ten thousand ages") and Kiangnan bridges. The decline of the tea trade, after 1880, commenced the decline of Foochow as an international port. Later the decrease in lacquerware exports and the loss of a good share of the camphor trade caused a further weakening of Foochow's commercial position.

Sand bars at the mouth of the Min Chiang prevent entry of large ships and shallows below the city caused the port proper to be located about 10 mi. downstream at Pagoda anchorage. Foochow remains a significant coastwise trading centre, but it cannot compete with deepwater ports having a large hinterland. Foochow's trade patterns continue to revolve around the exports of tea, timber products, lacquerware and leather products.

A rail connection to the Amoy–Ying-t'an line was constructed in the late 1950s, and Foochow is a highway transport centre for the Fukien region. The Chinese Communists, after 1952, began developing major industrial activities in Foochow, augmenting existing manufacturing. (J. E. SR.)

FOOD, CARE AND STORAGE OF (IN THE HOME). The prevention of food spoilage has always been one of man's major problems. Effective food care is based on recognition of the two primary causes of food deterioration: decomposition brought about by bacteria, molds and yeasts; and chemical changes within the food resulting from the action of enzymes normally present. Efficient methods of food care begin with the judicious selection of food, after which must be provided environmental conditions that will maintain optimal food qualities for as long as possible.

Temperature is the cardinal factor influencing the storage life of food, all deteriorative changes being decreased by lowered temperatures. Home refrigerators maintain temperatures of approximately 50° F., a temperature at which food storage life is almost tripled as compared with that at 70° F. Moisture content also is a critical factor. It is necessary to exercise extreme care to keep microbial contamination to a minimum. Air around stored food should be kept to the minimum, to reduce chemical changes. Foods whose pigments are sensitive to light should be held under light-restricted conditions. Fresh fruits and vegetables are best stored under refrigeration. Thorough washing (with clean water) of leafy and firm-textured vegetables and fruits is essential. These should be placed in moistureproof containers or bags and stored in the refrigerator. Berries should be spread out and held at cool temperatures; they should not be washed until just before using, since they are subject to mold growth.

Newly purchased meat cuts such as steaks, chops and poultry should be wiped with a clean, damp cloth, loosely rewrapped in a nonmoisture-absorbing material and refrigerated. The more extensive the area of cut surface, the shorter the length of storage life. Raw ground meat should not be held longer than one to two days in a refrigerator; thick roasts and steaks refrigerate well for six to eight days. Fresh fish should be cleaned, wrapped in a moistureproof, vapourproof covering and refrigerated. Storage of fresh fish or shellfish should not exceed two days.

Butter should be refrigerated in a vapourproof container to prevent the absorption of odours from other foods. Milk and cream are best stored in the delivery containers, kept covered and held at 40°–50° F. Cheeses should be kept in tightly covered containers in the refrigerator.

Shell eggs should be cleaned, if necessary, placed large end up in a covered container and stored in the refrigerator.

Frozen Foods.—The initial freezing of food is carried out at temperatures of 0° to −10° F.; after the food is frozen it should be stored at 0° or lower. Fluctuation of temperature in the freezer cabinet should be avoided. Packaging materials for frozen foods are designed to be as nearly moistureproof and vapourproof as possible. Aluminum foil, or the plastic films which are moistureproof, vapourproof and adhere tightly to food, provide protective covering.

Frozen fruits and vegetables may be stored in the freezer as purchased, in their original containers, for up to one year. In storing meats, poultry and fish it is essential to use moisture- and vapour-resistant packaging material that adheres tightly to the food. Vacuum sealing is desirable, since it greatly retards the development of rancidity. Butter may be wrapped in nonpenetrative wrappings, frozen and held in frozen storage for six to eight months. Firm cheeses, packaged in moistureproof cartons, may be held in freezer storage for one to two years.

Canned and Bottled Foods.—Transparent glass containers should be stored in a darkened area. Canned food is best stored in a cool, darkened room at temperatures of 45° to 55° F. If the entire contents of a can or bottle are not needed at one time, the unused portion may be safely left in the container at refrigerator temperatures.

Baked Foods and Leftovers.—Maintenance of good quality in baked products is dependent upon retaining the moisture in the food. These products should be carefully wrapped in moistureproof wrappers, such as aluminum foil, and kept at cool temperatures. Leftover dishes containing vegetables, eggs, cheese, milk, meat or fish require fastidious care. They should be carefully covered in tight containers, held at refrigerator temperatures and stored for only short periods of time.

See also FOOD PRESERVATION (IN THE HOME).

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FOOD, PURE: *see* HEALTH AND SAFETY LAWS.

FOOD AND AGRICULTURE ORGANIZATION. The FAO, first of the permanent specialized agencies of the United Nations to be founded after World War II, came into formal being in Oct. 1945 with the signing of its constitution at a conference held in Quebec, Que. The immediate factor leading to its foundation, was the Conference on Food and Agriculture convened at the request of Pres. Franklin D. Roosevelt at Hot Springs, Va., in 1943.

The ideas underlying foundation of the new organization came from two sources. First was the International Institute of Agriculture (*q.v.*), founded in Rome in 1905. The IIA was designed to protect farmers against the effects of sudden slumps and gluts

and was, therefore, concerned with information about market trends and agricultural statistics. Second was the League of Nations, which in the period immediately before World War II had been interested in problems of nutrition and their relationship to health. Both the IIA and the League, however, had been principally concerned with the more advanced countries, whereas in the foundation of the FAO several of the new and so-called "underdeveloped" countries took great interest and played an active part.

Since FAO was in part an answer to the question of feeding vast populations in the countries whose economies had been seriously disrupted by World War II, it was natural that the first few years should be devoted to trying to help bring about a rapid increase in the world's over-all supplies of food (*see* also FOOD SUPPLY OF THE WORLD). At the same time, the member countries had an eye on the possible emergence of surpluses of some commodities in certain countries should the distribution system break down or should needy governments not be able to pay for the food they required. Finally, an appreciation of the rapid rise in population in virtually all parts of the world in the immediate postwar period added urgency to the organization's work.

Sir John (later Lord) Boyd-Orr of Great Britain was the first director-general of FAO, 1945–48. His proposal for a world food board of wide powers, though not accepted by governments, resulted in establishment in 1947 of the Council of FAO, originally seen as a World Food Council, which subsequently became an interim governing body of 24 governments elected by the conference. During the following administration of Norris E. Dodd (U.S.), 1948–53, a proposal for an international commodity clearinghouse failed of approval. Dodd was followed by Philip V. Cardon (U.S.), 1953–56, and following his resignation for ill health, by B. R. Sen (India).

In 1951 the organization was transferred from its temporary headquarters, Washington, to a permanent seat provided by the Italian government in Rome. A regional office for North America remained in Washington; other regional offices were set up in Cairo (for the near east); Bangkok (far east), with a suboffice in New Delhi; and Santiago (Chile), Rio de Janeiro and Mexico City (for western, eastern and northern Latin America respectively). There was also a suboffice in Geneva, principally concerned with economics and forestry work, and an office in New York for special liaison with United Nations headquarters.

In its early years FAO sent advisory or exploratory missions to such countries as Poland, Greece and Venezuela. Certain funds and related agricultural projects remaining from the operations of UNRRA were handed over to FAO, including campaigns for the introduction of American varieties of hybrid corn (maize) into Europe, and for the eradication of rinderpest in Ethiopia. The hybrid maize campaign in particular was regarded as one of FAO's notable successes; it was eventually handed over, except for central co-ordination, to the various member countries.

With the creation of the United Nations Special Fund for Technical Assistance, further extrabudgetary sums became available for FAO's field operations and from 1950 onward an increasing number of countries received technical assistance from FAO under the terms of that fund. The range of projects covered all of FAO's activities in agriculture, nutrition, forestry, fisheries and economics.

Most of the experts working under the technical assistance program were on individual assignments, advising governments concerned on specific problems. FAO also helped its member governments through regional projects, including widespread plant and animal disease control schemes, such as the desert locust control program in the Arabian peninsula; projects for the eradication of rinderpest already referred to; and creation of a European commission for the control of foot-and-mouth disease. A broad educational program was also in continual operation, with training centres and seminars in many subjects and a fellowship program run in connection with the assignment of technical assistance experts.

These programs were implemented by various publications and reports of a technical nature, including the *Plant Protection Bulletin,* comprising the work of a world reporting service on plant diseases and quarantine regulations. A parallel informational service for animal diseases included an annual over-all summary of developments in the subject field as well as periodical reports. The FAO-sponsored monthly bulletin of agricultural statistics and allied yearbooks on production and trade in agriculture, fisheries and forest products were standard works in their fields.

Member nations met in full conference every second year, when the budget for the following two years was decided on. To this sum was added FAO's share of the UN technical assistance fund, varying from year to year but being approximately the same as the regular budget. *See* also references under "Food and Agriculture Organization" in the Index volume. (P. B. Cs.)

FOOD POISONING, BACTERIOLOGICAL. Illness may result from eating food containing any of a number of harmful agents: inorganic chemical poisons; poisonous plants and animals; or certain animal parasites and microorganisms. (*See* POISON; POISONOUS PLANTS; PARASITOLOGY.) Of these agents microorganisms, especially bacteria or their toxic products, are undoubtedly responsible for the greatest proportion of what generally may be called food poisoning. A distinction is often made between the toxins elaborated by such bacteria as the staphylococci and *Clostridium botulinum* (bacterial food poisoning in the strictest sense) and the intestinal disorders caused by such bacteria as the salmonellae, shigellae and streptococci (often termed "food infections").

Although spoilage and microbial putrefaction are often popularly associated with food poisoning, they are not invariable indications that food so tainted is harmful, however distasteful, unwholesome looking or odoriferous it is. (In fact, when controlled, spoilage and putrefaction often enter into the making of cheese, wines and sauerkraut and into the aging of meat.) On the other hand, some foods that look appetizing and taste good may in fact be dangerously contaminated with harmful bacteria or their products.

Still popular today, but wholly unscientific, is the term "ptomaine poisoning" ("ptomaine," from the Greek word for "corpse"). It was coined in 1870 by Francesco Selmi, an Italian toxicologist, to refer to the foul-smelling substances produced by putrefying food that was associated with cases of food poisoning and produced also by decomposing corpses. The "ptomaines," formed by the action of putrefactive bacteria on nitrogenous matter, are now known to be several different kinds of organic bases, some of which are toxic and others of which are harmless. Newspaper accounts of outbreaks of staphylococcus food poisoning sometimes refer to them as "ptomaine poisoning" outbreaks.

FOOD POISONING CAUSED BY BACTERIAL TOXINS

Staphylococcus.—Staphylococci are common in the air, in soil, on the skin and in the nose and throat. These spherical bacteria grow in grapelike clusters, and the toxin produced by some of them is responsible for the food poisoning.

Staphylococci are able to multiply under the same kinds of conditions that tend to kill other bacteria. For example, they grow abundantly in concentrations of salt and sugar that kill or prevent the growth of typhoid bacilli or spoilage bacteria. Therefore, a food partially preserved with a curing solution containing salt and other ingredients may not be a good medium for spoilage germs but may be an excellent one for food-poisoning staphylococci. The growth of staphylococci in food, with or without the production of toxin, is not detectable by taste or smell.

Staphylococcus food poisoning is probably the most frequent type of food poisoning (very few adult persons have never suffered attacks of nausea and vomiting due to it); but no reliable statement of its prevalence can be made because: (1) the illness may not be reported because it is mild or affects only one or a few persons; (2) it may be erroneously attributed to other causes.

The foods known to be involved have increased in number. Those already incriminated are milk, cheese and other milk products, custard-filled bakery goods, gravies and meats, including cured meats. The symptoms usually appear suddenly, within one to five hours after the contaminated food is eaten. They may

begin and end with nausea, vomiting, abdominal cramps and diarrhea. In severe cases the patient is weak and prostrate, his vomitus or stools may contain blood and he may even go into shock. Only rarely does a patient die, and ordinarily recovery occurs in a few days. There is usually no fever or other sign of infection such as occur in salmonella food poisoning (*see* below). A few resistant persons do not become ill after eating food contaminated with staphylococci.

The toxin responsible for staphylococcus food poisoning, called enterotoxin, is formed in food before it is eaten. Under experimental conditions enterotoxin has withstood boiling for as long as 30 minutes. For food to become poisonous it must: (1) be contaminated with a *toxin-forming* staphylococcus; (2) contain favourable nutritive requirements, such as the proper amount of moisture and degree of acidity or alkalinity; (3) be maintained at a temperature suitable for growth of the staphylococci; and (4) be kept under these conditions long enough to permit the organisms to grow and to form enterotoxin.

There is no effective specific drug or serum therapy in the treatment of severe staphylococcus food poisoning. Since frequent vomiting and diarrhea are present, it is unnecessary to remove unabsorbed poison from the gastrointestinal tract by emptying the stomach or by giving cathartics; on the contrary, the resulting loss of body fluids and the disturbances in salt balance, with accompanying acute prostration and symptoms of shock, requires that saline solutions be given subcutaneously or intravenously.

Prevention of staphylococcus food poisoning depends upon adequate refrigeration of perishable foods since contamination itself cannot be prevented. Staphylococci grow slowly at temperatures of 50° F. (10° C.), faster at room temperature (68° F., 20° C.) and rapidly at body temperature (98.6° F., 37° C.). In the cold months of the year they can grow in heated kitchens and buildings. In one experiment, in five hours on a summer day (82°–86° F., 27.78°–30° C.), staphylococci on food produced sufficient enterotoxin to cause illness in human volunteers.

Botulism.—This disease is caused by the production of a toxin in food by botulinum bacteria, *Clostridium botulinum*. These rod-shaped bacteria ordinarily live in the soil. They will not grow in the presence of free oxygen on agar surfaces that support the growth of many other bacteria, hence are called anaerobic. Since they produce spores that are resistant to heat, they succumb only to prolonged boiling. Six types (A, B, C, D, E and F) of *C. botulinum* have been described. Although each type produces a specific toxin, all of them cause similar symptoms in man or animals, or both. Antitoxins, which can be produced by inoculating animals with toxoid, are specific in their actions. For example, type A antitoxin will neutralize only type A toxin and not any of the other types. The toxin for type A has been crystallized and found to be a protein. The toxins are readily inactivated by heat and are destroyed in less than one minute at the temperature of boiling water (212° F., 100° C.).

Botulism of types A, B and E have been found in outbreaks of food poisoning involving man. Type E, unlike the others, will grow and produce toxin at 38° F. (3.33° C.) in six weeks. Type C has been found in naturally occurring outbreaks in wild waterfowl and in outbreaks in mink on fur farms, and type D has been associated with poisoning in horses and mules in South Africa. The outbreaks of type E botulism in man have been associated chiefly with canned fish products. Type F was isolated from home-made liver paste that caused an outbreak in Denmark in 1958.

In the United States, underprocessed canned foods are responsible for most outbreaks. The commercial canning industry early recognized the dangers of botulism and acted to control its processing of foods to avoid this disease. Despite the controls, a few scattered deaths continued to be caused by this source. Most cases of botulism in the United States are caused by home-canned foods, usually processed by the cold-pack method, in which the processing time and temperature have been inadequate to destroy the spores of *C. botulinum*. The pressure-cooker method, on the other hand, if operated according to the directions that come with the cooker, successfully destroys the spores and is especially recommended for preserving low-acid foods.

Of the more than 500 outbreaks of botulism recorded in the U.S. since the beginning of the 20th century, nearly one-fourth were traced to home-canned products, especially string beans. Next in importance were other vegetables: corn, spinach or chard, beets, chili peppers, etc. Also implicated were home-canned meat and fish products and dairy products. Relatively few botulism outbreaks were traced to commercially processed food products. In the U.S.S.R. outbreaks have been reported from eating salt herring, salt salmon, smoke-dried herring, dried sturgeon and smoked sturgeon. Shallots raised and canned in Naples were responsible for some cases of botulism in the United States, where the food was marketed.

Most outbreaks of botulism are dramatic in that symptoms may appear suddenly and progress rapidly to death. Symptoms usually appear within 12 to 36 hours after the toxin is ingested, although as short a period as 2 to 4 hours has been reported. In one outbreak one individual was active for eight days before hospitalization and died on the tenth day. Typical symptoms involving the nervous system are double vision, difficulty in swallowing and in speech, and laboured breathing. Death usually results from respiratory paralysis. In addition, patients may develop acute digestive disturbances with nausea and vomiting. These disturbances may be related to the degree of spoilage and to the amount of contaminated food consumed.

Experimental work has shown that spores of *C. botulinum* heated to destroy the toxin may be fed to susceptible animals without producing ill effects. Apparently spores living in the soil are toxin free, since soil and dust that contaminates fresh fruits and vegetables with their content of botulinum spores cause no ill effects when eaten by man.

The treatment of botulism is unsatisfactory. Damage done by the toxin, which is evident when symptoms are well advanced, cannot be repaired by the administration of antitoxin. It is advisable, however, to give combined type A and type B botulinum antitoxin to all patients to prevent further damage to the tissues. When the disease is discovered in a group of persons, antitoxin should also be given to those who have eaten food containing the toxin even though they may not have developed symptoms. The mortality varies for different outbreaks but the average is 65%.

The control of botulism obviously rests on adequately processing canned foods to destroy the spores of *C. botulinum*. Fortunately, foods in which *C. botulinum* has grown have an abnormal odour and taste, and the cans containing the tainted food are sometimes swollen. Foods, therefore, that exhibit these characteristics or are in swollen containers should be discarded.

FOOD POISONING CAUSED BY LIVING AGENTS

Salmonella.—*Salmonella* is a generic name applied to a group of bacteria, of more than 650 serotypes (distinct kinds), commonly known as the paratyphoid bacteria. Some of these organisms were implicated in outbreaks of food poisoning as early as 1888. The bacteria comprising the salmonella group resemble the typhoid bacteria in size, shape, staining properties, physiology, immunology and habitat in the intestine. They are not limited to man but live and grow in the intestinal tracts of other animals as well.

Some of the salmonella group produce in man a typhoidlike febrile disease that can be diagnosed only by isolating the specific organism. Others commonly produce the more usual gastroenteritis. It is known that *Salmonella* have to be living to cause either of these diseases, since bacteria-free filtrates of cultures or heat-killed organisms have failed to produce illness when fed to human volunteers. Typical food poisoning is initiated within 7 to 72 hours after the organisms are ingested and is characterized by nausea, vomiting, abdominal pain and diarrhea. The illness may start with a headache and a chill or with varying degrees of abdominal pain accompanied by diarrhea. The loose stools are usually foul smelling and may be watery. In severe cases the temperature rises, prostration, muscular weakness, faintness and thirst are present, and the white blood cell count increases. The severity of the disease differs in different outbreaks and among various individuals in the same outbreak. Convalescence usually

is rapid and may vary from a few hours to a week.

Salmonella food-poisoning outbreaks have been described in countries throughout the world. The number occurring annually cannot be estimated since not all cases are reported. The foods involved are often derived from infected animals or are contaminated during their preparation or storage by infected animals or persons. Foods contaminated with salmonella organisms have no abnormal odour or flavour.

Salmonella infections may be treated with certain antibiotics. Meat from animals ill with salmonella infection is condemned by government inspection at abattoirs in the United States where meat is sold in interstate commerce. Milk from infected cows may be rendered safe by adequate pasteurization, which kills salmonellae. Since some animals that are healthy may actually harbour salmonellae (*i.e.*, are carriers), uncooked animal products may be contaminated. The salmonellae are probably present only in small numbers under such circumstances, and if food is properly refrigerated and cooked, no ill effects follow. Foods should be stored in places inaccessible to mice and rats, which may carry salmonellae.

Streptococcus.—An alpha-type streptococcus was implicated in outbreaks of food poisoning in 1924 and was occasionally reported thereafter. If it were more generally sought in specimens of food during outbreaks, it might possibly be found more often. This streptococcus, identified as *Streptococcus faecalis*, is a bacterium commonly found in the intestinal tracts of healthy humans and animals. On the surface of blood agar plates it produces pin-point colonies surrounded by a greenish-coloured zone caused by chemical changes in the hemoglobin of the blood. Whether other related streptococci produce food poisoning still remained undetermined in the early 1960s.

The symptoms of this type of food poisoning are usually mild. They are characterized by nausea and sometimes by vomiting, colicky pains and diarrhea, symptoms that begin within 5 to 18 hours after the contaminated food is eaten. There is no specific treatment and recovery usually occurs naturally within 24 hours.

Experimental animals, with the possible exception of cats, are usually not affected after being fed food contaminated with living cultures of streptococci. Human volunteers, on the other hand, have been made ill by ingesting living cultures but not by heat-killed cultures or sterile filtrates from unheated cultures. The foods involved are numerous and include dairy products, meats, poultry and cream-filled bakery goods. In some outbreaks the contaminating bacteria were found to have had time to grow because the food was stored at warm temperatures for several hours. The control of streptococcus food poisoning requires sanitary methods in handling foods and adequate refrigeration of perishable foods.

Other Infectious Agents Transmitted by Food.—Many infectious agents may occasionally, and more or less accidentally, cause food poisoning by being transmitted in food. These include the causative agents of typhoid fever, bacillary dysentery, amoebic dysentery, scarlet fever, diphtheria, brucellosis, trichinosis, Weil's disease, infectious hepatitis, poliomyelitis and a number of other infectious agents. *Clostridium perfringens* and *Bacillus cereus* have been found in large numbers in foods implicated in outbreaks of food poisoning in which the symptoms were mild, resembling those for *Streptococcus faecalis*. In addition, many other bacteria have been suspected as being the cause of food poisoning because they have been found in the stools of patients, but convincing proof of their role in the disease is lacking.

See BACTERIAL AND INFECTIOUS DISEASES. For legislation regarding food and food handling *see* HEALTH AND SAFETY LAWS. Commercial methods used in preserving food are found in FOOD PRESERVATION; home methods are discussed in FOOD PRESERVATION (IN THE HOME).

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FOOD PREPARATION. This article covers methods of cooking generally and then deals more specifically with the preparation of the following kinds of foods: appetizers and soups; entrees; vegetables and salads; breads; desserts; beverages; and cheese, eggs and fruit. The final section is on the use of herbs and spices. For meal planning *see* DIET AND DIETETICS and NUTRITION; stoves and cooking utensils are discussed in HOME EQUIPMENT. For foods characteristic of various countries *see* FOODS, NATIONAL. *See* also articles on the various foods: BREAD; ICE CREAM; etc.

METHODS OF COOKING

Boiling and Simmering.—Water is the principal cooking medium in boiling and simmering. Boiling is cooking in water in which bubbles rise continually and break on the surface. At sea level, water boils at 212° F. (100° C.), but at higher altitudes water boils at lower temperatures, the decrease in boiling temperature being approximately 1 degree C. for each 1,000 ft. Water-soluble substances, such as sugar and salt, raise the boiling point of the water. Simmering is cooking in a liquid somewhat below the boiling point, 180°–211° F. (88°–99° C.), when bubbles form slowly and break below the surface. Throughout this article Celsius (C., centigrade) equivalents are given to the nearest whole degree.

Steaming.—Steaming, or cooking in steam, may result from added water or from water present in the food itself; in the latter case, the term waterless cooking sometimes is applied. The temperature of steam is equal to that of the liquid from which it is evolved. If the steam is confined as in pressure cooking, the temperature rises and at sea level temperatures of 228°, 240° and 250° F. (109°, 116° and 121° C.) are possible in a pressure saucepan or cooker at pressures of 5 lb., 10 lb. and 15 lb. respectively.

Broiling and Baking.—Air is the principal cooking medium in broiling and baking or roasting. Broiling is cooking by direct heat; the term grilling sometimes is applied to the same procedure. Baking is cooking by dry heat, as in an oven; roasting is the same process as baking but the term usually is applied specifically to meats. Nearly all oven cooking is done at temperatures between 250° and 500° F. (121° and 260° C.), 350° F. (177° C.) being referred to as a moderate oven temperature.

Frying.—Fat is the cooking medium in frying. The amount of fat varies from a small amount in sautéing or pan-frying to enough to cover the food in deep-fat frying. The cooking temperature is not limited by a boiling point but by the smoking temperature of the fat; *i.e.*, the temperature at which the fat decomposes and fumes become visible. Because the decomposition is irreversible and reduces the usefulness of the fat, heating a fat to its smoking point is best avoided. Temperatures of 350°–390° (177°–199° C.) are used in deep-fat frying.

Braising.—In braising, food such as meat is first browned in a small amount of fat in an open pan, then is cooked further, often on a bed of vegetables, with the pan covered. A small amount of liquid may be added after the browning is completed. The term fricasseeing may be applied to the making of a stew by braising small pieces of poultry, rabbit or veal. The braising of a large piece of meat sometimes is called pot-roasting.

Electronic Cooking.—In electronic cooking, radiant energy in the form of high-frequency radio waves causes molecular activity which generates heat within the food. Because the heat is produced within the food itself, rather than being transferred from a warmer source, interior heating is complete before exterior browning and crust formation occur. Many electronic ranges combine this rapid type of heating with a final browning under a broiler unit.

Other Heating Processes.—Some processes involve heating but are not in themselves methods of cooking. These include:

Blanching, a boiling-water or steam treatment followed by plunging into cold water, used to preserve the colour of vegetables and white meats, to remove excess salt and to aid in removal of skins from nuts and fruits.

Blazing, pouring an alcoholic beverage over a food and igniting it.

Caramelizing, heating sugar until a brown colour and characteristic flavour develop.

Glazing, treatment of the surface of a food to present a lacquerlike finish.

Parboiling, boiling a food until partially cooked, preliminary to completion of cooking by another method.

Rendering or trying or trying out, heating a fatty food to separate the free fat from the other tissue.

Scalding, either heating milk or other liquid to just below the boiling point or pretreatment of vegetables with boiling water before freezing.

Scalloping, baking pieces of food with a sauce or other liquid and a topping of crumbs.

Steeping, allowing a substance to stand in liquid below the boiling point in order to extract flavour, colour or other components.

Toasting, browning by direct heat.

APPETIZERS AND SOUPS

Appetizers.—Small portions of highly seasoned food served before a meal to stimulate the appetite are called appetizers; *e.g.*, fruit or vegetable juices; fruit cocktails consisting of various combinations of fruit; and sea food cocktails in which pieces of shellfish are served with a sauce. Hors d'oeuvres and canapés are also served as appetizers. An hors d'oeuvre can be selected from a large number of dishes, typical examples being various kinds of cold dressed vegetables, anchovies, sardines, smoked herrings, cubes and balls of cheese, stuffed eggs and other dainty relishes. Canapés, which are eaten with the fingers, consist of small crackers or pieces of bread, either plain, toasted or fried, spread with various combinations of butter, cheese, smoked meats and fish, etc., and decorated and glazed.

Soups.—The foundation of all good soups, whether thick or thin, should be a well-made stock, the basic ingredients being meat and/or meat bones, vegetables, seasoning and water. White stocks are made without first frying the ingredients, brown stocks by frying before adding the liquid. Bouillon is a plain clear soup, usually unclarified beef broth, while a consommé is a clear soup which has been clarified by the use of egg white. Consommé can be served hot or chilled, in the latter case usually jellied.

Thick soups range from plain vegetable purée soups to rich cream soups. Vegetable purée soups are made from fresh or dried vegetables and may be served with or without additional thickenings. Flour or some other starchy material, such as rice flour, is used for thickening soups and may be added at the beginning of the process, with butter or other fat, or toward the end, when it is blended with milk or other liquid. Potato and lentil soups are examples of thickened vegetable soups. Thickened meat soups include kidney, oxtail and some curry soups such as mulligatawny. Cream soups are made by adding cream or egg yolk and thin cream to the soup just before serving. Some cream soups tend to curdle, particularly those with a relatively high acid or tannin content, such as tomato and onion respectively, but the presence of starch and precautions taken when adding the milk help to prevent this occurrence. Tomato, mushroom and chicken are examples of popular cream soups.

Many soups are served with appropriate garnishes, the most usual being croutons (small cubes of bread either toasted or fried), tiny dumplings, grated cheese, lemon slices, shredded nuts, chopped hard-cooked egg, sieved egg yolk, cooked egg custard, thin strips or cutouts of vegetables and tiny meat balls.

ENTREES

Meat.—The animal flesh consumed by man consists largely of muscle tissue. A muscle is made up of bundles of fibres, each fibre, bundle of fibres and muscle being surrounded by connective tissue, the amount and kind of which influences the method of cooking a piece of meat. Fat is deposited around, between and within muscles and produces a mottled effect, called marbling, which contributes to juiciness and flavour of the cooked meat. The term cut or joint is applied to a piece of muscle tissue with the accompanying fat and bone. The large wholesale cuts into which a carcass is first divided are subdivided into the retail cuts which the consumer buys. In general, divisions are made in such a way as to separate tender from less tender parts. Composition of meat varies, with protein constituting 15%–20% of the edible portion and fat 5%–30%. The carbohydrate content is not appreciable.

During cooking most of the constituents of meat are changed. Pigments are decomposed, causing a change in colour. Proteins in the muscle fibres are coagulated by heat, causing a progressive increase in firmness. Some of the connective tissue, collagen, is changed to gelatin, allowing easy separation of muscle fibres. Another type of connective tissue, elastin, is relatively unchanged. Fat melts and some liquid evaporates which, together with changes in protein, causes shrinkage. Flavour is changed through volatilization of some constituents of meats and through changes in others because of surface browning.

Tender cuts, those containing a minimum amount of connective tissue, may be cooked by dry heat, less tender cuts by moist heat. Dry-heat methods include roasting, broiling or grilling, pan-broiling and frying. Roasting is cooking by radiated heat in an uncovered container in an oven or, less commonly, on a spit over a source of heat, and is used for relatively large cuts. A layer of solid fat may be placed on top of a very lean roast to prevent drying, or strips of fat (larding) may be forced into the muscle. Salt may be added either before or after the cooking. If a meat thermometer is used, the bulb should be centred in the largest muscle. A temperature of 300°–350° F. (149°–177° C.) is usual, as higher temperatures cause excessive shrinking and toughening. Searing or sealing, the use of a preliminary high temperature to "seal in" meat juices, has been found to increase, rather than decrease, cooking losses, but the method is still preferred by some because of the additional flavour and crispness produced.

The time required for roasting depends upon oven temperature, the initial temperature, weight, shape and composition of the meat and the desired degree of doneness. The most accurate means of determining doneness is measurement of internal temperature with a meat thermometer, but time-weight tables are useful guides in scheduling meal preparation. Broiling is a dry-heat method in which smaller tender cuts, such as steaks and chops, 1–2 in. thick, are cooked by direct heat, as under an electric unit or a flame (grills). Pan-broiling is cooking in a hot, uncovered heavy skillet or frying pan and pouring off the fat as it accumulates. Cuts which are less than an inch thick are frequently either pan-broiled or fried. Moist heat methods include braising and cooking in water. Braising is used for large, less tender cuts; pot roasts; and for smaller cuts, such as chops. The meat may be floured or coated with egg and crumbs prior to browning if a thick crust is desired, and the liquid added after browning may be water, milk, cream, meat stock, tomato juice or sour cream. Cooking is continued until the meat is tender. Overcooking in a moist atmosphere may change so much connective tissue to gelatin as to cause the meat to fall apart into stringy fibres. For cooking in water, more water is used than for braising. Stews are made by this method, and the meat may be browned before the liquid is added if a brown stew is desired. After the liquid is added, cooking is continued at a simmering temperature because boiling causes stringiness of the meat, which is usually either from a less tender cut or from a thin irregular piece of meat. A relatively large amount of liquid is used in the preparation of clear soups or in the cooking of certain cured meats as corned beef.

Differences in methods of preparing meats from different animals are due to their distinctive characteristics. Beef is roasted or broiled to rare, medium or well done (internal temperatures of 140°, 160° and 170° F. [60°, 71° and 77° C.], respectively). Veal, obtained from the calf, is treated somewhat differently because of its lack of fat and relatively high proportion of connective tissue; in order to prevent excessive drying and to soften connective tissue, braising, rather than broiling, is recommended for small pieces. Fat from another source may be added to roast veal to compensate for the fat deficiency and to supplement the mild flavour. Long, slow cooking is especially important in order to soften the connective tissue and, for this reason, veal is roasted at a temperature not exceeding 300° F. (149° C.) and is not served rare. Fresh pork is cooked well, both for sterilization and for development of the full flavour. Although sufficiently tender and low in connective tissue to be broiled, small cuts are more successfully braised because slow cooking develops more flavour than does rapid cooking. Cured pork can be cooked to a somewhat lower internal temperature than fresh pork. Because of the tenderness of lamb, parts of the carcass which for other kinds

of meat are cooked by moist heat may be cooked by dry-heat methods. Lamb roasts and chops are prepared either well or medium-cooked. The fell (the paperlike membrane covering the lamb carcass) usually is left on a leg during roasting. Mutton is stronger in flavour and less tender and moist-heat methods are therefore preferable.

Such special parts of the animal as edible organs and glands, oxtail and pigs' feet are termed variety meats or offal. Brains and sweetbreads, which are particularly tender, are precooked in acidulated water for increased firmness. Heart and tongue, the least tender of the variety meats, are simmered in water for relatively long periods. Most liver is tender enough to be fried or broiled and also may be braised.

For meat pies and puddings, *see* below, *Desserts*.

Poultry and Game.—Fowl or poultry may be cooked by all the methods described above. A large bird may be eviscerated, stuffed and roasted, provided it is not old and tough. Halves or quarters of very young chickens may be broiled. Pieces of young birds frequently are fried. Braising is used for pieces of practically any fowl. Large, less tender birds may be cut into pieces and simmered for stew or for stock.

Wild game also is cooked by the same methods. Venison, a dry meat which needs to be prepared with added fat, is improved by marinating, and braising is preferable to broiling. Rib and loin cuts may be roasted, provided they are from a rather young animal and the roast is overlaid with fat. Ducks and geese usually are stuffed and roasted. Pheasant and quail have a tendency to be dry-fleshed and frequently are braised. Squabs and partridges are broiled, roasted or braised.

Fish.—Fish are classified as to source, fresh water or salt water; as to general type, finfish or shellfish; as to oiliness of the flesh; or alternatively as roundfish, flatfish, crustaceans, mollusks and miscellaneous. In nonoily fish, fat is localized in the liver rather than scattered throughout the flesh as in oily fish. Because of extreme perishability, fresh fish should be chilled as quickly as possible after being caught and kept cold until used, which should be as soon as possible.

Finfish.—Fresh finfish can be purchased whole, in large unboned, unskinned pieces, in crosswise slices (steaks) and in boned lengthwise pieces (fillets). Because the connective tissue of fish is readily softened, tenderness is characteristic and cooking periods should be short. Cooking methods are substantially the same as those described in the section on meat. Broiling or grilling can be used for pieces of any type, except large, whole fish, the distance from the surface of the fish to the source of heat being varied according to the thickness of the piece. Fish is so easily broken that it is commonly broiled in a flat container rather than on a broiler rack and need not necessarily be turned during cooking. Baking is particularly satisfactory for a whole medium-sized fish or for pieces of large fish, as these may be stuffed. It is advisable to remove the backbone before stuffing the fish to facilitate serving, and the open edges of the fish can be sewn or held together with toothpicks. Fillets can be stuffed by spreading and rolling and then baked, or they can be cooked in an uncovered baking dish together with suitable ingredients such as sliced onion or other vegetables, sour cream and wine. Small, whole fish are frequently fried and pieces of large fish can be dipped into milk or egg and coated with flour or bread crumbs, or dipped into a batter mixture before frying, if a thick crust is desired. Marinating fish in French dressing before frying provides additional flavour. Cooking fish by poaching involves gently simmering in salted water or in a court bouillon, which should be prepared before the fish is placed in it. In its simplest form it consists of sufficient water to cover the fish, a tablespoon of white wine or wine vinegar, a bay leaf, a sprig of thyme, a little parsley, an onion pierced with a clove and a carrot sliced in two. These ingredients are simmered together for ½ to 1 hr. and strained before use. Because of the tendency for the fish to fall apart, it can be wrapped in cheesecloth or held in a frying basket or in a special rack during poaching. Steaming is similar to poaching except that the fish is held out of the water and cooked by circulating steam. Planking is a variation of either baking or broiling when the fish is cooked on an oiled hardwood plank and, during the last few minutes of cooking, may be surrounded by mashed potatoes.

Shellfish.—Shellfish, like finfish, are toughened by overcooking. Lobsters are purchased alive, dropped into boiling, salted water and then simmered until the lobster is just tender. The cooked lobster is then split through the centre from head to tail and the intestinal tract removed. The meat can be removed and combined with other foods in a variety of dishes or it can be served hot in the shell with melted butter. Lobsters also can be split and broiled. Hard-shelled or mature crabs are cooked and used similarly; soft-shelled crabs are broiled or fried. Clams and oysters often are served raw, with sauces, as well as cooked in a variety of ways. Oysters can be fried in deep fat, cooked in milk, baked with crumbs and butter or broiled in the shell, while clams can be steamed in the shell. New England clam chowder contains chopped clams, together with potatoes, onions, milk, fat and seasonings; Manhattan clam chowder contains no milk but consists of clams, tomatoes or tomato juice and celery and spices. Scallops are fried frequently or broiled or stewed and served in a cream sauce. Fresh shrimp can be cooked in the shell but the black intestinal vein running the length of the body is most easily removed before the shrimp is cooked. Shrimp can be simmered, fried in deep fat or sautéed.

Lemon butter, wedges and butterflies of lemon, parsley sauce and tart sauces, such as hollandaise and tartare, are common accompaniments for fish.

Stuffings and Gravies.—Variety can be introduced into everyday meals through the use of stuffings containing interesting combinations of ingredients. Stuffings may be classified most conveniently according to their basic ingredients, of which bread is the most commonly used. Bread stuffings contain crumbs or small pieces of dry bread, seasonings, liquid and fat. Ingredients such as chopped celery, onions, sausage, bacon, oysters, giblets, mushrooms, nuts and fruits commonly are used and corn bread is a modification. Bread stuffings are used for poultry, game birds, fish and thin pieces of meat which are rolled with stuffing, such as flank steak and breast of mutton. Rice, brown or white, may form a basis for a stuffing for green peppers or various rolled meats. An excellent stuffing for game birds is of wild rice and mushrooms, and chestnut stuffing, either with or without bread, is a favourite for turkey. Mashed potato stuffings are sometimes used for goose. Mixtures containing meat may be used for stuffing vegetables, such as marrow, squash and tomatoes, as well as for accompanying other meats. These mixtures usually are called forcemeats.

Gravies are served with meat and potatoes and are made from meat drippings, added liquid and thickening. Gravy is best made in the pan in which the meat has been roasted, provided the drippings have not been allowed to burn and excess fat is removed. The amount of liquid used depends upon the drippings available for flavour, and the amount of thickening depends upon the kind of meat the gravy is to accompany; *e.g.*, thin gravies are served with beef and thicker gravies with mutton and lamb. Fat and flour, approximately equal in amount, are blended with the drippings and allowed to brown if a dark gravy is desired. Browned flour has slightly less thickening power than unbrowned flour. The liquid, preferably meat stock or vegetable water, is then stirred in gradually and boiled for several minutes to cook the flour and dissolve the hardened meat drippings. Separation of fat from a gravy indicates too high a proportion of fat to liquid. If separation is caused by excessive evaporation of water, it may be corrected by replacement of the water.

Sauces, which often are served instead of gravies, are rich and concentrated in flavour and are usually thickened. The liquid used may be milk, cream, sour cream, stocks and/or wine. Mushrooms, herbs and other seasonings can be added to give a variety of flavours.

VEGETABLES AND SALADS

Vegetable Cookery.—Vegetables are cooked primarily to make them more digestible and more palatable. Softening of the cellulose and modification of the starch granules and pectic substances

cause a change in texture; and collapse of the cellulose causes a decrease in the bulk of green leafy vegetables. Succulent vegetables containing a high proportion of water require very little added water, whereas vegetables which tend to absorb water, such as those with relatively high starch content, require a larger amount of added water.

Pigments in vegetables may be green, yellow, white or red. Since a vegetable may contain more than one pigment, the cooking method which best preserves the colour depends upon the pigment which predominates. The yellow pigments are insoluble in water and relatively stable under ordinary conditions of cooking; thus, the colour of carrots is retained easily. Red pigments, which predominate in red cabbage and beetroots, are red in an acid solution and blue to blue-green in an alkaline solution; they are very water soluble. Red cabbage can be cooked with a slice of apple for preservation of the colour. White pigments become yellow in an alkaline medium but remain white in an acid solution; the addition of a small amount of cream of tartar or other acid to the cooking water helps to preserve the colour of, *e.g.*, onions and cauliflower. The predominating pigment in green vegetables is not water soluble, but is intensified in alkaline solution and changed to olive green in an acid solution. In spite of the effect of alkali on the green colour, bicarbonate of soda (baking soda) should not be added to green vegetables during cooking as it adversely affects texture, flavour and nutritive value.

Excessive loss of aromatic compounds through volatilization and loss through solubility in the cooking water of other flavour components causes a general weakening of flavour. Sulfur-containing aromatic compounds responsible for the distinctive flavours of strong-flavoured vegetables, such as cabbage, decompose during cooking, with a strong disagreeable flavour resulting when these vegetables are overcooked. The sulfur compound in onions and leeks merely volatilizes during cooking, with a weakened flavour resulting.

Preparation before cooking varies according to the type: root vegetables are washed and usually peeled or scraped; green vegetables are washed and crisped in the refrigerator if necessary and frequently shredded; the others are prepared variously.

Suitable methods for cooking vegetables are boiling, steaming, baking, panning and frying. The following are general rules for boiling vegetables: (1) The smallest possible amount of water should be used; an exception is the occasional recommendation that a larger amount of water be used for strong-flavoured vegetables. (2) The salted water should be brought to the boil before the vegetable is added. (3) Green vegetables should be cooked in fast-boiling water and cooked only till tender and not oversoft. Root vegetables should be cooked in gently boiling water, as these tend to break up rather easily. As a rule the pan should be covered to promote rapid cooking and minimum loss through volatilization. Desirability of cooking vegetables whole rather than in pieces depends upon the type, upon the amount of water and whether this is used later. The advantage of smaller pieces is that cooking time is shortened, thus canceling out the disadvantage of increased surface area from which loss of soluble nutrients could occur. Steaming is suitable for cooking root vegetables and some of the miscellaneous group, but not for green vegetables, as the colour will be affected adversely. A steamer made for the purpose has a lower portion for the boiling water and one or more perforated upper portions for the food. Alternatively steaming may be carried out in a saucepan with a rack. Steaming at a high temperature in a pressure saucepan shortens cooking time and is very useful for vegetables which require a relatively long cooking period and are not susceptible to undesirable colour changes, such as potatoes. In baking, water-soluble nutrients are well retained, but the relatively long cooking period required is damaging to the colour of green vegetables. Potatoes and squash are particularly satisfactory for this method. A few vegetables such as potatoes and parsnips are suitable for roasting. Panning is cooking in a small amount of fat in a tightly covered pan. Finely shredded green vegetables, such as cabbage, can be cooked by this method, since the very short cooking time required does not permit development of a strong flavour. The conservative method is similar, except that a little liquid is added as well and the cooking may be in a pan on top of the stove or in a casserole in the oven. Root vegetables are either sliced or shaped in small pieces when cooked by this method. Sautéing is a quick method using a little fat, but usually without covering the pan; mushrooms are frequently sautéed. A few vegetables are fried, the most popular being potatoes, which when deep-fat fried are called chips in Great Britain and French fried potatoes in the U.S. Tomatoes are sometimes shallow-fat fried and are one of the few vegetables which can be broiled.

All vegetables should be seasoned carefully with salt and sometimes pepper. Depending upon the method of cooking, some vegetables can be served without any further additions, but others are improved by the addition of butter or other fat. A few vegetables are served with or in white sauce, while others can be served with such sauces as hollandaise or cheese sauce.

Salads.—A salad may occupy any one of four positions in a meal. It can be served as the first course, in which case it functions as an appetizer. This type of salad is frequently a fruit salad and sharp in flavour, fresh fruit being preferable to canned fruit. As a main dish, a salad can be served for both luncheon and supper: it is frequently served with or contains pieces of cold meat, fish, hard-cooked egg or cheese, together with raw or cooked vegetables. A salad served as an accompaniment to the main course is smaller and less substantial than a main-dish salad and should emphasize tartness of flavour rather than sweetness. Such salads often are tossed in a French dressing. A dessert salad is made from a selection of fruits.

Great variety is possible in salad making. Green salads can be made with lettuce, water cress, fresh spinach, escarole or chicory, endive and other suitable ingredients, either singly or in combination, and usually are tossed. Other raw vegetables frequently used are: cabbage, carrots, cauliflower, celery, cucumber, onions, peppers, radishes and tomatoes. A typical mixed salad has a basis of lettuce with spring onions, radishes, cucumber, tomatoes and cooked beetroot. Single items, such as tomato, or a combination of two or three, for example, tomato and chicory, can be sliced and dressed. Besides beetroot, cooked vegetables commonly used in salads include: asparagus, beans, carrots, cauliflower, peas and potatoes. Potato and Russian salads are made predominantly from cooked vegetables with the addition of suitable dressings. Fruits used in salads may be fresh, frozen or canned. Both fruits and vegetables can be combined with gelatin mixtures and molded, while fruits occasionally are used in frozen salads.

Many dressings can be made to add to and accompany salads, most of them being variations and modifications of two classical recipes, French dressing and mayonnaise. The basic ingredients of French dressing are oil, wine vinegar, salt and pepper, while in mayonnaise oil is emulsified with egg yolk, and vinegar and seasonings added to taste.

BREADS

Yeast Breads.—The dough for yeast breads requires a fermentation or rising period prior to baking, during which the yeast cells grow and produce the leavening gas. Essential ingredients are flour, liquid and yeast: flour provides structure and enzyme activity; liquid assists the flour in the development of structure, holds other material in solution and makes possible the best consistency for yeast growth; and yeast provides the leavening agent. Salt is an important additional ingredient, as it helps to control fermentation and contributes to the production of an acceptable flavour. A small amount of sugar often is added as it slightly shortens fermentation time, and shortening, when added, has a tenderizing effect and improves keeping quality, but these are not essential. Characteristics of yeast breads may be varied through the use of flours other than refined wheat flour, *e.g.*, whole-wheat, soy, rye; through the use of different liquids, *e.g.*, water or milk or a mixture of the two; by use of different forms of sweetening, such as molasses or honey; and through the addition of nonessential ingredients, *e.g.*, eggs, caraway seeds, dates and raisins. Variations in the handling of the dough also affect the characteristics of the final product.

During the mixing or kneading, protein in the flour is hydrated by the liquid and forms the elastic network which gives structure and permits retention of the leavening gas. The dough then is set aside until double in volume, at which stage the dough is punched down or knocked back to expel excess gas and to equalize distribution of yeast cells and their food. In the making of loaves of bread, one further fermentation period is usual before shaping the loaves. Yeast rolls can be shaped after either the first or the second fermentation. After shaping the dough another fermentation or proving period completes the preparation for the oven. During baking the gas expands, protein is coagulated by heat, thus giving a permanent structure, the yeast cells are destroyed, the starch is cooked and the surface of the product is browned.

Temperature is important throughout the entire breadmaking process. Care must be taken during mixing to prevent premature destruction of yeast cells by excess heat, and for satisfactory fermentation the dough should be kept in a slightly warm place, about 80° F. (27° C.), free from drafts. The optimum baking temperature varies with the ingredients, ranging from 400° to 475° F. (204° to 246° C.).

Biscuits (U.S.), Scones and Other Quick Breads.—All these use a source of leavening other than yeast. Most are leavened by carbon dioxide produced chemically from baking powder or baking soda and a form of acid, but popovers are leavened by the action of steam.

Biscuits.—American biscuits are made from flour, shortening, liquid, salt and baking powder. The dough for rolled biscuits frequently is lightly kneaded in order to increase the volume, develop a cylindrical shape and a "flaky" or layered interior. After it is rolled, the dough is cut as desired and baked at 425°–450° F. (218°–232° C.). Dough for drop biscuits contains more liquid than that for rolled biscuits and is simply dropped on a baking sheet.

Scones.—These are the English equivalent of the American biscuit and are very similar. They usually are slightly sweetened and are better if not kneaded after mixing. Seedless raisins (Sultanas), dates or cheese are added for variation.

Other Quick Breads.—Other quick breads are corn bread, griddle cakes, muffins, popovers and waffles, all of which are quickly made and often served hot.

DESSERTS

Cakes.—Cakes are of two general types, shortened and unshortened, the former containing fat.

In the U.S., cakes usually are made by one of three methods. In the conventional method the sugar and fat are creamed together, the egg added and a mixture of flour, salt and baking powder mixed in alternately with the liquid, beginning and ending with dry ingredients. In the quick, dump or one-bowl method, all the ingredients except the leavening agent are put into a bowl and mixed vigorously, preferably with a power mixer, the leavening agent added and mixing completed. As a modification of the method, the eggs and part of the milk may be added as a separate stage. The muffin method involves adding the combined liquid ingredients to the combined dry ingredients but, although rapid and easy, this method unmodified produces a cake which tends to be coarse-textured and to have poor keeping quality. Chiffon cake is made by a modification of the muffin method in which the egg white is beaten separately and blended with the other mixed ingredients. Shortened cakes made by these methods can be baked in flat layer pans, in loaf pans or in individual cups and can be baked at oven temperatures of 350°–400° F. (177°–204° C.).

English cake recipes using fat are of two main types. The rubbing-in method can be used for most mixtures where the amount of fat is not more than half the amount of flour by weight: the fat is rubbed into the sifted flour, salt and leavening agent until the mixture is like fine bread crumbs; sugar and other dry ingredients such as dried fruit are added next, followed by beaten eggs together with any other liquid in the recipe. The ingredients must be mixed thoroughly without beating or overmixing for satisfactory results. The creaming method is used when the proportion of fat to flour is half or more by weight, thus producing rich cakes: the fat and sugar are creamed well together, the egg beaten into this mixture and the sifted flour and salt, together with raising agent if necessary, folded carefully in, followed by dried fruit and any liquid in the recipe. Baking temperatures vary from 290° F. (143° C.) for very rich fruit cakes to 425° F. (218° C.) for small buns.

Spongecake and angel food cake are examples of unshortened mixtures. These cakes depend largely upon incorporated air for leavening and, unless modified recipes are used, chemical raising agents are unnecessary, sufficient air to produce a light product being incorporated by whisking the eggs. In angel food cake, only the white of egg is used, beaten with cream of tartar, which is acidic and tends to stabilize the egg white foam; the blended flour, sugar and salt then are gently folded in and the desired flavouring added. A portion of the sugar may be beaten with the egg whites. When making spongecakes, two methods are possible: in the first, the unseparated eggs are whisked with the sugar and any flavouring and the sifted flour is then cut and folded into this thick light mixture; in the second, the egg yolks are beaten with lemon juice and all or part of the sugar and the egg whites are beaten separately with or without part of the sugar, the flour and salt being added to the yolk mixture and the whole combined with the beaten whites. Baking temperatures for unshortened cakes range from 300° to 450° F. (149° to 232° C.), the higher temperatures being used for thin products such as Swiss rolls. Cake or pastry flours give lighter, finer-grained and more tender cakes than do stronger flours, which are used for breadmaking.

Cookies (English Biscuits).—These usually are mixed by the creaming, quick-cake or rubbing-in methods and are of four general types. Drop cookies are made from a dough that is too soft to be rolled out on a board and is therefore dropped on to a baking sheet by spoonfuls. These cookies tend to be somewhat cakelike in texture. Rolled cookies are made from a stiffer dough which can be rolled out, cut and transferred to a baking sheet. This type of cookie tends to be crisp. Refrigerator cookies are made from a stiff dough formed into a cylindrical shape and chilled to facilitate slicing. These mixtures produce very crisp cookies. Bar cookies are made from mixtures which are baked in a continuous thin layer and cut into bar-shaped pieces after baking. Cookies are baked at temperatures of 350°–400° F. (177°–204° C.).

Shortbread.—Shortbread is sufficiently distinctive to stand in a class by itself. The ingredients—butter, fine sugar and flour or a mixture of flour and rice flour—are worked together without addition of any liquid and the result, if correctly made, is a very short product.

Pastry and Pies.—*Pastry.*—Plain pastry (similar to short-crust pastry) is made of flour, shortening (fat), salt and liquid. The fat is cut into the dry ingredients in pieces, or cut and rubbed in until the mixture looks like fine bread crumbs. The liquid then is blended gradually either into all the mixture, with a minimum of mixing, or into a part of the mixture; this paste is blended in turn with the remaining fat and flour. If liquid fat is used it is added to the dry ingredients with the other liquid. Soft flours, such as pastry and cake flours, give a shorter pastry than the stronger, all-purpose flour. Shortness is directly proportional to the amount of fat used and indirectly proportional to the amount of water added and the amount of manipulation involved. Flakiness is an internal layering obtained by leaving the fat in pieces and by using the maximum amount of water possible without producing toughness; the use of a minimum amount of water or the use of oil or melted fat tends to produce a pastry which is short but mealy rather than flaky. After the dough is mixed, it is rolled until gentle pressure with the fingers dents it only slightly and then placed in position with care to avoid stretching; otherwise the crust will shrink during baking. Pastry which is to be baked as a single shell for later filling is pricked with a fork before baking so that steam can escape. Plain and short-crust pastries can be modified by the addition of egg yolks, sugar and ingredients such as sesame seeds and chopped nuts.

The making of flaky and puff-type pastries, in which the proportion of fat to flour is high, involves special methods for the incorporation of the fat. In order to obtain the maximum amount

of flakiness and rise, most of the fat is added to the dough during the rolling process, thus forming alternate layers of fat and dough. Careful manipulation and cool conditions are essential for good results. Hot-water crust is made by boiling the fat and water together and whipping this mixture into the flour. The action should be as quick as possible as the paste must be molded while it is soft. Strong flours should be used for flaky, puff and hot-water pastries.

Dessert Pies.—Pies for dessert are of two general types, single-crust and double-crust. A single-crust pie frequently consists of a baked pastry shell filled with a starch-thickened mixture and topped with meringue: the crust is baked at a temperature of 425°–450° F. (218°–232° C.) until dry and slightly browned, and the cooked filling is added to the cooled shell. Typical fillings are chocolate-, lemon- and vanilla-flavoured mixtures. A meringue, consisting of beaten egg white, sugar and flavouring, is then spread over the filling and browned slightly in the oven. Another type of single-crust pie has an uncooked filling, in which case a baked shell is filled with a mixture containing some gelatin and the pie chilled until the mixture has set. These mixtures frequently contain fruit. Chiffon pies are those filled with gelatin mixtures to which whipped cream or beaten egg white has been added. Custard and pumpkin pies are examples of single-crust pies in which crust and filling are baked simultaneously. For minimum soaking of the crust, baking of such pies is begun at a relatively high temperature, *e.g.*, 425° F. (218° C.), and then finished at a lower temperature, 350° F. (177° C.). Single-crust pies also can be made in a deep dish with a top crust. Raw fruit, the filling generally used, is put into the dish with layers of sugar, a little water is added and the whole covered with short-crust pastry. The pastry is pricked or slit to allow steam to escape and then baked. Such pies usually are served with a sprinkling of sugar on the crust, added after cooking. In two-crust (usually fruit) pies an unbaked shell is filled with fruit, a thickening agent, sugar and spices or other flavouring; a flat piece of pie dough then is laid over the filling and the two crusts are sealed together. The top is pricked to allow for the escape of steam during baking. If this is not done, sufficient internal pressure may develop during baking to cause the fruit juice to boil out. A lattice-work of pastry strips may be used in place of the continuous top crust.

Pies can be made with a single crumb crust in place of pastry. Crumbs of crackers or cookies or breakfast cereal are mixed with butter, pressed into a piepan and either baked or chilled. Starch-thickened or gelatin mixtures are typical fillings. Crumbs also may be used to add variety as toppings for fruit pies and in deep-dish desserts, such as apple crunch or crumble.

In Great Britain, a dish with a bottom layer of pastry, with or without a top crust, is usually called a tart. Specific examples are apple, with a double crust; jam, which is baked open or with a lattice finish; and bakewell tart, which has a cake mixture type filling.

Meat Pies.—Meat pies are either deep-dish or raised. In both cases, the pastry has to withstand a comparatively long cooking period, and flaky pastry and hot-water crust are the two most commonly used. Flaky pastry is used for deep-dish meat pies, such as steak and kidney, veal and ham, and chicken pies. The usual procedure is to put the pie into a moderately hot oven to cook the pastry and then to cover the pastry with wet greaseproof paper, lower the oven temperature and continue cooking until the meat is cooked. If cooked meat is used, as in chicken pie, the pie should be ready when the pastry is cooked. These pies can be served hot or cold. A raised pie is a meat or savoury pie in which the filling is encased with pastry without requiring a dish for support. Hot-water crust is suitable for these pies since it can be molded by hand if used quickly after making. Pork and game are well-known examples of such pies, usually served cold. With both types of pie, it is usual to decorate with pastry leaves and glaze with egg before cooking.

Puddings.—Most of the products which can be classified as puddings have a farinaceous substance as one of the main basic ingredients and are oftener served hot than cold. The majority are suitable for the dessert or sweet course of a meal, but a few are not sweet and are served as or with the main course. Puddings can be subdivided into four main classes: those made with (1) suet as the form of shortening; (2) milk and eggs; (3) a cake mixture; and (4) cereal and milk. Depending upon the type, puddings are baked, boiled or steamed.

Suet puddings are of two main kinds: those with a suet crust and a filling, usually fruit, and those made of a suet mixture. The crust is made of flour, suet, salt, leavening agent and water, rolled out and used to line a pudding basin. Uncooked, prepared fruit is then packed into the basin with layers of sugar and the top covered with a remaining piece of rolled dough. The pudding is steamed 2–3 hr. and turned out onto a dish. Puddings with suet crust and dried fruit sometimes are baked. The second type of suet pudding, in which all the ingredients are mixed together, ranges from the very rich variety such as Christmas or plum puddings to plain leavened mixtures which are served with sauces, such as treacle or ginger puddings. Bread crumbs often are used instead of flour to give a light product. Long cooking is essential for these mixtures, which usually are boiled or steamed in basins.

Puddings made primarily from eggs and milk include batter puddings, which can be served with fruit or jam; pancakes and various fruit fritters; and custard-based dishes such as queen of puddings and bread-and-butter pudding. Most of this group are baked or fried.

A wide variety of puddings are made with a cake mixture base and frequently are cooked with jam, syrup and/or fruit; *e.g.*, steamed jam pudding, pineapple upside-down pudding and Eve's pudding. Usually steamed or baked, many are served with sauces.

Milk puddings vary from very plain recipes containing just milk, sugar, cereal and flavouring, to quite elaborate dishes which may have eggs and cream added and be topped with meringue. The richer puddings usually can be served hot or cold, while the plain varieties frequently are served hot with stewed fruit or jam. These puddings can be cooked in a double saucepan or baked.

Meat puddings are of the suet crust type and are made in the same way as fruit puddings, beefsteak and kidney being the most common filling. Dumplings, cooked and served with boiled beef and some soups, are made from a plain suet mixture and Yorkshire pudding is made from a batter and baked, usually as an accompaniment to roast beef.

Cold Sweets.—Fruit desserts are those predominantly or wholly composed of fresh or cooked fruit; *e.g.*, mixed fruit compote, fruit salad, stewed fruit and fresh fruit. Gelatin, an important ingredient in many well-known desserts, *e.g.*, jellies of fruit juice and fruit, and cream mixtures, such as *bavaroise*, is also often added to such desserts as cold *soufflés*, mousses and ice cream to give additional structure and smoothness. Eggs are used both as a thickening agent in custards and creams and as a foaming agent to give lightness in *soufflés* and similar dishes. Custard, a mixture of egg, milk, sugar and flavouring, may be either a stirred sauce or baked or steamed to form a set dish, caramel cream or custard being a well-known example of the latter. Egg whites often are used separately; *e.g.*, in hard meringues, which consist of beaten egg whites, sugar and flavouring, baked very slowly until dry and then filled with fruit and/or cream.

Starch of various kinds is an important thickening agent in many desserts and blancmange, made from cornstarch, milk, sugar, butter and flavouring, depends entirely on starch for its structure. Starch-thickened mixtures, or mixtures thickened with both starch and egg, are also used as fillings for cream puffs and éclairs, while whole grain cereals such as rice can be creamed and served with fruit or other flavouring.

Many popular desserts are combinations of several individual items, trifle and charlotte russe being good examples.

Chilled Desserts.—Many of the types of desserts mentioned above can be chilled to advantage. Whipped cream, beaten egg whites and gelatin are common constituents of such desserts, but various combinations of fruits, nuts, coconut, cookie crumbs and other ingredients also can be used. In frozen desserts, firmness is produced by ice crystals; smoothness and other characteristics, by the ingredients and the method of preparation. This group consists mainly of ices. The simplest form is the water ice consisting of fruit juice or other flavouring, water and a sweetening

agent. A sherbet is modified by the addition of gelatin or beaten egg whites to give increased smoothness of texture and may have milk or cream substituted for water. A sorbet (frappé in the U.S.) is a soft water ice with fruit or liqueur flavour and only half frozen. The usual basis of an ice cream is either cream or custard or a mixture of the two; flavouring, such as fruit purée or chocolate, sugar and often a little gelatin (to give additional smoothness) are added. A half-frozen ice cream is usually known in Great Britain as a frappé. Both ices and ice creams are stirred during the freezing process. Desserts that are frozen without stirring are mousses, parfaits and cold *soufflés*, which are light ice cream preparations made from custard, cream, fruit or sirups, whisked egg whites and flavouring. *Bombes* and ice puddings are combinations of at least two different frozen mixtures packed in a mold and refrozen.

Confections.—Homemade candies or sweets are of two general types, crystalline (*e.g.*, fondant and fudge) and noncrystalline or amorphous (*e.g.*, caramels, taffy, brittle and all kinds of toffee).

Crystalline.—In the making of crystalline candies, sugar in crystalline form is dissolved in excess water, combined with chocolate or other ingredients and cooked until properly concentrated. The degree of concentration may be checked either by taking the temperature of the sirup or by testing the sirup in cold water. During cooling of the concentrated sirup, the amount of sugar that can remain in solution decreases. Thus, at a temperature only slightly higher than body temperature, beating initiates recrystallization of so much of the sugar that a solid mass is formed. Vigorous beating during crystal formation tends to keep the crystals small and the texture of the candy smooth. Certain added ingredients also contribute to smoothness by interfering with crystal formation, *e.g.*, cream of tartar and other materials that act chemically; if used to excess or if allowed to act too long, as in very slow cooking, acids may interfere with crystallization to such an extent that the candy fails to harden. Butter and other fats and corn sirup act mechanically to keep crystals small. If a crystalline candy is cooked to or beaten at too high a temperature, a grainy product is likely to result, but this can be redissolved in water, cooked to the proper end point and finished satisfactorily.

Noncrystalline.—Noncrystalline candies are cooked at higher temperatures and the sugar solidifies so rapidly during cooling that crystals are not formed. These candies are not beaten and high proportions of substances which interfere with crystallization are sometimes added, *e.g.*, caramels are not agitated after cooking and have a high proportion of fat and of milk solids. Taffy is pulled when it is cool enough to be handled and this incorporates air, thus lightening the colour. Brittles are not manipulated except that they are sometimes stretched during cooling in order to make them as thin as possible.

Other confections include glazed apricots, prepared by cooking dried apricots slowly in a heavy sirup, glazed nuts, similarly prepared, and marzipan, a sweetened, flavoured paste of ground almonds frequently tinted and shaped for use as a decorative confection. Fondant can be used, with or without nuts, as stuffings for dates, prunes and apricots and also can be shaped and dipped in a special chocolate coating. It also can be melted, flavoured and tinted and either poured out in small amounts to form flat, round mints or used as a dip for balls of firm fondant.

BEVERAGES

Coffee.—Coffee is available in four forms: powdered, frozen liquid concentrate, whole bean and ground. Powdered coffee and the frozen concentrate are dissolved in hot or boiling water; coffee beans are ground and then used as ground coffee. The beverage may be prepared from ground coffee by several methods but, regardless of the method used, the aim in coffee making is extraction of the desirable flavouring substances with a minimum amount of the tannins and other bitter-tasting substances. Subboiling temperatures are preferable to boiling because (1) the desirable flavour constituents are volatile and thus easily lost during boiling and (2) the bitter components of coffee are increasingly soluble in water as the temperature rises. Caffeine, the stimulating substance in coffee, is soluble in hot water and therefore extracted with the other constituents, but decaffeinated ground coffees are available. There are three general methods of making coffee. Steeping requires no specialized equipment, the coffee being heated with water in a coffeepot or a covered saucepan and kept just below boiling point until the desired strength is obtained. In a percolator a small amount of water is forced upward through a tube and then filtered downward through the coffee grounds; the process is repeated until enough water-soluble material has been extracted to give the desired strength and colour. In the drip method boiling water is poured onto the grounds and allowed to filter through the coffee into a serving pot. Fineness of grind is important in this method as the water is in contact with the grounds only once and for a short time. In vacuum-type coffee makers, coffee is made by a variation of the drip method or by a method in which the extraction takes place as steam is forced up through the grounds. Automatic electric coffee makers are either percolator or vacuum in type. After-dinner coffee usually is served very strong in a small cup called a demitasse.

Teas.—Green, black and oolong teas differ because of their different treatment during processing. Black tea is subjected to a fermentation process not used for green tea, resulting in a mildness of flavour as compared with the pungent flavour of green tea. Oolong is partially fermented and its flavour compromises between those of green and black teas. Terms such as pekoe and orange pekoe are grade designations based on size of leaf, the smaller leaves being graded higher. The only general method for making tea is steeping: boiling water is added to the tea leaves, which are allowed to steep for approximately three minutes, after which the tea bag or ball is removed or the infusion is poured off the leaves. If a very strong beverage is desired, it is best obtained by using more tea leaves rather than by steeping for a longer time, as longer steeping results in the undesirable extraction of more tannin. Iced tea is made by pouring freshly made tea over ice: because of the dilution by melting ice, a particularly strong infusion of tea is used. However, if the infusion is too strong or if it is prepared by long steeping, the chilled product may become cloudy because of precipitation of tannins, which are less soluble in cold than in hot water. The stimulant in tea, theine, is the same as caffeine in coffee and is found in green and black tea in similar amounts.

Milk Beverages.—*Cocoa* and *chocolate* beverages contain milk and usually are served hot. Since cocoa contains starch, the mixture should be cooked for several minutes at some stage in the preparation, unless the precooked variety is used, in order to avoid a raw flavour and a sediment in the finished product. Cocoa and chocolate contain theobromine, a stimulant similar to caffeine.

Other milk beverages include *café au lait*, a mixture of strong coffee and hot milk, and numerous cold mixtures of milk and fruit juices.

CHEESE, EGGS AND FRUIT

Cheese.—Characteristics of various cheeses, the most pronounced of which are caused by differences in moisture content and methods of ripening, affect their use in food preparation. Moisture content may be as high as 75% for a soft cheese, as cottage cheese, or as low as 30% for a hard cheese, as Parmesan. Ripening may be brought about by acid-forming bacteria, as in Cheddar, by gas-forming bacteria, as in Gruyère, or by mold, as in Roquefort, and it is during ripening that the characteristic flavour and texture develop and that the cheese becomes easier to blend with other ingredients in cooking.

When cheese is heated, the fat melts and, as the temperature increases, the protein coagulates and the fat tends to separate; heating above 160° F. (71° C.) tends to toughen the protein and cause stringiness. In the preparation of a cheese sauce, grated cheese is mixed into a white sauce which has been cooled to approximately 125° F. (52° C.); if the cheese fails to melt, the sauce may be heated over hot water until the cheese is blended. In the preparation of baked cheese mixtures, such as macaroni and cheese, high temperatures and overcooking should be avoided.

Eggs.—In addition to adding colour, flavour and nutritive value,

eggs also contribute thickening, as in custards; structure, as in chou paste (cream puffs) and to some extent cake mixtures; leavening, as in angel food cake and sponges; emulsification, as in mayonnaise; and binding, as in croquettes and meat loaves.

Eggs are frequently used alone, either poached, fried, scrambled or cooked in the shell. Poached eggs are broken into simmering water and cooked until the white coagulates; fried eggs are broken into a skillet and cooked in fat. For scrambling, the eggs are broken and slightly beaten, a little milk and seasoning added and the mixture heated slowly with a little butter and stirred gently until just coagulated. Boiled eggs are cooked in the shell in simmering water until the required degree of coagulation is obtained. The formation of a dark ring around the yolk can be prevented by not overcooking and by immediately placing hard-cooked eggs in cold water.

The changes which occur during the cooking of eggs are largely due to the coagulation of protein at relatively low temperatures, 140°–160° F. (60°–71° C.) in the case of undiluted egg and a little higher with diluted egg mixture, such as custards. Overcooking eggs causes overcoagulation, with the result that the protein is toughened and liquid and solid separate in custards or other mixtures in which liquid has been added.

Fruit.—The changes which occur during the cooking of fruits affect texture, flavour and colour. Alterations in texture are due to several factors: softening of cellulose, the substance of which plant cell walls are composed; changes in the pectic substances which bind the cells together; cooking of the starch which is present in some fruits; and changes in moisture content. Flavour is due to the presence of sugar, organic acids, aromatic compounds and mineral salts, and the loss of aromatic compounds through volatilization is an important problem of fruit cooking. Losses of sugar, acid and salt are mainly the result of their solubility in cooking water.

The colour of fruits is chiefly due to a group of yellow pigments, carotenoids, and to red pigments, anthocyanins: the yellow pigments are so stable that their preservation during cooking is no problem, but the red pigments, although maintaining their colour in the presence of acid, are water-soluble and tend to leach out into the cooking water and, in some cases, to form blue or black compounds with tin and iron. Another group of compounds, tannins, also found in fruits but not classified as pigments, may react with iron to form dark-coloured compounds and therefore iron knives and pans of tin, iron or chipped enamel should not be used in the preparation of fruits.

Fruits can be cooked in water or a sugar solution, baked, broiled or fried. The amount of water used in cooking fruit depends upon the kind used; *e.g.,* berries require less added water than apples since they have a higher natural water content. Cooking fruit in a sugar solution tends to make it lustrous but, if the sugar solution is too concentrated, sufficient moisture may be drawn from the fruit to cause shriveling; on the other hand, if the sugar solution is very dilute or no sugar is added to the cooking water the fruit may become mushy. If the fruit is to be sieved, as for applesauce, it should be allowed to become mushy by cooking in water and the sugar, if needed, added after sieving, but if the fruit is desired for garnish, as in the case of coloured and spiced pieces of apple, a sugar sirup should be used. Fruits cooked in a sugar sirup are usually referred to as stewed or coddled fruits. Fruits which are sometimes baked include apples, bananas and pears: apples are frequently cored, stuffed with a mixture of sugar, butter, seasonings, raisins and nuts and baked whole; bananas and pears are halved, dotted with butter and sprinkled with fruit juice and cinnamon or other seasoning. Some fruits can be broiled; *e.g.,* grapefruit, canned and fresh pineapple rings and canned peach halves. Apples and bananas are sometimes fried and also made into fritters.

Cooked fruit can be used in a variety of ways during a meal: as an appetizer, *e.g.,* broiled grapefruit; as part of the main course, *e.g.,* fried apples; as a garnish, *e.g.,* cinnamon apples; or as dessert, *e.g.,* baked fruits and various fruit puddings.

The principal goal in the cooking of dried fruits is the replacement of water removed during drying. Rehydration can be achieved satisfactorily by slow cooking of the fruit in water or by a short soaking period followed by slow cooking. Sugar, if needed, should be added when the fruit is nearly done. Long soaking of the fruit prior to cooking tends to produce a watery product.

HERBS AND SPICES

Seasoning is an extremely important part of food preparation; real skill in the seasoning of foods requires experience, imagination, discrimination and restraint, for overseasoning can be even more serious than underseasoning. Herbs and spices provide an endless means for enhancing the natural flavours of food.

Herbs.—Herbs are plants with succulent, distinctly flavoured leaves, which can be used fresh or dried, preferably in a finely divided form and always in small amounts. Meat dishes, vegetables, salads, soups, sauces, fish, poultry and egg dishes may all benefit from additions of herbs. The following are some of the more commonly used herbs.

Basil, an aromatic potherb whose leaves have a strong flavour resembling cloves, is always included in the making of turtle soup.

Bay leaves, from a species of laurel tree, are used in soups, with meats and fish and one or part of a bay leaf is always included in the *bouquet garni* and in court bouillon.

Chervil, whose delicate flavour resembles both parsley and fennel, is used in salads, soups, sauces and meat dishes and sometimes in the fresh green state.

Chives, related to onions and similar in flavour, are used in salads and soups.

Dill is commonly used in pickling as well as in meat and vegetable dishes, soups, salads and sauces; the leafy tops are used as well as the dried fruit, usually known as dill seed.

Fennel, related to the parsley plant and with a flavour similar to aniseed, is commonly used for flavouring fish sauces, soups and salads.

Marjoram is one of the sweet herbs which, when dried, are included in mixed herbs for flavouring stews, meat dishes and soups, etc.

Mint is mainly used when fresh but sometimes in a dried form; the serving of mint sauce with lamb, hot or cold, is an English custom, as is the addition of mint leaves to the cooking of new potatoes and green peas.

Oregano is widely used in meat dishes, with eggs, beans, cheese dishes and fish, and is essential to Latin cookery.

Parsley, a lacy green herb with a slightly sharp flavour, is used as a garnish, in sauces and salads, can be fried and is used fresh to a greater extent than dried.

Rosemary is a mint-flavoured herb used with lamb and other meats and in stuffings.

Sage, a commonly used seasoning in bread stuffings for poultry and other meats, is also used in soups and sauces.

Sorrel is an essentially French herb used for making sorrel soup and for flavouring omelets and sauces.

Tarragon is used fresh in salads and for flavouring in chicken dishes, omelets, sauces and stews, as well as in tarragon vinegar.

Thyme, a pungently flavoured herb widely used in stuffings, sauces, soups and meat dishes, is traditionally used in the preparation of jugged hare.

Mixtures of herbs can be bought, such as poultry seasoning with sage usually predominating and mixed herbs, usually consisting of thyme, sage, marjoram and parsley.

Spices.—Spices are aromatic parts of plants, mostly tropical, which are dried and used in food preparation either whole or in a pulverized form. A spice may represent the root, bark, fruit, flower, bud or seed of the plant.

Allspice is the dried fruit of the pimento tree, its name being derived from the similarity of its flavour to that of a mixture of cinnamon, cloves and nutmeg and is used primarily in baked cakes and cookies.

Anise (aniseed) is an extremely small seed, the oil of which is used in confections, sauces, creams, sweet puddings and cakes, as well as pickling.

Whole *caraway* seeds are used in breads, cakes, meat dishes, salads and in some cheese.

Cardamom seeds resemble anise in flavour and are used similarly, and in curry.

Celery seeds are used in pickling and in soups, as well as in fish and meat dishes.

Cinnamon, the bark stripped from young branches of the cinnamon tree, is available either in the ground form or in rather large pieces and is used extensively in cookies, cakes and with fruits.

Cloves are the unopened flower buds of the clove tree, available either whole or ground, and are used for flavouring soups, stocks, meats and desserts.

Powdered *coriander* seed is used mostly in pickling and is a constituent of curry powder.

Cumin seed is ground and used in soups and meat dishes and is a constituent of curry paste.

Ginger is an example of a spice obtained from the rhizome of a plant and is available both in pieces as stem or crystallized ginger and in the ground form; it is used in baked products such as cakes and cookies, in certain meat dishes and in oriental cookery, being a common ingredient of curry powder and pastes.

Mace is the covering of the nutmeg, with a similar delicate flavour, and is used for flavouring the same kind of products as is the nutmeg, as well as in preserving.

Mustard seeds are of two varieties, black and white (yellow); the ground form is used mainly for making a condiment or relish, although it is also used in flavouring meat and cheese dishes.

Nutmeg is available either ground or as whole seeds and is used widely in the preparation of desserts, soups, beverages and baked products.

Black and white pepper are both obtained from the same plant, black pepper from the dried immature fruit and white pepper from the dried mature fruit with the hull removed; pepper is used as a condiment and as a seasoning in all savoury dishes.

Saffron, the dried stigma of a plant related to the crocus, is used occasionally for flavouring and colouring of special type cakes.

Sesame seeds are small, light-coloured seeds with a nutty flavour, and are used in breads and confections.

Turmeric (curcuma) is another example of a dried rhizome or root and is from a plant of the ginger family; the yellow powder is used extensively in curry powder and in prepared mustard.

Vanilla, obtained from the dried pod of a plant, is a very delicate flavouring that can be used for all kinds of sweet dishes.

Others.—Curry powders and pastes are made up of various combinations of many spices and herbs, each combination varying considerably in flavour. Curry, as a dish, is of immemorial use in India. Two important sources of flavour which cannot be classified as either herbs or spices are garlic and horse-radish. Garlic is the bulb of a plant, the small sections of which are known as "cloves" of garlic, and is used extensively in flavouring meat and vegetable dishes and salads, but needs to be used with care and discrimination. Horse-radish is a root with a somewhat peppery taste used grated and usually served as a cream sauce, particularly with roast beef. *See* also FLAVOUR; and references under "Food Preparation" in the Index volume.

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FOOD PRESERVATION. As foods in their natural state remain sound and edible for only a comparatively short time, food preservation has engaged the attention of mankind from the earliest times. Prehistoric man preserved his cereals by parching, vegetables and fruits by drying, milk in the form of fermented products or as cheeses, and fruit juices as cider or wines; and the hunter learned to dry or salt his game or fish. The ever-increasing spread of man over different parts of the world into widely different climates and still more the increase in urban populations have rendered the development of efficient methods of preservation a matter of vital necessity. For many centuries the art of preservation was at a standstill or developed only slowly and was purely empirical, fermentation, drying, smoking or curing with salt being the principal methods. As the biological causes of food spoilage became better understood, rapid advances followed and appropriate methods were soon developed for dealing with the causative agents.

Since most foods either carry or eventually acquire bacteria, molds or yeasts, microorganisms are the major cause of food spoilage. Other factors leading to deterioration or spoilage are the enzymes (ferments) naturally present in some foods, and various chemical reactions, particularly oxidation. Some factors which lead to spoilage in one food might be regarded as desirable in another instance and may be, indeed, essential for the protection of certain foods. For example, yeasts are applied in making wine, bacteria in the manufacture of sour milk and pickled products and molds in cheese making. Enzymes are used in both cheese making and in brewing, and the browning of roasts and bread crust is a type of chemical reaction that in many other foods leads to deterioration and spoilage.

There are several major processes for food preservation. The growth of microorganisms (and enzyme activity) in foods may be retarded by cooling or almost entirely prevented by freezing. Since water is necessary for the growth of microorganisms, dried (dehydrated) foods will keep for long periods. Or the enzymes and microorganisms present in foods may be completely or almost completely destroyed by the application of heat as in thermal processing (canning). In canned foods reinfestation by microorganisms must be prevented, hence the need for hermetically sealed containers. Finally, both enzyme action and microbial growth can be prevented by the addition of certain chemicals or through chemicals produced in fermentations. Smoking, salting and candying are the age-old examples of this type of food preservation, but the use of chemical preservatives and inhibitors, including antibiotics, is more important today. The preservation of food with ionizing radiations (cold sterilization) will doubtless be added to this list when the principles involved and the operational details are sufficiently developed to allow large-scale commercial application. Often several of the principles are applied in combination. For instance, cabbage is preserved as sauerkraut in the presence of salt and by the chemicals produced by the microorganisms during fermentation, and much of this product is later marketed in cans after heat sterilization. Some frozen food products are heated before freezing in order to inactivate the enzymes or to reduce the number of viable organisms present. A combination of dehydration and freezing is used in the processing of dehydro-frozen foods.

The modern objective of food preservation includes more than the mere prevention of spoilage. Quality, economy and convenience are in most instances important in the production and marketing of processed foods. Colour or appearance, flavour, texture or consistency and freedom from defects are the major quality factors. Nutritive value has also come to be recognized as a quality factor. Most countries have detailed and exacting requirements governing food processing from the standpoint of sanitation and quality, but the extent to which such regulations are enforced varies greatly. However, quality requirements for any food are also firmly ingrained in the consumer's mind and thus will govern his purchases. Therefore, quality must be retained by the processed food during preservation and in the period between its manufacture and consumption. Naturally, the emphasis given to quality factors will depend on the cultural and economic state of development and is more important where there is high purchasing power and an abundance of food allowing a choice. Yet quality requirements (or conforming to common usage) exist even in the most primitive cultures. In hardly any other field of human activity does tradition play as important a part as in our choice of food.

Convenience is a factor in food processing which has gained much importance. Whereas not many years ago most canned and otherwise preserved foods represented starting materials for the preparation of meals, today it is common for some or most of the preparation and compounding into the final complete dish to be done by the food processor. It is clear that the modern food processor, with his scientific control, large-scale operation and use of raw materials in their prime, has many advantages over the cook or housewife. Such preserved, partially prepared or complete dishes, or even complete meals, offer in the home easy preparation in a short time. Although price is still a major consideration in determining the marketability of a processed food, the gradual increase in the world-wide standard of living and the employment of a large proportion of the population (including women) in many countries tend to increase the consumer's willingness to pay the processor for some of the preparation and cooking. In spite of some of the early objections to processed foods it is now generally conceded that the increasing availability and use of processed foods has had a profoundly beneficial effect on the diet pattern in many countries, and that in most instances it has led to substantial improvements in the national nutrition. This is particularly true where fresh fruits and vegetables are available only

during part of the year or where foods transported from long distances make up a significant part of the diet. (*See* FOOD SUPPLY OF THE WORLD.)

Drying and Dehydration.—Desiccation or drying is nature's major method of preservation. Prehistoric man must have observed that dry cereals, berries and nuts kept well, and that meat and fish, when dried, could be kept for extended periods without spoilage. Many traditional sun-dried products are still used today, and the storage of dry cereals was a major factor in stimulating urbanization and the development of civilizations. Drying usually indicates a sun-dried product, whereas dehydration is used mostly for foods from which the water has been removed by artificial means. However, there are exceptions to the use of this terminology, particularly where artificial drying is used to supplement sun drying.

Food preservation by drying and dehydration depends on the fact that microorganisms cannot grow on dry materials and that enzyme action and various other deleterious chemical reactions are similarly retarded or prevented when the water content of a food is low. Previously it was thought that a moisture content of about 10% was sufficiently low to prevent both spoilage and deterioration of foods. But of late the upper limit of moisture content has been gradually reduced for most dried foods. This change was due, to a large extent, to the increased emphasis on quality retention, and was made possible by the development of more efficient means of artificial drying. The amount of permissible residual water is different for various products. The temperatures to which the product will be exposed during storage and the length of time between manufacture and consumption are major factors in determining the maximum permissible moisture content of a dehydrated food.

With the exception of eggs and milk, dehydrated foods were never as important in the United States as in Europe. During World Wars I and II, great efforts were made to increase production and to improve the quality of dehydrated foods since they offer great economy both in tin requirements and in storage bulk and shipping weight. Considerable activity in research and development after World War II continued in the United States and elsewhere and resulted in many new and improved dehydrated products.

Sun drying is used with many fruits such as apples, pears, plums, peaches, apricots, figs, currants and various raisin grapes. In order to prevent excessive darkening, most of these fruits are treated with sulfur dioxide before drying, most of the chemical being lost from the fruit during the subsequent processing. Some fruits, such as figs, must be fumigated with chloropicrin, ethylene oxide, methyl bromide or other agents in order to prevent infestation by insects. The water content of most dried fruits is in the range of 5% to 15%, with different requirements for various fruits. Meat is not now sun-dried in western Europe and the United States but this ancient method of preservation is still used in many other parts of the world. The sun drying of fish is common all over the world, and usually is done in conjunction with salting, brining and smoking, in various combinations.

Artificial drying (dehydration) depends on the efficient transfer of water vapour into a stream of air or other gases that are not saturated with water vapour. Thus the volume, temperature and relative humidity of the drying gas and the surface of moist material exposed to it will govern the drying efficiency. The design of food drying equipment is a highly specialized branch of engineering. Since every food particle has a different and typical attraction to moisture, most types of dehydrating equipment will be suitable for a limited number of products only. Cabinet dryers are drying chambers usually divided into several compartments, each holding several stacks of trays mounted on carriages. The cabinets are commonly heated by steam coils. In the old-fashioned kiln dryer or evaporator (still used with apple pomace, hops, etc.), the product to be dried is placed in an upper room which has a slatted floor, and a current of hot air is supplied from below. Tunnel dryers are extensively used—the drying takes place in tunnels 30–50 ft. long and about 6 ft. square. The material to be dried is loaded on slatted wooden or metal trays stacked on carriages which fit the tunnel snugly so that the air passes between the trays. The carriage loaded with the fresh material is introduced at one end of the tunnel and the dry material is removed at the other end.

Belts of stainless steel are sometimes used instead of trays and carriages. Drum dryers are commonly used for drying milk, pulped fruit, potato flour, mixtures for prepared foods and other products. In the most common type of double horizontal drum dryers the material to be dried is placed in the top well between two identical, closely placed, heated drums 3 to 6 ft. in diameter. The drums are slowly rotated so that the material to be dried is picked up by the drums and carried toward the outside. The drying is completed by the time the material on the drum reaches the scraper or "doctor blade" which shaves off the product. The material to be dried may also be fed from a pan under a single drum or sprayed on the drum.

Spray dryers are extensively used in the large-scale drying of milk and other dairy products, whole eggs, egg yolks, fruit and vegetable juices, purées, soluble coffee and tea and many other foods. This method of drying often allows economical large-scale production with the least damage to flavour. The material to be dried is finely atomized, usually into the top of a large cone-shaped chamber in which heated air or gas is circulated. The water in the droplets evaporates in the heated air and the solid particles are trapped by a collector which usually consists of a smaller cone-shaped structure. Spray drying is the quickest means of drying but the method is applicable only to a limited number of foods and the installation costs are high. Vacuum dryers provide rapid drying at lower temperatures and may be of the tray or continuous belt type. Freeze-drying, a specific form of vacuum drying in which the product is dried by sublimation of the water without raising the product temperature, produces a high-quality product that does not require refrigeration, and in the U.S. in the 1960s it was being used to a limited extent for such products as meat, soups and orange juice. The products were expensive, however, and the food industry continued to seek ways to reduce processing costs. In Britain, accelerated freeze-drying (AFD), in which low heat is applied in a high vacuum, reached the stage of commercial exploitation in the 1960s and promised to be a major advance in food processing.

Often it is most expedient to use a combination of various drying procedures. For instance, some vegetables are most economically dehydrated in tunnel dryers which remove the bulk of water. This is followed by drying in cabinet dryers, and lastly by removing additional moisture in bins through which air, dried in silica gel, is circulated. For storage and distribution, many dehydrated products are packed in cans in an inert atmosphere or under vacuum. The use of in-container dehydration by small packets of moisture-absorbing agents placed in the container with the dehydrated product allows attainment of new and hitherto impractically low levels of moisture content. (*See* DEHYDRATION OF FOODS.)

Salting and Pickling.—Salt is one of the oldest preservatives used for enhancing the keeping quality of fish, meat and vegetable foods. However, the preservative function of salt is not the same for all food products and some of the principles involved are not yet entirely understood. (*See* FISH CURING; PICKLING.)

Meat and fish are treated directly with dry salt crystals or are soaked in a strong brine. Salt is almost universally used for enhancing the keeping quality of butter, the proportion applied (in the U.S. and Canada) being in the range of 2.0% to 2.5%. Salt is used extensively in the manufacture of various types of cheese. In the preservation of vegetables the main function of salt is to govern the type of microorganisms which will grow in the product and the extent of the changes which the growing microorganisms will be able to produce. The effectiveness of salt in the control of microorganisms has been explained by a number of somewhat contradictory theories. Whatever may be its action, the fact remains that salt, particularly in combination with acids, has a selective action on microorganisms. This effect is extensively used in the manufacture of pickles, sauerkraut, cured olives and many other products. Pickles and sauerkraut are typical of

foods stabilized by directed fermentation. Other examples in this classification are meat, buttermilk, yogurt, cheese and the many foods which in their original forms were susceptible to spoilage before the advent of food processing and therefore were allowed to be fermented by the ever-present yeasts. Honey beer (mead), the common malt-hop beer and the innumerable types of fermented fruit juices and wines are in this category.

Smoking.—Preservation by smoking is applied almost exclusively to meat (particularly ham) and fish and is often used in conjunction with other methods of preservation. The preserving action of smoking arises from the drying action of heat as well as from chemicals (*e.g.*, wood creosote) deposited on the food during smoking. However, increased palatability is undoubtedly the major reason for the smoking of fish and meat in countries where other methods of food preservation are easily available. Smoke usually is produced by the slow burning of sawdust from such hardwoods as hickory, maple and birch.

Chemical Preservatives.—The use of chemicals is an old and well-recognized practice in both household and commercial preservation of foods. A large number of chemicals having real or supposed preservative properties have at different times been added to foods. This subject is inseparable from the problems presented by food adulteration and from the occurrence in foods of the toxic residues from chemical agents used to protect plants or animals against pests and diseases. Whereas in most countries willful adulteration has come to present less of a problem, the complications introduced by the multitude of protective chemicals necessary in agricultural production are serious.

Chemical food preservatives are substances which, under defined conditions, delay the growth of microorganisms without necessarily destroying them. Since the concept of food preservation now includes retention of quality as well as prevention or delay of spoilage, a distinction has to be made between the use of chemicals which will prevent deterioration of quality during manufacture and distribution on the one hand and those added for preventing microbial spoilage on the other. The first group includes some natural food constituents such as ascorbic acid (vitamin C), which is added to frozen peaches to prevent browning, and a long list of chemical compounds foreign to foods and classified as antioxidants, bleaching agents, acidulants, neutralizers, stabilizers, firming agents, humectants, etc. The second group again includes some natural food constituents which, when added to foods, will retard or prevent the growth of microorganisms. Sugar is used partly for this purpose in making jams, jellies and marmalades and in candying fruit. The use of vinegar in pickling and of alcohol in brandying is in this category as is the use of salt. Finally there is the group of chemicals foreign to foods and added strictly to prevent the growth of microorganisms, the chemical preservatives.

Sodium benzoate and other benzoates are among the principal chemical preservatives. The use of benzoates in certain products and in prescribed quantity (usually not exceeding 0.1%) is permitted in most countries, some of which, as the United States, require a declaration of its use on the label. Since free benzoic acid actually is the active agent, benzoates must be used in an acid medium in order to be effective. The ability of cranberries to resist rapid deterioration is attributed to their high benzoic acid content. Benzoic acid is more effective against yeasts than against molds and bacteria. The effectiveness of benzoic acid can be increased by the introduction of a side chain or by other modifications of the molecule. Other organic compounds used as preservatives include vanillic acid esters, monochloroacetic acid, propionates, dehydroacetic acid and glycols.

Sulfur dioxide and sulfites are perhaps the most important inorganic chemical preservatives. Although special laws forbidding the use of sulfur compounds were passed as early as 1400, a more tolerant view is now taken. Sulfites are more effective against molds than against yeasts and are widely used in the preservation of fruits and vegetables. Sulfur compounds are extensively used in wine making and, as in most other instances when this preservative is used, much care has to be exercised to keep the concentrations low in order to avoid undesirable effects on flavour. Sodium sulfite has been used as a preservative for meat although there is some doubt about its effectiveness. However, when incorporated with chopped meat that is in an incipient state of decomposition, it serves to bring out a red colour, thus tending to make the meat appear fresh. Oxidizing agents such as nitrates and nitrites are commonly used in the curing of meats.

Most governments attempt to control the addition of foreign substances to foods and the occurrence of toxic residues in foods. In the United States, the federal, state and city governments have regulations concerning this matter, but it is the Federal Food, Drug and Cosmetic act of 1938, amended and extended from time to time, which regulates the application of chemical preservatives in foods. Regulations concerning the use of food additives, including chemical preservatives, change frequently as new compounds become available or as the desirable or undesirable properties of agents in use become better understood.

The period after World War II saw an increasing use of antibiotics in food preservation; some European food preserving agents presumably containing antibiotics appeared on the market in the late 1940s. The use of antibiotics was given legal approval in the United States for the temporary preservation of poultry, and ice containing antibiotics was successfully applied in the cooling of fish. When the mode of action and absence of deleterious effects of residues and decomposition products are better understood, antibiotics may be more extensively used in food preservation.

Thermal Processing.—In thermal processing (called canning in the United States) the food is packed in hermetically sealed containers and heated sufficiently to destroy all living organisms or, at least, to assure that the conditions inside the container are such that no growth of residual organisms will occur. Many hundreds of different products are preserved by thermal processing in cans or tins and in hermetically sealed glass containers. In nonacid products the temperature must reach 240° F. (116° C.) inside the container and be maintained for several minutes. (Throughout this article Celsius [C., centigrade] equivalents are given to the nearest whole degree.) Even more extensive heating is required in some instances. Cured meats with salt and nitrate can be processed at somewhat lower temperatures, while for canned fruits the temperature of boiling water suffices. The flavour of some products, particularly liquid foods, is often detrimentally changed by heat sterilization and in such instances pasteurization is used since it involves only sufficient heat to destroy pathogenic bacteria without altering the flavour; pasteurization also will reduce the number of other organisms present sufficiently to enhance the keeping quality of the product. A common heat treatment is 145° F. (63° C.) for 30 min. or 160° F. (71° C.) for 15 sec. Milk is one of the most important foods pasteurized in large quantities. In the pasteurization of fruit juices, wine, beer, etc., treatment at different temperatures and for other periods of time is effective on account of the presence of alcohol and acids which, in combination with the heating, prevent the growth of microorganisms.

(*See* CANNING, COMMERCIAL.) (Z. I. K.)

Cold Storage.—The only method by which fresh foods may be preserved for a considerable period in the raw state is by subjecting them to as low a temperature as possible without causing damage by freezing. Storage at temperatures above freezing, in the neighbourhood of 35° F. (2° C.), is known as cold storage. Storage at such temperatures makes possible the holding in good condition of many fresh foods for considerable periods, and their shipment to distant markets and consumers. This has helped immeasurably to improve the variety and quality of foods in the markets of many parts of the world, notably in Europe and the Americas. Some cold storage is accomplished by means of ice which, in most cases, is produced artificially in ice-making plants. The great majority of cold storage is accomplished by the direct use of refrigerants in one or another of the mechanical or chemical refrigerating cycles, as in household refrigerators. Cold storage equipment ranges from the smallest of home refrigerators to marine, rail or motor truck refrigerated transportation and commercial warehouses.

Freezing.—It has been found that many varieties of food-

stuffs can be preserved for considerable periods with excellent results when frozen and kept in low-temperature cold storage. Under proper conditions the original flavour, appearance, nutritive value and texture of many foodstuffs are preserved more truly than by any other method of preservation. The remarkable similarity of the preserved product to the fresh or unpreserved food makes this method one that is most desirable. Coupled with this is the advantage that there is somewhat less labour involved in the preservation of foods by this method than by any other, especially in the case of home preservation in relatively small quantities.

History.—Freezing, as a method of preservation of foodstuffs, is not new. It has been used probably for as long as man has inhabited arctic regions where fish, game and other meats obtained in cold weather could be frozen and kept in that state for weeks and even months by natural means.

As early as 1842 a patent was granted to H. Benjamin in England for freezing foods by immersion in an ice and salt brine. Other patents followed at intervals during the century, both in the United States and in Great Britain, covering the freezing of meats and fish by special applications of ice and salt mixtures, either by direct or indirect contact. Indirect contact was obtained by placing the ice and salt in pans over the product to be frozen or by placing the products in tightly closed metal containers which were immersed in the ice and salt mixture.

It was not, however, until the development of mechanical refrigeration that it became possible to apply this method of preservation extensively. Mechanical refrigeration first made possible the freezing and transportation of meats over long distances, chiefly by sea. The first shipment of meat from Australia to Great Britain, about 1880, by refrigerated ship was not frozen before loading, nor was it intended that it be frozen. However, it did freeze and the results led to freezing as a standard practice.

Early in the 20th century attempts were made to preserve foods other than meats and fish by freezing. H. S. Baker, Sr., is credited with freezing fruits in Colorado about 1908. Large crops that could not be immediately marketed or processed by the commercial canners presented a potential waste unless they could be held and processed gradually over an extended period. Freezing part of the crop for use later appeared to be a solution, and experiments showed that this could be done. Only certain fruits were frozen at first by what was known as the cold-pack method. These were chiefly strawberries and cherries. The method consisted of placing alternate layers of berries and sugar in large barrels or smaller metal containers which were then placed in cold storage rooms where the temperature was maintained at −10° or −15° F. (−23° or −26° C.). Held at this temperature (or slightly higher) fruits kept well and later, after thawing, could be used for making preserves or directly in desserts such as ice creams, pies, etc.

Some experimental work was done by scientists in Europe on the freezing preservation of foods. In 1916, R. Plank, E. Ehrenbaum and K. Reuter are credited with showing in Germany the advantage of quick freezing; *i.e.*, freezing in a few hours as contrasted with several days. After that developments were rapid both in Europe and the United States. Most of the early investigations and development of procedures for freezing were carried on by the United States department of agriculture, the state colleges of Washington and Oregon and the growers and packers of the American northwest. Much credit can be given to Clarence Birdseye for the development of methods of freezing foods in small containers suitable for the retail trade. He began his work about 1917, but it was not until 1929, after much experimental work had been done by General Foods corporation, that the first Birds Eye commercial pack was placed on the market. This experimentation included work on vegetables as well as fruits, and it was found that many vegetables were admirably adapted to preservation by this method. Many obstacles were in the way of the acceptance of frozen foods by the public at large, chiefly the lack of adequate facilities in the retail market for handling frozen foods, coupled with a lack of knowledge on the part of the prospective consumers of the desirability of such foods and of how to use them.

Types of Frozen Foods.—Meats, including game and fish, were the first foods to be frozen for preservation. Dairy products, such as butter and cream, probably followed, except for possible isolated experiments. Early work on the freezing of fruits and vegetables indicated that, almost without exception, fruits and vegetables could be frozen and kept in storage in the frozen condition for considerable periods. On thawing it was found, in fruits and vegetables more than in meats, that the cell structure was broken down, causing a reduction in greater or lesser degree of the firmness or crispness of the fresh foodstuff. This structural change makes for rapid spoilage after thawing, making it necessary to hold such foods in the frozen state until nearly the time for using. However, when properly prepared and frozen, fruits and vegetables are much like the fresh product, even after months of storage, while there are some claims that meat is improved by being frozen; this, if true, is a result of the tenderizing effect.

Following World War II there appeared a new kind of frozen food product in the form of prepared dishes in considerable variety. Such dishes, requiring only to be thawed and heated before serving, gained ready acceptance. By the mid-1950s more than 500,000,000 lb. of such dishes were being frozen annually in the United States, and consumption increased thereafter. With the increasing production of frozen fruits and vegetables there was an intensified effort to develop new varieties which would be more desirable for freezing from the standpoints of growing, processing and acceptability as foods.

Processing of Foods for Freezing.—Meats in general require no special treatment prior to freezing. In the case of beef and venison a period of several days of aging in a room chilled to about 35° F. (2° C.) prior to freezing may improve the flavour and tenderness. With most other meats and poultry it is desirable that they be frozen as quickly as possible after slaughtering. Chilling to about 40° F. (4° C.) before cutting the meat for freezing is desirable, as it facilitates the cutting and helps to preserve the meat in the best possible condition. The reason for haste in freezing such meats is that the process causing rancidity of the fatty tissues sets in shortly after slaughtering. If rancidity starts even imperceptibly prior to freezing, it will rapidly become evident in the taste of the fat, as freezing and storing at 0° F. (−18° C.) retards its development but does not completely inhibit the process. The table shows the periods during which different meats and dairy products, as well as other foodstuffs, may be stored with reasonable expectation of good results. Many cases are on record of foods stored satisfactorily over much longer periods than those indicated in the table.

Safe Storage Periods for Various Food Products

Foodstuff	Approximate storage period (months)		
	At 0° F.	At 5° F.	At 10° F.
Beef, fruit juices	12 to 15	10 to 12	6 to 8
Fruits, vegetables, veal, venison	10 to 12	8 to 10	3 to 6
Lamb, poultry, rabbits, game birds, eggs	8 to 10	6 to 8	3 to 4
Fresh pork, ham, creamery butter, cheese	6 to 8	4 to 6	2 to 3
Ground meat (unsalted), lean fish, cottage cheese	4 to 6	3 to 4	1 to 2
Beef liver, fatty fish, slab bacon, cooked foods	2 to 4	2 to 3	1 to 2

Courtesy of J. D. Winter and A. Hustrulid, "Freezing Foods for Home Use," *Extension Bulletin 244*, University of Minnesota, revised June 1945.

In the case of fruits it is important that the maturity of the product when harvested for freezing be that which is best for eating the fruit fresh and that only fruit uniformly ripe and free from blemishes be frozen. It is also important that a minimum of time elapse between harvesting and freezing, as deterioration sets in and develops rapidly at room temperatures. Harvesting in the cool of the morning is advantageous as the fruit is then naturally cool and does not deteriorate rapidly after being picked.

Fruits may be frozen in a sirup or a dry sugar pack. Sirups for this purpose are most easily made from sugar and water in concentrations of from 20% to 65% sugar, depending on the

acidity of the fruit to be preserved and the taste of the individual. When the fruit has been prepared as for serving, it is placed in containers and cold sirup added in sufficient quantity to cover the fruit. This is to exclude air and prevent both oxidation and desiccation. Dry sugar may be used in place of a sirup when the fruit is sliced or cut so that the sugar will draw out enough juice to form a sirup and coat the fruit thoroughly. The handling of the fruit should be as rapid and as careful as possible, especially in the case of fruits that oxidize rapidly. Oxidation is evidenced by discoloration and is also accompanied by a somewhat unpleasant flavour. Browning of fruits, such as peaches and apples, before, during and after freezing may be prevented by treatment with a small amount of ascorbic acid.

The same precautions should be taken with vegetables as with fruits in the choice of quality, maturity, variety, harvesting, speed in handling and prevention of oxidation and desiccation. After preparing the vegetables as for cooking for the table they must be blanched or scalded in boiling water for from one minute (for peas) to as much as ten minutes (for corn on the cob).

The purpose of blanching is to inactivate the enzymes by heat, so preventing the deterioration which would take place even at very low temperatures were the enzymes to remain active. It is possible to freeze and store most vegetables for a short period without blanching; but for normal periods of storage at 0° F. blanching is essential. Without it all vegetables soon acquire a haylike flavour and deteriorate in colour. With proper blanching, however, frozen vegetables retain their colour, flavour and general appearance remarkably well.

Methods of Freezing.—There are several methods by which foodstuffs can be frozen. Essentially the problem is that of removing heat in a relatively short time and lowering the temperature of the product below its freezing point, commonly to 0° F. (−18° C.) or somewhat lower, which is the recommended storage temperature for frozen foods.

One of the earliest methods of freezing foods was by immersion of the product either directly or within a container in a mixture of ice and salt or a brine chilled by mechanical refrigeration. A method known as the "Z process" was developed in Europe for freezing fish by M. T. Zarotschenzeff. This consisted in passing the foodstuffs either packaged or unpackaged through a chamber in which they come in contact with an atomized, secondary liquid refrigerant, such as a brine. In the United States, R. B. Taylor and L. H. Bartlett developed a method for freezing foodstuffs naturally small in size or cut in small pieces, such as berries, peas, sliced peaches, cut beans, etc. Their method consisted in immersing the foods directly in a solution of glucose, sucrose or sodium chloride or combinations of the three. The disadvantage of direct immersion is that brine tends to penetrate into the foodstuff. The Taylor and Bartlett method tends to eliminate this effect or to produce a pleasing result in spite of some penetration.

With development of mechanically refrigerated cold storage, foodstuffs were at first simply placed in rooms at low enough temperatures to freeze them in due course in the still air. Still-air freezing is the slowest of all methods for any given temperature, because of the poor heat transfer that exists where the only circulation of air is that caused by natural convection currents. Fans placed in such rooms will help the air currents and improve the freezing rate somewhat. A systematic use of air in motion is obtained in numerous freezers developed chiefly between 1930 and 1940. Blowers are used to circulate air over refrigerated coils which chill the air, then over the foodstuffs and back to the blower to repeat the cycle. With velocities of 500 ft. per minute or more the rate of heat transfer is increased and freezing can be accomplished in a much shorter time than in still air. This is known as blast freezing.

Contact freezing is obtained by placing the foodstuffs either in packages or loose in metal trays on refrigerated surfaces, which may be either pipe coils made in the form of shelves, or refrigerated plates. Here the heat transfer by conduction through the metal surfaces is much better than that through air; the method is effective in proportion to the area of the foodstuff in contact with the refrigerated surface.

Storage of Frozen Foods.—Generally speaking it has been found that the lower the storage temperature the better and longer will foodstuffs keep in the frozen state. Deterioration takes place in the forms of oxidation, desiccation and enzymic action even at very low temperatures. However, it has been found that for most foodstuffs a temperature of 0° F. (−18° C.) is satisfactory for normal periods of storage. Many foods will keep for several years very well at this temperature if properly processed and packaged before freezing. Therefore, 0° F. (−18° C.) has become accepted commonly as a satisfactory storage temperature, though much storage of commercially frozen foods is at lower temperatures. However, the lower the temperature the more costly the storage, both from the point of view of the insulation of the space and the power to maintain that temperature.

An important factor in the proper storage of foodstuffs is the packaging, which must be such as to resist injury during the period of storage and which must also be of a vapourproof nature to prevent as far as possible desiccation and oxidation of the foodstuff within.

Locker Plants.—Plants or concerns devoted to the storing of frozen foods for individuals for private use and in relatively small amounts came to be known in the U.S. and Canada as locker plants. This enterprise began when farmers and hunters started early in the 20th century in the American northwest to store game or meat slaughtered on the farm in low-temperature cold-storage plants where it froze and kept quite well over extended periods. As this practice grew it became necessary for the cold-storage operators, who rented space for this type of storage, to make provision for separating the produce of one patron from that of another. For this purpose boxes were first used, and later locked closets or simply lockers, which gave the industry its name. Before long fruits and vegetables were being stored along with meats and the trade grew to the point where it was recognized as a business distinct from cold storage in the usual sense. In the late 1920s, it is believed, though there are no accurate records, the first locker plants were established to cater to this trade exclusively. The earliest growth of the locker plant industry in the U.S. was in the northwest, and from there it spread to the mountain states and on into the midwest where it grew rapidly in the heavy meat-consuming communities. During World War II public interest in frozen foods increased and the demand for locker plant facilities grew far beyond the supply, and in the years following the war expansion of the locker plant industry was rapid. However, in this same period a vigorous competitor for locker plants appeared in the form of the home freezer, similar in principle to the refrigerator for fresh foods, but maintaining the necessary 0° F. (−18° C.) temperature. As the number of home freezers grew, the demand for locker space fell off so that after the mid-1950s the number of locker plants diminished increasingly.

Transportation.—Along with the growth of the frozen food industry and the widespread distribution of frozen products came the problem of transportation. This was solved satisfactorily by refrigerated railway freight cars and refrigerated motor trucks. In the former, ice with salt has been widely used, although some cars are equipped with self-contained, completely automatic, diesel-powered refrigerating systems. Most motor trucks for frozen food transportation have self-contained refrigerating systems, powered mostly by gasoline engines, but many carry tanks containing some salt solution whose freezing point is around −5° F. (−21° C.). The solution in these tanks is frozen by electrically driven refrigerating systems on the trucks that are connected to power sources when the trucks are at their bases, or by refrigerant supplied from a stationary system through demountable hose connections. Low-temperature refrigeration is thus provided until the solution is once more thawed.

See also FOOD PRESERVATION (IN THE HOME); and references under "Food Preservation" in the Index volume.

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FOOD PRESERVATION (IN THE HOME). Food preservation, or the prevention of food spoilage, is of importance in providing adequate supplies throughout the year and making possible the transport of foods from areas of production to centres of need. Home food preservation makes it possible to save locally produced foods and provide more and a greater variety of foods. For commercial aspects of food preservation *see* FOOD PRESERVATION.

The causes of food spoilage fall into two major classes: changes brought about by reactions normal to the food and changes due to outside sources. The first group includes such factors as the sprouting of grain or potatoes, development of a woody or starchy texture in vegetables, liquefaction of fresh meats or eggs and softening of fruits. These are caused by the continuance of certain chemical reactions promoted by enzymes normal to the particular product. The second class is comprised largely of microorganisms which are present everywhere and which are divided into three classes: yeasts, molds and bacteria. In a favourable situation they are in the actively growing or vegetative stage. When the environment becomes unfavourable, many types change to the spore or resting form and are much harder to destroy. The procedures used in home food preserving are based on inactivation of enzymes and destruction of microorganisms.

Yeasts are one-celled plants which live chiefly on solutions of sugars and other carbohydrates. Their growth is favoured by moisture and warmth and is usually shown by production of gas bubbles. Though this fermentation is desirable when making wines, in preserves it can cause development of undesirable flavours and odours. Yeast growth slows or stops entirely at temperatures below 37° F. (3° C.) or when the moisture content of the food is reduced sufficiently, and the cells are destroyed at high temperatures, 150°–180° F. (65°–82° C.), although some spores are more resistant to heat.

Molds reproduce by spores which are carried in the air. The different species can grow on a wide variety of organic materials. The spores develop into actively growing colonies, forming fuzzy, coloured patches or clumps which are easily seen and can be removed from the surface of the food. However, if growth has continued for some time unpleasant flavours will have permeated the food. Like the yeasts, molds are inhibited by low temperatures and most of them are destroyed by heating to 150°–180° F. (65°–82° C.), though one species found in Great Britain can withstand temperatures up to 212° F. (100° C.).

Bacteria are the most difficult to control and the most dangerous. Yeasts and molds cause souring and off-flavours, but some bacteria can cause illness and possibly death. Bacterial growth may or may not produce visible signs and many bacteria cause spoilage without any readily apparent change in the food. Bacteria can grow over a much wider temperature range than yeasts and molds. Most of them grow at temperatures of 60°–100° F. (16°–38° C.) but psychrophilic or cold-loving bacteria can grow at considerably lower temperatures, while thermophilic or heat-loving bacteria can grow at temperatures as high as 160° F. (71° C.). The vegetative cells are killed at the boiling point of water (212° F., 100° C.) but some spores require temperatures as high as 240° F. (116° C.) maintained for more than 30 minutes for their destruction.

BOTTLING AND CANNING

Canning refers, in Great Britain, to preserving food in metal containers, while bottling is used for similar preservation in glass jars or bottles; in the United States canning refers to both. Since glass containers are used much more frequently than metal cans for food preservation in the home, the term bottling will be used in this article and will include canning unless otherwise stated. Bottling depends on heating the food to inactivate enzymes and destroy microorganisms and on hermetic (airtight) sealing to prevent recontamination. In bottling the jars are sealed while hot and, provided that no air can enter while the jars are cooling, the pressure inside the cold jar will be less than that of the surrounding atmosphere so that the lids will remain firmly in place. Metal cans, however, are sealed before processing.

Foods for Bottling.—A very wide variety of foods can be preserved successfully by bottling but, since the method itself includes cooking, any food ordinarily eaten or preferred in the raw state cannot be preserved in this way. Also, the amount of heating necessary to sterilize some foods causes serious overcooking and the development of off-flavour and mushy texture. Foods selected for bottling should be fresh, clean and sound and of the proper variety and maturity. Certain varieties of fruits and vegetables, as well as certain kinds of protein foods, yield a more palatable bottled product than others.

Two essentials in the selection of an adequate processing procedure are that the temperature be high enough to destroy any microorganisms present that can grow in the food being preserved, and that this temperature be attained throughout the entire mass of food being bottled. Foods may be divided into two general classes in selecting processing methods: fruits, most of which are acid in reaction, and vegetables and meats, fish and poultry, most of which are neutral or nearly so. Not only are microorganisms more easily destroyed in an acid medium than in a neutral one but the acid prevents any dangerous bacteria from developing, so that acid foods require less heat and lower temperatures for safe processing than do neutral or nonacid foods. Another important factor is the consistency of the food. Products which are bottled as distinct pieces surrounded by liquid will heat through to the centre of the container more rapidly than foods which pack down and fill the container solidly. In the same way, larger containers will take longer to heat through to the centre than smaller ones.

Processing Methods and Equipment.—The temperatures used in bottling depend chiefly on the acidity and the consistency of the food. Acid liquid foods, such as fruit juices, need only be processed at 140° F. (60° C.) for 30–40 minutes or for a correspondingly shorter time at a higher temperature. Low temperatures are particularly useful for fruit juices in which the flavour may be changed by high temperatures. With the exception of fruit juices and similar products, all foods should be heated at least to the boiling point. In acid products, this is sufficient to destroy any microorganisms present. Nonacid foods require long holding at the boiling point (more than five hours) or, preferably, temperatures above boiling to be sure that the products are sterile. It is particularly important to destroy any spores of *Clostridium botulinum*, which can produce a deadly poison. These spores are very resistant to boiling in a nonacid medium but are killed by heating for approximately 10 minutes at 240° F. (116° C.). In an acid food they are destroyed more readily by boiling and any survivors will fail to develop. It should be borne in mind that altitude has a considerable effect on the temperature attained in processing; water boils at sea level at 212° F. (100° C.). At higher altitudes the boiling point of water is lower; the decrease amounts to approximately 2° F. or 1° C. for each 1,000 ft. of elevation. This may be compensated for by increasing the processing time or by raising the boiling point of water; *e.g.*, by using a pressure cooker. A pressure cooker, or pressure pan, is a heavy pan which can be sealed so as to retain steam under pressure. The lid has a pressure indicator or control, a pet cock or vent which can be opened and a safety plug to prevent the pressure from rising above safe limits.

The temperature obtained is calculated on the basis of steam pressure, not air pressure, and the air in the cooker must therefore be replaced by steam to obtain the correct temperature. The pressure should be kept constant during processing, thus reducing loss of liquid from the bottles.

Various methods of processing fruit can be used. The prepared fruit may be heated sufficiently to kill the microorganisms, then put into sterile containers and sealed. This method is adequate for acid foods and may be more convenient with solid fruits, softening the structure so that the pieces fit into the containers more

readily. The containers and lids must be very carefully sterilized, filled with boiling hot fruit and sealed immediately so that the contents will not be contaminated. More frequently the food is placed in the container before processing, fruit being covered with sugar sirup or water and vegetables with dilute brine. Foods may be raw or partially cooked before being placed in the container.

In most cases the processing time required for a given hot-packed food is essentially the same as when raw-packed. In fact, in foods which soften during preheating to the stage where a more solid pack is obtained in hot-pack than in raw-pack, the processing time for the hot-pack will be longer than for the raw-pack. However, when dealing with large, solid pieces or highly starchy foods, preheating does reduce the time required for the material in the container to attain the correct processing temperature.

When the food is placed in metal cans, which are sealed before processing, a small free space should be left at the top to allow room for the expansion of the food during heating. Any empty spaces between the pieces of food should be filled with liquid. If the cans are to be processed above 212° F. (100° C.), provision must be made for exhausting, *i.e.*, driving out, most of the air before they are sealed.

Bottled fruit may be processed in a water bath or a pressure cooker. A water bath is recommended for fruit processed in metal cans. Nonacid foods should be processed under pressure in order to increase the temperature above 212° F. (100° C.).

Storage and Use of Bottled and Canned Foods.—Bottled or canned foods should be stored in a cool place as high storage temperatures lead to more rapid loss of vitamin content and deterioration of flavour.

Glass containers should be stored in the dark to avoid fading of the food colours.

Acid foods may be used cold straight from the can if desired. Nonacid foods should be heated thoroughly before consumption, as the botulism toxin is destroyed by boiling for 20 minutes.

Some loss of nutritional value occurs during canning, mostly of vitamins which are destroyed by heat and/or oxidation. However, if the containers are properly vented to remove air, oxidation will be kept to a minimum. Many vitamins and minerals are water soluble and a large part of the original amount in the food will be in the liquor surrounding the solid food. If this liquid is used, total nutrient losses from properly processed foods will not usually be greater than those caused by normal cooking procedures, with the exception of greater loss of thiamine (vitamin B_1).

FREEZING

Freezing as a method of food preservation depends on the marked reduction in rate of most chemical reactions at low temperatures. When food is frozen the low temperature and solid state of the water entirely inhibit the natural ripening processes or markedly reduce their rate. Growth of microorganisms ceases for the same reason. Some of the microorganisms will be killed by freezing but the products cannot be regarded as sterile since others survive and are capable of multiplying when the food is thawed. Foods can be preserved by freezing in a state close to that of the natural raw product. With the exception of vegetables, foods do not need any heat treatment before freezing, thus shortening the time required for preparation.

Since frozen foods must be held at a much lower temperature than canned foods, however, frozen storage is more expensive. The cost of suitable freezing cabinets seriously limited this as a method of preserving foods at home in Great Britain. There is little danger of food poisoning or food-borne illness from frozen foods, provided they have been properly handled. However, the growth of microorganisms when the food is thawed may be even more rapid than it would have been in the original fresh material as the formation of ice crystals during freezing tends to break up the structure of the food, softening the texture and making possible a more rapid penetration of microorganisms. For this reason foods should be kept solidly frozen until desired for use, then thawed and used immediately.

Guides for Success.—Only foods of high quality should be frozen. Unless the starting material is fresh, sound and adapted to freezing, the final product will not justify the time, effort and money. Some softening of the texture or firmness of the food will occur due to the nature of the freezing process and this should be kept in mind in any further preparation or cooking before the food is eaten.

Foods for freezing should be handled quickly and in small amounts so that they can be frozen as soon as prepared. The freezing capacity of the unit must also be kept in mind. The number of packages frozen at one time should be small enough to allow each package space for air circulation and contact with a primary freezing surface (in contact with the coils carrying the refrigerant). If the unit is filled with unfrozen food the rate of heat transfer from the centre of the load is so slow that foods in the centre may spoil before they freeze. All foods should be wrapped in moisture-vapour-proof materials and sealed tightly. The low temperature in the freezer produces a very dry atmosphere and unprotected foods will dry out rapidly, leading to a condition known as freezer burn. However, moisture-vapour-proof must not be confused with waterproof; many waterproof materials will hold water in the liquid stage, but are not impervious to the passage of water in the vapour or gaseous phase. Packages should be made as solid as possible as oxygen in the air leads to undesirable changes in flavour and colour and loss of some nutrients. However, when foods are packed in rigid containers some head space must be allowed since water increases in volume as it freezes.

Products should be frozen and stored at 0° F. (−18° C.) or lower; higher temperatures materially shorten the storage life of the food. Variations in temperature should be kept to a minimum. Every time the temperature rises slightly the food loses a little moisture which, as the temperature falls again, does not re-enter the food but freezes inside the package. This leads to in-package drying, with eventual loss of desirable colour, flavour and texture.

Frozen foods should be used while still in excellent condition. Each type of food has a definite period of storage life during which it will remain of high quality; if stored beyond this time the food may become inedible due to development of off-flavours and odours, destruction of colour and deterioration of texture.

Foods for Freezing.—Most foods can be frozen successfully with the exception of those high in starch, those usually eaten raw for their crisp texture and those containing emulsified fat. Starchy foods tend to become sticky or gummy. Crisp raw foods and those high in water content become limp and soggy due to rupture of the cell walls by ice crystals and collapse of the tissue with excessive loss of fluids on thawing. Freezing usually breaks emulsions so foods containing emulsified fat may curdle and separate.

Fruits may be frozen either with or without added sugar or sirup. In many cases, however, the addition of sugar or sirup improves the retention of the fresh flavour and natural colour of the fruit. Light-coloured fruits which tend to turn brown when cut require treatment to prevent discoloration. Effective measures include a light blanching or scalding of the cut fruit, dipping the pieces in a solution containing sulfur dioxide, or addition of vitamin C (ascorbic acid) to the liquid in which the fruit is packed.

Vegetables should be blanched or scalded, then cooled thoroughly, before packaging. The activity of the enzymes in vegetables is decreased but not stopped by freezing. Scalding is necessary to inactivate the enzymes, or the vegetable colours deteriorate and undesirable flavours develop.

Whole eggs and egg yolks require treatment to avoid gelling of the yolk material. Egg yolks contain lecithoproteins which coagulate at low temperatures and should therefore be mixed thoroughly with a small amount of sugar or salt before freezing to prevent this.

Many prepared and precooked foods may be frozen. Good foods for freezing are those that require long preparation, little more work when prepared in quantity than when prepared in small amounts and little attention between the freezer and the table. Mixtures should be seasoned cautiously, as some seasonings intensify or increase in flavour in frozen storage while others tend to disappear.

Frozen foods which have been carefully prepared and properly wrapped, frozen and stored will retain a large part of the nutritive value of the original food. However, some vitamins and minerals may be lost during washing and scalding of vegetables and excessive length of storage will lead to loss of nutrients as well as decreased eating quality.

JAMS AND JELLIES

Jams, jellies and other conserves depend on heat and high sugar concentration for preservation. Since they are made from fruit and are therefore acid foods, the boiling required to prepare them is sufficient to produce a sterile product. The high sugar concentration usually found in this type of food will prevent the growth of most microorganisms, although some can thrive in such an environment.

All the various kinds of jams and jellies are made of fruit and are characterized by a thick or gelled consistency which makes them relatively solid although still soft enough to spread easily. Jams contain crushed or pieces of fruit while jelly is made from the strained fruit juice; marmalades consist of slices of fruit and peel, usually citrus, suspended in jelly; preserves or conserves are whole or large pieces of fruit; while butters and cheeses are made from mashed or sieved fruit pulp.

Ingredients.—The traditional methods of making jam and jelly depend on the presence of three ingredients—pectin, sugar and acid—in addition to water, and on the balance among these four. Pectin, the primary gelling material, is present in varying amounts in all fruits and must usually be extracted by heat. Slightly underripe fruits contain a larger amount of pectin than do ripe fruits, while in overripe fruits most of the pectin has been converted to pectic acid, which has no gelling power. The pectin deteriorates if the fresh fruit is cut up or crushed and left in a warm place. Commercial pectins are also available and their use reduces the amount of cooking necessary to reach the gel stage and increases the amount of sugar that can be added to a given amount of fruit.

Sugar is added in relation to the amount of pectin in the fruit. The mixture of fruit and sugar is usually cooked to a sugar concentration of 60%–65%, indicated by a temperature of 219°–223° F. (104°–106° C.), to ensure good keeping quality. A gel may be obtained from a fruit very rich in pectin with a lower sugar concentration, but this may not have good keeping qualities unless hermetically sealed while hot. The sugar usually used is sucrose from sugar cane or beet. When purified, the sugar from these two plants is identical and can be used interchangeably. When sucrose is boiled with acid it is gradually converted into a mixture of equal parts of two different sugars, glucose and fructose, together often called invert sugar. This is an advantage, as there is less tendency for the sugar to crystallize out during storage when there is a mixture of sugars present than when any one predominates. Prolonged boiling of jam or jelly made from a very acid fruit may produce too much invert sugar; this usually separates out without any definite crystalline form. Separation of sucrose, which forms crystals like granulated sugar, is likely to occur when a fruit low in acid is added to a high proportion of sugar and boiled only for a very short time.

Acid is the third major ingredient. Both sugar and acid are necessary to change the pectin from a liquid to a semisolid. The majority of fruits used for jam making contain sufficient acid but if more is required it is often added in the form of lemon juice or citric or tartaric acid.

Preparation and Storage.—Jams are usually made in two stages. In the first, the prepared fruit is cooked slowly, with sufficient water to prevent burning, while the skins are softened and the pectin extracted from cells; in the second, sugar is added and the mixture boiled to evaporate excess water until the gelling point is reached. This occurs most readily when the sugar content is about 65%; roughly 5% of this will come from the fruit, the remainder from the added sucrose. This means that for maximum setting quality, the yield will usually be about 10 lb. for each 6 lb. sugar used. Even if a high proportion of fruit to sugar is used, a satisfactory gel can be obtained with a lower sugar concentration. A rough test for the gel stage may be made by pouring some of the boiling jam from a spoon. If the drops run together on the edge of the spoon and break off as a "sheet," rather than running off as a thick sirup, the product should set when cold.

Jellies are usually made from fruits that have good setting qualities and form a clear bright product. The fruit is cooked slowly with water and strained. A test that can be used in the home to estimate the amount of pectin in the extracted fruit juice is to mix a small amount of juice with an equal volume of alcohol. The formation of a solid clot indicates abundant pectin. Sugar is added in relation to the amount of pectin that the juice contains. A juice containing ample pectin can be mixed with an equal volume of sugar; one lower in pectin should have less sugar added. Boiling the jelly mixture results in evaporation of water and increased concentration of pectin and acid as well as sugar. This is the reason for adding less sugar to a juice containing less pectin; longer boiling will be required to reach the proper amount of sugar and the pectin will be concentrated sufficiently to gel the product. The gel stage can be tested as for jams. Jams and jellies can be made without cooking but the resulting product is not sterile and must be kept in a refrigerator to prevent spoilage.

Marmalades are made in the same way as jams, but as most citrus fruits are rich in pectin a smaller proportion of fruit to sugar is normally used and extra acid is required except for lemon, lime or bitter orange marmalade. Citrus fruits need thorough cooking to soften the peel before the sugar is added and so more water is required than in jams. Cooling the mixture to 176° F. (80° C.) before pouring it into glasses or jars helps to prevent the pieces of fruit from rising to the top of the containers.

Fruit butters are made by cooking the sieved or puréed fruit with sugar until thick and clear; spices are sometimes added. Fruit cheeses are made in the same way and boiled to give a cheese-like consistency when cold.

After these preserves have been cooked to gel stage, they should be poured into clean jars. Those with a high sugar concentration may be covered by pressing a prepared tissue on the hot surface, or by sealing with melted paraffin, and covering the containers to keep out dirt, insects and microorganisms. Those with lower sugar concentration need covering while very hot with an airtight seal, otherwise they may ferment in storage. Fruit cheeses and sometimes jellies are put into containers suitable for turning them out before serving.

A wide variety of fruits and other plant materials may be used in making products of a gelled consistency. They are usually used to add variety and interest to more staple foods rather than by themselves. Success can be achieved by careful following of directions and by experience, since many of the factors governing the gelling of these products are not easily measured.

PICKLING

Food preservation by pickling depends on the presence of acid or salt, or both, in the mixture. The growth of harmful microorganisms is usually inhibited by a sufficient concentration of acid or salt. Either vegetables or fruits may be made into pickles but the methods and type of finished product are quite different.

Vegetables used for pickling are usually high in water content, some of which must be removed. This is achieved by the addition of salt, since the salt solution will be more concentrated than the vegetable cell sap and some of the water will be drawn out of the vegetable to equalize the concentration. When natural fermentation is desired, as in making sauerkraut, salt is added in amounts of 2%–4% of the weight of vegetable. This amount of salt will check the growth of undesirable bacteria but allow the multiplication of acid-producing bacteria. When the acidity becomes high enough the product will keep in a cool place if protected from molds and yeasts. A fermentation process continued for several months is used commercially in the curing of vegetables prior to packing them in vinegar. In the home a quick brining process is generally preferred. The prepared vegetables are usually held for 12 to 48 hours in a 10% brine or sprinkled with salt and subsequently rinsed to remove any excess of salt. To produce a clear pickle, the drained vegetables are packed in jars and covered with spiced vinegar. In a mustard pickle or piccalilli the

vegetables are mixed in a sauce containing vinegar, mustard and turmeric. In fruit pickles, preliminary brining is not necessary and the prepared fruit is heated with sweetened spiced vinegar.

Whereas in pickles the fruits or vegetables are kept in recognizable pieces, in chutneys they are cooked to a pulp. The main ingredient is usually a fruit, with onions, garlic or similar vegetables for flavouring. Vinegar forms the chief preservative with sugar, salt and spices. Chutneys are cooked slowly to a smooth, jamlike consistency.

Sauces are made from essentially the same ingredients as chutneys but are sieved and should be of a pouring consistency.

Pickles, chutneys and sauces should be stored in jars or bottles and sealed to prevent evaporation. The covers used must also resist attack by acetic acid. Some of the sweeter pickles and sauces contain insufficient acetic acid to prevent spoilage and should be processed in a water bath and hermetically sealed while hot. Pickles, chutneys and sauces, like jams and jellies, are usually used to give variety and flavour to a meal. In general, their nutritive value tends to be rather low, especially in the water-soluble vitamins and minerals.

SIRUPS

Fruit sirups can be made from soft fruit that is too ripe to be used for most methods of preservation. The juice is extracted, with the minimum addition of water, sugar is added and the resulting sirup is preserved by means of heat or with chemical preservatives. Black currant, rose hip and citrus-fruit sirups may be useful sources of vitamin C.

CANDIED FRUITS

Candied fruits are made by cooking whole fruits or fairly large pieces of fruit in sirup until the fruit is clear and plump. To avoid shrinking the fruit the sugar concentration must be increased gradually. If the fruit is put directly into a heavy sirup, the water in the fruit will be drawn out because of the difference in concentration of the solutions inside and outside the fruit and the fruit cells will collapse, shriveling and toughening the pieces. Finally, the pieces are drained from the thick sirup and dried slowly until no longer sticky. *See* also FOOD, CARE AND STORAGE OF (IN THE HOME).

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FOOD PROCESSING INDUSTRY. Food processing is commonly understood to include canning, freezing and dehydrating, which permit foods to be stored; changing the form of the food, as in making preserves from fruit; or simply cooking food, as in baking bread. By a more general definition the pasteurization of fluid whole milk and the milling of flour are also included. Although various means of preserving foods have been used from the earliest times, the modern industry is one of the results of the Industrial Revolution, which brought about a concentration of population in urban areas, so that families produced less and less of the food they consumed. (A parallel development was that, with the mechanization of agricultural labour, improved land use and the like, agricultural production per man hour of labour rose greatly; *see* AGRICULTURE: *Productivity and Increased Output*).

At the same time that new markets for fresh and processed food products were created by the shifting of rural populations to urban industrial areas, the economic status and purchasing power of industrial workers improved markedly, as evidenced by the increased per capita consumption of beef, poultry and dairy products, fruits and vegetables and a decreased consumption of cereals and bread. This created a greater demand for certain foods and also a higher quality.

The rising cost of labour was another factor in the greater use of processed foods. By using modern processing equipment the food industry was able to keep the prices of its products comparatively stable in relation to the economy as a whole, and for the consumer the use of processed foods was in many instances more economical from the standpoint of preparation time, etc.

Other new markets for food products are created by the rapid increase of certain age groups in the population. For example, the great increase in the birth rate in the western world following World War II created an unprecedented demand for processed baby food products.

After about 1850—and more especially in the 20th century—great advances were made in the commercial production of food products, first in the prevention of spoilage and then in improved convenience, flavour, colour, aroma, texture and nutritive value. The food industry continues to do much research directed toward improved food products, and government-sponsored research laboratories also work in this area. Universities, agricultural experiment stations, trade associations and nonprofit foundations contribute basic scientific knowledge.

The food processing industry is closely related to the general industrial development of a country. Similar processes are used in all industrially advanced countries and may be expected in less industrially advanced countries as part of their technological growth. Canning and quick-freezing make an interesting comparison in this respect. Canning has been practised since the first decade of the 19th century, and a wide variety of products are canned throughout the world: a great number of products in the U.S. and Great Britain, the leading producers; fruits and vegetables in Australia, Italy, South Africa and Hungary; fish in Norway, Japan, the U.S.S.R. and Canada; pork products in Denmark and Germany. Despite the introduction of other forms of processing and packaging, the canning industry had by the 1960s grown at double the rate of the food manufacturing industry as a whole. Quick-freezing, on the other hand, requires more complicated handling. In the 1960s refrigerated cabinets in retail stores were common in the U.S., where the process was developed; in Britain and Sweden, which led in Europe, about 25% of all retailers were equipped with them; and in such countries as India and those in the middle east interest in this form of food preservation was just beginning to develop.

One of the major problems of the future will be to raise the status of food processing in less developed countries to the more efficient, larger-scale methods used in the industrially advanced nations. Thus the food processing industry will be able to meet the demand for improved standards of living by supplying a wider range of foods having a greater appeal and higher nutritional values.

Scientific and Engineering Developments.—The successful manufacture of high-quality food products on a large scale depends on the understanding of such characteristics of foods as their microbiology, biochemistry and physiology together with the application of engineering principles to the design and construction of food processing plants and equipment.

For example, in the U.S., until about 1940 milk pasteurization was performed in batch kettles by heating at 143° F. (61.67° C.) for 30 minutes. Additional studies of the thermal resistance of the tuberculosis organism and other pathogenic and milk-spoilage organisms and the paralleling resistance of the enzyme phosphatase to heat destruction made possible the design of short-time, high-temperature, continuous-flow pasteurizers. Now most market milk in the U.S. and Great Britain is pasteurized at 161° F. (71.67° C.) for 15 seconds or at higher temperatures for shorter times on a continuous-flow basis rather than in batch kettles. Furthermore, these techniques have resulted in improved flavour and nutritive value in the processed product.

Likewise, for many years canned foods were sterilized in batch steam-pressure vessels called retorts for relatively long processing times. As a result of research and development work, a growing percentage of canned goods is processed in continuously agitated sterilizers at high temperatures for appreciably shorter times. This, also, has resulted in improved flavour and nutritive charac-

teristics in canned foods. The design of these continuous-pressure sterilizers depended upon knowledge of the requirements for thermal destruction of heat-resistant bacteria that cause food poisoning and food spoilage as well as upon the engineering principles of heat transfer and material handling.

Other examples of the interrelationship between biological, chemical and engineering principles in the development of new food products and food-processing methods are the development of low-temperature vacuum evaporators for the production of frozen fruit juice concentrates, making it possible to conserve the vitamin C (ascorbic acid) content and flavour of the juices, and the development of spray-drying methods and equipment for the production of high-quality nonfat milk solids. The use of the tetracycline antibiotics in fresh fish and poultry to prolong their storage life is another important modern development.

A second type of development, strictly of an engineering character although involving a number of biological and chemical problems, contributed to the development of the food industry between 1910 and 1960. The first, and perhaps the most important, of these engineering advances was the development of low-cost, efficient mechanical refrigeration systems for cold storage warehouses, refrigerated motor trucks, railway cars, food freezing plants and household use. In fact, mechanical household refrigerators may well have been the most important development in this area because they made possible the storage of perishable and frozen foods in the home and thereby created a greater demand for these products. (*See* also REFRIGERATION.)

Another engineering advance that contributed to the growth of the food processing industry was the development of high-speed continuous material-handling and packaging machinery. Typical examples of these are sanitary pumps and conveyers for food products and high-speed bottling, canning, and package-filling equipment. New flexible packaging materials have also played an important role in conjunction with high-speed packaging machinery. Aluminum foil and transparent polymeric films have been especially significant. In addition, packaging materials have been developed that can be printed with descriptive material, thus eliminating the need for labels.

All of these developments have enabled food manufacturers to expand productive facilities to meet the new demands imposed by an increasing population with a greatly increased purchasing power. *See* also CANNING, COMMERCIAL; DEHYDRATION OF FOODS; FOOD PRESERVATION.

Practices and Trends.—Among the modern developments in food processing, none is more significant than the use of continuous-process methods rather than batch-process methods; it was made possible by the material-handling machinery mentioned above. Closely related is the increasing use of automatic process control devices. The continuous-process methods result in greater volume of production, reduced operating costs and better control of product quality.

The application of more refined knowledge of food chemistry is also a significant trend. In modern bread baking, for example, special conditioning of the dough is required to preserve its elasticity and strength during high-speed molding and rounding operations; fungal enzymes are used to effect this. Hams, bacons and other meats can be cured by vascular or direct injection of curing salt solutions, a process that shortens curing times from weeks and months to a few hours.

Another trend has been the recovery of valuable by-products. An example is monosodium glutamate, used extensively to enhance natural flavours in soups, poultry and seasonings; it is recovered in Steffens process beet sugar refining, thereby realizing an economic return from what would otherwise be waste material.

Following is a brief summary of some of the more significant practices and trends in producing the major kinds of food products, with references to articles of related interest.

Cereals and Cereal Products.—In the U.S. the dry milling of wheat is almost completely automated, in that production operations in the entire mill may be controlled by several operators at a master control panel board; only maintenance personnel are required for periodic checking of the equipment. The more important future trends in the milling of wheat and minor cereals include increased automation through the use of electronic control devices; milling by impaction, which eliminates one or more steps in the conventional milling operation; and the use of improved air classification procedures, which separate the flour into component parts that can then be reassembled into a new flour with specified baking properties. (*See* also FLOUR.)

Bakeries utilize high-speed, refrigerated mixers, various kinds of cabinets in which temperature and humidity can be strictly controlled, continuous-band ovens, vacuum coolers and high-speed slicing and wrapping machinery. The batch process is commonly used, but continuous bread manufacture has been introduced. (*See* BREAD.)

Other developments include packaged formulated cake, pastry and bread mixes; "instant" (*i.e.*, precooked) rice products; and the recovery of various products in the wet milling of corn and sorghums. (*See* also CEREALS; MACARONI.)

Edible Fats and Oil Products.—In the U.S. and to a substantial and increasing extent in Europe plant oils and products made from them have replaced to a considerable degree the use of animal fats in consumer products; shortenings made from a mixture of vegetable oils and animal fats are widely used in the baking industry. Salad oils made from refined, deodorized and bleached vegetable oils have largely replaced higher-priced olive oil. Margarine was improved considerably during and after World War II, and consumption of it has risen. (*See* also LARD; MARGARINE.)

Sugar and Sugar Products.—Perhaps the most important modern development in the sugar industry is the bulk handling of liquid cane or beet sugar in railroad tank cars or motor tank trucks under sanitary conditions that preclude microbial spoilage. The use of liquid sugar in the manufacture of ice cream, confectioneries and carbonated beverages reduces the storage space required for bagged sugar and contributes to effective employment of continuous-flow processing operations. (*See* also SUGAR; CONFECTIONERY MANUFACTURE.)

Meat, Fish and Poultry Products.—In the U.S., the meat packing industry was the first manufacturing industry to adopt assembly line techniques, but few improvements were made until the decade after 1950. (*See* MEAT; also articles on the various kinds of meat—BEEF; PORK; LAMB AND MUTTON; HAM; BACON; etc.)

In fish processing, Japan and the U.S.S.R. have been the leading nations in developing completely equipped processing ships. In the U.S., Great Britain and Norway, frozen fish and shellfish constitute an important portion of the processed fish sold. This development was very rapid in Great Britain during the 1950s, and the port of Grimsby became a major centre for the quick freezing of fish. Precooked frozen fish and shellfish products, such as breaded scallops, are also produced in large volume. (For other methods of fish processing *see* FISH CURING.)

As for poultry, a notable achievement of the quick-freezing industry, particularly in the U.S. and Britain, was to remove the "broiler" chicken from the luxury class to within the range of the average family as a staple item of diet. Spray-dried whole eggs and egg whites and frozen whole eggs and egg yolks are processed in large quantities for use—primarily by the baking industry.

Milk and Dairy Products.—In the U.S. milk cans have been almost eliminated for the transporting of fluid milk from the farm to the dairy plant, refrigerated tank trucks being employed instead. Continuous-flow processes are used in the manufacture of ice cream, butter and processed cheeses. Canned milk products are sterilized at higher temperatures and for shorter times than formerly, thereby conserving nutritional values and eliminating "burned" flavours. (*See* also MILK; BUTTER; ICE CREAM; CHEESE.)

Beverages and Spices.—Vacuum-packed ground coffee has long been on the market. Later developments in beverages include the manufacture of instant soluble coffee, in which further improvements in flavour may be expected, on the basis of extensive studies of the chemical nature of the flavour and aroma constituents in coffee. Instant tea is also manufactured, and the packaging of tea leaves has undergone various developments. Improvements in corrosion-resistant enamels have enabled the packaging of carbon-

ated beverages in tin cans. (*See* also COFFEE; TEA; SOFT DRINKS; ALCOHOLIC BEVERAGES, DISTILLED; BREWING; and articles on the various kinds of alcoholic beverages—BEER; BRANDY; etc. For spices and other flavourings *see* FLAVOUR; also articles on the various spices—CINNAMON; GINGER; etc.)

Fruits and Vegetables.—Fruits and vegetables are processed in a variety of ways, including canning, freezing and dehydration. Frozen fruit juice concentrates almost indistinguishable from fresh juices in flavour and nutritional value are now produced as a result of the development of high-vacuum, low-temperature evaporators. Several processes have been developed to cook and cool fruit and vegetable products rapidly and fill them without contamination into previously sterilized cans, a method that improves the flavour, colour and nutritive value of the product.

Food Additives.—In food processing various chemical substances are used, to retain or improve colour, flavour, appearance, texture or nutritive value; to prevent deterioration or spoilage; to facilitate the mass production of products of uniform quality; to improve sanitary packaging and distribution; or to improve the convenience with which the food may be prepared in the home.

The use of such additives is controlled by laws which vary among nations; in the early 1960s, for example, one investigation showed that in nearly 30 countries there was only one additive that was commonly allowed. This impedes trade of processed foods between such countries. Agreement may come, however, from the joint work of the Food and Agriculture organization of the United Nations and the World Health organization for a common policy, first in limited areas (for example, Europe) and eventually on a world basis. Developments within the European Common Market suggested that agreement would be reached between the participating countries in the 1960s.

See FOOD PRESERVATION: *Chemical Preservatives* and HEALTH AND SAFETY LAWS: *Food and Drug Laws.*

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FOODS, NATIONAL. There are many similarities in indigenous foods and therefore in prepared dishes among different countries and cultural groups. All countries use frying, baking, grilling and steaming; combinations of meat and vegetables for main dishes are popular all over the world; custards are universal; and every country has sweet cakes and flaky pastry; yet each individual dish is distinctly different from the others. The idea of a foreign food may be said to be attributed mainly to the particular combination of ingredients and the use of unfamiliar flavouring, but also to the variety of fruits and vegetables and the treatment of food materials.

The eating patterns of countries may vary considerably and are influenced by economy, geographical location and religious beliefs. Thus lack of refrigeration enforces greater emphasis on salted or dried foods where production is seasonal; a preponderance of cereal grains is inevitable in the diet of overpopulated and underdeveloped areas; and access to the sea encourages the use of sea foods. So-called typical dishes may alter with new knowledge and facilities, changing economy and the advent of other culture groups. On the other hand, some dishes continue throughout changing times because of high palatability.

UNITED STATES

In the mainly urban population, highly developed, competitive food industries market every conceivable item with few seasonal restrictions. Food may be bought partly or totally prepared, packaged flour mixes abound and canned and frozen precooked foods need only heating.

Among meats, beef is the most popular, although large amounts of fresh and cured pork are used; other meats are of minor importance. Cooking of meat is generally plain, grilling, broiling and roasting being the usual methods, but less tender cuts are often braised or stewed with vegetables. Juicy grilled or broiled steaks and medium-rare rib roast of beef are well liked but are relatively expensive; ground beef is used in a great variety of ways and grilled hamburgers compete with "hot dogs" (wieners or frankfurters) for the most popular lunch. Roast turkey with cranberry sauce is the traditional Thanksgiving main course, with pumpkin pie for dessert; chicken and turkey—particularly chicken—are served around the year. Fried chicken is thought of as a typically southern dish but is common throughout the country; with the widespread use of charcoal and other broilers, broiled chicken became popular. Barbecued beef—often but not necessarily cooked over an open fire—is a typical western food. Fish is used in only limited quantity but certain dishes are associated with certain parts of the country—for example, clam chowder and lobster with New England and various shrimp dishes, including shrimp creole, with the south Atlantic and Gulf states.

The commonest bread is commercially baked of white flour, the loaf being very white and soft with moist cakelike qualities, but other types are available in almost all grocery stores. Among hot breads, corn bread, made of ground corn (maize), is thought of as southern but is served throughout the nation. Milk and eggs are used a great deal. Among breakfast combinations, ham and eggs are frequently thought of as the one typically American dish but bacon and eggs are commoner. Prepared cereals are frequently served for breakfast; griddle cakes and waffles are popular but are more likely to be served for special occasions. Unripened curds and aged cheddars head the list of cheeses; cheddars are often softened by processing. Fruits of all types abound and fresh citrus is popular for breakfast. Vegetables are mainly cooked in water and seasoned only with butter. Boston baked beans are well known. Salads of fruits and vegetables are endless in variety and range from a simple accompaniment to a meal to the main course itself, especially for the midday meal. Ice creams in a great variety of flavours and apple pies are popular desserts. Black coffee of medium roast is the main beverage. The U.S. also has a rich heritage of national foods from other countries, and restaurants specializing in Italian and Chinese foods, for example, are common in all larger cities.

GREAT BRITAIN

Cooking is generally simple with the emphasis on roasting and baking and few seasonings or sauces detract from the natural flavour of foods.

Breakfast is traditionally of fried bacon and eggs, followed by toast with butter and marmalade, but smoked haddock and herring (as kippers) are popular alternatives.

The midday meal is frequently of roast meat with boiled vegetables and a dessert of fruit pie and custard. Roast beef with Yorkshire pudding is famous, the latter being made from a thin batter baked in a little hot fat often around the meat. Except in Yorkshire, where it is eaten first, it is served with the meat and roast potatoes. A variation of Yorkshire pudding is called toad-in-the-hole, when sausages are baked with the batter to form a main dish. Roast lamb is served with mint sauce, roast pork (stuffed with sage and onion forcemeat) with applesauce. Grilled lamb chops, rump steak, steak and kidney pie and steamed steak and kidney pudding are other favourites. Many counties are well-known for their special dishes, including Lancashire hot pot—lamb or mutton chops stewed in a casserole with layers of sliced potatoes, onions and mushrooms—Cornish pasties and Melton Mowbray pork pie. Popular are boiled cod with parsley sauce and fried fillets of fish, especially plaice—indeed, "fish and chips" (fried fish and fried potatoes) has become a byword, particularly in northern England.

Both white and whole meal brown breads are eaten and there are many types of richer yeast doughs; *e.g.,* Bath buns, Sally Lunns, Yorkshire teacakes, Chelsea buns, lardy cake and bara brith, the national bun loaf of Wales. Fruit pies and plate tarts, particularly made with apples, are common for dessert, and so are steamed puddings. The plum pudding traditional at Christmas-

time is a rich steamed pudding with dried fruit, currants, sultanas, raisins, suet and brown sugar. The Christmas cake is a rich fruit cake first covered with almond paste and then white icing. Buttered scones are popular for afternoon tea and in Scotland they are baked on a griddle or may be dropped scones such as small thick pancakes which are buttered without splitting.

Oatmeal is used frequently in Scotland, where porridge, oatcakes and haggis (*q.v.*) are particularly famous. Herrings are split open and dipped in oatmeal before frying. Scotch shortbread is a rich biscuit of butter, flour and sugar.

Potatoes and cabbage appear often in Irish cooking. Irish stew consists of mutton cooked with potatoes, onions and stock until almost all the liquid has been absorbed. Mashed potatoes replace flour for scones baked on a griddle, which are split open, buttered and eaten hot. A common country dish is boiled bacon or pig's cheek with cabbage. Carrageen moss is an edible seaweed made into a sweetened jelly and eaten with cream.

Throughout Great Britain tea with milk is the most popular beverage. The midmorning habit of "elevenses," consisting of coffee and biscuits, appears to have originated there.

THE COMMONWEALTH OF NATIONS

Australia and New Zealand.—English cooking combined with indigenous foods characterizes the dishes, together with both American and Chinese influences.

In Australia cooking is plain with plenty of meat, a variety of vegetables and few sauces. Bacon and eggs for breakfast are popular and so is the roast beef of Great Britain. Fish is plentiful and shellfish, crayfish, lobster, prawns and oysters are favourites. The barramundi, a fish from Queensland, is stuffed with prawns and crayfish and baked in wine and butter for a special occasion. Oysters with steak are not unusual and a carpetbag steak consists of a two-inch-thick steak cut to form a pocket and stuffed with oysters and mushrooms. A fried egg is also often served with grilled steak and roast pork with cloves and pineapple is another favourite dish.

There are plenty of salads and vegetables all the year round. Salads, which are often combinations of vegetables and fruit, are eaten either as a main course or with the main dish. *Aubergines* ("eggplant") capsicums and pumpkins are well liked, the latter being used as both a vegetable with meat and as a filling for a dessert pie.

World-famous among sweets is Pavlova: a meringue shell, crisp on the outside and like marshmallow inside, filled with whipped cream and fruit, often passion fruit; it is a typical festive dish. Apple blossom pie is also a national dish: a sweet pastry crust is filled with three layers, first a mixture of apples and passion fruit, then a layer of condensed milk, egg yolk and lemon juice, and topped with pale pink jelly whipped with beaten egg white and decorated with whipped cream. Sponge cakes filled with whipped cream and raspberry jam and chocolate cakes with fudge frosting are popular at tea time and lamingtons (sponge squares dipped in chocolate icing and rolled in desiccated coconut) are well-known favourites. In New Zealand the national skill is particularly displayed at tea time in the scones, fruit or nut loaves, biscuits and cakes. Cakes and biscuits are frequently made with whole meal flour, while nuts, dried fruit, brown sugar and treacle are common ingredients. Typical are the crisp round biscuits called anzacs, and a light sponge filled with cream and passion fruit pulp is also very popular.

Canada.—Both French and American as well as British cooking has influenced the national dishes, with original salad mixtures, fish dishes, crisp cookies and maple sirup as a characteristic flavouring. Gammon rubbed with mustard and brown sugar and baked in pineapple juice is a popular meat dish, as is roast turkey with chestnut stuffing. Salads are often sweet and savoury mixtures; *e.g.*, oranges and tomatoes mixed with tomato sauce and orange juice, or celery, pears, peanuts and capers dressed with mayonnaise and lemon juice and served on lettuce leaves. Blueberry, pumpkin and lemon chiffon pies are popular desserts. Popovers are made from a light batter baked in small tins, sometimes with fruit, and are served with butter and maple sirup. Both maple and pumpkin sirups often accompany pancakes and waffles. Maple nut cakes, coconut cookies and brownies are typical.

EUROPE

France.—The French above all have developed cookery into an art. Herbs, spices and wines are delicately blended to give subtle, tantalizing flavours and sauces are often used to enhance the natural flavour of foods.

Specialities of the soup course are broths and bisques. A clear, well-flavoured stock, devoid of fat as in a consommé, is typical of the broths which are served with crisp croutons of fried bread; the famous French onion soup consists of onion rings, cooked in butter, in a well-flavoured stock. Shellfish are widely used for bisques, which are often enriched by folding in whipped cream immediately before serving. The classic Mediterranean fish soup, bouillabaisse, prepared to perfection in Marseilles, is made from eight or more different fish.

A substantial white bread loaf with a crisp crust is often baked in a characteristic long shape. *Croissants* (sweet crescent-shaped flaky rolls) are eaten at breakfast and often with hot chocolate.

A frequently used meat is veal, which combines well with ham, mushrooms and other vegetables or elaborate sauces, whereas collops of veal can be quickly and simply prepared by coating in egg and crumbs and frying in butter. Veal, chicken or fish may be cooked in their own juices in parchment paper; seasonings and often herbs are added to the individual portions, which are securely wrapped for cooking and then served still in the covering. Typical of the popular grilled fillet of beef are *tournedos*, small fillets of about three ounces served on rounds of fried or toasted bread, which absorb the juices, and accompanied by a particular sauce or garnish which gives the dish its name. Stews are numerous and varied, red and white wine being used as well as stock.

Salads are very popular and generally consist of a single vegetable with a vinaigrette, oil and vinegar, dressing. Plain dressed lettuce is always served with poultry and game. Salads with mixtures of raw and cooked vegetables and also meat, poultry and fish salads are also found. Vegetables are varied and often served as a separate course, young tender vegetables being cooked quickly and flavoured with browned butter. Potatoes are cooked in numerous ways, including mashed with butter and milk to give a typical soft purée, cooked, sliced and fried with onion rings. Potato duchess, made by adding egg, butter and seasoning to mashed potatoes, is used to garnish meat dishes by piping the mixture through a bag with a star pipe and then browning in the oven.

Pastries and cakes are artistic and often require considerable skill. The puff pastry for fruit or cream tarts begins with a thin pastry dough which is rolled out and spread with a layer of softened butter; the process is repeated several times and cases of various shapes are cut before baking. The French dessert course is of a light and airy nature. Soufflés are numerous and so delicate in texture that they must be served directly from the oven. Éclairs and tiny profiteroles are made from a rich *roux* into which eggs are beaten and which is piped through a plain pipe in a bag and then cooked in a hot oven. They are then filled with cream and coated with icing or sweet sauce. A rich spongy yeast dough with currants is used to make *babas*, cakes, usually round, which are soaked in rum sauce for serving. Caramel is a popular flavour and cream caramel custard a favourite dessert. Crepes suzette are rich thin pancakes spread with sweetened orange-flavoured butter, rolled up, covered with liqueur and set alight just before serving. *Petits fours* may be tiny decorated cakes, crystallized fruits or bonbons.

The French excel in using eggs in many ways, frequently as a main dish, but milk is not used extensively except for making cheeses, of which there are several hundred kinds. Roquefort, a salty cheese made originally from ewe's milk and treated with a greenish-blue mold, originated in France; soft-ripened Camembert is another typical cheese.

Coffee and chocolate are the favourite beverages. Strong coffee may be diluted with an equal quantity of hot milk to produce *café au lait*. The origin of the use of bitter roasted chicory is attributed to the French, although it is not used consistently.

The Netherlands.—A characteristic of Dutch cookery is that typical dishes are based on nourishing ingredients; this is probably because the evening meal is generally the one hot meal of the day. Cheese and boiled eggs are eaten for breakfast with a variety of breads and butter and jam. The midday meal is of a sandwich type; *e.g.,* breads and rusks topped with liver sausage, ham or rare-cooked beef, to which a fried egg or an omelette may be added. Dinner is of three courses: (1) soup, of which those made with eels, beans and peas are all famous; (2) a main dish of meat or fish with potatoes and several vegetables; and (3) a sweet or fruit. Methods of cooking are simple, so that food takes little time to prepare, but the former Dutch possessions overseas have influenced national dishes in the use of rice and spices.

Vegetables are cooked by steaming with butter and are often flavoured with spices, particularly nutmeg and cinnamon. Dried peas and beans—staple articles of diet—are soaked overnight in water, then simmered gently until tender; they may be served with fried bacon, fried onions or gravy. Among other popular vegetables are beetroot served with apples and nutmeg, stuffed cabbage, endive with a nutmeg-flavoured sauce and red cabbage with apples and nutmeg. Much fish is eaten, particularly herrings and plaice. Salted and smoked herrings are famous and uncooked smoked herrings are a national dish. Beef, often cooked rare and sometimes eaten raw, pork and veal are the preferred meats, of which joints may be stuffed or boned and rolled. Small fritters made of yeast dough served hot with melted butter and sugar are frequent features at fairs and carnivals. Pancakes filled with jam or served with treacle or brown sugar are well liked. A popular pudding called John in the sack is made from a yeast dough mixed with milk and egg, with raisins, currants and citrus peel added. It is then put to rise before being wrapped in a cloth and boiled. This is served with butter and brown sugar or treacle. Dutch Edam and Gouda are mild smooth-textured cheeses which may be flavoured with caraway seeds or cloves. Tea without milk and coffee with cream are the main hot beverages.

Belgium.—Although influenced by French and Dutch cuisine, Belgium has a number of typical national dishes. One of these is the *waterzoie,* a chicken broth which includes dry white wine. A similar soup is also made with several different kinds of fish. The *carbonnade flammande,* one of the best known Belgian dishes, is essentially a beef stew cooked in a brown sauce made with beer and served with plain boiled potatoes, so that the sauce can be appreciated fully. The popular fricandels are minced meat balls made with fresh pork which, after frying, are poached with potatoes in white wine, beer or stock. A typical dish from the Ardennes is rabbit with prunes: the meat is steeped in a marinade of red wine, vinegar and herbs and simmered in red wine with previously soaked prunes. Chicory, asparagus and hop shoots are favourite vegetables. Chicory is often eaten raw as a salad, or cooked slowly in the oven in a covered dish with butter and seasoning. Cooked heads of chicory are also wrapped individually in a slice of ham and covered with cheese sauce to make a main dish. Among the desserts are rich waffles made from yeast dough enriched with eggs, butter and cream, and a flaky pastry tart with a sweet filling of cream cheese, sugar, butter and eggs. Brown spicy biscuits (cookies) cut in animal shapes and iced in white and pink are traditional for the feast of St. Nicholas.

Germany.—Characteristics of German cooking are the use of sweet sauces and garnishes for meat and poultry, substantial beer soups, many kinds of sausage and fermented cabbage (sauerkraut), consisting of layers of shredded white cabbage sprinkled with salt and caraway seeds and pressed down in a special kind of tub for three to four weeks. Plenty of bread, particularly pumpernickel, a dark whole meal rye bread, is served at all meals.

Weissbiersuppe consists of a light-coloured beer flavoured with cinnamon and lemon and thickened with potato flour. A favourite fish dish is carp cooked in beer. Both fresh and salt herrings are used a great deal. Rollmops are filleted raw herrings spread with chopped shallots, capers and sliced gherkins, rolled up and skewered. They are put in a jar with a few mustard seeds and peppercorns and covered with wine vinegar, and are ready to eat in a few days. Pork, beef and veal are the favourite meats, pickled pork with sauerkraut being a famous dish; pork chops with plums, stewed in wine, or roast loin of pork stuffed with prunes are also typical. Roast goose is stuffed with apples, chestnuts and raisins, mixed with the liver and giblets. An orange cake with rum icing is popular, and a rich sweet pastry mixed with eggs is used for an open tart with apple purée and chopped almonds. Cinnamon, nutmeg and almonds are used to flavour small cakes and biscuits. Cheeses include the strong-smelling Limburger and also Tilsiter. Light beer, frequently drunk with meals, and medium roast coffee are the usual beverages.

Austria.—Austrian soups are rich and substantial and often a meal in themselves, with the addition of forcemeat balls, dumplings, rice sausages and vermicelli or noodles. Beef broth with liver dumplings is typical. Fresh-water and salt fish are both popular. Dishes, of which paprika is a frequent ingredient, are often highly seasoned. Pork, veal and venison are eaten extensively and veal or beef goulash is popular. A favourite dish is Wiener schnitzel: very thin slices of veal from the fillet or leg are floured, coated in egg and white bread crumbs, fried quickly and served at once with a garnish of lemon slices. Goose is commoner than chicken and a characteristic dish is *kalte Gans,* cold roast goose with cucumber salad flavoured with chopped dill or caraway seeds. These two flavourings are used in many dishes and sauces. Pheasant *Zigeunerart* is stuffed with previously cooked snipe, fat salt pork and truffles.

Austrian pastries are world-renowned, with *Apfel strudel* the particular speciality: a plain pastry dough is pulled to paper thinness on a floured cloth, covered with fried bread crumbs, sliced apples, currants, sugar and cinnamon, then rolled up and baked before cutting into slices. Other fruits are used as well and also sour milk or cream with eggs, sugar, raisins and currants. Yeast doughs are used for sweets and cakes. *Gugelhupf* is made in a special fluted tin and served with coffee or chocolate topped with sweetened whipped cream.

Hungary.—The use of paprika to give the characteristic bright red colour to soups, fish and meat dishes is typical of Hungarian cookery. So too is the use of fresh green and red peppers, sour cabbage and sour cream. Hungarian goulash is a national dish which may be either a soup or a stew. As a stew equal quantities of beef and onions are cooked slowly with a liberal sprinkling of paprika, very little liquid, tomato purée and a flavouring of caraway seeds. This is served with potatoes, rice or very small dumplings. Chicken paprika is a similar and another characteristic dish. Cherry cake and a poppy-seed cake are typical sweets. Lipto (Liptauer) cheese is made from sour milk and flavoured with capers, anchovies, onion and paprika.

Poland.—Among the Slavonic nations Poland has a distinctive cookery of its own dating back for many centuries. Basically Slavonic, it is tempered by a sense of balance and proportion common to western cultures. There is a choice of soups of which the cold *chlodnik* (a salt cucumber soup with sour cream) is perhaps the most original. Fresh-water fish are prepared in many ways, the most popular being *karp po polsku* (carp stuffed with veal forcemeat). *Potrawka z rakow* is a tasty dish of crayfish with groats or rice, flavoured with dill. Beef, pork and venison are the commonest meat dishes; *zrazy z kasza* (rolled and stuffed fillet steaks with buckwheat groats) and *bigos* (sour cabbage with meat, game, mushrooms, apples and tomato purée) are perhaps the most popular. *Flaki popolsku* (tripe prepared with dumplings, grated cheese, paprika and marjoram) is a delicacy. There is a great choice of vegetables, desserts and pastries. Black coffee or China tea (without milk) are the hot beverages.

Italy.—Italian cooking is varied, each region or province often having its own specialities or variations of a national dish; *e.g.,* in Bologna spaghetti is served with a rich sauce of minced beef, tomatoes and mushrooms. Among soups is the famous *minestrone:* made with fresh young vegetables, it is very thick and served either hot or cold, sprinkled with grated Parmesan cheese.

Pastas made from eggs with either flour, semolina, maize or potato flour appear in many shapes—shells, spirals, tubes and noodles, for instance. The name often varies with the thickness or length of the paste. Pasta is properly cooked *al dente* (liter-

ally "to the tooth"), not sticky or mushy, and may be served with cheese alone, or with some kind of tomato or meat sauce. Ravioli are small cushions of broad noodle paste either plain or filled; *e.g.*, with spinach and forcemeat. Rice is used for *risottos*, the best-known perhaps being *alla Milanese*, when the rice is cooked in butter with beef marrow, stock, wine and saffron and served with grated cheese.

Vegetables are important in the menu and include globe artichokes, asparagus, beans, peas, small marrows, sweet peppers or capsicums (yellow, red and green) and also celery and *aubergines*. Fennel and oregano are herbs frequently used. Raw salads with oil and wine vinegar are served as an hors d'oeuvre or *antipasto*. Potatoes are used in soups and *gnocchi*. The Neapolitan dish pizza may be either savoury or sweet: bread dough $\frac{1}{4}$-in. thick is covered with tomatoes, crisscrossed with anchovy fillets and baked, then sprinkled with cheese and browned. As a sweet, short or puff pastry is used and one version is spread with honey, spice and nuts and rolled before baking. Fish of all kinds are used, including eels, lobster, crayfish, scampi, crabs, scallops, clams, oysters and mussels. The fish dishes of Venice have been famous for centuries. Beef, veal, lamb, chicken and pork are generally roasted, grilled or fried.

Sweets are not usually served, fresh fruits being more popular, but *zabaglione* is a famous dish made from egg yolks, sugar and Marsala wine beaten together over hot water to form a light and frothy mixture. There are many varieties of cheeses, notable among them being mozzarella, a soft creamy cheese made from buffalo milk, the well-known Gorgonzola and bel paese. Coffee is the favourite hot beverage, an unusually dark roast producing a distinctive flavour.

Spain.—Spanish food is characteristically rich, colourful and highly seasoned. Oil is used a great deal for frying and baking and garlic, chili peppers, paprika and cumin are common seasonings. Mixing many foods into one dish is illustrated by the well-known *paella* which may consist of chicken, lobsters, crabs, mussels, clams, scallops, scampi, globe artichokes, french beans, peas and rice, flavoured with garlic and saffron. Colour is added to dishes by using tomatoes and sweet red and green peppers.

Substantial soups with many ingredients, mainly vegetables, are common and may be thickened with rice and vermicelli. A typical soup has little forcemeat balls added to a good meat stock. Another, *la fabada*, which is a meal in itself, includes salt beef, ham, black pudding, haricot beans and special local sausages, the meat and sausages being served separately after the soup. Chicken, pork, lamb and mutton are common meats. Salads are very popular, including both raw and cooked vegetables, *e.g.*, pimentos and *aubergines*, tomatoes and runner beans, as well as crisp leaves of lettuce or endive with an olive oil dressing. A great many olives are also eaten. Sweets for dessert are not served often but sweetmeats such as all sorts of crystallized fruits and *turrón* (a kind of very sweet nougat flavoured with vanilla and nutmeg) are universal. *Churros*, which are eaten for breakfast with chocolate or coffee, are fritters made of *chou* paste piped into hot fat, where they puff up into long curls; they are sprinkled with sugar for eating.

Portugal.—The food is similar to that of Spain, but simpler and less exotic. Eggs, fried, scrambled and as omelets, are staple food and fresh raw fruit such as oranges, watermelons and many varieties of grapes are eaten as dessert.

Mexico.—Mexican cookery is often considered synonymous with that of Spain, but the food is more highly spiced with hot chili peppers and dishes are frequently made from *tortillas*. The *tortilla*, the bread of Mexico, is a thin unleavened cake cooked quickly on a hot ungreased griddle. The flour is made from finely ground lime-treated corn or maize but white flour also may be used. Enchiladas are rolled *tortillas* filled with minced beef, chopped onion and grated cheese and baked in a spicy tomato sauce. Another popular use of the *tortilla* is a *tostado*, a crisp envelope made by sautéing the *tortilla* in a little hot fat and folding once to hold a mixture of lettuce, green peppers, onions and cooked meat. Tamales are also very common; they are made of cornmeal mixed with minced meat and seasoned with chili peppers, small portions of which are wrapped in cornhusks and steamed. Butter beans and rice are mainstays of Mexican cookery. Beans are often just boiled, mashed and sautéed, or may be baked in a casserole with bacon, onions, tomatoes and treacle. *Verdulagas* (vinelike greens) and *nopales* (prickly pear cactus), wild plants indigenous to Mexico, are chopped and cooked in water, which is discarded; bacon fat, garlic and onion are then added and the mixture simmered in a tomato sauce, which may be enriched with eggs. Chili peppers range from very mild to peppery hot; one dish is of stuffed long mild chilis dipped in batter and fried. A popular salad is made of mashed avocados mixed with chopped raw tomato and onion. Mango and papaya are common fruits often eaten at breakfast. Chocolate is a popular beverage, characteristically flavoured with cinnamon. Typical candies are made from cactus and sweet potato.

Scandinavia.—Cooking is influenced by the cold climate and short growing season, particularly in the north, and by accessibility to the sea.

Norway.—Quantities of fish and salted meats are eaten. Fish are frequently bought alive so that they are eaten very fresh. Smoked meats are also common, particularly smoked mutton which is eaten both raw and cooked. Smoked reindeer tongues are a delicacy. Chicken is stuffed with butter and parsley for roasting.

Many varieties of hors d'oeuvres are served with rye bread, including salted herrings, smoked salmon, anchovies and shellfish. This is not unlike the smorgasbord of Sweden which characteristically consists of a variety of both hot and cold dishes eaten with bread and butter and intended as a prelude to the main course.

Sweden.—Herrings are a basic food, eaten salted and raw with a dressing of vinegar. The crayfish season in August is a good reason for *kräftor* parties, at which these miniature lobsters are eaten and schnapps is drunk. Dill is a frequent flavouring herb, dill sauce being popular with fish and lamb. A typical Swedish jam is made from lingonberries, which resemble cranberries. The characteristic Swedish limpa bread, a yeast dough with a cakelike consistency, contains a high proportion of rye flour and is flavoured with treacle and orange peel.

Denmark.—Soups are substantial enough to form a complete meal; *e.g.*, *gule arter* made with pork and yellow split peas. Flour dumplings and forcemeat balls are often added. A sweet buttermilk soup is made with ground rice, lemon, cinnamon and chopped almonds. Much fish is eaten, particularly cod, which is boiled and served with mustard sauce, and also mackerel, plaice, salmon and shrimp. Beef, veal and lamb are roasted and stewed, and pork, chicken, duck and goose are also common: duck is stuffed with apples and prunes, and roast goose, served with stewed red cabbage, is traditional on Christmas Eve. Stewed rhubarb and red currants are common with hot meats and poultry. Among vegetables caramel potatoes are outstanding. Potatoes are boiled in their skins, peeled, rolled in sugar and fried in butter. For salads cucumber and beetroot are well liked. A favourite summer sweet is *rodgrod*, a fruit jelly made with fresh currants and raspberries and thickened with potato or corn flour. Other sweets are apple cake pancakes and doughnuts. The world-famous Danish pastries consist of a yeast dough, enriched by rolling in butter as for flaky pastry, formed into different shapes with fillings such as almond paste, vanilla *crème* or prunes, and then baked. They are often eaten for breakfast. Danish blue cheese is well known and other distinctive varieties include Danbo, Fynbo, Elbo and Samsoe. In Denmark cheese is always cut in very thin slices.

The Danish *smørrebrød* are open sandwiches with hundreds of different toppings on thickly buttered bread, usually of rye. Typical is the Andersen sandwich of buttered dark or light rye bread with a topping of crisp fried bacon, liver paste and tomato slices, garnished with horseradish and jellied consommé. Another is *tartar med aeg*, chopped raw steak spread on buttered bread, in the centre of which a raw egg yolk is circled by a ring of raw onion.

Greece.—Lamb is the favourite meat and grilling the usual method of cooking. At Easter whole animals are roasted. Small pieces of meat (*souvlakia*) are marinated in oil with onions and herbs, then placed on a skewer alternately with tomato, onion,

mushroom and bacon before grilling. This is served with boiled rice. A famous national dish, *moussaka,* is made of alternate layers of minced meat, first fried in oil, and sliced vegetable such as *aubergine* or potato, covered with a cheese sauce and baked in the oven. A typical soup, *avgolemono,* consists of chicken stock in which rice is cooked, enriched with eggs and flavoured with lemon juice. Olive oil is the popular cooking fat. Baked fish, using bream or mullet with onions, tomatoes and garlic, is another national dish. Grilled eel, fried octopus or mussels and fish soups are also liked.

Rice dishes are popular, the pilafs being very like those of Turkey, whose cookery has obviously influenced that of Greece. Vegetables are stuffed with cooked rice and raw minced meat flavoured with herbs; vine leaves (*dolmas*), cabbage, lettuce, pimentos and courgettes are also prepared in this way. A salad of shredded white cabbage with olives, capers, beetroot and beans, dressed with a vinegar and oil dressing, is frequently served with *souvlakia.* A shortbread, *kourabiedes,* is made from butter, flour and icing sugar worked together and baked very slowly, cut into fingers and coated in icing sugar. This is eaten on festive occasions. An unripened Fedde cheese is eaten with bread for breakfast and enclosed in pastry for snacks. Sweet black tea and Turkish coffee are the favourite hot beverages.

ASIA

Turkey and the Arab World.—In Turkey, mutton, rice, vegetables and oil are characteristic ingredients. Kebab, a famous dish, consists of small pieces of fat breast of lamb marinated in vinegar with oil, onions, cloves and parsley, then grilled on skewers and served with pilaf (rice cooked so that it absorbs all the liquid and is quite dry with every grain separate). *Aubergines* are a popular vegetable and vine leaves or spinach stuffed with forcemeat of uncooked minced mutton, rice, herbs and spices are also favourites. Sesame seed paste is very popular. *Tihini* may be seasoned with lemon and served with fish or vegetables or sweetened for a spread on crackers. The well-known sweet *halva* is made of crushed sesame and sugar sometimes flavoured with chocolate and containing almonds. Two unique breads may be found. *Balady* bread, a mainstay of the Egyptian diet, is baked in small, round, very flat "loaves" which easily open into an envelope for filling. *Fool medames,* well-seasoned beans baked very slowly overnight, are the commonest sandwich filler. A similarly shaped loaf turns out to be a hollow ball of crisp texture. *Baklava,* a flaky pastry with almonds and honey, is a favourite dessert.

India.—The economy and religious practices of India preclude the use of much meat and therefore grains constitute the mainstay of the diet—particularly rice, dhal (a split pulse resembling lentils) and chapati, the bread of India. It is eaten with everything except rice and is made from whole meal flour mixed to a stiff dough with water, rolled out thinly like a pancake and baked on a griddle. Other characteristics of Indian cooking are the use of ghee (clarified butter from buffalo milk) instead of oil, and the use of spices, especially the distinctive curry flavour. For best flavour the spices from which curry powder is made need to be freshly ground, the ingredients including turmeric, cumin and coriander seeds, ginger, pepper, cardamom, fennel, chilies, mace, cloves, mustard and poppy seeds in varying proportions. Curries may be made with meat and vegetables or vegetables only. Lamb and chicken are eaten extensively, beef by some groups. The large Dublin Bay prawns or Norwegian lobsters are a favourite fish. *Dopiaza* curries have a small quantity of rich sauce that has been reduced during the cooking; *kofta* curries are characterized by the forcemeat balls made from minced or pounded chicken, pork, lamb, beef or fish. Many kinds of vegetables are used for curries (*chankees*) and mashes (*bhurthas*), the chief ingredients of which are onions, green chilies and lemon juice.

Aubergines, yams, okra, capsicums, potatoes, beans and peas are popular vegetables and are frequently cooked in butter flavoured with cumin. Rice is always served with curry, as are side dishes of various fruit chutneys and Bombay duck, a small phosphorescent fish which is dried, salted and toasted and sprinkled over the curry dish. Milk is used a great deal for cooking, making sweets and yoghurt or soft cheese. Curds (*dahi*) are made from soured milk allowed to stand and may be served as a sweet with sugar or with salt and rice. Curds are mixed with sugar, ground almonds and butter, spread in a dish and decorated with lightly fried sliced blanched almonds. Tea and coffee are both taken as hot beverages.

U.S.S.R.—The distinction of Russian cookery is a combination of western and eastern (mainly Armenian, Georgian and Turkish) influences. There is a great variety of hors d'oeuvres (*zakuski*), the most famous, though expensive, being caviar; a typically Russian way to serve it is on hot *bliny* (buckwheat pancakes) with sour cream. The true *russki salat* comprises not only cold vegetables but also meat, poultry, game or fish; it is served with mayonnaise or *à la vinaigrette.* Soups are traditionally Slavonic, the most popular being *shchi* (cabbage soup) and *borshch* (beetroot soup or meat stock with other vegetables); *borshchok* is a clear beetroot consommé served with *piroshki* (pancakes stuffed with forcemeat or chopped cabbage with mushrooms). *Kulebiak* is a roll stuffed with fish (salmon or sturgeon), or with cabbage and mushrooms. There are many game and meat dishes served with sour cream and a choice of vegetables, including pickled cucumber and sour cabbage. The Russians drink mainly China tea without milk, often without sugar but with cherry or strawberry jam.

China.—The subtle flavour of Chinese cooking, which can be compared to that of French *art culinaire,* is characterized by the generous use of rice, of the soybean such as bean sprouts, of bean curd instead of milk and as a sauce, of fresh root ginger, of many dried foods and by the fact that butter, milk, cream and cheese are never used. Spices and herbs are rarely found but garlic and onion are used for strong flavourings. Several dishes, often in multiples of eight, are accompanied by fluffy white rice, a little being taken from each dish in turn, with bites of rice in-between. All food can be eaten with chopsticks or a spoon and fork. A knife never appears at the table, since the food is cut up during the preparation.

Chinese birds'-nest soup is unique: a hardened gelatinous substance, regurgitated by certain birds in nest making, is softened by soaking and then cooking, and is added to a chicken broth, thickened with rice flour. Other typical soups are light and delicate in flavour; two may be served during a banquet to clear the palate. Fish is a favourite food, particularly fresh-water varieties and lobster and prawns. Pork, chicken and duck are the supreme meats, but beef, lamb and mutton also are sometimes eaten. Both fish and meat may be prepared in a sweet-sour sauce of sugar and vinegar with mixed fruits. The meat is often dipped in batter and shallow fried in peanut or soybean oil before being added to the sauce. Rice and noodles are staple foods and maize and millet are also used. Large quantities of vegetables are eaten. They are cooked quickly in a small amount of liquid and crisp vegetables garnished with slivers of meat form many main dishes. Mushrooms, particularly a large black variety, bamboo shoots, water chestnuts and bean sprouts are typical vegetables. Monosodium glutamate is frequently added to savoury dishes and this and soybean sauce, which replaces salt, are common flavourings. Peaches, pears, persimmon, mango and litchi are enjoyed among fruit. Almond biscuits and almond paste soup served either hot or cold are typical desserts, as is a tart made of rich, very flaky pastry with a slightly sweet bean paste or other filling.

Shao hsing is Chinese yellow rice wine used in cooking as well as to accompany meals. Tea, either green or semifermented, is served at every meal. Jasmine tea, which contains the flowers as well as the leaves, is served in small handleless cups without milk or sugar.

Japan.—Cooking is plain and simple and grilling and baking are common methods. The Japanese excel in the artistic decoration of dishes and the utensils for serving add to the attractiveness of the table.

Many courses of small portions are served. Rice takes the place of bread, and noodles made from flour and egg yolks accompany main dishes. Black noodles are made with soybean flour. Stock for soups is frequently made from dried tunny fish. A popular soup is made by adding well-beaten eggs to hot stock so that soft curds are formed. The Japanese are great fish eaters, one hot and

one cold dish often being served at a meal. Dried fish is frequently used and some fish is eaten raw with a typical salad of brined sliced cucumber and lettuce.

Sukiyaki is known throughout the world as a Japanese main dish; it consists of beef, vegetables and *tōfu* (cubes of pressed soybean curd) which are cooked at the table over a spirit lamp. Vegetables such as thinly sliced spring onions, bamboo shoots and leeks are browned singly in a little fat, moistened with stock, covered with very thin slices of beef and simmered a few minutes. The dish is seasoned with *shōyu*—a sauce made from soybean seeds, wheat and salt. Pork and chicken can be used instead of beef.

Sake is the national drink and is made from rice by a fermentation process. Tea is drunk with all meals and the tea ceremony (*q.v.*), when a bowl of tea is offered to each guest in turn with sweet and salty biscuits, is an important custom.

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FOOD SUPPLY OF THE WORLD. Since time immemorial, food production has been the chief occupation of mankind. It still engages more than half the world's labour force. The processing, transporting and retail distribution of foodstuffs occupy many additional millions of people. However, the proportion of labour engaged in food production is different in various countries at different levels of economic development, the proportion tending to decline with economic progress. Similarly, the share of expenditure for food in the budget of individual households declines with elevation from a lower to a higher income level. In the United States, for example, outlays for food represent about 45% in the lowest-income groups, 30% in middle-income families and only 15% in higher-income households. Similarly, the share of food in total consumer expenditures fluctuates between 30% and 35% in highly developed industrial countries, approaches 50% in less-prosperous industrial countries such as Japan and is still much higher, up to 65% or 70%, in primarily agricultural, underdeveloped regions.

Income level is one of the decisive factors in determining the per capita consumption of food both quantitatively, as measured by the average daily calorie intake, and qualitatively, as characterized by the variety and proportion of protective foods—meat, dairy products, leafy vegetables, vitamin C-rich foods and others. Least elastic is the demand for cereals and root crops, while that for meat, dairy products, fruit and vegetables tends to increase with the rise in the standard of living. Income level divides mankind into "cereal eaters" and "meat eaters."

Nutrition patterns in different parts of the world have developed around local food production, each people adjusting habits and tastes to domestically produced foodstuffs. In sheep-raising countries, such as Australia and New Zealand, the per capita consumption of mutton and lamb is many times greater than in the United States, while the per capita consumption of pork in the U.S. is many times greater than in those countries. In sparsely populated cattle-raising countries such as Argentina and Uruguay, meat consumption is among the highest in the world, while milk and dairy products predominate in Switzerland, the Netherlands, Belgium, Luxembourg and the Scandinavian countries—all areas with intensive husbandry. In regions where agriculture is concentrated on production of grains, cereals constitute the bulk of the diet.

The over-all volume of food production in various parts of the world is determined by the abundance or scarcity of arable land in relation to population, fertility of the soil, climatic conditions and the level of agricultural techniques. Thus, in certain areas there are deficiencies in food production, and in others there are surpluses. (The terms "deficiency" and "surplus" are usually applied to staple foods such as cereals, roots and sometimes sugar, rather than to crops that can be raised only under special climatic conditions, such as tea, coffee, cocoa beans, southern fruits or various oil-bearing seeds and nuts.)

Food in Foreign Trade.—Staple crops are largely consumed within the producing areas. In underdeveloped countries a large part of the harvest is consumed directly on the farm without passing through domestic markets. Only a comparatively small proportion of such crops enters international trade: about 15% of wheat, less than 10% of corn, 2%–3% of rice—about 5%–6% of all grains combined. Export rates (the ratio of export to output) for the more perishable foodstuffs such as staple vegetables, milk and meat are still lower. They are much higher for sugar (40%), coffee and tea (70%–75%) and cocoa (more than 90%).

In international trade staple foods move from a few surplus areas to deficiency regions widely spread over the world. Wheat and coarse grains are exported from the U.S., Canada, Australia and Argentina; rice, mainly from Burma, Thailand, Formosa and Indochina, with smaller amounts coming from the U.S. and Italy; meat, from Argentina, Denmark, Ireland, Australia and New Zealand; cheese and butter, from Denmark, the Netherlands, Australia and New Zealand. The main destination areas are Great Britain, the Federal Republic of Germany and other countries of northwestern Europe, India, Pakistan, Malaya, Ceylon, Japan and some countries of Latin America. Products of plantation agriculture—tea, coffee, cocoa, spices, etc.—move from the tropical zones of Latin America, Africa and southeast Asia to industrially developed areas in temperate zones. International trade in these commodities, as also in wheat, meat and dairy products, is primarily intercontinental and transoceanic. Trade in rice belongs chiefly to the intra-Asian exchange.

Foodstuffs (including beverages and tobacco) represent approximately 20% of the value of foreign trade, but their importance in international balances of payment is much larger than is suggested by this rate. Even a small deficiency in foodstuffs represents a very serious problem for economically underdeveloped areas. On the other hand, cash crops are the foundation of local economy in certain areas: sugar cane in Cuba, Brazil, Puerto Rico and Hawaii; tea in Ceylon, India and Indonesia; coffee in Brazil, Colombia, Guatemala, Venezuela and the Sudan, etc.; cocoa in Brazil, Ghana, Nigeria and others; bananas in Central America; pineapples in Hawaii; and coconuts in Ceylon and the Philippines.

This article discusses the major aspects of the food supply of the world according to the following sections:

I. The World's Larder
  1. Cereals
  2. Other Food Crops
  3. Meat and Milk
  4. Fish
II. Output by Region
  1. Food Crops
  2. Meat and Milk
  3. Fish
III. Increasing World Food Production
IV. Food Supply and Nutritional Patterns
V. Adequacy of Net Food Supply
VI. Food Supply and Expanding Population

I. THE WORLD'S LARDER

The food supply of the world may be represented as a giant larder from which people draw their everyday food while it is replenished by the never-ending work of the tillers of the soil in all parts of the world. Some stocks are replenished once or twice a year after the harvest; others come in continually. A part of the supply is carried over for periods longer than a year. Because of fluctuations in weather conditions and other factors, the annual world consumption of single food products is not necessarily equal to the annual output, but in the long run the two items tend to balance one another.

However, not all world supplies of foodstuffs are used as human food. Some amounts are needed for seed, and some are wasted in the process of storing, transporting and marketing on the long way from the farm to the ultimate consumer. A substantial part of food crops is fed to livestock; another part is diverted to industrial purposes. Of the former, only a fraction reappears for human consumption in the form of meat, fat and dairy products: about ten pounds of grain go into the production of one pound of meat.

For all these reasons, the actual net supply of foodstuffs available at the retail level for human consumption, including foodstuffs consumed directly by producers, forms only a part, though the largest and most important part, of the annual gross output of foodstuffs described here as the world's larder.

This larder may be visualized as divided into three compartments for different types of foods. The largest and most important is that for cereals; next is a huge one for potatoes, other tubers and roots, sugar, pulses (legumes), oilseeds and fruit; the third one is stocked with meat, poultry, dairy products and fish.

In round numbers, the annual amount of food produced in the world approaches and in some years exceeds 1,700,000,000 metric tons or approximately 3,400,000,000,000 lb. on the average, a little more than 1,200 lb. annually or 3.3 lb. daily for each person in the world. These figures do not include tea, coffee, cocoa beans, various vegetables and fruit, and numerous other foodstuffs raised locally in comparatively small quantities for which statistics are not available. Nor do they take account of the loss from extraction for cereals or oilseeds, waste in storage and distribution, or the part of crops used for seed and industrial purposes. Furthermore, some of the crops listed in the first compartment of the larder are used for feed and so reappear, in much reduced amounts, in the tonnage of animal foodstuffs in the third compartment. There is also a great difference between the world per capita amount of available food and the quantity actually consumed by the population in different regions, individual countries and different income groups in each area.

Before discussing the output of different foodstuffs by region, we will briefly survey the shelves of the world's larder.

1. Cereals.—The most important cereals are rice and wheat, used chiefly for food, but also as feed for animals. In food, cereals are to some extent interchangeable and in feed almost completely so. Grains used for feed in economically advanced countries are consumed as food in underdeveloped parts of the world where cereals supply from 70% to 75% of the daily calories.

Rice is the staple food of the Asian peoples, almost half of mankind. Although Asia accounts for more than nine-tenths of the world's output of rice, it must supplement its production with imports, particularly in years of poor harvest. Rice is an economical crop: it yields more food per acre than any other grain, and only 3% to 5% of the yield need be reserved for seed, as compared with from 8% to 15% for wheat. Indeed, Asia could not support its teeming millions with any other crop. In the history of Asia failure of the rice crop time and again has resulted in famine and starvation.

In contrast to rice, wheat is raised in all parts of the world, occupying a larger part of arable land than any other crop. Wheat enjoys an almost exclusive position among all grains because wheat dough raised with yeast retains large quantities of gases in the breadmaking process. Rye, the only other bread grain, possesses this property to a lesser extent. Rye bread has a coarser texture than wheat bread and is less digestible. Because of the general consumer preference for wheat, even in areas where it cannot be grown in sufficient quantity, the export rate of wheat is higher than that of any other grain. In the past century wheat invaded the areas where rye bread had predominated and made the latter a poor-man's bread. Rye is less exacting to grow, being much more winter-hardy, ripening earlier than wheat, and on soil of low fertility yielding more than any other small grain. Because of these advantages and because rye can be raised as a cover crop and is also appreciably cheaper than wheat, it has more or less maintained its position in Europe and the U.S.S.R.

Maize (corn) is the grain contribution of the western hemisphere to the old world. It ranks first in acreage in the United States and is also important in Latin America, Asia, Africa and southeastern Europe. As direct food, it serves only 50,000,000 to 60,000,000 persons but hundreds of millions consume it in the form of pork, beef or dairy products. Most of the corn produced on farms of the U.S. leaves them on the hoof. Processing of corn by animals is, however, expensive: a bushel of corn consumed as whole corn meal meets the daily requirements of 23 persons for food energy and protein, but if consumed in the form of eggs meets the requirements of only 2 persons for energy food, and of 8 for protein.

Sorghum and millet can withstand long periods of dry weather by reverting to a dormant state and then growing again with the monsoons or as soon as the soil obtains enough moisture. Furthermore, these prolific crops have a short growing season and respond to the most primitive cultivation methods. All these characteristics have enhanced their importance in the monsoon area of Asia and the subtropical zones of Africa where they are consumed in the form of flat bread, grits, porridge and confectionery. While the chief use of sorghum and millet in other parts of the world is for feed, a bread variety of millet (proso) is staple food, eaten mostly as thick porridge, throughout the U.S.S.R.

Oats in the form of porridge ranks high among breakfast cereals in many countries of Europe, mostly in the north, and in the U.S. It has maintained its position in the world, though motorization of highway transport and mechanization of field work have reduced its use as staple feed for horses.

2. Other Food Crops.—Of other food crops, roots and tubers are the bulkiest. In their raw state they are largely composed of water and carbohydrates and contain only small amounts of protein and still less fat. They are highly perishable and therefore of limited transportability but constitute important energy food in many parts of the world. Also, when hunger arises the farmers often turn to these crops, since they can be raised in abundance rather quickly and at relatively low cost They are also used extensively as feed for animals.

Potatoes, sweet potatoes and yams, and cassava predominate in this group. Though potatoes originated in the Andes, they are grown today in many areas but mostly in the cool, moist regions of northern and central Europe and the U.S.S.R. In the U.S. potatoes are harvested in some area during any of the four seasons. Sweet potatoes and yams are widely grown in Asia, particularly in China, Korea and Japan. In Japan they are one of the basic foods. Cassava is widely cultivated in Africa, Asia and Latin America.

Dry beans, broad beans, dry peas, lentils and chick-peas are the main pulses. They contain more protein than the cereals or roots and tubers and can therefore serve as substitutes for animal proteins, particularly in the world's underdeveloped regions: less land and labour is required to raise pulses than to feed and maintain animals for the same quantities of protein. In the diet of people in North America, western Europe and Oceania they are used merely as vegetables to supplement meat courses. Though pulses have been raised for several thousand years in many parts of the world, their nitrogen-producing quality was discovered only late in the 19th century. Because their decaying roots release nitrogen in the soil, pulses are often grown for rotation purposes and also for enriching poor soil.

Oil-bearing crops include oilseeds, nuts and some oil-containing fruit. They supply a wide variety of oils for both human consumption and industrial purposes, and their fat-free residues after extraction of oil provide valuable feed concentrates. The importance of edible oils varies from country to country. Being cheaper than animal fats, they are widely used in butter substitutes by low-income groups even in well developed countries where preference for butter has become traditional.

Sugar, an essential energy food, is provided by the sugar beet and sugar cane. The former is a root crop grown in temperate climates and the latter is a tropical stalk crop, but in processed form both supply an identical product. Their relative position in the world changed several times during the 19th century, but after the 1920s sugar cane dominated the field. Because these crops contain a large amount of water and are therefore bulky, their processing is usually carried out in the growing area. In the case of the sugar beet, extraction and refining are carried out in a single operation. In contrast, raw sugar extracted from the cane is often shipped for refining to factories closer to consumer markets.

3. Meat and Milk.—Meat is important in human diet because it contains protein of highest quality, many mineral elements (phosphorus, iron, copper and others), some of the vitamins and fats. Moreover, it stimulates the flow of digestive juices. Another

important nutrition element, calcium, is provided mainly by milk. Since milk contains the greatest assortment of nutritive elements of any single food, it is considered a complete food in itself.

The number of domestic animals in the world is approximately equal to the number of people in the world. As there is such a large domestic animal population, man has had to assume the responsibility of feeding it. Thus a substantial part of the world's farm land is devoted to pasturage, and where the herds have outgrown the available pastures, cropland is taken over to produce food for animals. In the United States, for example, about three-fifths of all land is used for hay and pasture, and two-thirds of all cropland for producing feed and forage crops. In such a densely populated country as the Federal Republic of Germany permanent meadows and pastures occupy nearly 40% of all agricultural land. In New Zealand more than 95% of all agricultural land is in natural and sown pastures. Even in Argentina, with its vast open stretches, pastures compete with crop fields for land. Moreover, a considerable proportion of all crops raised in the world is fed to livestock. In Canada not only about 80% of the barley and 90% of the oats but also about 25% of the wheat is used for animal feed. In Denmark only about 10% of all grain goes for direct human consumption. The rest, except for what is withheld for seed and industrial purposes or wasted, is used for feed. In contrast, in underdeveloped regions such as India, Pakistan or China, man cannot share with animals even the coarse grains and uses his harvest almost exclusively as food.

4. Fish.—Seafood in general and fish in particular is a less expensive source of protein than meat and could therefore be a very important food, especially in areas generally deficient in animal foodstuffs. Yet because of the tenacity of food habits, perishability of fish, inadequacy of handling techniques and, most of all, lack of knowledge of marine resources and insufficient recognition of their food value, fish plays an insignificant role in human diet except in a few countries, such as Japan, Thailand, the Philippines and the northwestern countries of Europe. For the world as a whole, fish represents only 2% of all foodstuffs consumed and 3% of the proteins.

Fish is a unique food source in the sense that it replenishes itself without such efforts as are required to produce all other kinds of food. The distribution of fish depends, like that of plants, on climatic and physical conditions. The ocean offers a wide range of environmental conditions for vegetal and animal life, the most significant of which are temperature, salinity and currents. In the ever-moving waters, fish, too, are always moving, gravitating toward sources of food. Plankton, the small floating or drifting animal or vegetable matter which is the chief pasturage of the sea, is more abundant in cold waters than in warm, in shallow layers of water exposed to sunlight than in the depths and in coastal waters rather than in the open sea.

Fish find the most abundant and variegated plankton on continental shelves, and it is there that both marine life and fisheries are concentrated. The most productive fishing grounds, supplying nearly 95% of the world's fish catch, are in the northern hemisphere. Since fishing is not limited by national boundaries and fish have no nationality until caught, fishermen of any nation can exploit the world's fishing grounds, no matter how far from their own land. The only limitation to foreign fishing is on coastal waters, usually a 3-to-12-mi.-wide strip, while a few small countries claim a 200-mi. limit for their coastal waters. On the other hand, a fisherman has no exclusive rights on his customary fishing grounds as has the farmer on his land. He may arrive with all his gear at the fishing banks, only to discover the season's harvest nearly captured by others.

In contrast to the small use of fish as food, the world's demand for fish meal for livestock and poultry feed grew continually. Before the value of its highly concentrated protein was recognized, small fry and little-known species had been simply thrown overboard by the fishermen. This practice was not completely eliminated, but, increasingly, the industry used inedible species and the waste from processing the edible catch. Even a part of the catch previously consumed in fresh or canned form came to be diverted to fish meal production, which was also stimulated by improved reduction techniques. Whenever there is difficulty in marketing the edible catch, fish meal plants present a ready outlet.

II. OUTPUT BY REGION

1. Food Crops.—Though rice occupies less of the world's land than wheat (the ratio is 8 to 10), the world's harvest of rice in normal years is larger than that of wheat. Next in line is maize, with other coarse grains, barley, millet and sorghum, and oats close runners-up. Among roots and tubers, potatoes rank first.

Asia accounts for about 40% of the total output of major food crops in the world (exclusive of the U.S.S.R.). Not only is it the almost exclusive producer of rice but it also raises nearly 70% of millet and sorghum, sweet potatoes and yams, about 70% or more of pulses and half the oilseeds. This huge output is not sufficient, however, to feed its vast population. Were it not for surplus production of rice in a few smaller countries within this region, the largest countries of Asia—China and India—would increasingly depend on food supplies from other continents.

Europe leads in the output of potatoes, with about 75% of the world total (exclusive of the U.S.S.R., also an important producer), but it is deficient in many other crops and must import them in large quantities for both food and feed purposes. Wheat is the main European crop, the chief producers being France, Italy and Spain, followed by the Federal Republic of Germany and Great Britain.

North America accounts for nearly 55% of the world's maize, more than half the oats and 25% of the wheat. The U.S. ranks first in these crops. Canada is another important producer of wheat.

Some three-fifths of the world's sugar is produced in Europe (beet sugar) and Latin America (cane sugar). Chief European producers are Germany, France, Poland, Czechoslovakia and Great Britain. In Latin America, Cuba leads, followed by Brazil, Puerto Rico and the Dominican Republic.

2. Meat and Milk.—North America and Europe were the main producers of meat, each accounting for about 30% of the world's total, in the early 1960s (exclusive of poultry meat and edible offals). Asia produced about 20% of the world's total. The rest came from South America, Oceania and Africa.

Half the meat produced in the world is beef and veal, which rank first in the meat output of North and South America, Africa and Oceania. In South America beef and veal account for about 80% of the total meat produced. Pork is next in importance, while mutton and lamb account for less than 10% of the world's meat output. Pork predominates in the meat output of Europe and the far east.

Poultry meat is comparatively expensive food for areas short of grain. In such areas—Asia and some European countries—chickens are kept chiefly for egg production. Stimulated by growing demand for lighter protein fare, the world output of poultry meat nearly doubled between 1940 and 1960. About 55% was produced in the United States and about 19% in Europe. Europe produces nearly half the world's milk, North America over 25%. The world's largest single producer of milk is the U.S. Considering the vast population of Asia, its output of animal foodstuffs and particularly of milk is extremely low. Half of its milk comes from cows; somewhat less than half from buffaloes.

In countries with a well-developed dairy industry, the yield per cow has shown a steady increase in modern times. It is still very low in areas with poor and unproductive livestock breeds. The annual yield per cow ranges from 6,440 to 8,130 lb. in Switzerland and the Netherlands to 1,220 lb. in Peru.

While before World War II half the milk produced in the world was used for butter and cheese production, consumption of milk in liquid form increased in postwar years. Production of powdered milk expanded more rapidly than that of condensed and evaporated milk.

World production of eggs is concentrated in North America (about 40%) and Europe (35%). Better breeding and feeding, a better selection of the laying strains and many improvements in the care of laying hens during the first ten years after World War II brought an increase in egg production of 50% in the world

as a whole, 75% in North America and 25% in Europe.

3. Fish.—The Food and Agriculture Organization of the United Nations (FAO) estimated the world's seafood catch at about 38,000,000 tons for 1960. The major world producer of fish was Japan, followed by Peru, the U.S.S.R., the U.S. and Norway. In Japan, coastal fishing is carried on in numerous tiny villages, while deep-sea fishing is concentrated in a few ports equipped with the necessary facilities. The U.S., with its two coasts stretching over thousands of miles, has a greater variety of marine life than any other nation. Great Britain and Norway, where fishing is a traditional trade, have excellent fishing grounds off their coasts, efficient fleets and experienced fishermen. In Canada, particularly in Newfoundland, fishing is an important industry, and the entire economy of Iceland is keyed to fishing and export of fish.

Marine fishing supplies nine-tenths of the world's catch; the rest comes from fresh waters, of which about 70% originates in Asia. Cod, herring and related species constitute about 45% of the marine catch, the remainder consists of salmon, trout, tuna, numerous other species and a variety of mollusks, crustaceans and other aquatic flora and fauna. Whales and other aquatic mammals are not included in the estimate of FAO.

About 45% of the world's live weight of total catch is marketed in the fresh or frozen state; about 25% is cured by salting, drying or smoking; about 7% is canned; and the rest, together with offals from dressing, is used for making fish meal. In international trade, fish products move in greater quantities than meats—2,800,000 and 1,500,000 tons, respectively. However, the value of fish in international trade is less than half that of meat.

III. INCREASING WORLD FOOD PRODUCTION

In 1945 the world found itself with greatly reduced food production, yet with a population that was more than 200,000,000 greater than in the pre-World War II period. In war-torn countries agriculture was disorganized and beset with many difficulties. The soil needed reconditioning after years of inadequate fertilization, and livestock had been decimated for lack of feed. Obsolescence of equipment, lack of new machinery and parts, a shortage of fertilizer, quality seed, labour and draft animals, and other difficulties were aggravated by unsettled political conditions in many regions. Even in areas where there had been no actual fighting or enemy occupation, agriculture had suffered from such indirect effects of the war as cutting off of normal sources of supplies and outlets, shortage of manpower, lack of goods to offer farmers in exchange for their produce, etc. Food production expanded rapidly during the war only in North America, particularly in the U.S., despite the decline in the agricultural labour force. The rising output of food crops in North America so far exceeded the growth of population that that continent became the world's chief supplier of grain.

With world agriculture out of balance, the problem of food supply became acute in the early postwar years. In 1946–47, when efforts in many countries were concentrated on the increase of food production, output of food in the world as a whole still lagged 7% behind the prewar level. There was even 15% less food per capita than in prewar years. Only international help through the United Nations relief, large direct shipments of food from the U.S., and rationing and price control in many countries staved off famines.

The problem of an insufficient food supply was attacked in various ways. Some countries continued or intensified the wartime policy of shifting from nonfood crops to those of high-calorie content, forbade the use of cereals for feed, raised the extraction and milling rates of grain, etc. In others, governments assumed control of agricultural production and distribution of foodstuffs. The policy of farm price support and subsidies to farmers for obtaining quality seed, fertilizer and equipment became widespread. Agricultural extension service was established in the majority of countries. The most important factor, however, was a broader application of science in agriculture.

New scientific methods revolutionized world agriculture, and while progress was particularly marked in advanced countries, especially in the U.S., gains were also made in underdeveloped regions. Arable land was expanded by bringing millions of additional hectares under irrigation in Asia, Latin America and the middle east. Commercial fertilizers were used in countries which had never used them before or had applied them only on export crops. In the two decades between 1938 and 1958 world consumption (exclusive of the U.S.S.R.) of nitrogenous fertilizers increased from 2,400,000 tons to 7,500,000; of phosphoric acid, from 3,500,000 tons to 7,800,000; of potash fertilizer, from 2,500,000 tons to 6,500,000. India, Pakistan and the Philippines built plants for domestic production of nitrogenous fertilizers. Power mechanization was increasingly applied to increase yields by more timely operations, to extend the zone of cultivation or to plow up land with deep-rooted weeds, as in India and some African territories. In the world as a whole, exclusive of the U.S. and the U.S.S.R. where the use of tractors was a feature of agriculture before the war, the number of tractors increased from about 400,000 in 1938–39 to well over 4,000,000 by the early 1960s. In many underdeveloped countries, governments and co-operatives established tractor pools to bring mechanized farming within reach of villages.

Synthetic insecticides and pesticides came into wide use not only in advanced countries but also in underdeveloped regions. Their general use greatly reduced the losses from pests and plant diseases and in some cases was responsible for sharply increased yields.

Perhaps most significant was the spreading use of high-quality seed. Plant breeding was not a new development, but the hold that it took on farmers in underdeveloped regions and the ever-increasing recognition of its potentialities everywhere were new. Where plant breeding had been concentrated before on export and industrial crops, it became centred on food crops. Rice received primary attention in southeast Asia, maize in Latin America. Hybrid corn, the great achievement of United States agriculture, caught the imagination of farmers in Europe and the U.S.S.R. Some provinces of northern Italy had up to 95% of their maize area under hybrids.

New agricultural methods also invaded livestock production and fisheries. Attack on chief animal diseases and internal parasites was carried out in many countries. For example, application of better and cheaper vaccines on a very wide scale achieved good results in the fight against rinderpest in the far east and Africa. Spraying with insecticides of a large area in southeast Africa nearly eliminated the danger from the tsetse fly. Artificial insemination was used in many underdeveloped regions, and use of antibiotics in animal feeding made great progress, particularly in the U.S. and Europe.

South and southwest Africa, Angola, Peru, Chile and several other countries emerged as considerable fish producers in the postwar years. Much progress was achieved in fish preservation and in equipment of fisheries.

The list of technical innovations introduced in world agriculture in the decade could be extended, but even this brief enumeration may provide a picture of the changes in this sector of economy. Simultaneously, many institutional changes were made in land ownership, land tenure and land taxation, in order to raise farmers' income, encourage the improvement of holdings and stimulate intensification of production. Agrarian reforms, varying in extent, were carried out, fully or partly, in Japan, India, Burma, Pakistan, China and Formosa in the far east; in Turkey and Egypt in the middle east; in Bolivia, Guatemala and Puerto Rico in Latin America; in Finland, Italy, Spain and eastern European countries. These reforms involved changes in the tenancy system to provide security to the tenants, establishing the right to compensation for improvements, elimination of personal services to landlords, etc. Attack on excessive fragmentation of land, an old obstacle to the increase of agricultural productivity, was launched in many countries not only in Europe but also in Asia. In Japan, for example, nearly 20% of all cultivated land was consolidated by the end of 1954. India and Pakistan initiated an active policy against land fragmentation. Collection of taxes through intermediaries leading to exploitation and village poverty was abolished in such countries as Japan, India, Pakistan and Mexico, among others.

These and other measures revitalized world agriculture so that ten years after the end of World War II the food output of the world as a whole exceeded the prewar level by 20%. Because of increased population, however, the output per person was only 1% higher than before the war.

The development was highly uneven. In many regions production did not keep pace with the growth of the population. Thus in Latin America food production in the late 1950s was higher than before World War II but because of the rapid increase in population the per capita food production was 3% below the prewar level. The worst food situation was in Asia, where food supplies always have been very low and where the rapid growth of the population has outstripped the modest advances in agriculture. Moreover, this continent faced much greater difficulties than other parts of the world in expanding its food production because of continuing political disturbances and lack of capital, equipment and technical knowledge.

Though the index of per capita food production in the early 1960s was lower in Oceania than in the far east generally, actual food conditions in the two areas are entirely different. Oceania's agriculture is highly developed and geared to export of large quantities of agricultural surpluses. The decline in per capita output of foodstuffs does not, therefore, affect the exceptionally high nutritional standards of this area; it only reduces surpluses available for export. On the other hand, a food shortage in Asia presents Asian peoples with a dilemma; they must either make further cuts in their meagre diets or seek ways to increase production.

The most important conclusion to be drawn from the statistical data of the early 1960s is that food output per capita of population in the less-developed areas of the world, taken as a whole, showed no increase over the prewar level: gains in Africa and the middle east were offset by losses in Asia and Latin America. Actually, the small increase in the world output per capita was mainly because of the larger output in North America and western Europe. In the opinion of FAO, the predominant share of these two regions in the increase in world per capita output would exist even if the estimates included the U.S.S.R., eastern Europe and China, which were omitted because of lack of data.

While food deficiency remains a grave problem for a large part of the world population, burdensome surpluses of foodstuffs, especially of grain, accumulated in the United States and some other countries in postwar years. Burma and Thailand, the traditional exporters of rice in Asia, became loaded with surpluses because domestic production of the importing countries began to satisfy the requirements for rice to a greater degree than before the war. For the same reason Latin America was faced with surpluses in sugar. The abnormality of such a situation was somewhat mitigated by the fact that most of the stocks were in the hands of governments trying to avoid dumping of surpluses on the world market in order not to cause a catastrophic drop in farm prices: the experience after World War I taught the world that unorganized unloading of surpluses disorganizes world agriculture and ruins millions of farmers.

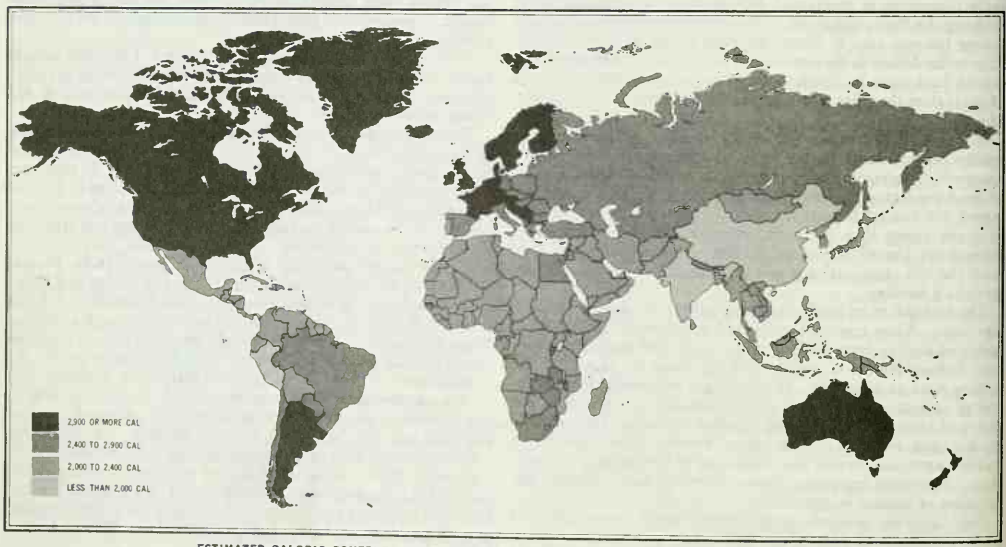
Agricultural surpluses in economically advanced countries became an inhibiting factor on the production of foodstuffs in the 1950s. Since levels of consumption in these countries were fairly high, demand for additional foodstuffs rose slowly, and mounting surpluses together with increasing competition in world markets tended to discourage increasing output to the fullest extent possible. In contrast, demand for food rose rapidly in less-developed areas because of the rapid growth of the population and also some rise, however small, in the income of the masses of the people.

Trends in the composition of agricultural production also differed in these two groups of countries. In the advanced countries the main commodity group to show the most substantial increase was that of livestock products for human food. The share of other commodities in the total food output changed only slightly. In the less-developed areas the main expansion was in crops such as sugar, oilseeds and the like, produced for both domestic consumption and export.

IV. FOOD SUPPLY AND NUTRITIONAL PATTERNS

With due reservation for a considerable margin of error, the food balance sheets prepared by FAO for individual countries provide a picture of the net food supply available in each country at the retail level and can serve as a basis for comparing the nutritional patterns in different countries. These patterns may be measured in pounds and ounces of foodstuffs consumed, or in caloric value of different foods per person in average national daily diets, and characterized by the composition of the daily calorie intake.

According to FAO estimates, total daily calorie intake per per-



ESTIMATED CALORIC CONTENT OF PER CAPITA DAILY FOOD SUPPLY THROUGHOUT THE WORLD

son varies from country to country, ranging from less than 2,000 cal. in some underdeveloped areas (India, Peru and others) to more than 3,000 in prosperous countries such as the United States, Canada, Great Britain, Switzerland, Denmark, Australia and New Zealand.

Apart from this general correlation between the level of prosperity, roughly measured by the per capita income and daily intake of calories, the pattern of nutrition in different countries depends on climate, composition of the population and national food habits. The daily number of calories per person in most countries with a per capita income of more than $500 either exceeds 3,000 cal. or is very close to it. As one moves down the scale of per capita incomes, the daily food supply in terms of calories diminishes and, at the bottom of the scale, falls below the physiological requirements, as in India.

More revealing than total calorie intake is the composition of national diets. The more prosperous a country, the less important are the cereals and starchy roots in its diet. The caloric content of meat and dairy products in the daily intake per person varies from 1,234 in New Zealand and 1,084 in the United States to only 61 in Japan. (Note that these figures do not indicate total calorie intake from all sources but only that from meat and dairy products.) These are the extremes on the international scale of consumption. But daily rations of meat providing 600 to 1,000 cal. are quite usual in prosperous (or livestock-raising) countries, while rations of less than 200 cal. are characteristic of primarily agricultural, underdeveloped countries. The first group includes countries of northwestern Europe and the cattle-raising countries of Latin America (Argentina and Uruguay). The second group embraces almost all of Africa, the middle east and the countries of Asia for which statistics are available. A few small areas such as Israel have a slightly higher intake of livestock products than is characteristic of this group, but this does not change the general nutritional pattern of the vast region from the Atlantic coast of Africa to the China sea and the Pacific coast of Asia.

A large part of Latin America from the Rio Grande to the borders of Uruguay and Argentina, southern and eastern Europe including Italy, Greece and Yugoslavia, and the southern tip of Africa form a middle group, with 200 to 600 cal. from livestock products in their daily diets. China is among the countries with the lowest consumption of meat. The position of the U.S.S.R. is less certain: there are indications that its consumption of meat and dairy products is very low but it may be close to the border line between the areas with less than 200 cal. and those with 200–600 cal.

Because fish is cheaper than meat, its consumption within any specific country is usually larger in low-income groups than among the rich. But this correlation disappears when comparison is made among individual countries. The development of fisheries in certain areas has been determined by geographic and historical conditions. Sweden, one of the most prosperous nations in the world, has about the same number of daily calories from fish consumption as less-prosperous Portugal. New Zealand, with a fairly high annual per capita income, obtains 25 cal. daily from fish consumption, as much as Egypt, which has a low per capita income.

The role played by fruit and vegetables in human diet also depends on geographic conditions. It is greater in subtropical and tropical zones than in areas with temperate climates, but also is correlated to some extent with the economic level, being much higher in prosperous countries than in poor ones. In India, for example, less than 2% (29 cal.) of daily intake comes from consumption of fruit and vegetables, as compared with more than 5% (160 cal.) in Canada.

V. ADEQUACY OF NET FOOD SUPPLY

Individual food requirements vary considerably depending on climate, age, sex, type of work performed and various other factors. FAO has calculated average physiological requirements for the population of different countries basing its estimates on climatic conditions in specific countries and the physical characteristics of their population.

According to these estimates, average daily food requirements in most countries of the temperate zone vary between 2,600 and 2,850 cal.: about 2,840–2,850 for Sweden and Norway; 2,710–2,750 for Canada, Switzerland and Denmark; and 2,600–2,670 for the United States, Belgium-Luxembourg, the Netherlands, Great Britain, Argentina, Australia and New Zealand. In countries with a warmer climate the requirements are estimated at 2,250–2,500 cal. for Pakistan and India and 2,440–2,550 cal. for Italy, France, Portugal, Turkey, Brazil, Mexico and Venezuela.

A comparison of actual daily intake per person with the estimated requirements reveals that average consumption of food, in terms of calories, in prosperous countries exceeds the physiological requirements, while in other countries the net food supply available to the people at retail level is insufficient to provide them with the number of calories required for health and normal functioning of human bodies. Moreover, food supply is usually very unevenly distributed among different population groups within a country. High-income groups often may consume more food than is good for their health, while at the other extreme many low-income groups cannot obtain even the required minimum of calories in their daily diet.

VI. FOOD SUPPLY AND EXPANDING POPULATION

The challenge to world agriculture in the early 1960s was twofold, quantitative and qualitative: to produce more food for the growing world population and to intensify production of protective foods such as meat and dairy products.

Agricultural experts were confident that, apart from annual fluctuations depending on weather conditions, the world's food supply would continue to increase in the years to come more rapidly than the world population. There were still large areas of unused land capable of cultivation on all continents, and these were to be brought gradually under plow by irrigation, flood control, drainage and fertilization. Yields per unit of land in underdeveloped regions were expected to rise as a result of broader application of improved agricultural methods developed in advanced countries. Higher yields would cover the world's needs for cereals and other starchy foods and release some land, now occupied by crops for human consumption, for pastures and feed crops. Such a development would favour the growth of a modern livestock industry and diversification of agricultural production.

These expectations were supported by the observation that there is a time lag between the improvements in agriculture and their effect: the results of improvements already accomplished or nearing completion in underdeveloped areas in the first 15 years after World War II would become more and more evident as time passed.

The main and most disturbing feature of the world food supply at the beginning of the 1960s was the great contrast between the surplus in food production in certain areas and food deficiency in others. There was little possibility of an automatic alleviation of this situation at an early date. The equilibrium between production and consumption of food in the world would depend, to some extent, on the outcome of plans for industrialization and economic development in areas where undernourishment of the population is a condition of long standing. If these plans were successful they would lead to a rise in per capita income and a higher standard of living. As income rose in underdeveloped countries, the first call of the people would be for more food to satisfy hunger. Progress in domestic agricultural production might not be sufficient to meet the growing demand. Increased imports of foodstuffs from surplus areas might then become necessary—a logical movement of foodstuffs from comparatively sparsely populated to overpopulated countries.

Along with measures for further economic development, FAO recommended measures designed to change food habits by teaching people about the advantages of a nutritionally balanced diet. A campaign of this kind concerning the nutritional value of liquid milk resulted in a substantial increase in milk consumption in western countries. FAO believed that similar results might be achieved elsewhere. Among other means for raising consumption of protective foods were measures to reduce production and marketing costs of such foods. This would bring them within the reach of large groups formerly unable to afford them not only in under-

developed areas but all over the world. In brief, the problem of food supply in the world is not simply a question of the race between the increasing population and the carrying capacity of the earth. Rather, it is a complex economic problem that appears in different forms in different areas and ultimately merges with the general problem of social and economic progress in the world. *See* also FAMINE; FOOD AND AGRICULTURE ORGANIZATION; NATURAL RESOURCES.

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FOOL (JESTER), a simpleton whose imbecility, real or assumed, is utilized for entertainment. The origin of the professional fool is obscure. In Muslim and early Irish sources, madmen are mentioned who, inspired with poetic and prophetic powers, behaved as professional jesters; *e.g.*, Buhlul, who flourished at the court of Harun al-Rashid in the 9th century, and Mac-da-Cherda in 7th-century Ireland. Dwarf fools may have been kept for luck as well as for fun, in the belief that deformity can avert the evil eye and abusive raillery transfer ill luck from the abused to the abuser. The Asian Indian dwarf buffoon Vidusaka, whose name means "an abuser," appears in drama and society during the early centuries A.D. In the 19th century the buffalo sacrifice of south Indian villages was accompanied by the buffoon Raniga, who railed at everyone including the officiating priest and the earth-goddess, and the fool of European folk customs plays a similar part. His raillery and association with a mock king suggest that he was once a scapegoat substituted for a royal victim. E. K. Chambers (see *Bibliography*) finds traces of sacrificial *exuviae* ("garments") in the foxtail, calfskin, etc., of the festival fool and in the coxcomb, eared hood, bells and bauble which, with the motley coat, formed the official costume of the household jester. At Christmas, particularly in France, medieval clergy celebrated a "Feast of Fools" derived from the pagan Kalendae. A mock bishop or pope was elected, ecclesiastical ritual was parodied, low and high officials changed places and masked clergy rioted inside and outside churches.

In imperial Rome, fools were kept in wealthy houses, and deformity and imbecility fetched high prices in the slave market. References to household fools reappear in the 12th and increase during the 14th and 15th centuries, particularly in French account books. Fools were attached to courts, private households, corporations, taverns and even brothels. During the Renaissance, interest was taken in famous fools such as Il Matello, the pet of Isabella d'Este, marchioness of Mantua; Triboulet, who amused Louis XII and Francis I; Cardinal Wolsey's enemy Will Sommers; the French female fool Mathurine; the German Claus Narr and Kunz von der Rosen, the intelligent, loyal fool of Maximilian I. The last official French royal fool was the formidable L'Angely who, standing behind Louis XIV at table, terrified courtiers with his sarcasm until finally banished for impertinence. Archibald Armstrong, fool to James I and Charles I, made so much money that, after being "unfrocked" for insolence to Archbishop Laud, he became a landowner in Cumberland. His successor, Muckle John, an insignificant simpleton, was probably the last English royal fool. In the 18th century household jesters declined in western Europe but flourished in Russia, and offending courtiers were sometimes degraded into court jesters.

The fool also appears in drama. In 15th-century French mysteries, he clowns, addresses the audience and even makes satirical comments on God, while the role of the Vice in Tudor interludes is probably derived from that of the domestic fool, who is thus connected with the English stage clown. When *As You Like It*, *Twelfth Night* and *King Lear* were produced, the clown in Shakespeare's company was Robert Armin, who published an account of household fools.

From the late 15th century to the early 17th century, the suppressed Feast of Fools was continued by members of secular fool societies who, adopting the dress and licensed freedom of the domestic fool, satirized contemporaries in burlesque processions and in farces (soties), which culminated in disrobing the characters to display the motley coat beneath the learned gown. The theme of 15th- and 16th-century fool literature was the universality of folly and its satire was Christian satire: Sebastian Brant's *Narrenschiff* is packed with knaves in cap and bells, for the knave is a fool who buys temporal pleasure for eternal pain. On the other hand the fool, having no social standing, can see truth impartially and even symbolize the divine "foolishness" which is "wiser than men." These ideas all contribute to the ironies of Erasmus' *Praise of Folly* and Shakespeare's *King Lear*.

The fool is easily confused with the buffoon. The laughter-making parasites who gained free dinners in Greece and Rome, the itinerant tricksters who contributed to the art of storytelling in medieval and Renaissance Italy and the madcap poets and friars who diverted Pope Leo X, all exploited their eccentricities for purposes of entertainment. Such characters attract stock jokes and may become mythical heroes of jestbooks, and many pranks of Till Eulenspiegel, John Scogan and Bertoldo were derived from the legend of the peasant Marcolf who outwitted Solomon. The buffoon resembles the fool in his irresponsible absurdity, but he is mischievous rather than insane, whereas the fool is essentially a real or pretended lunatic. *See* also CLOWN.

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FOOLS, FEAST OF, was a popular festival of the middle ages, held on or about Jan. 1 and particularly in France, that consisted of farcical imitations of the rites and ceremonies of the church. The origin of such festivals is connected with Christian participation in the Roman Saturnalia (*see* SATURN). Through strong condemnations of early bishops and the substitution of liturgical feasts, such as that of the Circumcision on New Year's day, there was a gradual eradication of idolatrous traits. By the 11th century, however, these feasts had become a burlesque of Christian morality and worship, with a special rite for each grade of clerics, and with much associated buffoonery and even obscenity. The celebrations at Sens and Beauvais were especially famous. In spite of repeated prohibitions, and imposition of several penalties by the Council of Basel, the feasts continued till the middle of the 15th century and, greatly diminishing, died out in the 16th century. *See* also BOY BISHOP.

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FOOL'S-PARSLEY, in botany, the common name for *Aethusa cynapium*, of the family Umbelliferae (*q.v.*), a common weed sparingly naturalized in the eastern United States and Canada and in cultivated ground in Great Britain. The plant has a nauseous smell, and, like various other members of the family (*e.g.*, water hemlock), is poisonous. It is an annual herb, with a spindle-shaped root and a smooth, hollow, branched stem one to three feet high, with much divided (ternately pinnate) smooth leaves and small compound umbels of small irregular white flowers.

See also POISONOUS PLANTS.

FOOT, in vertebrate animals, that part of the lower extremity on which the body rests when in an upright position, standing or moving. It articulates with the leg at the ankle joint. (*See* ANATOMY, GROSS; SKELETON, VERTEBRATE.)

The word is also applied to such parts of invertebrate animals (mollusks, for example) as serve as a foot, either for movement or attachment to a surface. From the resemblance to the foot, in regard to its position, as the base of anything, or as the lowest member of the body, or in regard to its function of movement, the word is applied to parts of many nonliving objects.

As a lineal measure of length the "foot" is of great antiquity,

estimated originally by the length of a man's foot (*see* WEIGHTS AND MEASURES).

See also references under "Foot" in the Index volume.

FOOT, DISEASES AND DISABILITIES OF. The normal human foot is composed of 26 bones related to one another through joints, supported and stabilized by ligaments and controlled by muscles and tendons. (For its anatomy, *see* SKELETON, VERTEBRATE: *Appendicular Skeleton: Lower Limb* and JOINTS AND LIGAMENTS.) Its purposes are (1) to support the weight of the body and (2) to serve as a lever in propulsion of the body. Function of the feet depends upon anatomical integrity, joint stability, elasticity of the arches and good muscular tone. Anything disrupting any one of these factors will affect function adversely. Measures designed to preserve or improve these factors are basic to all programs of prophylactic or therapeutic foot care. Well-fitted supportive shoes, hygienic care, weight control and muscle-strengthening exercises are the most important.

Congenital Disorders.—Clubfoot and flatfoot, the two commonest congenital anomalies, are discussed in the separate articles CLUBFOOT and FLATFOOT.

A condition often mistaken for clubfoot is one in which the forefoot turns in, unaccompanied by downward flection or extreme rigidity. This is called metatarsus adductus. It is a condition ordinarily self-limited and self-correcting. Prolonged treatment is seldom necessary.

Bunions occur as a result of a congenital foot abnormality. This condition, hallux valgus, consists of an angulation outward (*i.e.*, away from the median line of the foot) of the first metatarsal bone, with a compensatory deviation inward of the great toe. This results in a prominence of the medial aspect of the metatarsal head. Irritation by shoes results in an irritation of the soft tissues overlying the bone. The inflamed, tender bursa thus produced constitutes the bunion. Conservative treatment often suffices to control symptoms. Surgical reconstruction of the deformed foot gives the best long-term results in young patients.

Developmental Disorders.—Many of these overlap with congenital disorders. They may be subdivided into those produced by trauma and those produced by disease.

Metatarsalgia is basically an irritation of the soft tissues underlying the forefoot. When it is severe enough, weight bearing may be excruciatingly painful. Proper general foot care plus shoe corrections normally bring gradual relief. Other conditions of similar etiology are "policeman's heel" (calcaneal bursitis), inflammation of tendons (tenosynovitis) and inflammation of other bursae.

Disease may attack the feet as anywhere in the body—pyogenic infections, tuberculosis and tumours are not uncommon. Transient interruption of local blood supply to portions of certain bones produces aseptic necrosis, the local death of bone. Treatment is aimed at avoiding trauma until the body can replace this dead bone with living bone, limiting further deformity.

See also FRACTURES AND DISLOCATIONS; HAMMERTOE; PODIATRY; SKIN, DISEASES OF. (J. DY.)

FOOT-AND-MOUTH DISEASE (APHTHOUS FEVER, EPIZOOTIC APHTHA, ECZEMA EPIZOOTICA) is a highly contagious viral disease affecting practically all cloven-footed animals, including cattle, sheep, goats and swine. It is characterized by the formation of vesicles (blisters) on the tongue, lips and other tissues of the mouth, and on parts of the body where the skin is thin, as on the udder and teats, between the two toes of the feet and around the coronary band above the hoof.

The disease appears suddenly and spreads very rapidly. The virus has an affinity for epithelium (the covering of the skin and mucous membranes of the gastrointestinal tract); it forms a primary vesicle where it gains entrance in the body. Within 24 to 48 hours it enters the blood stream, causing fever. During this phase, lasting 24 to 36 hours, the virus is excreted in the saliva, the milk, the urine and the feces. The characteristic smacking of the lips then usually becomes prominent, ushering in the phase of the formation of secondary vesicles. These latter rupture in about 24 hours, leaving raw, painful surfaces.

Losses caused by foot-and-mouth disease are tremendous. The mortality in ordinary mild epizootics (animal epidemics) is only about 5%, but malignant forms of the disease have led to losses up to 50%. In those animals that survive, great losses in weight occur because the animals cannot eat. In surviving milk-producing animals the flow of milk is sharply diminished. Abortions and mastitis are common. Secondary infections are frequent, especially about the feet.

The diagnosis of foot-and-mouth disease is complicated by the existence of two other vesicular diseases, vesicular stomatitis and vesicular exanthema. Careful study is necessary to differentiate among the three. As is generally the case in virus diseases, an exact diagnosis can be made on the basis of animal tests. The horse is not susceptible to foot-and-mouth disease. The cow and the guinea pig are not susceptible to vesicular exanthema. When a fever, followed by characteristic vesicles, develops in swine, cattle and guinea pigs, but not in horses, a diagnosis of foot-and-mouth disease is justified. When all four of the animals develop vesicles, a diagnosis of vesicular stomatitis is justified. When lesions are seen in swine, but not in cattle or guinea pigs, and infrequently and to a mild degree in horses, a diagnosis of vesicular exanthema of swine is justified.

The virus of the foot-and-mouth disease is one of the smallest viruses known. Estimates indicate that the virus of smallpox is 10,000 times larger. In common with all viruses, living tissue must be used to cultivate it. It has been cultivated in tissue culture containing epithelium procured from guinea pig embryos.

The virus is resistant to destruction if the conditions are right. When contained in the epithelium of the vesicular coverings, it has been shown to remain active in hay for 30 days. In beef and pork carcasses kept at freezing temperature, the virus from the bone marrow was still active after 76 days. The virus is resistant for hours to such standard antiseptics as 0.1% bichloride of mercury, 5% phenol and 3.5% liquor cresolis compound, but 2% sodium hydroxide destroys the virus in a few minutes.

Immunity to foot-and-mouth disease is complicated by the existence of seven known types of the disease virus. An animal recovering from foot-and-mouth disease is immune only to the type of virus that caused the disease but is susceptible to the other six known types. Further, the immunity is not permanent, many animals being susceptible to reinfection with the same virus type after one year. Immunization by vaccination is possible, but this confers immunity for only about four months. Adding to the complexity of the problem are variants of the disease virus within a type. There are recorded instances in which a virulent variant broke through the protection afforded by a vaccine of the same type.

Diagnosis of the type or types of virus is often important. This was an expensive procedure until 1952, when the Foot-and-Mouth Disease Research institute at Pirbright, Eng., announced a test that determines the type of virus involved within a few hours.

Foot-and-mouth disease is reputed to be more than 2,000 years old, but not until the 17th and 18th centuries is there found trustworthy evidence of its presence. The disease is present in most countries of the world. In the early 1960s the only countries reporting freedom from it were the United States and its territories, Australia, New Zealand, Greenland, Iceland, Norway, Ireland, Northern Ireland, the Channel Islands, Central America, islands of the Caribbean and the West Indies.

The disease first invaded England in 1839 and quickly spread throughout Great Britain. There were 11 more outbreaks in Britain between 1839 and 1902, then none until after World War I. Each outbreak was stamped out as it occurred, but reinfection from other countries came with disturbing frequency.

Foot-and-mouth disease first invaded the United States in 1870 through cattle imported via Canada from England. Imported livestock were also responsible for outbreaks in 1880 and in 1884. After the latter outbreak, inspection, quarantine and rigid regulations prevented introduction of the disease with livestock. Other outbreaks occurred in 1902, 1914 and 1924 because of the importation of infected materials such as hay and garbage or imported smallpox vaccine. An outbreak occurred in 1929 because regulations were violated.

With the invasion of Venezuela (1950) and Colombia (1951), every country in South America had become victim to the plague. An outbreak which occurred in Mexico during 1946 caused grave concern to the United States. To fight it a Mexican-United States commission was formed that carried on an extensive campaign leading in 1952 to final elimination of the disease in Mexico. At the height of that campaign about 8,200 workers were employed, and more than $1,000,000 a month was spent. (NA. BR.)

FOOTBALL, the name given to a number of games in which each of two teams attempts to kick, carry or otherwise force a ball through a goal or across a goal line defended by the opponent. (For the U.S. game of soccer, *see* SOCCER.) This article, covering the major variations of football, is divided into the following sections:

I. Early History
II. U.S. Football
  A. U.S. College Football History
  B. Rules and Fundamentals of U.S. College Football
  C. U.S. Secondary School Football
  D. Six-Man Football
  E. U.S. Professional Football
  F. Glossary: U.S. Football
III. Canadian Football
IV. Association Football (Soccer)
  A. British Association Football
  B. World Association Football
  C. Glossary: Association Football
V. Rugby Football
  A. Rugby Union
  B. Rugby League
  C. Glossary: Rugby Football
VI. Australian Rules Football
VII. Gaelic Football
VIII. Special (British) School Games

I. EARLY HISTORY

The highly organized modern games grouped under the generic name of football all developed out of the *mêlées* or mellays of ancient and medieval Britain in which a round or oval object, usually the inflated bladder of an animal, was kicked, punched, carried or driven toward some goal. The immediate origin of the mellays is obscure in most cases. The real origin may well have been the child's apparently instinctive desire to kick any small object in its path, go on kicking it and keep it from other would-be kickers.

The Romans undoubtedly played a game called *harpastum*, the name being derived from the Greek word for "handball." An ancient writer says that the players were divided into two bands, each of which tried to force the ball beyond a line drawn behind its opponents; the game was started by throwing the ball up in the air in mid-field and in the course of the struggle there was much pushing backward and forward. It has not been proven that the Romans played *harpastum* in Britain during their occupation of the country, but it is extremely probable that they did, and in several cities and towns of Roman origin there are traditions of early games which might have been developments of *harpastum*. From early times there was a game of football annually on Shrove Tuesday at Chester, a town founded and named by the Romans. The shoemakers annually delivered a leather ball, to the value of 4*od.* or more, to the drapers, who played football with it between the hall of Rodehee and the common hall of the city; the tradition that the first ball used was the head of a dead Danish brigand may, however, mean that this game was not a child of *harpastum* but the result of an indigenous method of celebrating victory over one's enemies. The game became so violent that it was stopped and replaced by a running match at Rodehee. Shrove Tuesday, a day of festival before a fast, became the day on which nearly all these medieval mellays, which seem to bear more or less resemblance to football, took place; among the more notable were those at Derby, Corfe Castle, Alnwick and Bromford, and the Cross of Scone and Midlothian, Scot.; in the last of these the married women of a parish used to play the spinsters and almost invariably beat them severely.

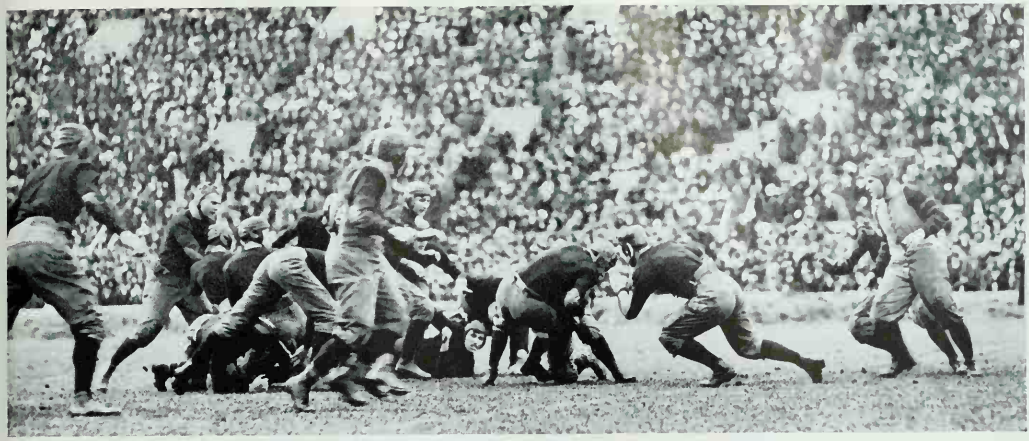
As their popularity increased among the humbler citizens these games were no longer confined to days of festival, and village greens became the scenes of practice matches at all times. Kings of England began to fear that the youth of the country was being distracted from the proper study of archery and that the efficiency of their armies would suffer. A Scottish writer reports that the Anglo-Scottish war which began in 1297 was not taken with a proper seriousness by either party; King Edward I's foot consisted of 2,500 levies from Cheshire and Lancashire, of whom the Lancastrians were old opponents of the Scots raiders and had to be restrained by orders to their commanders from playing football with instead of fighting their hereditary enemies. Whether this is a true story or not, Edward III decided in 1365 to prohibit football for military reasons and further edicts were made by Richard II, Henry IV, Henry VIII and Elizabeth I; these prohibitions were no more effective in the long run than were those in Scotland against the playing of "gowffe." The festival matches became bigger and bigger, and Richard Carew in his survey of Cornwall, published in 1602, records that goals were set three or four miles apart and two or three parishes united to play two or three others "hurling over country." Most of these games had local names such as "hurling" or "camp ball," but between them they contained in embryo most of the characteristics of modern football with mellays or scrums and judicious passing and running. Joseph Strutt, a great historian of English sport, wrote in 1801 a description of a match at football which is easily recognizable: ". . . an equal number of competitors take the field and stand between two goals placed at a distance of 80 or 100 yards the one from the other. The goal is usually made with two sticks driven into the ground about two or three feet apart. The ball, which is commonly made of a blown bladder and cased with leather, is delivered in the midst of the ground, and the object of each party is to drive it through the goal of their antagonists, which being achieved the game is won. The abilities of the performers are best displayed in attacking and defending the goals; and hence the pastime is more frequently called a goal at football than a game at football. When the exercise becomes exceedingly violent the players kick each others' shins without the least ceremony, and some of them are overthrown at the hazard of their limbs."

So great, indeed, was the violence of the games in the 18th century that other historians report that broken shins, broken heads, torn coats and lost hats were among the minor casualties, and that a Frenchman watching a game at Derby exclaimed that if Englishmen called this playing it would be impossible to say what they would call fighting.

Origin of Rugby.—Football began to become more orderly and a regular pastime, as opposed to a periodic outbreak of legal (or illegal) violence, with the growth of the great English public schools, where the sons of the richer and more aristocratic families were cooped up together and for long periods could not take their sports individually as they had done formerly at home with rod, gun, horse or sword. They adopted in one form or another the rowdy games which had been played so long by workingmen but which still were regarded by the university authorities as boisterous, undignified and totally unsuited to gentlemen, particularly those headed toward scholarly lives.

No two schools seem to have had anything like the same rules; there was still no governing body for the game, and almost the only thing on which there seems to have been common agreement was that the ball must never be carried or passed by hand in the direction of the opponents' goal.

It was a famous violation of this rule on carrying the ball by William Webb Ellis at Rugby school in 1823 which led to the development of the basic feature dividing modern players into two parties, those who want to play with their feet alone and those who want to play with both hands and feet. At first Ellis' behaviour was condemned even at Rugby; but the school soon decided to permit running with the ball by players who received it by fair catch; next it was permitted if the ball were caught on the bound; and finally all restrictions on running with it were abolished. Ellis was translated from a lawbreaker into a great hero, and a tablet on one of the boundary walls of the Rugby school ground bears the following inscription: "This stone commemorates the exploit of William Webb Ellis who with a fine disregard

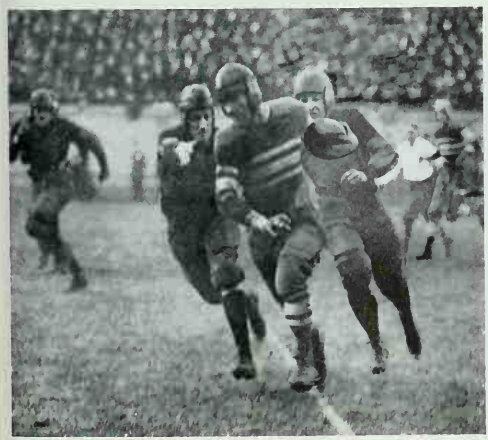


A football game between Harvard and Princeton in 1912

Coach Knute Rockne and the "Four Horsemen," outstanding Notre Dame backfield of 1924. Left to right: Rockne, Harry Stuhldreher, Elmer Layden, Don Miller, Jim Crowley

FOOTBALL IN THE UNITED STATES

PHOTOGRAPHS, UNITED PRESS INTERNATIONAL



A. N. ("Bo") McMillin carrying ball for Centre college, Danville, Ky., as his team upset Harvard 6–0 in 1921

Jim Thorpe about to make a tackle in a professional game between the Canton Bulldogs and the Frankford Yellowjackets

FOOTBALL

Tom Harmon, Michigan back, carrying the ball around right end in 1938 game with Pennsylvania. Michigan won 19–13

Bronko Nagurski, Keith Molesworth and Harold ("Red") Grange of the Chicago Bears as they practised for a game against the New York Giants in 1932

Cecil Isbell preparing to pass to a Purdue teammate in 1937 game won by Fordham 21–3

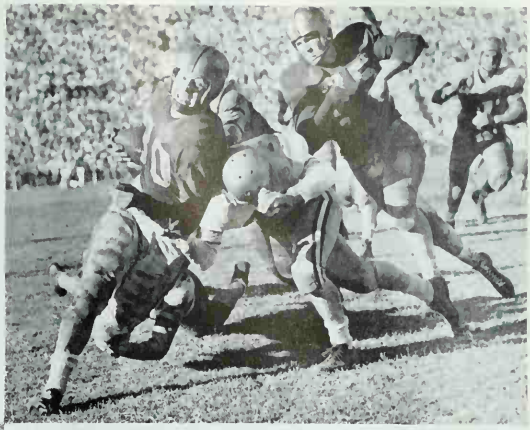
Frank Maznicki, Boston college, brought down by three Georgetown players after 15-yd. gain. Boston won 19–18, the first loss for Georgetown in 23 games, Nov. 16, 1940

George McAfee of the Chicago Bears plunging over Washington Redskins' line in National Football league championship game of Dec. 8, 1940. The Bears used T formation, won 73–0

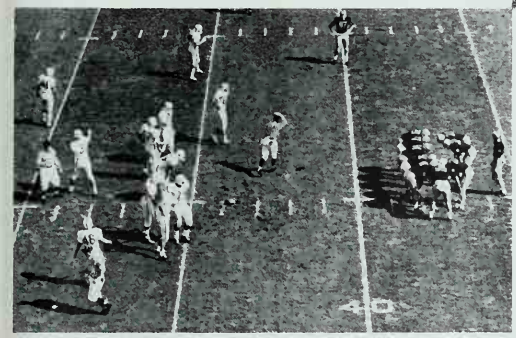
U.S. COLLEGE AND PROFESSIONAL FOOTBALL

PHOTOGRAPHS, (TOP, CENTRE RIGHT, BOTTOM LEFT) UNITED PRESS, (CENTRE LEFT, BOTTOM RIGHT) INTERNATIONAL NEWS

Otto Graham, Cleveland Browns quarterback, scoring in game against Chicago Cardinals, Oct. 24, 1954. It was the ninth straight year in which Graham led the team to a division championship



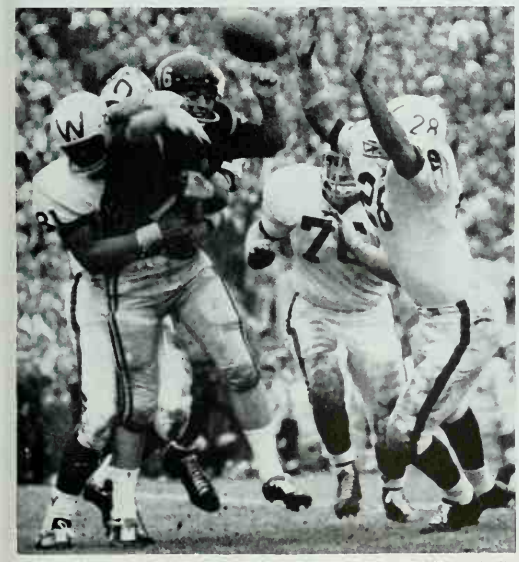
Orange Bowl game of 1952. Dick Parma, Baylor, running around right end against Georgia Tech. Georgia Tech won 17–14



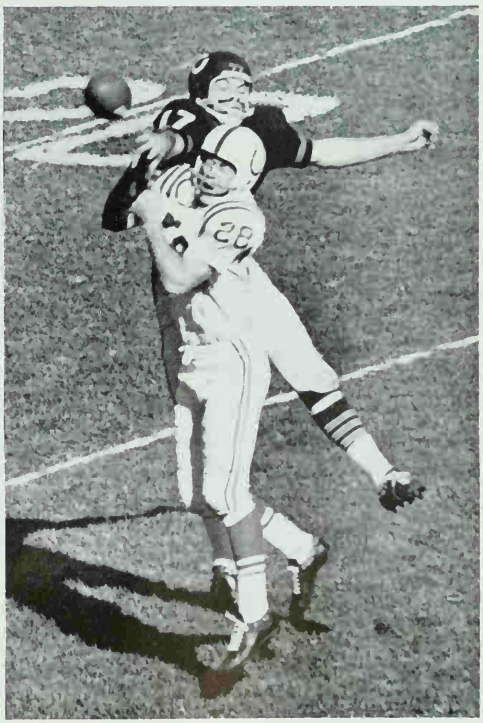
The "lonely end" football formation inaugurated by Army in 1958. Note right end Bill Carpenter (dark jersey) in his position as the West Point team huddles

U.S. COLLEGE AND PROFESSIONAL FOOTBALL

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT) WIDE WORLD, (OTHERS) UNITED PRESS INTERNATIONAL



Bill Nelson (16), University of Southern California, fails to get off pass in the 1963 Rose Bowl game as Larry Howland (81), Wisconsin, tackles him for a 5-yd. loss. Southern California won 42–37



Jimmy Orr (28), Baltimore Colts, and Richie Petitbon, Chicago Bears, battle for a Johnny Unitas pass intended for Orr in a 1962 game. Officials ruled interference, giving Colts a completed forward pass

FOOTBALL

ACTION IN INTERNATIONAL ASSOCIATION FOOTBALL

The fullback of the Italian soccer team drives the ball away during a match with Northern Ireland at the Olympic stadium in Rome. The action headed off a score and the Italians won 1–0 in the eliminations for the 1958 World tournament played in Sweden

Goalkeeper G. Merrick of England out to block a shot by S. Kocsis of Hungary during game of Nov. 25, 1953, at Wembley. Hungary won, 6–3, England's first recorded defeat at home by a foreign team

PHOTOGRAPHS, (TOP) PLANET NEWS LTD., (BOTTOM) UNITED PRESS INTERNATIONAL, LONDON

The Czechoslovak goalkeeper makes a good save during a Brazilian attack in the 1962 World Soccer final at Santiago, Chile. The Brazilian team retained the world title and the Jules Rimet trophy by winning 3–1

ASSOCIATION FOOTBALL CHAMPIONSHIPS

The Tottenham Hotspurs retained the Football Association cup by beating Burnley 3–1, at Wembley in 1962

PHOTOGRAPHS, (TOP) PLANET NEWS LTD., (BOTTOM) PHOTOGRAPHIC NEWS AGENCIES, LTD.

FOOTBALL

K. Jones, Wales, getting away with the ball to score a try as Wales defeated France 21 points to nil in international rugby match at Cardiff, 1950

RUGBY FOOTBALL

L. Booth, Huddersfield, is about to tackle the Wakefield Trinity fullback in a 1962 game at Wembley. Wakefield won the Rugby league challenge cup 12–6

J. Douglas, Scotland, grabs the ball in a lineout during an international match with England in 1961 at Twickenham

The Welsh forwards have heeled the ball from a tight scrum during a game with England in 1962. L. H. Williams, the Welsh scrum half, passes the ball out

PHOTOGRAPHS, (TOP, CENTRE RIGHT, BOTTOM) SPORT AND GENERAL PRESS AGENCY, (CENTRE LEFT) KEYSTONE PRESS

for the rules of football as played in his time first took the ball in his arms and ran with it, thus originating the distinctive feature of the Rugby game. A.D. 1823." It was at Rugby, too, that the players seem to have been posted in something like the modern Rugby positions in the field; Thomas Hughes records in his description of a Bigside game at Rugby in *Tom Brown's School Days* that the teams were divided into four groups—the forwards who fought out the mauls or scrummages, the dodgers (rather like halfbacks), the boys in quarters (modern three-quarter backs) and the goalkeepers.

Codification of Rules.—Outside matches were not played by the schools at this time; indeed, it would have been almost impossible to play them as each school had its own game and there were no independent clubs until the middle of the 19th century. Rugby school played its first outside match only in 1867 and did not meet another school until 1896. However, old boys of the schools began to feel the need for settled rules and organized clubs so that they might go on playing. Two old boys of Westminster founded an ill-fated old boys' club in 1846, and in the same year H. C. Malden and George Sault called a meeting at Cambridge university of representatives of all schools which drew up a code of rules; no copy of this code survived as the game did not achieve popularity at the university at that time; but it is known that the meeting took what it thought the best features of the various games and expressly prohibited running with the ball in the Rugby manner. In the next 15 years a number of independent clubs came into being; among them were Guy's Hospital Football club (founded in 1843 according to one claim but probably a little later in fact), Sheffield (1855), Blackheath (1857, but reformed in 1862), Hallamshire (1857), Old Harrovians (1859) and Forest F.C. (1859 or 1860), later known as the Wanderers. There were still only a few rules in common; most clubs restricted teams to 20 a side and prohibited offside play; a player was considered off side generally if he was between the ball and his opponents' goal; a match was decided by a majority of goals and a goal was scored by kicking the ball between the sticks or posts defended by the other side and under a tape; the ball was a round inflated rubber "bladder," generally covered with cowhide. Only Blackheath stood firm for the Rugby running with the ball.

In Oct. 1863 football enthusiasts at Cambridge finally agreed upon a set of uniform rules and had them published. In the same month representatives of the various independent clubs met at the Freemasons tavern, Great Queen street, London, to draw up a set of rules. Cambridge had rejected the Rugby principle, but the independent clubs held many long debates on this point. Eventually they decided against carrying the ball and on Dec. 1 published a set of rules entitled *Rules of the London Football Association,* which prohibited carrying. Blackheath, which had once more led the Rugby party, withdrew from the association and went its own way. It was not long alone, for in the same year the Richmond Football club had been formed and supported carrying; the north of England was of the same opinion and had powerful clubs at Manchester and Liverpool; and in 1869 the Oxford University Rugby Football club was formed. Obviously there had to be Rugby rules, and on Jan. 26, 1871, representatives of 17 clubs and 3 schools met at the Pall Mall restaurant, Regent street, London, formed the Rugby Football union, drafted bylaws, appointed officers and instructed a committee of 13 to draw up the laws on the basis of the code in use at Rugby school. The actual drafting of the code was left to three Rugby alumni—A. Rutter, E. C. Holmes and L. J. Maton; they in turn deputed Maton as draftsman, who completed his work in good time, and saw the laws accepted as they stood by a special general meeting on July 24.

Both parties in football now had rules and a governing body; both still consisted almost entirely of old boys of the public schools; probably neither had the least idea that the Industrial Revolution and consequent collection of huge numbers of persons in the towns was to lead to the spread of their sports until association football (soccer) was the game of all the world and Rugby well known in all the British Commonwealth countries and a popular sport in France and elsewhere. Soccer and "rugger," as they became known popularly, were on the move. (L. M.)

II. U.S. FOOTBALL

A. U.S. College Football History

The Beginnings.—U.S. colleges and universities along the Atlantic seaboard had known various games generally classified as football and enjoyed as informal campus pastimes from early in the 19th century. From time to time schools officially frowned upon or tolerated these games, as circumstances seemed to dictate. At Princeton in 1820 a form of association football called "ballown" was played.

The following account traces the development of the modern game and the evolution of the rules that made it a distinctive sport. Among major developments were the gradual acceptance of rules permitting a player to run with the ball, differentiating the game from soccer, for example (and leading to tackling and, eventually, passing); and the introduction of team possession of the ball, instead of determining possession by a scrummage, as in Rugby football, each time the ball was put into play (this set the stage for the development of distinctive football offensive and defensive plays and strategies—and almost ruined the game until rules were invented to prevent one team from retaining possession indefinitely). Accounts of early games tend to be confusing, in part because methods of scoring varied so greatly, sometimes from game to game: goals (scored by kicking, as explained below), like runs in baseball, had no numerical value; in games in which running with the ball was permitted, running with the ball over the goal line (later to become the chief scoring play, the touchdown) scored no points at all, merely earning the runner's side a free kick to try to convert, or score a goal.

As in the British schools, games of football in the U.S. colleges varied from campus to campus, but all played fundamentally the kicking or booting game (*see* Soccer). Intercollegiate contests were undreamed of in the middle of the 19th century.

The Harvard faculty banned football games from the campus in 1860, and town authorities at New Haven, Conn., forbade Yale students to play them on the public green in 1858. Interest in football games nevertheless continued to grow in the colleges, and finally in 1867 the Princeton rules were drawn up, specifying 25 players to a side, and a Princeton team of that number engaged in a game with Princeton Theological seminary. It was then only a step to the first intercollegiate meeting, played by Princeton and Rutgers at New Brunswick, N.J., on Nov. 6, 1869, by sides of 25 men. Rutgers won by 6 goals to 4. The game, as played at the two colleges, was not timed by a watch but was decided when one team scored six goals.

The teams used a round, rubber ball, and a goal was scored when the ball was kicked under the crossbar (rather than over it as in the modern game) and between the posts defended by the opponents. No running with the ball was permitted, but it could be batted with the hands as well as kicked. Under Princeton rules a player might make a fair catch and gain a free kick therefrom. The game at New Brunswick was played under Rutgers' rules. A week later the teams met in Princeton, N.J., under Princeton's rules, with the special provision that eight goals were required for victory. Princeton won that game 8–0. The faculties of the two colleges then joined forces to prevent the playing of the third game, scheduled for New Brunswick on Nov. 20.

Columbia joined the intercollegiate football family in 1870, suffering a 6–3 defeat by Rutgers at New Brunswick on Nov. 12. Yale became a competitor in 1872, defeating Columbia 3–0 at New Haven on Nov. 16 with 20 players on a side. The Harvard faculty lifted its ban on football in 1871 and the game began to reappear on the campus. Harvard, however, played a carrying game, more like Rugby, called the "Boston game." This prevented the university from participating in the first intercollegiate rules convention in the United States because the other colleges—Yale, Princeton, Columbia and Rutgers—adhered to the kicking game.

At that convention, held in New York city on Oct. 19, 1873, uniform rules along association lines (see *Association Football [Soccer]*, below) were adopted. The first Yale-Princeton game was played under those rules at New Haven on Nov. 15 of that

year, Princeton winning 3–0. The same year Yale met, and defeated 2–1, a team from England calling themselves the Eton Players. They played with 11 men on a side and persuaded Yale to play with that number instead of 20. So Yale was to become the advocate of 11-man teams.

Harvard continued with its running game, which permitted a player to pick up the ball and, if pursued, to run with it. Lacking games with U.S. colleges because of differences in rules, Harvard scheduled two games with McGill university of Montreal, Que., in the spring of 1874. They were played in Cambridge, Mass. A third game was played in Montreal in the fall. The first of the two at Cambridge was played on May 14 under Harvard rules. Largely a kicking game despite the rules allowing running with the ball, it was won by Harvard 3 to 0. The next day the teams played under the rules of the Rugby Football union with an egg-shaped ball, and a scoreless tie resulted. Canadian Rugby rules allowed tries or, as they came to be called in the U.S., touchdowns (running with the ball across the goal line), as well as goals to count in the score. One goal, however, counted more than any number of touchdowns, the chief value of the latter being the fact that the team scoring a touchdown then had a free chance to convert or kick a goal (see *Rugby Football*, below). In the third game, at Montreal, Harvard won 3 touchdowns to 0, no goals having been scored by either side.

The games with McGill had far-reaching importance in committing Harvard to the running Rugby game, and thus influencing the pattern of the U.S. game that was to evolve. Harvard adopted the Rugby rules and Harvard and Yale met for the first time on Nov. 13, 1875, in New Haven in a game that was largely Rugby. The desire for a contest between the two universities had led to a meeting of representatives at Springfield, Mass., on Oct. 16, 1875, where the "Concessionary Rules" were adopted. Yale conceded to the Rugby principle of running with the ball and tackling. Yale was won over to Rugby in that game, won by Harvard 4 goals and 3 touchdowns to 0, and adopted the Rugby rules in 1876. That year Harvard conceded to Yale's request to play with 11 rather than 15 men on a side.

The 1875 game was witnessed by two Princeton players, W. Earle Dodge and Jotham Potter, who were so taken with Rugby that they called a mass meeting at Princeton in early Nov. 1876. By a narrow margin in a turbulent session it was voted to adopt Rugby and to invite Harvard, Yale and Columbia to a convention. Thus came about the important meeting of Nov. 23, 1876, at Massasoit house, Springfield, at which the Intercollegiate Football association was organized and the Rugby union code adopted with a change in the scoring. Rule 7, which read, "A match shall be decided by a majority of goals alone," was changed to "A match shall be decided by a majority of touchdowns. A goal shall be equal to 4 touchdowns, but in case of a tie, a goal kicked from a touchdown shall take precedence over four touchdowns."

The old round rubber ball was replaced by the egg-shaped leather Rugby ball and players were now initiated into the complexities of "off side" and "on side."

Yale went into the Springfield meeting convinced that Rugby could best be played by 11 men. When the convention voted against reducing the sides, Yale declined to become a full member of the league but readily became a playing member. Yale won the first championship by defeating Princeton 2 goals and 1 touchdown to 0, and Columbia 2 goals and 5 touchdowns to 1 touchdown. The league code was made retroactive to include games played prior to the meeting, giving Yale credit for its victory over Harvard by one goal to 0 the week before the meeting was held. Harvard agreed to count only goals in its game with Yale. According to its records it made 4 touchdowns; Yale records put the number at 2.

Experiment With Rules.—Yale continued to attend meetings of the Intercollegiate Football association, being represented by Walter C. Camp of the class of 1880, who had made his football debut on the Yale Blue's 1876 championship team and whose name soon became almost synonymous with football in the United States. Though Camp continued to insist on a reduction of teams to 11 men, the league still refused to effect the change; Yale continued playing in the league while refusing to become a full member. It finally joined the league in 1879, and a year later the league reduced the sides to 11 men. The playing field was reduced from 140 by 70 yd. to 110 by 53⅓ yd. in 1880, conforming to the British maximum length but dipping almost one-third under the British maximum width.

Next came another distinctive feature of the U.S. game: definite possession of the ball. Also, the quarterback made his appearance, along with a new method of putting the ball in play—by the holder snapping it back with his foot to the quarterback. In Rugby the forwards heeled it back in the scrum.

This practice was legalized in 1880 when the U.S. scrum officially became a scrimmage and definite possession of the ball became an approved tactic. This was the first great change which sent the U.S. game along a path so divergent from that of Rugby. Thus begun, the tendency to change accelerated, and finally the game of U.S. football evolved.

Definite possession of the ball having been established, teams soon learned that, if they themselves could not score, superior opponents could be prevented from scoring if the team in possession of the ball refused to surrender it. No means had been devised to force surrender of the ball, and Yale and Princeton availed themselves of this oversight to the fullest. The two strongest teams in the association, Yale and Princeton played annually for the championship in the late 1870s and through the 1880s. Having respect for each other, they turned their games of 1880 and 1881 into farces by what became known as the "block game." The team receiving the kickoff would retain the ball for the entire half, without making any particular effort to advance it. The results were two dull scoreless ties and a demand from the college public that something be done about it.

Since there was no penalty for making a safety, a team pressed back near its goal line could touch the ball down behind its goal and bring it out to the 25-yd. line. It could do this indefinitely and thus retain possession of the ball. In 1879 Princeton, the champion in 1878, was ruled to have retained its title after defeating Harvard and playing a scoreless tie against Yale. It touched the ball down five times for safeties and Yale did so twice. In 1880 Princeton again defeated Harvard and figured it would win the championship again if it got a scoreless tie with Yale, which also had beaten Harvard. It was content to maintain possession around its 25-yd. line, and no less than 11 times it touched the ball down for safeties, to the disgust of the spectators, in another scoreless tie. Yale made five safeties.

Walter Camp sought to have safeties count in the scoring (against the team making them) at the 1881 convention of the Intercollegiate Football association, as a means of making teams either advance the ball or give it up by kicking. He failed, but at least he put through a ruling that a team making four fewer safeties than its opponent would be declared the winner should both fail to score. Princeton, however, found a loophole in the rules to circumvent this restriction of "block" tactics. It discovered that the rules permitted bringing the ball out to the 25-yd. line by touching it down not only behind the goal line for a safety but also out of bounds in the extension of the goal lines and side lines known as "touch-in-goal."

By using this loophole when playing against Yale, Princeton maintained possession of the ball throughout the first half. Yale, getting the ball in the second half, gave Princeton a taste of its own medicine, and the game ended without a score or a safety being registered, to the anger of the crowd. Princeton, which had also played a scoreless tie with Harvard, was checkmated in its expectations of being named champion when the association awarded the title to Yale. Yale had played a scoreless tie with Harvard, too, but had made no safeties in the game, whereas Harvard had made four, and so Yale was the winner under the new rule.

The public dissatisfaction with block tactics made it imperative for the association to take corrective action. Camp solved this situation in 1882 by introducing the system of downs with a rule requiring a team to gain five yards in three downs or surrender the ball to the opponents on the spot of the third down. This rule forced the attacking team to kick on third down unless it seemed

certain that sufficient yardage could be gained to retain the ball. As a result of the five-yard rule the U.S. football field took on its barred appearance, with horizontal white lines at intervals of five yards, and the term "gridiron" became a synonym for the football field.

The rule was the heart of the modern game. It led to the development of a plan of attack, to the use of strategy, to Yale's abandonment of kicking as the predominant offense and the development of the running attack by short, hard rushes.

The idea of numerical scoring was forced on the football world by the Harvard-Princeton game of 1882, in which Harvard scored a touchdown and a field goal while the Tigers, as the Princeton team was called, scored a touchdown and goal after touchdown. Referee R. W. Watson (Yale, 1881) ruled that Harvard had won, but the game aroused so much discussion that Camp decided that the time for numerical scoring had arrived.

In 1883 Camp's leadership was responsible for the adoption by the convention meeting on Oct. 17 of a numerical scoring system. The point values assigned were 5 for a field goal, 4 for a goal on the try after touchdown, 2 for a touchdown and 1 for a safety. A year later the value of the touchdown was raised to 4 points and the goal after touchdown dropped in value to 2 points. The safety was set at 2 points to maintain its value as half that of a touchdown. Other alterations were made in scoring values in the ensuing 28 years, each tending to give importance to the touchdown and causing it to overshadow the field goal. Scoring, nevertheless, was let alone more than anything else in the game and was not altered between 1912 and 1958. The touchdown was increased to 5 points in 1897 and the goal after touchdown (conversion) reduced to 1. From 1922 the team scoring a touchdown was no longer limited to converting by means of a place kick but could also score the extra point by a run or a pass into the end zone or by drop-kicking a goal. The field goal was cut to 4 points in 1904 and to 3 in 1909. The touchdown was increased to 6 points in 1912. In 1958 the conversion became worth 2 points if scored by a run or a pass rather than by a kick.

Assured of uninterrupted possession of the ball by the revision which established the U.S. scrimmage in 1880, teams soon began to devise signals to indicate to their players the particular play they intended to use. At first, these were spoken words or phrases. Within a decade words had been replaced by numbers. In the early 1920s the huddle was introduced by Robert ("Bob") Zuppke, University of Illinois coach, and soon was universally adopted. In the shouted signals, the quarterback invariably called the play, sometimes at the direction of the captain or the coach. In the huddle, any player may give the signal, or even call the play by name, with no fear that the opposition will be the wiser.

Alignment of the players in the U.S. game, after the establishment of uninterrupted possession of the ball and before the game was closed up, departed sharply from the practice in British Rugby. Instead of being locked in a scrimmage, U.S. forwards were widely spread across the field and the backs played at correspondingly wide posts, from three to five yards behind the line. Players in the line (linemen) earned, in the 1880s, the names by which they now are known—ends, tackles, guards and centre—though at the outset the end was known as the end rush and the centre as the centre rush. The centre rush heeled the ball back, or passed it with his hand, to the quarterback, who was not eligible to run with it. The quarterback, in turn, passed it back to a halfback or the fullback.

Players still were prohibited from taking any part in a play if they were ahead of the ball (off side), but backs soon developed a habit of running at the side of the ball carrier to fend off tacklers. It was only natural to progress from this to running ahead of the carrier and, while thus off side, to blocking intended tacklers out of the play. This infraction first was winked at and then was incorporated into the rules as a legal move. Interference for the runner thus was born and legalized, with Princeton a leader and George W. Woodruff and William W. Heffelfinger of Yale the most famous of the early blockers.

The zeal of interferers was matched by that of tacklers. The rules prohibited tackling below the waist, but inspired defenders began creeping down toward the knee. This practice also was winked at in its early years. Finally, in 1888, it was made legal, completing the final phase of the metamorphosis which had been begun in 1880 with the establishment of definite possession of the ball. At the same time, linemen were required to hold their arms at their sides instead of extending them. As the linemen, formerly spread across the field, were brought in close, the backs came in close too, for protection against the low tackle.

Thus came about the standard close formation, known as the T formation, and the end of the open Rugby game. The wide arc from which the attack might spring in the backfield was constricted. Wide passes and open play disappeared overnight. To plow through tacklers who were permitted to grasp a runner as low as the knee, backfield men had to charge low and hard and with tremendous interference. Football was no longer graceful and fast; it was lumbering and slow and very rough.

Spread of the Game.—From its cradle in the larger eastern colleges of the United States, football spread quickly through the east and then to other sections of the country. Pennsylvania, Wesleyan, Stevens Tech, Amherst, Williams, Dartmouth, Brown, Cornell, Penn State, Lafayette, Lehigh, Trinity (later Duke) and many others took up the game in the 1870s and 1880s. In Canada, football already was well established at Toronto and McGill.

In the U.S. middle west, the University of Michigan (Ann Arbor) became the pioneer. A team was organized as early as 1873, but Michigan could find no opponent until Racine college, Racine, Wis., was met in the park of the Chicago National league baseball club on May 30, 1879. Michigan won by one touchdown and one field goal to nothing (Michigan records list the score as 7 to 2, although point values were not assigned to scoring until the 1883 convention discussed above), and went on to establish football on a firm foundation in the next few years. The Wolverines (as the Michigan team was called) also pioneered in intersectional football in 1881, meeting Harvard, Yale and Princeton within five days on a single eastern trip. Michigan lost all three games but, nothing daunted, tried the same thing again in 1883, this time against Wesleyan, Yale, Harvard and Stevens Tech. Michigan again lost all the games, but football was on its way at Ann Arbor and in the west. Minnesota, Iowa, Purdue, Northwestern and other middle western universities took up the game in the 1880s. The most significant addition of all, although comparatively unnoticed at the time, was that of Notre Dame, which made its debut by losing, 8–0, to Michigan at Notre Dame on Nov. 23, 1887.

Football was introduced to the south in 1877, when Virginia Military institute played Washington and Lee. On April 9, 1880, Centre college of Danville, Ky., famed 40 years later for its "Praying Colonels," and Kentucky university (later Transylvania) played a scoreless tie in Lexington, Ky., but the game was destined not to catch on in the south until later. Eight years passed before Trinity defeated North Carolina by 16–0 at Raleigh, N.C. This game was played on Thanksgiving day of 1888. Football then spread quickly to Virginia, Vanderbilt, Auburn, Georgia and other south Atlantic and southern colleges. It also returned to the Kentucky colleges in the early 1890s, and soon afterward spread to the southwest, the Missouri valley, the Rocky mountains and the Pacific coast. By the turn of the century it had become the national academic game, but the power remained concentrated at the colleges which had pioneered in the game in the east—Yale, Harvard, Princeton and Pennsylvania. In the middle west, Michigan, Chicago, Minnesota and Wisconsin were beginning to challenge the supremacy of the east, but the westerners were about a decade away from gaining real equality.

Concentration on Power.—Speed and deception had been the prime requisites for success at the Rugby-style game played in the United States up to 1888. Legalization of knee-high tackling in 1888 had closed up the game and placed a premium on power. Winning requisites became power, speed and deception, with the first far outweighing the other two.

Inventive genius on the campuses remained the same as it had been in the years when young Americans first began making over the original Rugby game. Other youths began devising ways and

means of getting greater power into the plays in order that massed defenders could be either crushed down or split asunder to give the runner free passage toward the enemy goal. The game was rough, but since it also was slow injuries were not so numerous as often supposed. Injuries were destined to mount only when some semblance of speed had been regained. This speed was acquired when momentum, prior to the snap of the ball, was added to the mass game through the inventiveness of Lorin F. Deland of Harvard and George Woodruff of Yale, who coached Pennsylvania to its first real football success in the middle 1890s.

An invention dating back to Rugby days served as the vehicle for the most devastating of these momentum mass plays—the "flying wedge." As early as 1884, strategists at Princeton and Lehigh (no one knows which thought of it first) discovered that nothing in the rules said that the ball had to be kicked to the receiving side on a kickoff. They learned that the rules could be satisfied if the kicker merely touched the ball with his foot. He then was free to tuck himself away within a wedge formed by his ten team mates and go trotting along for what usually amounted to a handsome gain against opponents who were restrained by rule to a point ten yards removed from the kickoff. This became known as the "V trick" and was first used by Princeton against Pennsylvania in 1884. It was then abandoned until the 1888 Yale-Princeton game, after which it became the standard means of putting the ball into play by all teams.

Lorin F. Deland, a chess player and Harvard fan who never played football but who was a master strategist, devised a means of adding momentum to the V trick in 1892. He grouped the ten men of the wedge not around the kicker on the 55-yd. line but near the side lines and back on their own 25-yd. line, five men on each side of the field. At a given signal, the two groups charged forward together, headed for the kicker. At the instant they converged on him, the kicker "babied" the ball with his toe and stepped within the wedge. The play was saved for the Yale game of 1892, and the result was devastating. Harvard failed to win the game, failed even to score with the play, but it did plow 45 yd. through amazed Yale defenders to the Blue's 10-yd. line. Yale later scored a touchdown and goal to win by 6–0, but the flying wedge was the sensation of the game. It spread to all points of the football map in 1893, and injuries from its use aroused widespread criticism.

George Woodruff became coach of the University of Pennsylvania in 1892. He introduced the principle of flying interference by grouping two or three linemen in the backfield and having them start forward, with the spare backs, before the ball was snapped. The carrier took the ball from the quarterback and took his place in this charging set of players, usually second in a group of four interferers or third in a group of five. It was necessary to get power behind the ball as well as in front of it, since interferers and carrier were permitted to run with arms interlocked about bodies, and pushing and pulling were entirely legal. From this mass momentum principle Woodruff, in 1894, invented a famous play known as "guards back."

Prior to this Amos Alonzo Stagg, the most inventive of all football coaches and one of Yale's most famous graduates, had launched the fast-moving mass attack with his "ends back" formation of 1890–91 at the International Y.M.C.A. college at Springfield, Mass. He followed it with the "turtleback" in 1891 (claimed by Harvard in 1893) and the "tackles back" in 1894 at The University of Chicago.

Meanwhile, the uproar against injuries resulting from mass momentum plays had increased. The universities themselves were at odds over it and over the eligibility of graduate students. Harvard and Pennsylvania, having large graduate departments and schools and an abundance of brawny material, advocated mass play and eligibility of graduate students, regardless of how long they had played football before taking up graduate courses. Yale and Princeton, being in the main undergraduate colleges and having few men other than undergraduate students on their campuses, insisted on a four-year eligibility rule and the minimization or even elimination of momentum from mass play. It never occurred to anyone then that mass play itself could be eliminated. The original Intercollegiate Football association was being broken up by these disputed points after the season of 1893.

In this emergency, the University Athletic club of New York invited Yale, Harvard, Princeton and Pennsylvania to send representatives to a meeting in the spring of 1894 and draw up a code for the use of all colleges. Yale had just broken relations with Pennsylvania; Princeton and Harvard had not been competing for several seasons; Yale was on the verge of its break with Harvard; and Princeton was about ready to say good-by to Pennsylvania. But to save the game, representatives of what had come to be known as the Big Four subordinated their personal differences and agreed on reformations. In the sweeping rules revision the old Rugby kickoff was brought back. The Lehigh V, Princeton wedge and flying wedge were outlawed by a decree that, to be in play, the ball had to travel at least ten yards on the kickoff unless touched sooner by a member of the receiving team. Playing time was reduced from 90 minutes to 70 minutes, divided into halves of 35 minutes each, and a compromise was reached on momentum. The rule makers decreed that no more than three men might group behind the line of scrimmage for the purpose of launching a momentum mass play, and these could be no more than five yards back.

These reforms accomplished much, but not enough to satisfy Yale and Princeton. These two colleges enlisted the support of Navy and broke with Harvard and Pennsylvania in the spring of 1895 to formulate separate rules of their own. Harvard and Pennsylvania took Cornell into their group and drew up another set of rules. The Yale-Princeton rules struck at momentum mass play by decreeing that seven men must be on the line of scrimmage of the team in possession of the ball and that only one offensive back might start forward before the ball was snapped. Harvard, Pennsylvania and Cornell retained the rules of 1894.

With two sets of rules in effect, the season of 1895 was not chaotic but it was far from satisfactory to either camp. A compromise was reached early in 1896 and a permanent rules committee was set up. Proponents of momentum mass play yielded by agreeing that no player on the offensive side might take more than one step toward the goal of the defensive team before the ball was snapped without coming to a full stop. The Yale-Princeton group gave ground by permitting the offensive scrimmage line to be reduced to five players, with the other two forwards in the backfield to add power, if not momentum, to the plays. Momentum thus was reduced to a minimum, but the mass remained and football continued to be rough. Nevertheless it proceeded for another decade before being struck by another major reform wave.

Chief tactical development of the 1890s, other than Woodruff's guards back, was the play along the same lines known as tackles back, worked out by Stagg, who was coaching at Chicago. It was just as rough and effective as guards back but was more mobile. It depended for its success on the power of interlocked interference, power behind the ball. It embodied the art, expounded for purposes of war by Gen. Nathan Bedford Forrest, of striking a given point with superior force before defenders had time to reinforce it or even realize the necessity of reinforcing it. It had greater deception than guards back. In 1899 Harry Lane Williams of Yale, coaching at Penn Charter school before launching his distinguished career at Minnesota, used the "tackle back," pulling one tackle back to line up behind the other. Camp introduced it at Yale in 1900.

Birth of the Modern Game.—In the decade following the reform of the mid-1890s, football went on its course little changed. At the beginning of the 20th century, Fielding Harris Yost of West Virginia and Lafayette coached Michigan to pre-eminence, perennially challenged by Stagg at Chicago and Williams at Minnesota and by various coaches at Wisconsin, including Philip King of Princeton. A Yost pupil, Daniel Earl McGugin, lifted Vanderbilt from the ranks of ordinary elevens and set the pace for development all through the south. Yale let well enough alone in the east and went on winning regularly from Harvard and Princeton.

But football kept on injuring players, and the public outcry against the game became greater and greater. The middle western universities, organized for about a decade into the Western con-

ference, heeded these protests by making drastic revisions following the 1905 season. Freshmen students were barred from varsity teams, and schedules were limited to five games. Transfer students were eligible only after one year's residence, and all players were limited to three years' participation in football. The Western conference was powerless, however, to effect any changes in the game. That authority was vested solely in the rules committee which had grown out of the reform wave of the mid-1890s.

In this emergency Pres. Theodore Roosevelt acted. Realizing the necessity for devising a more open and less brutal game if football was to survive, the president summoned representatives of Yale, Harvard and Princeton to the White House and urged them to take steps to save the game. Representatives of 28 colleges met in New York city and formed a committee that was the forerunner of the National Collegiate Athletic association. Led by Capt. Palmer E. Pierce of the U.S. Military academy (West Point, N.Y.) it merged with the established governing body headed by Camp. The two groups formed the American Inter-Collegiate Football Rules committee and at a meeting on Jan. 12, 1906, adopted a reform program to make the game safer and more interesting.

From that conference grew the modern game of football. The prime demand was that the game be opened up. This was accomplished by the revolutionary legalization, contrary to all Rugby fundamentals, of the forward pass. Introduction of the forward pass in 1906 took rank with the legalization of the U.S. scrimmage in 1880 as one of the greatest steps away from parent Rugby toward a distinct U.S. game. Compared with these fundamental changes, other alterations through the years had been minor. Without definite possession of the ball, U.S. football still would have been Rugby. Without the forward pass, it still would have been mass football.

The forward pass, recommended to Camp by John Heisman of Penn State as early as 1903, was sponsored strongly at the 1906 meeting by John C. Bell of Pennsylvania and Paul J. Dashiell of the U.S. Naval academy (Annapolis, Md.). It was adopted—but with severe restrictions, which were to be eliminated one by one through the ensuing few years. At the outset, the forward pass had to be thrown from five yards behind the scrimmage line and had to cross the scrimmage line at a point at least five yards out from the spot where it had been put into play. (To make it easier for officials to note infractions of this latter rule, chalked lines, running the length of the field parallel to the side lines, were laid out at five-yard intervals, thus giving the gridiron a checkerboard appearance.) Eligible receivers were the players at the ends of the line of scrimmage and those behind it, excepting of course the thrower. Penalty for failure to complete a forward pass was 15 yd. from the point where the ball had been put into play, and loss of a down. With such restrictions, the forward pass was little used, particularly in the conservative universities of the east which had little to gain through the development of the pass and much to lose. Yale nevertheless defeated Harvard in 1906 through a long forward pass which set up the game's only touchdown.

Other changes adopted included increase of the distance to be gained in three downs from five to ten yards. All players except the kicker were ruled to be on side the instant any punt struck the ground. Hurdling was prohibited and offensive centres, guards and tackles were forbidden to play in the backfield unless they moved at least five yards back. The neutral zone was established, separating the teams by the length of the ball. Time of the game was cut from 70 minutes to 60, divided into halves of 30 minutes apiece. Other important changes followed in a series of experiments which continued until 1912, when the modern game assumed its ultimate pattern.

In the mass game of 1888–1905 the defensive alignment amounted to a ten-man line. The two halfbacks backed up the tackles and the fullback backed up the centre, virtually on the line. The quarterback was stationed from 20 to 40 yd. back, depending on the down and the ability of the opposing punter. This arrangement was effective and satisfactory as long as the offensive team could not throw the ball forward. It could cope with the interlocked interference hurled at it. In introducing the forward pass in 1906, the rules committee neglected to outlaw interlocked interference. Necessity demanded that the defensive halfbacks withdraw from support of their tackles and play several yards back to be on guard against forward passes. Restrictions on the pass being what they were, this made little difference in 1906, but unsupported tackles took increasingly severe beatings through the next few years as one restriction after another was removed from the pass and as more and more men learned to throw the ball. The defensive halfbacks moved farther and farther away from the tackles and left them more and more open to being overwhelmed by interlocked attackers. Tackles frequently suffered serious injuries from this circumstance.

In 1907 the 15-yd. penalty for failure to complete a forward pass was removed. In 1910 it no longer was necessary for the ball to cross the scrimmage line at a point five yards out from where it had been put into play, and the field lost its checkered pattern. In that same year the pass could not be thrown more than 20 yd. beyond the scrimmage line and a punt, to put players of the kicking team on side, had to travel 20 yd. or more beyond the line—keeping both the umpire and the field judge busy measuring with their eyes. In 1912 the onside kick was eliminated (unless the kicking team had a man stationed behind the kicker, in which case he was on side without regard to the ball's striking the ground) and all restrictions were removed from the forward pass, except that only one such pass could be thrown during a single scrimmage, and it had to be thrown from five yards behind the line of scrimmage. Through these developments of the pass and experimentations with the onside kick, the running game, featuring interlocked interference, came more and more to overtax the capacity of tackles left unsupported by halfbacks who had more demanding chores to perform elsewhere. Matters came to a head in 1909 when at least half a dozen tackles, including Cadet Eugene Alexis Byrne of Army, were killed or fatally injured on the field of play. The solution which had been beckoning after 1906 was accepted; interlocked interference was outlawed, beginning in 1910. The offense was required to have seven men on the line of scrimmage.

Abolition of interlocked interference so weakened the offense in 1910 and 1911 that the balance of power passed to the defense and many scoreless ties resulted. Teams of anywhere near equal strength were unable to carry out any sustained attack against each other. More often than not games were decided on the breaks or on field goals. This led the rules committee to untrammel the forward pass in 1912 and give the attacking team a fourth down in which to make its ten yards. The value of the touchdown was increased to 6 points in 1912 to enable a team scoring a touchdown and goal to defeat an opponent which had kicked two field goals. The length of the field was reduced to 100 yd. in 1912, but two end zones 10 yd. deep were established. In these end zones the attacking team was permitted to complete forward passes. In 1927 the goal posts were moved from the goal line to the rear of the end zone.

Development of the Modern U.S. Game.—The metamorphosis of football from the close-order game to the open game was accomplished by the rules changes effected between 1906 and 1912. The rules themselves were changed only by degrees from 1913 to the mid-1950s, but tactics and strategy of the open game had hardly begun to take effect before 1913. Up to 1906 the team with the greater power always won. Large eastern elevens, as a consequence, were little disposed to experiment with any innovations in the open game wherein a physically inferior rival with fewer resources might not only score upon but even defeat one of the football mighty. The big teams included the pass in their repertoire of plays but chiefly because all major rivals might be expected to do the same. All used it with caution.

It remained for Coach Jesse Harper and his Notre Dame eleven to open the eyes of the east to the dazzling possibilities of the forward pass in the first Notre Dame-Army game at West Point on Nov. 1, 1913. Led by the forward pass combination of Charles E. ("Gus") Dorais and Knute Rockne, this unheralded Notre Dame team humbled Army by 35–13 that afternoon. The result was not only defeat but progress for Army. The progress

developed when Cadets Vernon E. Prichard and Louis Merillat, Jr., obtained permission from Coach Charles D. Daly to use a forward pass play which those two cadets had been experimenting with all summer, even as Dorais and Rockne had experimented with Notre Dame's pass. The result was a crushing defeat, by 22–9, of a favoured Navy team in Army's climactic game.

Football development continued apace until the entry of the United States into World War I, but it was not until after that war that the game reached its ultimate development by the spread of good material and good coaching to all major colleges and to all sections of the country. It was not until after the war that the forward pass reached its highest development and that Rockne led Notre Dame to unchallenged pre-eminence.

Robert C. Folwell of Pennsylvania, coaching at Washington and Jefferson (Washington, Pa.), developed a short forward pass straight over the line and made it more effective by sending his tackles crisscrossing into the enemy backfield to take out the defensive halfbacks, then a legal move. Later, players ineligible to receive a forward pass were prohibited from coming into contact with defenders.

Williams had developed the Minnesota shift in the years between 1906 and 1909 and had done extremely well with it, the Gophers having won or tied for the Western conference championship in 1909, 1910 and 1911. Heisman, coaching at Georgia Tech, Atlanta, had adapted the shift and improved it in 1910. With its help he won the championship of the south in 1916 and gained national recognition in 1917. Thomas L. Shevlin, called to help bolster a losing Yale eleven with late-season coaching in 1915, introduced the play in time for Yale to win from a highly favoured Princeton eleven, 13–7. The success of the play resulted from the small momentum the attacking team gained as its linemen leaped into position at the snap of the ball. Notre Dame used the shift with conspicuous success under Rockne, who credited Stagg with originating it. Stagg first used a line shift at Chicago in 1902 and the backs joined in in 1904. In the 1920s the teeth were drawn from the Notre Dame shift by restrictions requiring shifting backs to come to a palpable halt before the ball could be put into play.

Erection of Stadiums.—More far-reaching in effect than anything which took place on the playing field in the years immediately preceding World War I was Yale's decision in 1913 to erect a concrete amphitheatre. Harvard had built a concrete stadium seating about 30,000 in 1903 and had added a colonnade on the rim and wooden seats in the open end several years later to increase the capacity to about 50,000. Syracuse had built its Archbold stadium several years later, seating about 35,000, and Princeton already was discussing plans for Palmer stadium, which eventually was sped to completion in 1914 and opened exactly four weeks prior to the dedication of the Yale Bowl. But none of these stadiums had captured the imagination of the public as the Yale Bowl was to capture it. (*See* also STADIUM.)

U.S. Football Prior to 1917–18.—From 1908 through 1916 Percy Duncan Haughton coached Harvard teams to outstanding victories. Harvard was undefeated and untied in 1912 and 1913, undefeated in 1908, 1910 and 1914 and defeated only once each year in 1909 and 1915. Power remained an essential to victory in the open game, but it was distinctly secondary to speed—and even the power had to be raced hurriedly into position ahead of the ball in the form of interference instead of being placed behind it in the form of "pushers" as had been the case in the old mass game. Haughton won at Harvard where others had failed because he was one of the first major coaches to realize that speed and power were, in themselves, relatively valueless unless properly masked by deception. Harvard played football only informally in 1917 and 1918, but returned to the field in 1919. The master coach had retired, but enough of his teaching and his impetus remained to carry Harvard through to the 1919 championship and a Rose Bowl victory over Oregon by 7–6; yet Harvard was nearing the end of its brief reign as a real football power.

Illinois under the mercurial Zuppke and Ohio State under John W. Wilce had taken prominent places in middle west football. Zuppke's victory over a mighty Minnesota team, 14–9, on Nov. 4, 1916, was still talked about years later as one of the greatest football upsets of all time. Illinois had won the Western conference championship in 1914 and had tied with Minnesota in 1915, but Minnesota was supposed to win as it pleased in 1916—and did everywhere except in the Illinois game. The upset of Minnesota enabled Ohio State to win its first championship in 1916 by what was largely regarded as a fluke. Wilce proved that this charge was groundless by repeating with another championship in 1917. Michigan, which had withdrawn from the Western conference as a result of the upheaval following the 1905 season, returned to western competition in 1917 and was undefeated and untied in 1918, sharing the championship with Illinois and Purdue, also undefeated and untied in conference play.

Post-World War I Boom.—Those close to football realized the game was to experience a boom in the years immediately following World War I, but not even the most extravagant estimates encompassed what was in store. The lesson Camp had taught college football managers by inspiring the building of the Yale Bowl was well remembered, and colleges throughout the land began rushing stadiums to completion, on borrowed funds more often than not and with unfortunate results in some instances. In the main vast stadiums were confined to larger universities, those with larger undergraduate bodies and either large graduate bodies or large concentrations of townsfolk eager to see football games, and in these cases the building programs worked out very satisfactorily. The stadiums were paid for in due course and the earnings of the football teams were diverted to the provision of athletic facilities for the general mass of the students. In the case of Notre Dame, profits from the game also provided new buildings and academic improvements. Because Notre Dame played most of its big games away from home, the university was one of the last of the major institutions to build a modern stadium on its own campus. In colleges of minor football stature, however, the erection of stadiums beyond their needs brought financial disaster, even in boom times. With nobody but the public to draw upon, such colleges soon found that the public would not pay to see a loser. This led to recruiting of players by offering them inducements outside the amateur code, but sometimes not even this proselyting produced winning teams.

Rise of "Small" Teams.—Into this setting of prosperity arrived, in 1919, several so-called "small" teams which achieved sudden success and fame. The two most successful elevens in 1919 were Notre Dame and Centre. Also undefeated was Texas A. & M., but that feat went largely unrecognized because sectional football developments were not considered, in 1919, to be of national importance. Notre Dame had produced undefeated and untied teams in 1912 and 1913 (without having attracted undue attention in the east, despite its 1913 victory over Army), and Centre college had produced several championship elevens in the south. Rockne was becoming famous at Notre Dame, and "Uncle Charley" Moran of Tennessee was putting together another championship team at Centre which became known as the "Praying Colonels" because the players were said to kneel in prayer before each game.

Centre in 1919 attracted even more attention than did Notre Dame. West Virginia, beaten in an early-season game by Pittsburgh, upset Princeton by 25–0 on Nov. 1, but suffered defeat by Centre, 14–6, a week later as Princeton was coming back to tie Harvard. That circumstance forced the Praying Colonels into the consciousness of the football public, with far-reaching results. Harvard, with an undefeated but tied eleven and a Rose Bowl winner, failed to get the recognition which its graduates felt was its due, and agitation was begun to arrange a more difficult schedule for 1920. Urged by influential graduates, Harvard invited first Illinois, Western conference champion of 1919, and next Michigan to play at Cambridge in 1920. Each declined unless Harvard would return the visit in 1921. Harvard authorities then invited Centre to come to Cambridge for the big midseason game of 1920, and Centre accepted.

Camp in 1919 had chosen Alvin N. ("Bo") McMillin and James R. Weaver, quarterback and centre respectively of Centre, for his All-America team, contrary to all precedent, and football enthusiasts in Boston were eager to see what manner of men these

Praying Colonels, who had upset the accepted order in football, were. As a result, Soldiers field, Boston, was filled to its capacity of 52,000 on Oct. 23, 1920. Although defeated by 31–14, Centre rewarded the curious by scoring more touchdowns in Harvard stadium in 15 minutes than Yale had scored there in 15 years. Harvard suggested another game in 1921. Centre accepted, filled the date and the stadium and won by 6–0 when McMillin ran 32 yd. around right end for a touchdown, aided by the interference of All-American James M. ("Red") Roberts. Harvard naturally wanted revenge, so Centre was invited back for 1922. The Colonels again filled the stadium to its full capacity, but Harvard won by 24–10, and thus ended the series.

Soon after Centre had disappeared from football fame, Notre Dame came back on the scene with even greater achievements. Notre Dame had gone undefeated in 1919 and 1920, but had failed to repeat that success in 1921, 1922 and 1923. Rockne then produced his great 1924 team, which won all its games and went on to defeat Stanford by 27–10 in the Rose Bowl. This team had Elmer Layden at fullback, Harry Stuhldreher at quarterback and Don Miller and Jim Crowley at the halfbacks. When Notre Dame defeated Army by 13–7 at the Polo Grounds in New York on Oct. 18, 1924, Grantland Rice, writing in the *New York Herald Tribune*, described the backfield men as "the Four Horsemen," a sobriquet which endured and helped establish the team as one of the most famous in history.

Rise of Pacific Coast Teams.—Football came into its own in the far west simultaneously with its rise at smaller colleges in other sections of the United States. The University of California had played football as early as the 1880s, and Stanford and California met annually from 1892 (when both spring and fall contests were played) through 1905 in the "big game" of the Pacific coast. Washington, Oregon, Nevada, Idaho, Whitman, Washington Agricultural (later State) and Oregon Agricultural (later State) had taken up the game by the late 1890s, and were playing representative schedules, including games with Stanford and California, when the reformation of 1906 struck college football. Stanford, California and other California colleges dropped U.S. football and played Rugby for about ten years. This opened the way for the colleges farther north to establish themselves in football, which they proceeded to do by organizing the Pacific Northwest conference in 1908. Coached by Gilmour Dobie, Washington dominated this group from 1908 through 1916, a nine-year stretch without defeat during which Dobie's teams won 58 games and tied 3. From 1909 through 1913 Washington went through five straight seasons without defeat or tie. Washington won or tied for the Pacific Northwest championship in each of the seven seasons from 1908 through 1914, and then tied Oregon for the first Pacific Coast conference title in 1916. Washington and Oregon played a scoreless tie in their own game, but Oregon got the call to the Rose Bowl and defeated Pennsylvania by 14–0 on Jan. 1, 1917, in the third game in this Bowl series.

Andrew L. Smith by that time was established at California, laying the foundations for his "wonder teams" of the 1920s. The lesser-known Melbourne C. ("Fighting Bob") Evans coached at Stanford in 1919, and sent an inspired eleven against California in the big game. California finally won by 14–10, but Oregon had a better record and captured the Rose Bowl assignment. No team went through the conference season undefeated, and Harvard added to western woe by winning in the Bowl game by 7–6.

From that point onward Smith was on his way. He won four straight championships from 1920 through 1923, and was undefeated but tied twice in 1924, when Stanford took the title and the assignment to the Rose Bowl (where Notre Dame's Four Horsemen won by 27–10). California crushed Ohio State, Western conference champion, by 28–0 in the Rose Bowl on Jan. 1, 1921, and played a scoreless tie with Washington and Jefferson on Jan. 2, 1922. The Pacific Coast conference refused to send its champion team to the Bowl following the seasons of 1922 and 1923.

Evans, a San Francisco businessman, had no desire to remain in the coaching profession, and Stanford authorities began seeking the services of a well-known coach. After trying two temporary coaches, they decided, in 1922, on Glenn ("Pop") Warner, who after 1915 had been building strong Pittsburgh teams. From 1915 through 1918 Warner's Pittsburgh teams were undefeated by college opposition, winning 23 major games and losing only to the Cleveland Naval Reserve eleven, 10–9, in the final 1918 game. He rated his 1916 team as the best of all the elevens he developed. Earlier, Warner had coached at Georgia and Cornell, his alma mater, and had won national fame as mentor of the famous Carlisle Indians, who included among their number the great Jim Thorpe. The Stanford situation suited Warner exactly, but his commitment at Pittsburgh prevented his taking the post until 1924. In this emergency, Warner dispatched one of his assistants, Andrew Kerr of Dickinson, to Palo Alto to coach in 1922 and 1923.

Southern California meanwhile had joined the conference and had high football ambitions. Trojan authorities engaged Howard Harding Jones, who had coached Yale in 1909 and Iowa in 1921 and 1922 to championship seasons before moving to Trinity (Duke) of North Carolina. Smith died in Jan. 1926 before this new triple rivalry of master coaches could more than get under way, and was succeeded by Clarence M. ("Nibs") Price. Washington, coached by Enoch Bagshaw, had won the 1925 championship, but Price, Jones and Warner fought for the next several titles. The style of play taught by Warner was due to vie with the game advocated by Rockne at Notre Dame for the favour of almost all the other U.S. coaches.

The Game in the South.—In all the years prior to U.S. entry into World War I, the supremacy of Virginia, nicknamed the Cavaliers, in the south Atlantic states and of Vanderbilt in the central south had never been seriously challenged. North Carolina or Georgetown or Virginia Polytechnic (Blacksburg) in some years would crowd Virginia closely, or even win, but in the main the Cavaliers were victorious. The supremacy of the Vanderbilt Commodores in the deep south was even more marked. Sewanee, Centre or Auburn would win a championship here or there, or tie for one; Kentucky State (later Kentucky) and Central university of Richmond, Ky., had undefeated, untied elevens in 1898, but failed to meet each other and found Sewanee and Auburn, also undefeated and untied in conference competition, owning shares in a championship split four ways as Vanderbilt experienced one of its rare losing seasons. Clemson college (Clemson, S.C.) coached by Heisman, won in 1902 and shared the 1903 title with Vanderbilt and Sewanee, after Cumberland college (Williamsburg, Ky.) was narrowly eliminated. But for the most part Vanderbilt was on top. From the start of football at Vanderbilt in 1890 through the season of 1912, the Commodores dropped only 12 games to rivals in the central south, exactly half of them to their then archrival, Sewanee. In the nine seasons following the arrival of able Dan McGugin on the Vanderbilt campus in 1904, Vanderbilt lost only one game to a southern team. This was a 16–5 defeat by the champion Sewanee eleven of 1909. Sewanee had held the Commodores to a 6–6 tie in 1908. Vanderbilt also proved the worth of southern football, or more properly its own football, in other sections in the 1904–12 era, playing several close games with Michigan, tying Yale, 0–0, at New Haven in 1910 and losing to the champion Harvard eleven of 1912 by only 9–3. Vanderbilt won or tied for the championship of the central south in 1904–07 and 1910–12.

Sewanee had its greatest success just before the turn of the century. The Purple Tigers cut into the four-way tie for the 1898 championship and had fine prospects for 1899. They engaged a capable coach in Herman M. Suter of Princeton. A trip into Texas to play Texas and Texas A. & M. grew into a junket in which five games were played in six days. Sewanee defeated Texas, Texas A. & M., Tulane, Louisiana State and Mississippi in succession and held all opposition scoreless. The Tigers finished a perfect season with 12 victories and saw their goal line crossed only by Auburn, which was defeated by 11–10 in Montgomery, Ala., on Thanksgiving day. Two days later, Sewanee defeated North Carolina by 5–0 in Atlanta, Ga. North Carolina was south Atlantic champion, and the Tigers thus won the championship of the entire south.

Heisman moved to Georgia Tech in 1904, but experienced many lean years before he began to challenge the supremacy of Vanderbilt. Through these years Heisman endeavoured to win by guile and craft, but he failed to make an impression with his Georgia Tech eleven until 1916, when he won the title. Georgia Tech won all its games in 1917, defeating Pennsylvania by 41–0, Carlisle by 98–0, Vanderbilt by 83–0, Auburn by 68–7, Tulane by 48–0 and Washington and Lee by 63–0.

Such was the status of southern football up to the end of World War I. The postwar years saw the rise of Centre and of Alabama, coached by William Wallace Wade. In Wade's second season he lost only to the champion Centre eleven of 1924, and in his third he completed a perfect campaign with a 20–19 victory over Washington in the Rose Bowl on Jan. 1, 1926, the first visit of a southern eleven to Pasadena. Alabama also won the championship in 1926 and climaxed its season with a 7–7 tie against Stanford in the Rose Bowl. Georgia Tech returned to power in 1927 and 1928, and sent its 1928 eleven to Pasadena to defeat California by 8–7 in the game made famous by the dash of California's Roy Riegels toward his own goal. Bernard ("Bernie") Bierman of Minnesota built Tulane into a feared and respected team before he went to Minneapolis to establish his own alma mater as the greatest eleven in football during the period 1934–41. Capt. (later Gen.) Robert Neyland was turning out great elevens at Tennessee, but the Volunteers seemed always to miss the championship by suffering one tie while some rival turned in an all-victorious campaign. Capt. Lawrence ("Biff") Jones of Army was engaged to build up the Louisiana State eleven, with which Bernard H. Moore of Carson-Newman won championships in 1935 and 1936 after Jones had moved to Nebraska.

Wade had another great year coaching the Crimson Tide of Alabama in 1930, winning the championship, crushing Washington State in the Rose Bowl by 24–0 and winding up second only to the great undefeated and untied Notre Dame eleven, the last Rockne coached before he was killed in an airplane crash in Kansas on March 31, 1931. Wade then moved on to Duke where he continued to develop championship teams. Frank W. Thomas of Notre Dame moved from Georgia to Alabama in 1931, and gave the Crimson Tide five championship elevens between 1933 and 1945.

In the south Atlantic area, Virginia abdicated from the ruling seat in the early 1920s, but no new power rose to take its place. Virginia Military institute won the championship in 1920, sparked by a great back, James Leach; North Carolina produced great teams coached by the Fetzer brothers, Bob and Bill, winning the championship in 1922. North Carolina repeated in 1929 under Chuck Collins of Notre Dame. Wake Forest college, Winston-Salem, N.C., meanwhile, defeated North Carolina in four straight games from 1924 through 1927, and won the south Atlantic title in 1924. But no team in the south Atlantic seemed to aspire to national football honours except Duke, which had not yet become a threat.

Other Sections.—Great teams were developed in the Southwest conference by such men as Dana Xenophon Bible, Ray Morrison, Madison Bell, Leo R. ("Dutch") Meyer, Homer Norton and others. Although southwestern teams failed to get a full share of national attention following World War I, they gave a good account of themselves everywhere in intersectional games. Favouring indiscriminate use of the forward pass, the Southwest conference became known as the "passer's league." From the conference came Sammy Baugh, later of the professional Washington Redskins, whose passing prowess made gridiron history. The southwest's chance for fame came after the 1935 season, when Stanford, hard pressed to choose a Rose Bowl opponent, decided that Texas was far enough "east" to qualify Southern Methodist as the "eastern" team in the classic. Stanford won by 7–0.

In the Missouri Valley conference, Nebraska long had been a power. The Cornhuskers were strong enough to win their share of games from the great elevens of the Western conference, even before World War I, and they continued the pace in the years following the war. Nebraska continued to dominate its field even after the six leading teams in the Missouri Valley conference withdrew from the old organization in 1928 to form the Missouri Valley Intercollegiate Athletic association, popularly known as the Big Six (Nebraska, Missouri, Kansas, Oklahoma, Kansas State and Iowa State). The league became the Big Seven in 1948 with the admittance of Colorado university, and the Big Eight in 1957 with the admittance of Oklahoma State.

The Rocky mountain teams play few intersectional games and so receive little or no nationwide publicity. Utah, coached by Ike J. Armstrong, became a perennial power in that section. Colorado developed a championship team in 1937 under the coaching of Bernard F. ("Bunny") Oakes—a team made famous by Byron ("Whizzer") White (later a U.S. supreme court justice), the greatest ball carrier developed in the Rocky mountains after Colorado college produced Earl ("Dutch") Clark. In 1938 Colorado, Denver, Colorado State (then called Colorado A. & M.), Wyoming, Utah, Brigham Young and Utah State withdrew from the Rocky Mountain conference and organized the Mountain States (Skyline) conference, leaving the older organization to the five "smaller" teams, one of which—Colorado college—soundly trounced one and all in the Rocky mountains in 1943.

New Strategy and Tactics.—The established major teams remained generally conservative in the first few years after World War I, but they changed after a few startling incidents such as the one "Bo" McMillin engineered on an astonished Harvard eleven in the first Centre-Harvard game in 1920. With the score tied at 7–7 in the second quarter, Centre had a fourth down on its own 30-yd. line with 6 yd. to go. McMillin stood back for what even Centre supporters supposed would be a punt, but he did not punt. Instead he took the ball, faded back a few more yards, and defied every "don't" in the football book by sailing a high forward pass over the heads of Harvard defenders into the hands of Eddie "Cutie" Whitnell, 50 yd. away on Harvard's 30-yd. line. Whitnell raced over the Harvard goal line for the touchdown which put Centre ahead. Nobody gave McMillin credit for realizing how far and how accurately he could throw a football or for having the courage to throw one in the clutch. Four years later Princeton received Harvard's opening kickoff on the same field and immediately threw a forward pass from deep in its own territory. That one failed, but the Tigers promptly tossed another which succeeded—and then went on to crush Harvard by 34–0.

In the years preceding 1917 large eastern teams used the forward pass mainly as a threat to open up the defense in order that the running plays might work better. Its disuse could be traced to the absence of any passers of outstanding ability. Dartmouth used the air attack in 1924 and 1925 when Andrew J. ("Swede") Oberlander convinced Coach Jess B. Hawley that he could throw a football both accurately and far. With Oberlander passing to Myles J. Lane and George C. Tully, Dartmouth humbled all opposition in 1925 and claimed at least a share of the national championship.

The two most successful coaches in the years immediately following World War I were Rockne of Notre Dame and "Pop" Warner of Pittsburgh and Stanford. It was only natural that other coaches, even conservative easterners, should borrow their methods, that colleges everywhere should demand Rockne-trained or Warner-trained men as coaches. The methods of the two men were at wide variance, but the results they obtained were similar. Both attacks were predicated on speed, but in the Warner scheme power was on a parity with speed. The Warner game could not be played without power and, if necessary, speed was sacrificed to power. The Notre Dame attack did assign two men to take out the defensive tackle, but otherwise it consisted of precision, speed and timing with man-to-man blocking.

In the decade after World War I Notre Dame relied a good deal on the backfield shift, but the rule makers removed all advantage from the shift by requiring a full halt between the final jump and the snap of the ball, robbing the play of its momentum. This nullifying of the advantage of the shift led to Rockne's developing the "weak side" attack, thus discouraging opponents from overshifting on defense to the strong side, as had been their practice. Rockne always had his backs work behind a balanced

line, with both guards racing out to lead interference. For this reason he required guards who could do more than hold their ground and withstand line drives of the opposition. Rockne needed and obtained "watch-charm" guards. Notre Dame backs lined up in a T and shifted into an oblique box an instant before the ball was snapped. This arrangement was not unlike Warner's single wing formation, except that in the Notre Dame system the outer back's position was about two yards inside his own end instead of one yard outside.

The entire Notre Dame attack was designed to produce long gains, to break a man into the open for a touchdown run from any part of the field. It has been said that every play in football would mean a touchdown if each offensive player carried out his assignment perfectly. Notre Dame men then, more often than players on other teams, did carry out their assignments to perfection. Rockne by no means scorned the pass, but he never had a superior passer. The pass therefore never overshadowed his running attack, but remained always a threat. Rockne much preferred to have his players catch passes thrown by other teams and run them back for touchdowns.

When the two defensive halfbacks first were forced away from their tackles by the introduction of the forward pass in 1906, the defensive setup of the backs was changed from an inverted T to a roughly shaped diamond. As passing developed, the points of the diamond were made equidistant, since many coaches believed this to be the best defense against both rushing and passing. As more and more teams began to remove the centre from the line and play him "loose" in support of the fullback (really an eight-man line with six primary and two secondary defenders), the diamond defense was converted into what is known as the 2–2–1 defense. Rockne to the last preferred the diamond defense, although he did not invariably employ it.

The Warner game, in which defensive power is theoretically crushed by a greater concentration of offensive power, dissipates some of its power in the feints it calls for on sweeps and reverses, but both guards usually are in position to deal telling blows for the carrier on the ultimate development of the play. There is also the danger that the fullback will spin and, without having delivered the ball to some mate as seemingly was his intent, go plunging through the middle of the line, deserted by defenders.

The Warner system operates from an unbalanced line, shifted in either direction and with both tackles lined up on the same side of the centre. This has the dual benefit of getting interfering power closer to the point of probable attack and of inducing the defense to overshift and leave the weak side vulnerable to a surprise thrust. The Warner single wing attack usually strikes the strong side, sometimes after a back has dashed with the ball toward the weak side and then handed it to the weak side end moving in the opposite direction (a reverse), but it feints at the strong and then strikes around the usually unguarded weak side just often enough to keep the defenders uneasy. This weak side thrust following a feint at the strong side is the "naked reverse."

After Warner had gleaned many victories from the single wing back formation and had seen it copied the length and breadth of the land, he developed the double wing back, which he unveiled for the east in Yankee stadium in New York city on Dec. 1, 1928, to the acute discomfort of Army. Stanford won by 26–0. In the double wing, the fullback stands about four yards back of his centre in an unbalanced line, the quarterback is two yards in front of the fullback and slightly less than two yards to his right, and each of the two halfbacks is about one yard outside one of the ends and one yard to the rear of him. Reverses (which are deeper) are even more important in the double wing formation than they are in the single wing, but slants and plunges also are effective. Great physical superiority is required to make the double wing attack effective, and it is little used.

Other coaches modified Warner's single wing attack by pulling the tail or carrying back sufficiently to the rear of the offensive formation to enable him to throw a quick forward pass without being forced to fade backward in order to comply with the five-yards-back-of-the-line rule. As there was always the possibility, in the minds of the defenders, that he might actually kick, this tended to spread the defense, thus opening the way for running plays. This style of play is called the single wing and short punt formation game.

In the decade preceding the outbreak of World War II, an increasing number of teams began to experiment with five-man lines on defense. These lines retained the eight-man principle of the line in the 6–2–2–1 defense, and further aided the defensive team by confusing the offensive team's blockers on their assignments. Most young football players are decidedly upset if they have been taught to block a given defender on a given play and then suddenly discover that the foe is not there to be blocked. Coaches met this situation by drilling their players in two sets of blocking assignments, one for the five-man line and one for the six-man defense. A third set was required when any possibility existed that an opponent might go into the fast-disappearing diamond defense with a seven-man line, but the variation in blocking between seven- and six-man lines was negligible. The centre could be out of the line without upsetting the offense. It was the disappearing guard or tackle who caused all the confusion. As soon as offenses mastered the five-man line defense its use began to disappear, except for nuisance purposes, although many teams peel down to a four- or even a three-man line to guard against passes in the closing minutes of a game when a beaten foe can do nothing but throw the ball in desperation, hoping for a completion and a score.

In the late 1930s George Halas, owner and coach of the Chicago Bears of the National Football league, departed from the accepted practice of employing either Rockne or Warner football. He revived an offensive formation which had come into being almost simultaneously with the closing up of the old Rugby-style game in 1888 but which had been generally abandoned before the start of World War I. The revived formation became known to the football world as the T formation because in it the backs line up in the form of a capital T, the halfbacks on either side of the fullback and all in a straight line from four to five yards back of the scrimmage line, with the quarterback "up under the centre." In the T formation, the ball is never passed directly to the carrier, but is always handled through the quarterback, who also is invariably the forward passer. Deception is increased by employing one of the halfbacks as a flanker or man in motion. Moving obliquely toward his own goal line in advance of the snap of the ball, this man in motion is a multiple threat to the defense. The T usually operates behind a balanced line. Its leading advantages are its deception and full utilization of speed. The attack breaks sharply and quickly through openings made in the defensive line. With its brush blocking, it calls for less power than either the Rockne or the Warner system, and frequently enables teams of inferior physical ability to defeat, on sheer speed, foes using Warner or Notre Dame football.

Halas' Bears won tremendous victories with the T formation at Chicago. Clark Shaughnessy, while coaching at The University of Chicago, helped Halas develop the formation and install it as the system of the Bears. After The University of Chicago abandoned football following the 1939 season, Shaughnessy was engaged to coach Stanford, which had failed to win a single game on the Pacific coast in 1939. Shaughnessy installed the T formation at Stanford in 1940, and the Indians played through an undefeated season.

Coaches who had been hesitant about adopting the T then rushed to install it. Its spread was limited only by the ability of coaches to assimilate it and teach it to players who had spent their football careers working under either Warner or Rockne systems. At Notre Dame itself, Coach Elmer Layden had, quite naturally, been teaching Rockne football to his players after he became head coach in 1934. In March 1941 Layden resigned to become commissioner of professional football. Frank W. Leahy, then coach at Boston college, was engaged to take his place. Leahy adopted the T and developed one of his greatest teams in 1943. Earl Blaik at West Point also went over to the T and Army was invincible from 1944 through 1946 with Felix ("Doc") Blanchard and Glenn Davis in the backfield.

By the end of World War II, more than 60% of the major colleges had adopted the T, but new defense alignments were

solving it and these were countered, in the following years, by combinations of the basic T and single wing formations, resulting in the wing T; widespread linemen, flankers and a deceptive man in motion. The split T, originated by Don Faurot at Missouri in 1941, with wider spacing of the line and making a runner of the quarterback on the famous option play, achieved a great vogue. Oklahoma and Maryland, coached by Charles ("Bud") Wilkinson and James Tatum, who both had been Faurot's assistants during World War II at Iowa Pre-Flight, won national championships with the split T in the 1950s.

Wilkinson achieved great success from 1948, a year after he became head coach at Oklahoma, through 1958. Prior to this Blaik and Leahy had been the big "name" coaches, along with Fritz Crisler and Bennie Oosterbaan of Michigan. Leahy, after developing his great Notre Dame team of 1943, went into the navy, and Blaik was supreme with his all-conquering Army elevens of 1944 and 1945. Leahy returned from the war in 1946 to challenge Blaik, and their unbeaten teams played a scoreless tie. Michigan challenged Notre Dame for supremacy in 1947 and 1948, but in the latter year Wilkinson started Oklahoma on its climb from mediocrity.

After losing its opening game under Wilkinson in 1948, Oklahoma won 31 games in succession. It then lost to Kentucky in the 1951 Sugar Bowl and to Notre Dame in 1952. In 1953 Oklahoma lost its opening game to Notre Dame and was tied by Pittsburgh in the second game. Then for 47 successive games Wilkinson's teams were invincible. The team that ended their winning streak in 1957 was Notre Dame, the same team that had last beaten them, in 1953.

The split T formation that Wilkinson used with such success began to lose some of its vogue in the late 1950s. The slot T, splitting an end wide and putting a back in the gap, off the line, was introduced by the professional teams and taken up by the colleges as an effective forward-passing arrangement. The wing T, with variations, took on an increasing vogue. The double wing T appeared, and Army's "lonely end" formation, in which the flanker remained out of the huddle, originated by Earl Blaik in 1958 to stop the defense from packing in tight against the running attack, led to the general practice of splitting an end wide, as well as stationing a back far out on the opposite side as another flanker. The trend continued toward more and more diversification in offensive operations.

All-Star Teams.—Caspar Whitney, probably with the assistance of Camp, in 1889 established the custom of selecting all-star elevens at the close of each football season. His selections were called the All-America team, and they appeared in a magazine called *The Week's Sport,* as did those of 1890. The choices included only 11 first-string players, 4 line substitutes and 4 backfield substitutes. From 1891 through 1896 Camp and Whitney apparently collaborated on the selections. Their selections appeared in *Harper's Weekly* in Whitney's column and in the *Spalding Football Guide* under Camp's name. Whitney's own magazine had ceased publication. The 1891–96 selections also were limited to a first team and eight substitutes, but the "honourable mention" list was introduced in 1891. Camp took over Whitney's column in *Harper's* in 1897, when Whitney was absent from the United States. Camp in that year introduced the practice of choosing first, second and third elevens and retained the honourable mention list. In 1898 Camp moved to *Collier's,* and his All-America selections appeared in that magazine through 1924. Camp died in March 1925, and *Collier's* engaged Grantland Rice to carry on the annual selection.

Even before the turn of the century, other football devotees began to make their own All-America selections. The number of such selectors increased as football grew, but Camp's choices always were accepted by the football public as "official." It seemed doubtful that anybody else could command universal acceptance of selections, since there were hundreds of good football players in the 1920s whereas there had been only dozens in the 1890s. More than 100 good teams were in the field instead of perhaps 20. Obviously, no one man could possibly hope to see all the good teams or all the good players, much less choose the 11 best. Rice and *Collier's* met this problem by compiling their selections from the findings of a country-wide board of the American Football Coaches association, of which Rice served as chairman until his death in July 1954. He was as pre-eminent among sports writers as was Camp as a football leader. The three major U.S. news-gathering services, Associated Press, United Press and the International News Service (the latter two combined to form United Press International in 1958), also choose All-America teams annually on the findings of representatives scattered throughout the country, and these selections enjoy wide acceptance. A fifth major selection group was the All-America board, established by Christy Walsh of the Christy Walsh syndicate in 1924. Walsh's honour teams were chosen by "name" coaches whom he enlisted to perform this service. Original members of the board included T. A. D. Jones of Yale, Rockne, Warner and William A. Alexander of Georgia Tech. The Football Writers Association of America picks a team for *Look* magazine.

World War II and the Postwar Years.—The effects of World War II on football and other college sports were not so immediate or so far-reaching as those of U.S. participation in World War I had been. Lessons learned in the earlier conflict enabled colleges to avoid mistakes made in 1917 and to maintain athletic competition for the remaining students. Action of the colleges was backed by the war and navy departments, which requested that athletics, particularly football, be continued, not only to train youths physically but also to bolster civilian morale.

The army and the navy soon began using facilities at most of the colleges of the country. This was projected as early as 1942, but was not carried out until after the completion of the 1942 football season, which progressed much as had any peacetime season, despite the fact that teams everywhere were weakened by loss of players who had entered the armed forces. Crowds remained large, although not quite so large as they had been in 1940 and 1941. Transportation shortages already had begun to be felt, but they had by no means become acute.

Before the 1943 season opened, trainees were in virtually full occupancy of all the colleges, and curtailment of travel had become a necessity. Few civilian players were left from 1942 teams, but the navy department made up for this in navy-trainee colleges by granting permission to use trainees on varsity elevens. The war department, however, forbade army trainees from taking part in varsity competition. This caused many army-trainee colleges to drop football temporarily. Others, however, carried on and some fabulous elevens were produced in the war years, notably the so-called "dream team" at West Point. But many colleges had only 17- and 18-year-old players available and the peacetime competitive balance was missing.

The last season of wartime football was 1945, but many of the colleges which had recently dropped the game were again fielding teams in 1944 and, with the return of draftees from the European front, competition was soon restored to prewar levels. The homecoming G.I.'s brought abundant manpower and talent to nearly all teams and the return of unrestricted auto and rail transportation filled the nation's stadiums with capacity crowds. It was boom time for football. A period of spectacular and record-breaking play followed. The Korean War caused few disruptions and schedules were completed throughout that conflict.

The wartime swing to offensive football continued. The attack was centred in the pass. More were thrown and the portion completed climbed above 60% for outstanding performers. On the ground, bewildering variations of wing and T formations with a man in motion became increasingly popular and increasingly effective. This mounting efficiency in attack led inevitably to more scoring by both of the teams in a game.

In 1948, the last season in which prewar players were eligible, both teams in 965 major games scored and only 2 major games in that season were scoreless ties.

Platoons and De-emphasis.—The two-platoon system—an offensive and a defensive eleven for each team—was a popular postwar innovation. Introduced by Michigan in 1945, it developed highly skilled specialists and superior play in both offensive and defensive departments. But it also called for greatly in-

creased squads and coaching staffs and, largely because of soaring costs, was eliminated in 1953 by a return to prewar substitution rules.

In the 1948–52 period a move to de-emphasize football gained momentum. The N.C.A.A. stopped mushrooming bowl games by sanctioning only those which allotted 80% of the gate receipts to the participating teams. The Ivy group (Brown, Columbia, Cornell, Dartmouth, Harvard, Pennsylvania, Princeton, Yale) and the Missouri Valley conference banned postseason games entirely and also banned spring practice. Steps were taken by the N.C.A.A. to curb excesses in the recruiting and subsidizing of athletes. Football coaches adopted an ethics code to eliminate unsportsmanlike practices.

The N.C.A.A. and some of the conferences, probably influenced by the example of the Ivy group in setting up strict faculty regulations of their athletics under the presidents' agreement of 1954, took punitive action against member colleges for recruiting and giving financial aid to athletes in violation of restrictions. Colleges in the Pacific Coast, Western (Big Ten), Southwestern, Southeastern, Southern, Missouri Valley (Big Eight) and Atlantic Coast conferences were disciplined. The penalties included probation for from one to four years, barring the school from N.C.A.A. championships and postseason (bowl) games, depriving players of a year of eligibility and, in one instance, the suspension of the coach for a year. The punishment meted out to four colleges in the Pacific Coast conference brought a strong protest from alumni groups and in 1959 the conference broke up and a new conference, the Athletic Association of Western Universities (Big Five), was formed.

Postseason Games.—The postseason or "bowl game" idea was launched at Pasadena, Calif., on Jan. 1, 1902, when the Tournament of Roses committee of that city arranged the first tournament game between the national co-champion, Michigan, and a Stanford eleven which had not been able to win the title on the Pacific coast. Michigan won by 49–0. No more games were played until New Year's day, 1916, when Brown was defeated by Washington State, 14–0. Except for a two-year hiatus in World War I (when service elevens were substituted), the Tournament of Roses (Rose Bowl) game was an annual feature.

The East-West Shrine games for charity were started at San Francisco, Calif., in 1925. The Orange Bowl game was launched at Miami, Fla., in 1933; the Sugar Bowl at New Orleans, La., in 1935; the Cotton Bowl at Dallas, Tex., in 1937; and the Gator Bowl at Jacksonville, Fla., in 1946. All the major Bowl engagements are played ordinarily on Jan. 1.

B. Rules and Fundamentals of U.S. College Football

Although U.S. football originated from Rugby, the game in the United States resembles its British parent only in the shape of the ball, which is an oval leather case covering an inflated rubber bladder. Its long axis measures 11 to 11¼ in., its short axis measures 6.73 to 6.85 in. and its weight is from 14 to 15 oz.

Number of Players.—Teams consist of 11 players: 4 backs (quarterback, left halfback, right halfback, fullback) and 7 linemen (left end, left tackle, left guard, centre, right guard, right tackle, right end). Players line up in various formations for offense and defense but, when a scrimmage begins, each team must be "on side" and the offensive team must have at least seven players on its forward line. One offensive player may be in motion, laterally or backward. If such a player starts from his scrimmage line, he must be at least five yards behind that line when the ball is snapped.

BY COURTESY OF NATIONAL COLLEGIATE ATHLETIC ASSOCIATION

FIG. 1.—DRAWING OF U.S. COLLEGE FOOTBALL FIELD, SHOWING MARKINGS, ZONES AND MEASUREMENTS

Objective of Game.—Each team's objective is to score more points than its opponents; the team having the most points at the end of the game is the winner. A touchdown (6 points) is scored when a player carries the ball across his opponents' goal line or completes a forward pass or recovers a free ball in his opponents' end zone. With each touchdown goes the privilege of trying for extra points. The ball is given to the scoring team on the defenders' 3-yd. line for one play. On this play one point may be scored by a place or drop kick in the manner of a field goal, two by a run or a pass which ends beyond the opponents' goal line. A field goal (3 points) is scored by drop-kicking or place-kicking the ball from scrimmage over the crossbar or directly over an upright of the opponents' goal. A safety (2 points) is scored when a play ends with the defenders in possession of the ball behind their own goal line, the defenders themselves having given the impetus which caused the ball to cross their goal line. The official score of a forfeited game is 1–0.

Playing time is 60 minutes divided into 15-minute quarters and 30-minute halves. Time is taken out for various delays and the elapsed time for a game is well over two hours. Between the first two and between the last two quarters, there is a one-minute interval when the teams exchange goals and the ball is relocated so that its position, as related to goal lines and side lines, is the same at the start of the ensuing quarter as it was at the end of the previous quarter. There is a 15-minute intermission between the two halves during which both teams leave the field.

Before each game, the referee tosses a coin in the presence of the two captains, asking one to call. The winner of the toss gets his choice of goals or of kicking or receiving the first kickoff. The loser gets the same choice at the start of the second half.

Each half of the game starts with a kickoff—a place or drop kick from the kicking team's 40-yd. line and with the receiving team behind a line 10 yd. distant (*i.e.*, a "free kick"). Someone on the receiving team tries to catch the ball and run it back toward the kicking team's goal as far as he can before someone on that team tackles and stops him. A tackle is made by grasping the runner's body with the arms and throwing him to the ground.

Following the kickoff and runback, the team in possession of the ball gets a series of four scrimmage downs during which it must either advance the ball a minimum of ten yards or forfeit possession of the ball to the defenders. Each down starts with the ball resting on the ground and with the teams separated by a neutral zone whose width is equal to the ball's length. The centre snaps the ball back between his legs to a back who may run with it himself or pass it to a teammate who runs with it. Opponents try to stop any advance toward their goal by tackling the runner or by batting down or intercepting passes in flight. Each down ends when the ball becomes dead. At the end of any down, if the attacking team has the ball beyond its line to gain (ten yards from where the series started) it gets a new series of four downs with a new line to gain. At the end of the fourth down, if the attacking team has the ball behind its line to gain, the ball is given to the defenders and they become and proceed as the attacking team. Scrimmage downs, in successive series for one team or the other, continue until a series ends in a score. Then comes another free kick and the same pattern (free kick—runback—scrimmage—score) is repeated until playing time for the current half expires. After a touchdown (and the try for extra points) or after a field goal, the defenders choose between kicking or receiving the ensuing kickoff. After a safety, the defenders get a free kick from their own 20-yd. line.

During any scrimmage down, the attacking team may, and often does, surrender the ball to the defenders by kicking it. When that is done the kicking team may not interfere with a defender's opportunity to catch the ball. A defender may gain added protection by signaling (arm aloft) for a fair catch. If he does so he

must stand fast after a catch and the kicking team is prohibited from tackling him. The traditional privilege of making a free kick after a fair catch was abolished in 1950.

Three methods of kicking the ball are permitted: a drop kick, made by dropping the ball from the hands and kicking it as it touches, or is rising from, the ground; a place kick, made by kicking the ball while it is resting on the ground or a tee—the ball may be, and usually is, steadied by another member of the team; and a punt, made by dropping the ball from the hands and kicking it before it strikes the ground.

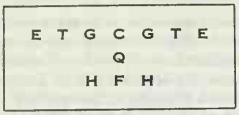


FIG. 2.—BALANCED LINE AND BALANCED BACKFIELD FORMATION:
(E) end; (T) tackle; (G) guard; (C) centre; (Q) quarterback; (H) halfback; (F) fullback

Systems of Play.—In the T formation, three of the backs (the left halfback, the fullback and the right halfback) line up from four to five yards behind the centre, just as they did in the early days of the game. The quarterback, now as then, plays close to and directly behind the centre. In the older game, the quarterback was required by rule to handle the ball before it could be touched by any other back except on a punt. In the modern T, he always handles it so as to prevent defenders from knowing just which back has received it, a deception less likely to succeed on a direct pass.

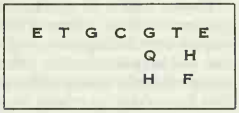


FIG. 3.—NOTRE DAME FORMATION

Rockne Notre Dame football, which enjoyed a big vogue in the 1920s and 1930s but was employed by few teams after World War II, also operates behind a balanced line (*see* fig. 3), but the backs are deployed differently, and the ball is always passed to them by direct pass from centre. The backs in the Notre Dame system first line up in a T and then, at a given signal, jump into the formation shown in fig. 3. They may also jump into the same formation toward the left. The two forward backs are slightly more than 1 yd. behind the line; the two rear backs are about 4½ yd. behind it.

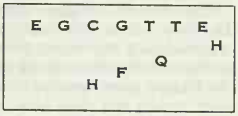


FIG. 4.—WARNER SINGLE WING FORMATION

Warner or single or double wing football calls for an unbalanced line (*see* fig. 4 and 5) and a widely deployed backfield. The line usually is unbalanced by shifting a tackle, but some coaches choose to shift a guard instead. In the single wing (fig. 4), the forward halfback (wing back) stands one yard behind the line and up to one yard outside the end. The quarterback (blocking back) is placed about one-half yard to the rear of the wing back and about two yards inside the wing back position. The fullback (plunging back) is 1½ yd. behind and 1 yd. inside the quarterback. The left halfback (carrying back or tail back) is 1½ yd. to the rear and 1 yd. inside the fullback. In single wing, teams may shift to the left as well as to the right, depending upon the needs of the moment or the position on the field.

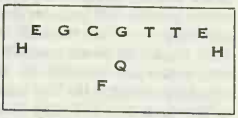


FIG. 5.—WARNER DOUBLE WING FORMATION

In the double wing, rarely used (fig. 5), each of the halfbacks (wing backs) stands one yard behind the line and one yard outside his end. The quarterback (blocking back) stands about two yards behind the strong side guard. The fullback (plunging back) is from 3½ to 4½ yd. behind the centre, depending on what play has been called. The fullback is far more than a plunger in the double wing. He handles the ball first on most of the plays and is a key man in starting the delicately measured reverses.

Defense.—Defensive formations vary with the coaching systems and with the position of the ball on the field. A defense naturally must be much tighter when the attacking team has the ball near the defensive team's goal line than it would be near mid-field. This tightening has given rise to the term, "zone of intense resistance."

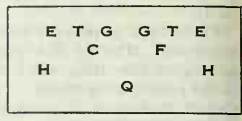


FIG. 6.—6–2–2–1 DEFENSE

The objectives of the defense are (1) to recover the ball if an opponent fumbles it; (2) to throw the runner for a loss or limit him to as short a gain as possible; (3) to bat down or intercept any forward pass; (4) to block and try to recover any punt; or (5) to catch a punt and run it back toward the opposing goal line.

To accomplish these ends coaches employ various defenses. The commonest all-purpose defense is the 6–2–2–1 or 6–3–2 alignment (fig. 6 and 7). The offense must have, as noted, seven men on the line of scrimmage. The defense is free to get along with as few as it dares to leave there. In all defenses where only six men are left on the defensive scrimmage line, the centre, invariably a sturdy player, is the man withdrawn. Defenses calling for fewer than six men on the scrimmage line are used less often, but five- and even four-man lines still are commonplace.

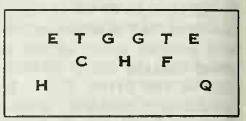


FIG. 7.—6–3–2 DEFENSE

When the centre is withdrawn from the line of scrimmage to aid in defense back of the line, he shares with the fullback the duty of protecting the zone immediately back of the line. He and the fullback are called the "backers up" or "linebackers." Both stand about one yard back of the line, usually behind the defensive tackles. The line on defense is spread more widely than it is on attack and is shifted to meet offensive shifts.

From four to ten yards behind the backers up (in a 6–2–2–1 defense) are the defensive halfbacks. Their lateral spacing varies with different coaches. If they are too widely spaced, a forward pass may easily be completed between them in the "middle alley." If they are too close together, offensive backs may more easily run outside them or passes may be completed in the "flat zones." On an average, the defensive halfbacks stand no more than one yard outside their own ends.

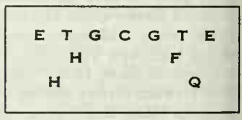


FIG. 8.—BOX DEFENSE

Back of the four forward defenders in this secondary defense stands the safety man. He is 20 yd. behind the scrimmage line on ordinary plays, but, if the attacking team is likely to kick, he is from 30 to 40 yd. back.

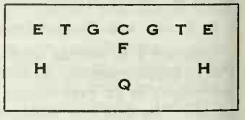


FIG. 9.—DIAMOND DEFENSE

The 6–3–2 defense is used only when the offensive team is certain not to kick or when the offensive team is so close to the defending team's goal that no kick will be made except a drop or place kick in an attempt to score 3 points by goal from the field. In the 6–3–2 alignment there is no safety man, but there are three backers up.

The box defense (fig. 8) calls for a seven-man line, two backers up and two men in the secondary defense. The diamond defense (fig. 9), favoured by Rockne but now used only rarely, also calls for a seven-man line with one backer up, two defensive halfbacks and a safety man.

Defenses calling for the five-man line are used in part to confuse the offensive players on their blocking assignments. An offensive blocker cannot block a man who is not there to be blocked. The five-man defense invariably calls for three backers up—each a potential line defender if he is agile enough to plunge one yard forward to the threatened area of the forward wall.

The vogue of the T and especially the split T formations changed the defensive thinking. To stop these attacks coaches deployed their forces in ever-changing patterns. The rules fa-

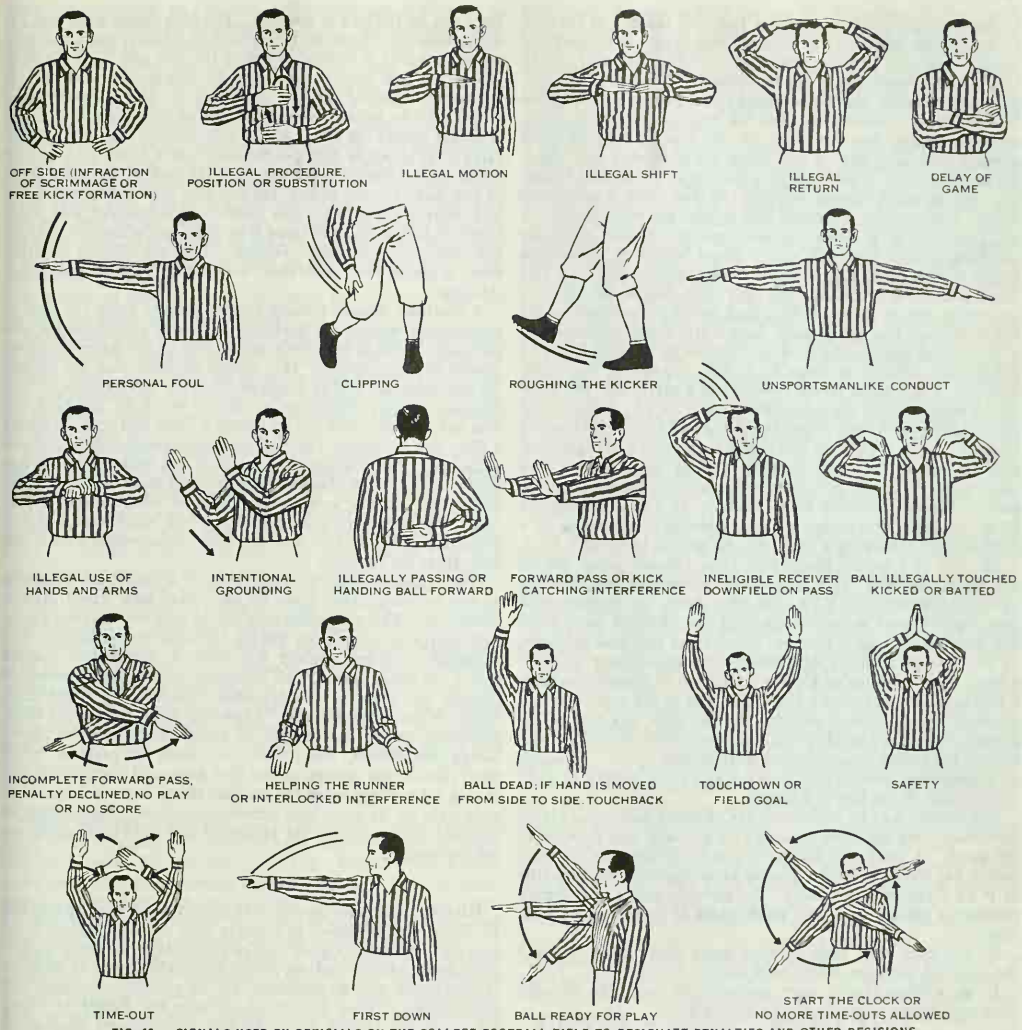


FIG. 10.—SIGNALS USED BY OFFICIALS ON THE COLLEGE FOOTBALL FIELD TO DESIGNATE PENALTIES AND OTHER DECISIONS

voured the defense in that it was not required to have any set number of men on the line of scrimmage, nor did the players on defense have to come to a pause in their forward movement before the ball was put in play.

The old standard defenses had difficulty in adjusting to the split T line spacing, creating gaps. It became necessary to put more men close to the line of scrimmage. Five-man lines became commonplace and the four-man lines ceased to be a novelty. The 4–5, 4–4, tight 5, angling 5 and the Oklahoma 5 or corner defense (which does away with the old type of end play by bringing the ends in so close that they are no longer a force for containment) are among the arrangements used. They amount to eight- or nine-man lines, leaving two or three players in the secondary. The design is to create chaos by getting more men into the offensive backfield.

Along with these new deployments, coaches adopted the practice of keeping their defense in a constant state of flux. Line backers pop in and out of the line, changing positions and switching assignments. This prevents the offense from taking a second look at the defensive setup before the ball is snapped and has a disconcerting effect upon the offense in carrying out blocking assignments.

Officials.—The playing of a game is supervised by a referee, an umpire, a linesman, a field judge and sometimes a back judge. Primarily the referee positions the ball, orders play started and stopped according to rule, inflicts all penalties, declares all scores and is in over-all charge. The umpire inspects and rules on equipment and conduct of players. The linesman locates the line to gain and keeps count of the downs for each series, notes whether players are on side when each play starts and marks the distance gained or lost by each play. The field judge keeps time, using a stop watch or a scoreboard clock operated by an assistant, and supervises downfield play which has passed his fellow officials.

Fouls and Penalties.—In addition to their primary duties, all officials have a joint responsibility for calling fouls; *i.e.*, infractions of the rules (fig. 10). Each one carries a marker which

he tosses or drops when he calls a foul. At the end of the play he reports his ruling to the referee, who inflicts the prescribed penalty. Loss of yardage, loss of a down and forfeiture of the ball to the offended team are the penalties frequently inflicted. No team, however, may be penalized more than half the distance between the enforcement spot and the goal line. Common fouls, with the penalty for each, are: off side (prematurely charging across a restraining line), 5 yd.; illegal use of hand or arm (holding an opponent), 15 yd.; ineligible pass receiver (in legal formation, any offensive lineman between the ends when a scrimmage starts) first touching a forward pass beyond the neutral zone, 15 yd. plus loss of a down; unsportsmanlike conduct (side-line coaching, invalid fair-catch signal, illegal return of disqualified player to the game, rule violation during intermission), 15 yd.; illegal position or procedure (less than seven men on the offensive scrimmage line at the snap, wing back less than one yard behind the scrimmage line at the snap, false start, illegal substitution), 5 yd.; illegal motion (by back or lineman at the snap), 5 yd.; illegal shift (failure to come to a full, one-second stop after shifting), 5 yd.; illegal return (re-entry of a player into the game before eligible under the substitution rule), 15 yd.; delay of the game (taking more than 25 sec. to put the ball into play, excessive time-out), 5 yd. (15 yd. for delaying the start of a half); personal foul (piling on, hurdling, tripping, kicking an opponent, late tackling, etc.), 15 yd., possible ejection of the offender from the game; clipping (blocking from behind), 15 yd.; roughing the kicker or place-kick holder, 15 yd.; intentional grounding of a forward pass (throwing a pass into the ground to avoid a loss), 5 yd., loss of a down; illegal pass (two forward passes during one down, throwing from beyond the scrimmage line, handing ball forward illegally), 5 yd., loss of a down; interference with pass receiver, pass declared completed and offended team given first down on the spot of the foul; interference with pass defender, 15 yd., loss of a down; interference with opportunity to catch a kick, 15 yd.; batting or kicking a free ball or illegally touching a free kick, offended team's ball at the spot of the foul; crawling (attempt by a runner to advance the ball after any part of his person, other than a hand or foot, has touched the ground), 5 yd.; helping the runner or interlocked interference, 15 yd. Although an incompleted forward pass does not call for a penalty as such, it does result in the loss of a down.

Any penalty may be declined by the offended team but a player who is declared ineligible because of a personal foul must leave the game. A team will decline a penalty if the play, as completed, has given the team a greater advantage than would accrue to it by accepting the penalty. An example would be a team's declining a penalty on a play which ended in its scoring a touchdown.

On the same play, fouls by both teams offset each other and the resultant penalties cancel each other.

If, on a single play, a team commits two fouls, the offended team may accept either penalty or decline both.

(A. S. Bl.; W. J. Ch.; Ar. R. H.; A. Da.)

C. U.S. Secondary School Football

History.—Since football requires rather expensive equipment, its expansion in high schools was slow prior to 1920. By that time, township and community high school districts with larger taxing units were being formed. Since more money was available for the purchase of athletic equipment and for the construction of adequate playing fields, high school football began to expand. About 1928 a high school in eastern Illinois (Westville) provided a lighting system for the playing of night football. This greatly increased the attendance, since it permitted working people to attend and permitted games to be played on Friday night as well as on Saturday afternoon. Approximately 50% of high school games are now played at night.

Rules.—High school football is played under a code which permits a slightly more open type of game than that played by the larger colleges and universities. Significant features of the code include the following: When a scrimmage kick or a free kick touches anything in the receivers' end zone, the ball becomes dead and no runback is possible. The high school game has 12-minute quarters (8-minute for junior high schools) and a 3-minute warm up period is prescribed before the first and third quarters. More than one forward pass may be thrown provided each is thrown from behind the line of scrimmage; and a forward pass screen may be formed beyond the line of scrimmage if the pass is caught behind the line. Also a kick receiver may make a fair catch after which he may put the ball in play either by a snap or a free kick. The rules are the same for each of the three types of free kick; *i.e.*, the kickoff, the free kick after safety and a free kick after a fair catch. Any number of substitutes may enter when the ball is dead and there is no limit on the number of times any player may re-enter. During a time-out charged to either team, a player from each team may confer with his coach at a side line.

A carefully devised penalty system permits fixing the spot of enforcement without the necessity of making exceptions for special cases. This is commonly referred to as the "three-and-one" system of enforcement. This system provides that the penalty for any dead-ball foul is enforced from the succeeding spot (see *Glossary*, below), regardless of where, on or off the field, the foul occurs. If a foul occurs during a loose ball such as during a kick, pass or fumble, the basic spot for measurement is the previous spot. All measurements are from this spot unless the foul is committed by the offensive team and at a place behind the previous spot. In that case, measurement is from the spot of the foul. The same principle applies to a foul which occurs during a running play. In this case, the basic enforcement spot is the spot where the run ends.

High school football rules are made by a committee composed of one representative chosen by each state high school athletic association. This committee acts jointly with the National Junior College Athletic association and the National Association of Intercollegiate Athletics. Safety and research committees operate during the entire season. All committee efforts are co-ordinated through the office of the National Federation of State High School Athletic Associations. Eligibility rules, regulations about scheduling games, the number of games which may be played during one season, the number of weeks of practice which must precede the playing of the first game and the opening and closing dates which mark the football season are administered in each state by its state high school association. No national or sectional championships are permitted and bowl-type games are not approved.

D. Six-Man Football

History.—Six-man football was originated in 1934 by Stephen E. Epler, athletic coach at Chester high school, Chester, Neb., who felt the need of a game that could be played by small secondary schools which could not produce enough players to build an 11-man squad plus an additional 11 for practice scrimmage and substitutions. Other considerations were the danger to young players in the 11-man game, the cost of equipment beyond the means of many small schools and the great distances between schools in states such as Nebraska.

The rules drawn up by Epler were such as to retain the essential factors of blocking, tackling, running and passing while opening the way to new possibilities for skill and strategy. This produced a sport with many characteristics of a new game rather than merely regulation football played by teams of six players each.

The first six-man game was played in the fall of 1934 at Hebron, Neb. The two teams, made up of players from four different Nebraska high schools, battled to a 19–19 tie. The game had an appeal for small secondary schools which had never attempted to compete in regulation football and to other schools whose athletic budgets had been reduced during the depression years of the early 1930s, and spread throughout the U.S. and to Canada. It was played by primary and secondary schools, boys' clubs and college intramural teams.

Rules.—The game is played by two teams of six men each. A team consists of a centre, two ends, a quarterback, a halfback and a fullback. The field of play is 100 yd. long and 40 yd. wide

with two end zones 10 yd. deep. Three officials, a referee, an umpire and a linesman, supervise the play. The essential differences between the 6-man and the 11-man game are as follows: After the ball is snapped, a clear (backward) pass or a forward pass must be thrown before the ball can cross the scrimmage line. Violation of this rule is a foul and calls for a five-yard penalty; a hand-off is not considered a pass. Every player is eligible to receive a forward pass; during a series of downs, the team in possession must advance the ball 15 yd. or give it up to the opposing team. A field goal counts 4 points. The try after touchdown starts at the 3-yd. line with a successful kick scoring 2 points; a run or a pass scores only 1. Fair catches and return kicks are not used. Also, if at the end of the first half or during the second half a team acquires not less than 45 points more than its opponent, the game ends.

In nearly all other essentials the rules for 6-man football are the same as those for 11-man football.

Variations.—In the 1950s many schools changed from 6-man to 8-man teams, which played on the smaller field but under the 11-man rules. The team is made up the same as the six-man team with the addition of two linemen who, with the centre, are ineligible to receive forward passes. In a few areas, games are played by teams made up of five or nine players.

Touch and Tail Football.—Touch football may be played with little or no equipment by varying numbers of players. Either 6-man or 11-man rules may be followed. Body contact is kept to a minimum since the ball carrier need only be touched, usually with both hands, rather than tackled. Sometimes each player carries a handkerchief protruding from a hip pocket. In such cases the possession of the handkerchief is substituted for touching. This form of the game is known as tail football.

Other rules peculiar to touch football are: The ball becomes dead whenever it strikes the ground. A team which intends to punt must announce its intention before the down begins and must actually punt the ball, neither team being allowed to cross the line of scrimmage until after the kick. There is no try after touchdown. If a game ends in a tie the ball is taken to mid-field and each team is allowed one series of four downs. One point is scored by the team making the longest total advance during this overtime series. (H. V. P.)

E. U.S. Professional Football

Early History, 1895–1920.—The first professional football game to be officially recognized as such was played in the township of Latrobe, Pa., on Aug. 31, 1895. Latrobe beat a team from Jeannette, 10 mi. away, by the score of 12–0 and major league football had been inaugurated. For the next ten years, Latrobe fielded a powerful team which played whenever and wherever it could for whatever returns it could earn.

John Brallier, who became a dentist in Latrobe, was recorded as the first "confessed" professional after he left the University of West Virginia team to play for Latrobe. Other college athletes, however, were earning expenses in scattered games of the time. Fielding Yost, later to become an outspoken opponent of professional football, played with the Greensburg, Pa., team. Walter Okeson of Lehigh, Walter Howard of Cornell and Thomas Trenchard of Princeton were heroes of many off-the-record contests. In 1897 the entire backfield of Lafayette college in Easton, Pa., played also for Greensburg.

During the next few years other professional teams appeared. In Pittsburgh, Pa., the Duquesne County and Athletic club was created and its rosters listed some of the most famous college players of the day. Heffelfinger of Yale, Arthur Poe of Princeton, G. H. Brooke and P. D. Overfield of Pennsylvania, Fred Crolius of Dartmouth, Bemus and Hawey Pierce, the two magnificent American Indian athletes from Carlisle, all as prominent then as the All-Americans of a half century later, played for Duquesne.

Upper New York state followed Pennsylvania into professional football soon after the start at Latrobe. There were teams in Buffalo, Syracuse, Watertown, Auburn, Corinth, Clayton, Oswego, Alexandria Bay and Ogdensburg. On Dec. 28, 1902, Syracuse, with "Pop" Warner and his brother Bill in the line-up along with Phil Draper, Williams college immortal, and the Pierce brothers, defeated the Philadelphia Nationals, 6–0, in the first indoor football game at Madison Square Garden, New York city. Thirty years later the Chicago Bears beat the Portsmouth Spartans, 9–0, in the Chicago stadium. These two contests were the only major league games held indoors.

In 1902 Cornelius ("Connie Mack") McGillicuddy (1862–1956) organized a football team which he named the Philadelphia Athletics. In the line-up was George ("Rube") Waddell, the famous pitcher of Mack's baseball team. Mack claimed the "championship of the world" after his club vanquished a squad representing Pittsburgh which had Christy Mathewson, another great baseball pitcher, as its fullback. Mathewson had been a star during his college days at Bucknell. Again the Pierce brothers were on hand, playing for Philadelphia.

Like New York state, Ohio began to sponsor town teams. For 20 years leading to 1920, when the American Professional Football association (later the National Football league) was formed, there were teams in Canton, Massillon, Akron, Shelby, Columbus and Dayton. At Canton Jim Thorpe, the American Indian athlete, first played as an admitted professional after leaving Carlisle in 1912, the year of his triumph at the Olympic games in Stockholm. Thorpe ended his career in 1926, again with Canton after playing with Cleveland, Rock Island, the New York Giants and, in 1923, with a team of his own called the Oorang Indians made up entirely of Indians.

College stars of the time did not enter the professional game as eagerly as they did in the more prosperous years after World War II, but the early squads included such players as Willie Heston of Michigan, D. O. ("Tuss") McLaughry of Dartmouth, Charles Brickley of Harvard, Herbert ("Fido") Kempton of Yale, Fritz Pollard of Brown, John ("Jock") Sutherland, Earle ("Greasy") Neale, Lou Little of Pennsylvania, the Horween brothers, Arnold and Ralph, of Harvard and many others.

One of the most unusual teams of history represented Columbus, O., in 1906 and for several years thereafter. Sponsored by the Pennsylvania railway and calling itself the Panhandles, this team had six brothers, the Nessers, who were railroad workers, in its line-up. These rugged men practised in their leisure hours after full days of railroad work. All of them—John, Ted, Frank, Phil, Fred and Al Nesser—were besieged with contracts from colleges and other professional teams but they preferred to stay on the job at home and play the bruising game "just for fun." Only Al accepted outside offers, playing with teams in Akron and Cleveland and with the New York Giants championship team of 1927. He completed 25 years of professional football in 1931.

The combination of World War I, a chance remark by Robert Zuppke, veteran coach of the University of Illinois, and the enthusiasm for football of George Halas of Chicago combined in 1918 to spark the beginning of the modern major league game.

Zuppke, at the postseason banquet of his 1917 Illinois team (on which Halas had been an outstanding end), said that it was unfortunate that football players at the time when they were just beginning to learn something about the game were graduated from college and played it no more. A few weeks later, reporting for training at Great Lakes Naval Training station in Illinois, Halas found several recent college stars eager to continue playing. By New Year's day of 1919, a Rose Bowl championship match was held, in which Great Lakes upset a powerful Mare Island team.

On the Great Lakes squad were players who were to be the first stars of the National Football league. John ("Paddy") Driscoll of Northwestern university was one of the halfbacks; James Conzelman, Emmett Keefe, Harold Erickson, John ("Dutch") Lauer and Hugh Blacklock were other Great Lakes players.

Through this same period the pattern of football was developing and changing rapidly, with the professionals in large part leading the way. In 1906 the forward pass was legalized in an effort to refine and open up the game but it was not until 1913 that the passing game began to assert itself (see *U.S. College Football History*, above). For the next 25 years the pass play fermented, being used mostly as a desperation maneuver and often not suc-

cessfully. Then came the explosion of the T formation as played by the Chicago Bears, with Sid Luckman at quarterback. In the championship game of 1940, the Bears defeated the Washington Redskins, 73–0. With this game, and the performance of Sammy Baugh in the same era, the pass took its present place as almost half of each team's attack. (*See* below.)

Rockne, who was to become one of the immortals of football as a coach at Notre Dame, was one of the busiest and hardest-to-trace professional players of the 1914–20 period. He played as often as he could for whatever team was offering the best salary. One team claimed he played against them in six successive games in six different uniforms. He was one of the trickiest and hardest ends to stop.

The Growing Years, 1920–45.—As the early days ended with the organizing of the American Professional Football association in 1920, hundreds of unrecorded warriors of the gridiron faded from the scene. Scant records had been kept and the bruising battles of pickup games were lost forever. Even the glory of the individual stars dimmed, leaving only Jim Thorpe to live a few more years in sports pages. Unpadded, often unpaid, the pioneers played a vicious and smashing game of football, often for the full 60 minutes of each encounter unless crippled beyond the possibility of completing the game. A "big" squad of those days might have contained 15 players; the modern teams of more than 30 players, specialists and platoons were unknown.

Jim Thorpe was a superlative back, but his approach to the game was lighthearted and erratic. Despite contempt for the ordinary training rules, however, Thorpe could run in the open, crash the line and shatter the attack of his opponents. He ran like the later star, Harold ("Red") Grange, with swiveling hips, change of pace and extreme confidence. Defensively he broke up opponents with a lethal and "slightly illegal" special shoulder pad with an outer covering of sheet metal, which he was ordered not to wear when the league was formed. It was said by those who had played with and against Jim Thorpe that he was one of the greatest football players of all time. Thorpe, who died in 1953, also excelled in other sports and was recognized by many as a great athlete. In his honour, the towns of Mauch Chunk and East Mauch Chunk, Pa., were joined and renamed Jim Thorpe.

Eleven league franchises at $100 each were sold when the American Professional Football association was officially formed on Sept. 17, 1920. Jim Thorpe was elected president and George Halas purchased a franchise for the Staley Starch company of Decatur, Ill., which had recently made him athletic director. The first 11 teams in the league were the Canton Bulldogs (Thorpe's team), Cleveland Indians, Dayton Triangles, Akron Professionals, Massillon Tigers, Rochester, N.Y., Giants, Rock Island, Ill., Muncie, Ind., Hammond, Ind., the Chicago Cardinals and the Decatur Staleys, who became the Chicago Bears in 1922.

The league had a perilous beginning that fall. Few games were played and there seemed little chance that the league would survive. However, in April 1921 the league elected Joe Carr, an experienced promoter, as its new president. Carr, who guided the National Football league until his death in 1939, created an immediate realignment of teams. Massillon, Muncie and Hammond dropped out; Green Bay, Wis., Buffalo, Detroit, Columbus and Cincinnati came in and a full schedule was completed with the Chicago Bears winning more games than any other team. Not until 1933 did the N.F.L. play in two divisions with an annual championship game.

The appearance of the Green Bay Packers in 1921 was the beginning of a football saga. With a population of only 30,000 (growing to 50,000, 35 years later), Green Bay always gave the team more support than New York city gave its Giants. For more than a decade the National Football league survived with little support from the fans and even less from newspapers. Some franchises moved to other cities; new teams joined; some dropped out. From 1921 more than 45 cities were the homes of N.F.L. teams.

The first trend toward prosperity began in 1925 when "Red" Grange left the University of Illinois to play with the Chicago Bears. Grange was the biggest name in the sports world at that time, and he was the spark that professional football needed. His debut against the Chicago Cardinals drew a capacity crowd of 36,000. Seven days later 68,000 jammed New York's Polo Grounds to see him play against the Giants. Grange and the Bears then went on a coast-to-coast tour that sowed the seeds of interest in the sport. Later, television helped complete the job of publicizing major league football. Grange established himself as one of the all-time stars of the N.F.L. before he retired in 1935.

Other factors were boosting the public interest. One was the T formation which was to startle the entire sports world in 1940; the other was a long list of brilliant players developed in the N.F.L. Most spectacular of all were two quarterbacks, Baugh and Luckman, beginning careers that stretched over many seasons. Baugh amazed experts through 16 years of competition.

Football's offense at this period was specializing in the single and double wing, with some plays being run from punt and short punt formation. The defense, as it always does, was catching up with these maneuvers, however, and the Chicago Bears' Halas, retired since 1930 as a player and spending his full time as head coach, was working on the T formation. Aiding and abetting these schemes to crush opponents of the future was Clark Shaughnessy, one of the top strategists of the game. In 1939 Luckman, a Columbia university star, joined the Bears and the T was ready.

In the championship game of 1940 against the Washington Redskins it was exploited, and a fine Washington team was the victim of a 73–0 massacre. The single wing and other formations, beginning in 1941, were eclipsed by the T formation in U.S. football.

Luckman's individual brilliance through his 12-year career with the Bears was helped by the outstanding ability of his teammates. Squads were built for years around the centre Clyde ("Bulldog") Turner.

Baugh, joining the league with the Washington team in 1937, soon demonstrated his unprecedented ability as a passer. When Baugh finally retired in 1953, he was acclaimed as a great offensive player as well as a sound defensive competitor and the league's leading punter through three seasons. He also led the league in interceptions one season besides being the top passer statistically through six. In 1945 Baugh threw 182 passes, completing 128 for a .703 completion record. Only four were intercepted. Twice he tossed six touchdown passes in one game and by the end of his career he had attempted 3,097 and completed 1,709 for 22,085 yd. and 187 touchdowns. His six-in-one-game record was first beaten by Luckman, who fired seven in 1943 against the New York Giants.

During World War II the league continued. Some franchises were merged to provide better competition, and the sport continued to draw growing support of the fans. A strong factor in its fast growth prior to World War II was the annual All-Star game in Soldier field, Chicago, promoted by the Chicago Tribune Charities fund and fielding the professional champions of each previous season against a picked squad of recently graduated college stars. Started in 1934, the series began to lose public interest in the early 1950s following several devastating defeats of the College All-Stars, but interest revived when the sponsors appointed professional coaches for the All-Star team in the 1954 game and thereafter.

The Modern Era.—In 1945 a rival league, the All America Football conference, was formed and began play in 1946 with eight clubs representing Brooklyn, Buffalo, Chicago, Cleveland, Los Angeles, Miami, Fla., New York city and San Francisco. Dan Topping, owner of the former Brooklyn N.F.L. team, transferred his entire squad to the A.A.F.C. In 1947 Miami forfeited its franchise and was replaced by Baltimore. There was considerable opposition among the N.F.L. owners against the new league, and four years of competition for support followed. When it ended before the 1950 season, professional football in general had come of age and the fans from coast to coast were aware of its existence. Under an agreement between the leagues, Baltimore, San Francisco and Cleveland moved their teams into the N.F.L. and the balance of the A.A.F.C. players were pooled and drafted by the 13 clubs in the N.F.L. After one season the N.F.L. was reorganized into 12 clubs: the New York Yanks, Chicago Bears, Chicago Cardinals,

Cleveland Browns, Detroit Lions, Green Bay Packers, Los Angeles Rams, New York Giants, Philadelphia Eagles, Pittsburgh Steelers, San Francisco Forty-Niners and Washington Redskins. In 1952 the Yanks franchise moved to Dallas, Tex., for one year after which the Baltimore Colts, whose franchise was dropped in 1951, were allowed to pick it up and transfer it to Baltimore. Attendance records started to climb rapidly as the new era opened. Bert Bell, veteran player, coach and owner, was commissioner of the league from 1946 until his death in 1959. Pete Rozelle, general manager of the Los Angeles Rams, was named as Bell's successor in 1960. In 1960 the Cardinals moved to St. Louis and a new team, the Dallas Cowboys, was added to the league. The following year the Minnesota Vikings (Minneapolis-St. Paul) brought the league to 14 teams.

In 1959 the American Football league was organized with Joe Foss, World War II air hero and former governor of South Dakota, serving as its first commissioner. Initially, in 1960, there were A.F.L. teams in Boston, Buffalo, Dallas, Denver, Houston, Los Angeles, New York city and Oakland, Calif. After their first season, the Los Angeles Chargers' franchise was transferred to San Diego, Calif. Rules were basically the same for both leagues, the major difference being that the A.F.L. adopted the collegiate conversion rule, giving two points for a successful try when the ball was carried or passed over the goal line.

Rules.—The rules of professional football permit a more wide-open, high-scoring game than that played by the colleges, despite the fact that in the N.F.L. only one point can be scored after touchdown whether the ball is run, passed or kicked. Because the professional goal posts are on the goal line rather than at the back of the ten-yard end zone as in the college game, the professionals attempt and make more field goals than college teams.

In professional ball a member of the defensive team can run with a recovered fumble; the colleges call the ball dead at recovery. A professional ball carrier can rise and run if he falls to the ground unless he has gone down as the result of contact with an opponent; the collegian is down even though he slips and falls. The professionals have added a fifth official, the back judge, to the four who are standard in the college game. Substitutions are unrestricted in professional rules while the colleges moved toward the same system after the drastic antiplatoon ruling in 1953.

In professional football, divisional play-offs or championship games cannot end in a tie. If the score is tied after the regulation 60 minutes, additional periods of 15 minutes each are played. The first team to score a touchdown, field goal or safety is declared the winner and the game ends immediately. This "sudden death" system allowed Baltimore to defeat New York, 23–17, for the championship in 1958 by scoring a touchdown after 8 min. 15 sec. of the first overtime period.

Court Ruling.—In 1957 a lawsuit instigated by a former N.F.L. player, William Radovich, resulted in a decision by the U.S. supreme court that professional football is a business subject to antitrust laws (Sherman act) in spite of a previous court ruling that professional baseball is exempt from this law.

(R. L. Tr.)

F. Glossary: U.S. Football

Approved ruling.—An official decision on a given statement of facts. It serves to illustrate the spirit and application of the rules.

Blocking.—Obstructing an opponent by contacting him with any part of the blocker's body; also stopping or deflecting an opponent's kick before it passes the scrimmage line.

Catch.—Act of establishing player possession of a live ball in flight.

Chain gang.—A group of men under the direction of the linesman who handle the yardage chain and the down indicator.

Completion.—A catch of a teammate's pass.

Conversion.—A successful try.

Dead ball.—A ball not in play.

Dead-ball spot.—The spot on the playing field at which the ball became dead at the completion of the last previous down.

Disqualified player.—A player who becomes ineligible for further participation in the game.

Down.—A unit of the game which starts with a snap or free kick and ends when the ball next becomes dead.

Down indicator.—A device mounted on a rod and showing the number of the down in the current series, the rod being positioned at one of the side lines on the defending team's scrimmage line.

Enforcement spot.—The spot from which the penalty for a foul is enforced.

Fade.—The movement of a passer toward his own end line prior to throwing a forward pass.

Fair catch.—A catch of a kick beyond the neutral zone by a player of the receiving team who has obviously signaled his intention by raising one hand clearly above his head. When a fair catch is made the ball becomes dead on the spot.

Field goal.—A place kick or a drop kick which passes over the crossbar or directly over an upright of the receiving team's goal before it touches the ground or a player of the kicking team. It may be a scrimmage kick or a return kick, but not a free kick. A field goal scores 3 points for the kicking team (4 points in six-man football).

Flag or *handkerchief.*—An official's penalty marker.

Forward pass.—A live ball thrown toward the opponents' end line. The ball becomes dead if it touches the ground before being caught.

Free ball.—A live ball, other than a forward pass, not in player possession.

Free kick.—A kick made under restrictions which prohibit either team from advancing beyond established restraining lines until the ball is kicked.

Fumble.—Loss of the ball by a player other than by handling, passing or kicking.

Gain.—Advancement of the ball beyond the line of scrimmage during a down.

Goal to go.—An expression used when the line to gain is the goal line.

Handing or *hand-off.*—Transferring the ball from one teammate to another without throwing or kicking it.

Inbounds spot.—The intersection of the nearer inbounds line and the yard line passing through the dead-ball spot or through the spot where the ball is left by a penalty.

Interception.—A catch of an opponent's fumble or pass.

Kickoff.—A free kick which starts each half of the game and follows each try or field goal. It must be a place kick or a drop kick.

Lateral or *backward pass.*—A live ball thrown toward or parallel to the passer's end line. The ball remains live even though it may touch the ground before being caught.

Line to gain.—For a series of downs, a line 10 yd. (15 yd. for six-man football) in advance of the ball's most forward point at the commencement of the series, but if this line is in the opponents' end zone the goal line becomes the line to gain.

Live ball.—A ball in play. A ball passed, kicked or fumbled which has not yet touched the ground is a live ball in flight.

Loose ball.—A free ball.

Loss.—Failure to advance the ball to the line of scrimmage during a down.

Loss of a down.—Denial of the right to repeat a down because of a penalty or an incompleted forward pass.

Measurement.—The bringing in of the yardage chain from the side line to determine whether a team has advanced the ball to or beyond its line to gain.

Muff.—An unsuccessful attempt to catch or recover a ball, the ball being touched in the attempt.

Neutral zone.—The space, equal to the length of the football, between the two lines of scrimmage.

Out of bounds.—Any area other than that bounded by the two side lines and the two end lines.

Out-of-bounds spot.—The point at which, according to rule, the ball is declared out of bounds.

Pass.—Throw. A pass ends when the ball is caught, recovered or declared dead.

Play.—The tactic used during a down to advance the ball.

Player.—Any one of the participants actually in the game at any particular time.

Play ruling.—Statement of a play situation and the correct ruling.

Possession.—A player is in possession when he has a live ball in his hands and is exercising control over that ball. A team is in possession when one of its players is in possession, while a kick is being attempted or while a forward pass thrown by one of its players is in flight.

Previous spot.—The point from which the ball was last put into play.

Receiver.—A potential pass catcher on the offensive team or a potential kick catcher on the defensive team.

Recovery.—Securing player possession of a live ball after it strikes the ground.

Return kick.—A kick after change of team possession during a down, or kicking the ball while it is held for an opponent's kick.

Runback.—Advancement of the ball by a catcher of an opponent's kick, pass or fumble.

Runner.—A player in possession of a live ball.

Safety.—*See* Touchback.

Scrimmage.—The interplay of the two teams during a down in which play begins with a snap.

Scrimmage kick.—A kick by the team designated to put the ball into play during a scrimmage before team possession changes.

Scrimmage line.—For each team, the yard line and its vertical plane which passes through the point of the ball nearest that team's end line.

Series of downs.—A group of four consecutive scrimmage downs during which the team in possession must advance the ball to or beyond the line to gain. If they succeed a new series of downs is begun. If

they fail they must surrender the ball to their opponents.

Snap.—Handing or passing a ball back from its position on the ground with a quick and continuous motion of the hand or hands, the ball actually leaving the hand or hands in this motion.

Spot of the foul.—The point at which a foul occurs; if out of bounds between the goal lines, the intersection of the nearer inbounds line and the yard line extended through the spot of the foul; if the foul is committed by a nonplayer, the spot of the foul is the previous spot.

Spot where a run ends.—The point where the runner loses player possession of the ball or where the ball becomes dead in his possession.

Substitute.—A replacement for a player or a player vacancy.

Succeeding spot.—Relating to a foul, the point at which the ball would have been put in play if that foul had not occurred. If the foul is committed after a touchdown but before the try, the succeeding spot is the 40-yd. line (30-yd. line in six-man football) of the team which next kicks off.

Touchback.—When the ball is out of bounds behind a goal line (except from an incompleted forward pass), when the ball becomes dead in possession of a player behind his own goal line or when a penalty leaves the ball on or behind that line, it is a touchback if the attacking team is responsible for the ball being on or behind that goal line. If the defending team is responsible, it is a safety and scores 2 points for the attacking team.

Touchdown.—A score of 6 points for the team whose player is legally in possession of the ball while any part of it is on, above or behind his opponents' goal line.

Try.—An attempt by the team making a touchdown to further increase its score during one scrimmage down from the defending team's 2-yd. line (professional and secondary school football) or 3-yd. line (college and six-man football) while time is out. During this down, a drop kick or a place kick in the manner of a field goal scores 2 points in 6-man, 1 point in 11-man football. A forward pass or run ending beyond the goal line scores 2 points in college and A.F.L. football, 1 point in N.F.L., six-man and most secondary school football.

Yardage chain.—A chain, joining two 5-ft. rods, the rods being exactly 10 yd. apart (15 yd. in six-man football) when the chain is fully extended. Used on one of the side lines to mark the line to gain.

Yard line.—Any line, marked or unmarked, on the field of play parallel to the end lines. A team's own yard lines are numbered consecutively from its own goal line to the 50-yd. line (40-yd. line in six-man football).

Yards to go.—On any down, the distance between the line of scrimmage and the line to gain. (A. Da.)

III. CANADIAN FOOTBALL

Although Canadian football stems from English Rugby, modern rules changes brought it closer and closer to U.S. football. Only the practised eye can discern the differences. The playing field is larger, being 110 yd. long and 65 yd. wide. The end zones are 25 yd. deep. The wide field encourages lateral passing and the deep end zones, forward passing for touchdowns. There are 12 men on a team, and the extra man is called a flying wing. He is invariably used in the backfield on offense and as a linebacker on defense. The other positions are the same as those in U.S. foothall and have the same names. Formerly they were different, but many players were imported from the U.S. after World War II and U.S. nomenclature was introduced.

There are only three downs in the Canadian game. Teams must try for the big gain, which makes the play more open than in U.S. foothall. Blocking, unlimited in U.S. football, was restricted in Canadian football to a point ten yards beyond the line of scrimmage. A single point may be scored in Canadian tootball it the team in possession kicks the ball over the defending team's dead line, which is 25 yd. beyond the goal line, and it may also he scored if the defending team's safety back is tackled or run out of bounds in his own end zone after receiving a kick. Otherwise the scoring in the Canadian game is exactly the same as that of the U.S. game, except that the try after touchdown (from the 5-yd. line) is worth only 1 point regardless of how it is made. Offensive and defensive formations are similar to those in U.S. football. (D. C.)

IV. ASSOCIATION FOOTBALL (SOCCER)

A. British Association Football

Rules of Play.—Association football (commonly abbreviated as "soccer") is played by two sides of 11 men each, with a round, leather-covered, inflated rubber bladder not more than 28 in. or less than 27 in. in circumference and weighing not more than 1 lb. or less than 14 oz. at the beginning of the game. The ball may be kicked, butted or played with any part of the body except the hands; only the goalkeeper is allowed to handle the ball and he may handle it only in his own penalty area (and when so doing may not take more than four steps without bouncing the ball on the ground). The game is played on a field (pitch) not less than 100 yd. and not more than 130 yd. long, and not less than 50 yd. or more than 100 yd. wide. As a general rule full-size pitches are 115 yd. long and 75 yd. wide. Goals eight yards wide and eight feet high are placed in the centre of each end line. The markings on the field and the normal positions of the players at the start of the game are shown in fig. 11. The team scoring the greater number of goals wins the match. To score a goal a side must force the ball into its opponents' goal without throwing, carrying or propelling it by hand or arm; a player diverting the ball into his own goal by any method scores for his opponents. A free kick at the spot of the offense is awarded to the nonoffending side after a breach of the rules, the most common offenses being offside play, handling the ball, tripping, pushing or illegally charging or obstructing an opponent. An unintentional breach of the rules in most cases does not earn punishment. Many fouls by a defending player within his own penalty area (*see* fig. 11) are punished by a penalty kick, taken by any one of the attacking side from the penalty spot 12 yd. in front of the centre of the goal with only the kicker and the goalkeeper within the penalty area. The game lasts for 90 minutes or such less time as may be agreed upon, and is divided into two equal periods, the sides changing over and attacking different ends after half time. The teams toss before the start and the winners of the toss may decide either which end they will attack first or whether they will kick off first. The game is started or restarted after a goal or the change of ends by a place kick from the centre spot. If the ball is driven over a side line or touch line, play is restarted by a member of the side which did not last touch the ball throwing the ball into the field of play with both hands from above the head from a stationary position. This is known as a throw-in. If the attackers force the ball over their opponents' end or goal line, the defenders re-

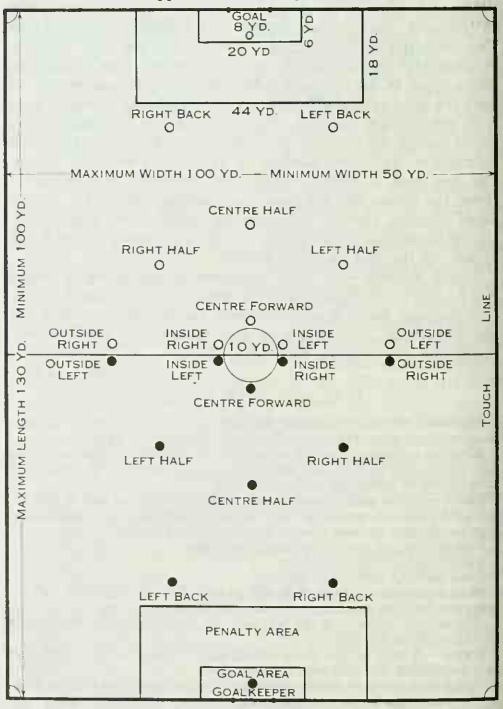


FIG. 11.—SOCCER FIELD AND POSITION OF PLAYERS AT THE KICKOFF

start play with a free place kick from within the goal area (*see* fig. 11); if the defenders divert the ball over their own end line the attackers restart play with a free place kick from within one yard of the nearest corner of the playing area (a corner kick).

Changing Conditions.—Enthusiasts of the game would have had some difficulty in recognizing the sport until about 30 years after the founding of the Football association in 1863. For a long time a side consisted of a goalkeeper, one back, one halfback and eight forwards who roamed the field more like a pack of hounds than a forward line. These forwards relied almost entirely on mass dribbling and on charging, especially charging of the goalkeeper out of the way of an expected shot or centre. Preston North End was, perhaps, the greatest exponent of this method of overcoming the most important member of the defense. The next formation was a goalkeeper, two backs, two halfbacks and six forwards; but from 1883 on, most teams translated another forward into a halfback and so adopted the normal modern formation. The throw-in from touch at first was done with one hand, but so expert did some players become at hurling the ball into the goalmouth from a 40- or even 50-yd. range that it was thought necessary first to make the thrower use two hands and then to make him throw with two hands from above his head from a standing position. Crossbars did not replace tapes and so avert innumerable arguments until 1883. Until 1891 there were no linesmen; each side had its own umpire and the referee was used only as a final court of appeal; after 1891 the umpires were abolished and the referee became an active participant; one result of this was the founding in 1893 of the Referees' association, which improved the standard of refereeing immeasurably and was the forerunner of similar invaluable organizations all over the world. It was only in 1891, too, that the goalkeeper was protected from charging except when he was in the act of playing the ball or was obstructing another player. At about this time, again, the penalty kick was introduced. It was not only the rules, however, which were far different in those days; so was the appearance of the players. For a long time it was customary to wear knickerbockers fastened tightly below the knee, with long, overlapping stockings; boots were of the ordinary type, with the addition of two or three crossbars on the sole and one crossbar on the heel; the wearing of moustaches and caps was normal, that of beards and top hats not rare.

The Offside Rule.—The rule which caused most trouble through the years was the one defining off side. From 1886 to 1928 it read: "When a player plays the ball or throws it in from touch any player of the same side, who, at such moment of playing or throwing in, is nearer to his opponents' goal line, is out of play and may not himself touch the ball or in any way interfere with an opponent until the ball has been played, unless there are, at such moment of playing or throwing in, at least three of his opponents nearer their own goal line. A player is not out of play in case of a corner kick or when the ball is kicked out from goal or when it has last been played by an opponent."

Difficulty in applying the law arose from the words "at such moment of playing or throwing in." Presume that a centre forward (*A*) has the ball at his feet at the halfway line, that the outside left (*B*) is behind the halfway line and that seven or eight of the opposing side are in their own half. *A* now kicks the ball forward and high to the left-hand touch line; the attention of the players, and probably the referee, is directed toward the spot where the ball will fall. But just as it is about to fall *B* suddenly arrives, having rushed up the field under the kick, and takes the ball on with him, although only two of the opposing side now are between him and the goal line. *B* obviously is not off side, because when the ball was kicked by *A* he was behind *A*. But from the crowd there is likely to be a vociferous shout of "off side." The difficulty of seeing and remembering the exact position of each player at the moment of kicking caused endless disputes. The adoption of the diagonal system of refereeing did much to ensure accuracy of official judgment. Under this system the referee moves along a prearranged diagonal of the field and each linesman is responsible for one set of forwards and always will be up with that set when it is attacking. The referee is in the best position to see incidents in the goalmouth and will always have one linesman co-operating with him there while the other linesman is ready for a breakaway. The offside rule was revised in 1928 to provide that a player cannot be off side in his own half of the field and in his opponents' half needs to have only two opponents instead of three at the moment when one of his own side behind him sends the ball forward. The change had become necessary because fullback strategists, notably W. McCracken of Newcastle United, had developed great skill in putting whole forward lines off side by clever anticipation of attacks and moving upfield at the crucial moment.

Changes of Style.—There were many big changes in the style of play after association football became an organized sport, and it became a far cry from the pack of eight forwards who dribbled, hacked and barged their combined path hither and thither. In the period 1880–96 the best sides began to add passing to their armoury while retaining all their old skill at dribbling. William Gunn (Notts County) and George Brann (Swifts), two great international cricketers, N. C. Bailey (Old Westminsters), W. I. Bassett (West Bromwich Albion), W. N. Cobbold (Old Carthusians), J. H. Forrest (Blackburn Rovers), W. J. Townley (Blackburn Rovers) and J. Goodall (Preston North End and Derby) were among the brightest individual stars of this time. Soon after 1896 passing was developed to an extreme degree, and dribbling, outside Scotland, began to be neglected; individual brilliance began to play a smaller part in comparison with good teamwork, but the great figures of the years between 1896 and the start of World War I in 1914 became as much household names as any of their predecessors or successors. G. O. Smith (Old Carthusians), who was awarded 21 caps (*i.e.*, played in 21 full international games for England), S. Bloomer (Derby County, 24 caps), R. Crompton (Blackburn Rovers, 42), J. W. Crabtree (Burnley, 14), E. Needham (Sheffield United, 16), W. J. Oakley (Oxford university, 6), J. Pennington (West Bromwich Albion, 25) and V. J. Woodward (Tottenham Hotspur, 23) were among England's best; in Scotland R. Walker (Heart of Midlothian) played 33 times for his country, but the most remarkable record of all was that of W. Meredith (Manchester City and Manchester United), who played in 50 full international matches for Wales between 1895 and 1920. Crompton's English record was not broken until W. Wright (Wolverhampton) won his 43rd cap in 1952. Wright played for England 85 times, 70 times as captain, by the end of the 1956–57 season.

After World War I dribbling never recovered its position, and passing at times seemed to become an obsession when quick shooting clearly was demanded. Heading the ball became a great art and W. R. Dean, centre forward for Everton and England, probably was the greatest marksman with his head ever seen. The speed of the game increased, at times beyond all reason, so that play seemed to become a matter of kick and rush, but the most successful sides always had fine constructive halfbacks.

The most important change, however, was the result of the change in the offside law (*see* above). Under the old rule the outside forwards had taken the ball down to the corner flag before centring in order to ensure that their companions were on side. There was no longer so much need for this and outsides began to cut in and shoot or make short passes.

Herbert Chapman, manager of Huddersfield Town during its three successive championships in the 1920s, became manager of Arsenal and he fitted a fine team superbly to the new conditions and set a new style. The centre half, who previously had supported his own forwards closely in attack, was now made a defensive player lying well back to block the centre approach to goal; he had to be tall in order to ensure that he could deal with any high balls and he was not to be tempted to wander. The two backs hitherto had marked the opposing inside forwards and had kept fairly close together in front of goal while the wing halfbacks marked the outside forwards; now the backs stayed wider apart and took the outside forwards and the wing halfbacks took the inside forwards. In attack the cutting in by the outside forwards tended to crowd the penalty area and, partly because of this and partly in order to provide a necessary link with the de-

fensive centre half, the inside forwards were stationed behind the other forwards so that the line resembled a letter W; this disposition of forwards is, indeed, known as the W formation. Chapman not only worked out the implications of the new offside law but also had the men to put his ideas into practice; J. Hulme and C. S. Bastin were two fast outside forwards who could shoot hard with either foot; E. J. Drake was a fearless and dashing centre forward, and D. B. N. Jack and A. James were two remarkably constructive insides; at centre half he had tall "policeman" H. Roberts and at wing half two great international players in W. Copping and W. J. Crayston. In the last ten seasons before World War II Arsenal won the Football league championship five times and was runner-up once and third once, and won the Football Association cup twice and was runner-up once. It became the most famous team in the world, and its style was copied everywhere; unfortunately where the players modeling themselves on Arsenal were not expert the result was iron defense and kick and rush attack—which was dull.

The great problem in modern football inevitably became how to lure the centre half away from his post in front of goal or circumvent him. In no case has a side been consistently successful in this without having good constructive wing halfbacks. Teams such as Manchester United (Football Association cup winners and perennial top contenders in the Football league after World War II) achieved a good deal of success by having a wandering centre forward who popped up anywhere in the line and performed a scissors movement with his outside forwards, either breaching the defense on the flanks or eventually getting the centre half on the wrong foot. Others used inside forwards who could make cross dribbles toward a far corner flag and then shoot across a through pass back to their own normal position, having again put the defense on the wrong foot. The Italian side that was unlucky to lose to England at Tottenham in Nov. 1949 sorely upset the English centre half by adopting a deep V formation with the centre forward at the point of the V. There he received the ball in unmolested comfort from his own halfbacks and became, as many years before, a distributor of the ball, leaving the centre half, as it were, hanging in the air and confounding him with delicate ground passes for other forwards to run on to behind the centre half's back.

The Austrians developed in the middle years of the 20th century what was called the bolt system of defense. The centre half had a roving commission in mid-field and was helped there by the centre forward, who left the other four forwards to do the brunt of the raiding. The two backs played one behind the other in the centre to cover any breakthrough and the wing halves marked the opposing outside forwards. This system was most confusing to sides meeting it for the first time, since they could not mark the men that they were used to marking. At the same time both continental European and South American teams concentrated far more than the British on accurate and patterned passing, which often seemed to the uninitiated to go on endlessly and pointlessly but was in fact done in the hope of exasperating their opponents or of causing them to make some desperate attempt to recover the ball which would result in the defense's losing position.

In mid-century Hungary under the autocratic control of G. Sebes developed an almost unbeatable team. It won the Olympic tournament in 1952 and in 1953 became the first team from outside the British Isles to win a full international match on English soil, succeeding by 6–3 at Wembley stadium, and won the return game 7–1 in Budapest. Germany's victory over Hungary by 3–2 in the World cup final in 1954 was the surprise of the year.

The Football Association.—The Football association (F.A.) in 1905 turned itself into a nonprofit limited liability company. It supported the formation of the Scottish, Welsh and Irish associations to supervise the game in those countries instead of trying to keep under its own control the clubs in those countries which had joined it in the early days. When those associations wished to introduce certain rules of their own it settled the differences by proposing an international board with two representatives from each of the four countries and later it joined the Fédération Internationale de Football Association (F.I.F.A.) in forming a new board to look after the rules. When it became obvious that veiled professionalism was taking place, the Football association did not attempt to evade the inevitable, but kept control of the situation by recognizing professionalism in 1885 and fixing rules for it. Its policy has been to avoid interference in the domestic affairs of the professional clubs except where they offend against the bylaws of their association. When this occurs, it comes down on them heavily with the full support of the professional leagues' own management.

The F.A. organized in the 1871–72 season the first of a series of knockout competitions for the F.A. cup which were soon to become world famous. At first the competition attracted only a handful of entries, fewer than did the Scottish F.A.'s cup, first competed for in 1873. Amateur clubs, including Queen's Park (Glasgow), dominated the competition for the first 14 years and it was not until 1883 that the cup went to the north of England for the first time, to Blackburn Olympic; thereafter it left the north and midlands only rarely. The Scottish clubs soon dropped out but a small number of Welsh teams were admitted annually and one of them, Cardiff City, won the trophy in 1927. By the second half of the 20th century most victories in the final had been won by Aston Villa, Blackburn Rovers, Newcastle United, Wanderers (all before 1880), Sheffield United, West Bromwich Albion, Bolton Wanderers, Arsenal, Sheffield Wednesday and Wolverhampton Wanderers. After 1891 only Newcastle United in 1952 had retained the trophy in the following year. The Wanderers and Blackburn Rovers each had won it three times in succession and twice in succession. Except in 1893 (Manchester), 1894 (Everton) and 1915 (Manchester), the final had always been played in London, first at the Oval or Lillie Bridge, then at the Crystal palace, then at Stamford Bridge and finally at Wembley; replays usually were outside London but there had been no replay necessary in the final since 1912. Immediately after the coming of professionalism the attendances at the "cup ties" began to increase rapidly. More than 100,000 spectators watched three of the finals at the Crystal palace and the record there was 120,028 in 1913. After the final was taken to Wembley in 1923 the attendance was limited to between 91,000 and 100,000 ticket holders, but when Bolton Wanderers met West Ham United there in 1923 the decision to make the final an all-ticket match had not been taken and the gates were rushed by persons trying to pay at the turnstiles. It was estimated that there were about 150,000 people inside the ground and many more outside. A new record of receipts at a final, £49,881, was set in 1955. The original F.A. cup was stolen from a Birmingham shop where it was on show after Aston Villa's victory in 1895; it was not recovered and a new cup was presented by Lord Kinnaird, himself holder of the record number of five cup winner's medals.

After the professional clubs had begun to swamp the amateurs in the F.A. cup competition the association put up another trophy for competition among amateur clubs. The final for this was taken to Wembley in 1949, and in 1951 a record crowd of 98,327 saw Pegasus beat Bishop Auckland. In 1954 Bishop Auckland and Crook Town had to replay twice; 100,000 watched them at Wembley, 60,000 at Newcastle and 36,727 at Middlesborough.

The association's other activities became almost boundless; by mid-20th century it represented about 50,000 clubs and more than 1,000,000 players. It controls and organizes international and representative matches, plans courses for players, coaches and referees, makes instructional films and publishes instructional books, approves the rules and regulations of all leagues, is the supreme court of appeal for those charged with breaking the rules in England and is continually giving advice and help to football organizations all over the world. Its address at 22 Lancaster gate, London, became one of the best-known in the football world. Two of its secretaries, Sir Frederick Wall and Sir Stanley F. Rous, were given knighthoods for their services to the game.

League Football.—William McGregor, known afterward as the "father of the league," wrote in 1888 to the strongest professional clubs suggesting that they should combine and form a league, arranging a championship on the basis of home-and-away

matches with each other. The suggestion was accepted and 12 clubs formed the original Football league for the 1888–89 season. For a time they were almost a closed corporation but in 1892 a second division of the league was formed and the first division was increased to 16 clubs. Soon after the principle was adopted of promoting the first two clubs in the second division at the end of each season into the places of the last two clubs in the first division. A southern league founded shortly before World War I was incorporated as a third division of the Football league in 1920 and in 1921 a northern section of the third division was formed, the first club in each section of the third division to be promoted annually into the second division into the places of the two bottom clubs in the second and the two bottom clubs in each section of the third to apply to their fellow members for re-election. Twenty-two clubs now were in each of the first two divisions and 24 in each third division, so that after the mid-1950s there were 46 Football league matches each Saturday in the season. Of the original 12 members of division I not one had retained its place in division I continuously; the last of them to fall was Aston Villa in 1936 and it returned to the top flight two years later. Three division I teams had never been relegated, Sunderland, Arsenal and Portsmouth. Sunderland was co-opted in 1890; first division status was won by Arsenal in 1904 and by Portsmouth in 1927. Liverpool had not been out of division I since 1905. Nineteen different clubs had won the championship by 1956—Arsenal (7), Aston Villa and Sunderland (6 each), Everton and Liverpool (5 each), Newcastle United and Sheffield Wednesday (4 each), Huddersfield Town (3 in succession), Manchester United (3), Blackburn Rovers, Portsmouth and Preston North End (2 each) and Burnley, Manchester City, Tottenham Hotspur, Sheffield United, West Bromwich Albion, Wolverhampton Wanderers and Chelsea.

Normally, more than 1,000,000 spectators watch the Football league games each Saturday; more than 80,000 have seen single games on the Chelsea and Manchester City grounds and even in division III 49,000 watched a league game between the two Nottingham clubs in April 1950. Nowhere had there been an association football league of such power and such a hold on the public's interest. Football pools were organized in many countries depending on the Football league results.

One of the most important rules in the Football league is that once a professional player has joined a member club he may not normally leave it for another without his old club's approval and the payment by the new club of such sum for his transfer as may be mutually agreed. These transfer fees grew enormously, even absurdly, and in 1951 J. Sewell, a young inside forward, was transferred from Notts County to Sheffield Wednesday for the record sum of £34,000, the player himself receiving nothing except a legal £10 signing-on fee, percentage of benefit accrued (£750 for each five years of continuous service with a club) and the top weekly wage then permitted, £12. Such fees had become a burden to players transferred and though these fees might have been an advantage to clubs in financial distress, they were also a complete bar to many clubs' efforts to strengthen their sides. Transfer fees also caused dissatisfaction among the players who claimed that if the clubs could afford to pay out such huge sums for comparatively unknown players they could afford to pay much better wages. The fees had risen because the clubs had refused to impose self-discipline on themselves as a body. J. Seed, manager of Charlton Athletic, a first-division club, wrote in Fenmore's *Football Year Book, 1949–50,* that only their own jealousy and selfishness prevented their calling a halt in a drift toward undisguised commercialism. It was a source of satisfaction to many, however, that huge expenditure on new players in midseason had failed many times to save a club from relegation and that most successful teams, such as Portsmouth, Wolverhampton Wanderers, Burnley and Manchester United, had relied on finding their own talent and spent almost negligible sums on transfers. The transfer fee, or, in the case of a new professional, the big signing-on fee, had become the accepted thing among professional clubs the world over, and the F.I.F.A. had to take some steps to control international transfers. Outside Great Britain probably the strongest and best professional league in the mid-1950s was the Italian National league. There the clubs, with the aid of wealthy patrons, offered huge signing-on fees and wages to players in other countries, and their activities seriously weakened the national team of Sweden, where there was hardly any full professionalism.

The Position of Amateurs.—The standard of play in the early British professional clubs rapidly put the amateurs in the shade. In order to enable the best amateurs to meet the professionals on more or less even terms and facilitate the welding of the best of both in international teams, N. L. Jackson, assistant honorary secretary of the F.A., suggested the formation of a club made up of the best amateurs only. In this way was born the Corinthian F.C., and as long as Jackson remained active the club was remarkably successful. After his retirement in 1898, however, the club began to lose ground rapidly. In the 1920s an effort was made to improve matters by entering for the F.A. cup and the team was excused the qualifying rounds, but little success was achieved and later the club had to join forces with the Casual F.C. The Corinthians did not, perhaps, cast their net wide enough, particularly among the smaller universities, and at a time when almost every other club competed in some league there was a natural reluctance on the part of players to desert their old clubs to join a noncompetitive club. There remained, however, many good amateur club sides all over Great Britain and there was a noticeable revival of the game at Oxford and Cambridge, culminating in the formation of a joint past and present club called Pegasus which won the F.A. Amateur cup in 1951 and 1953, its third and fifth seasons. The game at these universities had for long been handicapped by the fact that the majority of the old public schools had adopted Rugby; association remained the chief game, however, at Aldenham, Bradfield, Charterhouse, Highgate, Lancing, Malvern, Repton, Shrewsbury, Westminster and Winchester, among others.

The British associations' insistence on the prohibition of payments to amateurs for loss of time at work doubtless helped to drive many players into becoming professionals, and it became comparatively rare to see an amateur in a club's Football league eleven and rarer still to see one in England's full international team. In Scotland, however, Queen's Park, one of the oldest clubs in the game, maintained its position remarkably. In 1946 it supplied two of Scotland's full team, and in 1948 it was in the A division of the Scottish league; it suffered relegation the next season (not for the first time) but in 1956 recovered its senior status. Its ground at Hampden park had for long been the biggest in the game and it held 149,547 spectators for the Scotland *v.* England match in 1937. Among the most famous players the club produced was A. Morton, an outside forward who later became a professional with the Glasgow Rangers, easily the most powerful Scottish club through the years; while with the two clubs he won 32 Scottish full international caps between 1919 and 1932.

Outside Great Britain payments to amateurs for broken time were permitted as a normal thing and in consequence full professionalism either did not obtain or rarely became as dominant as in Britain. For instance, Sweden's team, which beat England in 1949 in Stockholm, was composed entirely of players classified as amateurs under Swedish rules. In any case, however much publicity the professional leagues and players might receive, the amateurs remained the true backbone of the game in all countries; of 1,000,000 players attached to clubs under the F.A. at mid-20th century only about 6,000 were registered professionals.

B. World Association Football

Once association football had become a popular sport in Great Britain, its spread throughout the world was only a matter of time. Everywhere that Britons went they played association or "soccer"; and the simplicity of its basic principles and rules and the fact that it could be played satisfactorily under almost any conditions except in fog added to its appeal. Other countries soon started their own clubs, in many cases with the help of local British residents or visitors; such British clubs as the Corinthian F.C. made innumerable missionary and holiday tours in foreign countries. National associations followed naturally, in almost every case

modeled on the Football association, and in 1904 these national associations combined to form the F.I.F.A. This vast federation, earliest and biggest of its kind, directs the game in almost every country in the world from its headquarters in Zürich, Switz. The British associations withdrew from the international body in 1928 because of differences of opinion on points they regarded as fundamental—the payment of allowances to amateurs for time lost from work and the use of substitutes in a match—but the F.I.F.A. and the British associations remained good friends and continued to work together on the International Football Association board, whose chief duty was to discuss and accept or reject proposed alterations in the rules of the game. The British associations later rejoined the international body and by the second half of the 20th century few countries were not members.

Some form of world tournament became inevitable and in 1930 the F.I.F.A. organized its first competition for the Jules Rimet cup, commonly called the World cup. Uruguay won the title of world champions that year and Italy was successful in 1934 and 1938. The British associations did not compete in these first tournaments, but having rejoined the F.I.F.A. England entered the 1950 competition, in the final of which Uruguay beat Brazil. This tournament is divided into three parts. First, small regional qualifying competitions are decided. The winners of these and a few who have been given byes go forward to the second stage in the host country.

One of the greatest difficulties in international football had been the widely different interpretations put on the rules in different countries. In 1949, therefore, the F.I.F.A. invited Sir Stanley F. Rous, secretary of the Football association and a former referee of the F.A. cup final, to draw up instructions for the referees for the World cup tournament. The referees for the finals are chosen from a list submitted by all national associations, the final choice depending on their experience in international matches, knowledge of languages and age. Arrangements are made to call the chosen officials together in advance for a short course in order to obtain a uniform interpretation and a high general standard; this is one of the most valuable services of the F.I.F.A. to the game.

United States.—In the United States the first professional association football was played in 1918 when a team was organized at the Bethlehem (Pa.) Steel company. Several professional leagues came into existence before World War II, but even the most important of these (the American league) was limited almost entirely to the factory districts of New York and Philadelphia. The game was played and supported chiefly by foreign-born factory workers, though the business management was predominantly British. Whatever chance it had to become a leading sport in the U.S. was lost when professional U.S. football became established on a solid financial basis in the middle 1920s. Professional U.S. football draws crowds of up to 50,000; at association games it was rare before World War II to find as many as 5,000 spectators. Efforts were made to popularize the game by arranging visits from British clubs and national sides.

The game is played in many U.S. preparatory schools (corresponding roughly to British public schools) and city high schools, but only occasionally in other schools and colleges. Great surprise was caused when the United States team beat England 1–0 in the World cup series in 1950 in Rio de Janeiro. When a return match was played in Yankee stadium, New York city, in June 1953, however, England won 6–3. The popularity attained by the game in the U.S. at that time may be gauged from the fact that only 7,271 spectators were present. (For further history and the rules of the U.S. game, *see* SOCCER.)

The World cup tournament is an open one in which amateurs and professionals compete on level terms, but amateur players also have their private world tournament every four years at the Olympic games (*q.v.*).

C. GLOSSARY: ASSOCIATION FOOTBALL

Corner area.—At each corner of the playing field, a quarter circle with a radius of one yard, drawn inside the field of play.

Corner kick.—A direct free kick from one of the corner areas by a member of the attacking team; used to restart play when the ball has been propelled across the goal line, but not between the goal posts, by a member of the defending team.

Direct free kick.—A free kick from which a goal can be scored directly against the opposing side.

Dribbling.—Movement of the ball along the ground by a player by a series of very short kicks, usually with the instep or side of the foot, to gain ground or take the ball past an opponent.

Foul.—A breach of the laws of the game, punishable by a free kick, direct or indirect.

Free kick.—A kick during which no member of the opposing team, unless he is standing on his own goal line between the goal posts, may approach within ten yards of the kicker until the ball has traveled the distance of its own circumference.

Goal.—Two upright posts, eight yards apart, joined by a horizontal crossbar and placed in the centre of each goal line. A net is fastened to the posts below the bar. Also the name given to a score made by propelling a ball between these posts and under the crossbar.

Goal area.—A rectangular area immediately in front of each goal, 20 yd. wide and extending 6 yd. into the field.

Goal kick.—An indirect free kick by a player of the defending team; used to restart play when the ball has been propelled by a member of the attacking team over the goal line, but not between the goal posts. The kick is taken from within the goal area and the ball must be kicked beyond the penalty area.

Handling.—Any other player than the goalkeeper intentionally carrying, striking or propelling the ball with hand or arm.

Heading.—Striking, propelling or deflecting the ball with the head.

Indirect free kick.—A free kick from which a goal cannot be scored unless the ball has been played or touched by a player, other than the kicker, before passing through the goal.

Kickoff.—A place kick from the centre of the field by a player who kicks it into the opposing team's half of the field; used to start each half and to restart play after each goal is scored.

Passing.—Propelling the ball by head or foot from one teammate to another.

Penalty area.—A rectangular area in front of each goal, 44 yd. wide and extending 18 yd. into the field.

Penalty kick.—A direct free kick from a spot 12 yd. in front of the centre of the goal with all other players except the defending goalkeeper and the kicker outside the penalty area; may be awarded for any one of nine offenses by defenders within the penalty area.

Pitch.—The field of play, bounded by the goal lines and the touch (side) lines.

Throw-in.—A method for restarting play when the ball has been driven over a touch (side) line; it consists of a player of the team not responsible for the ball being out of bounds throwing it back into the field of play.

Touch line.—Side line. (L. M.)

V. RUGBY FOOTBALL

A. RUGBY UNION

Laws of the Game.—Rugby union football is played with an oval leather-covered ball by teams of 15 players each on a field not more than 110 yd. long and not more than 75 yd. wide, with an extra area, called in-goal, not more than 25 yd. in depth and the same width as the main field behind each end or goal line (*see* fig. 12). The extreme end lines are called the dead-ball lines. In the centre of each goal line there is a goal, comprising two uprights of not less than 11 ft. in height and 18 ft. 6 in. apart with a crossbar 10 ft. from the ground. Lines are drawn across the field at halfway and 25 yd. from each goal line. Intermittent lines are marked ten yards each side of the halfway line and five yards infield from each side (or touch) line. A match consists of two halves of not more than 40 minutes each, the teams attacking different ends in the two halves, and a match is won by the side scoring the greatest number of points.

A player touching the ball down on the ground in his opponents' in-goal area, before any of them can do so, scores 3 points for a try; any member of his own side may then take the ball out any distance into the field of play at right angles to the goal line from the spot at which the ball was touched down and endeavour to kick a goal with a place kick or drop kick; a goal is scored by kicking the ball over the crossbar and between the posts or the imaginary extensions of the posts, the ball not being touched by one of the defending side between the moment when it is kicked and the moment when it passes over the bar; the defending side is restrained behind its goal line until the kicker begins his run or offers to kick; thereafter they may charge and endeavour to stop or touch the ball; if the kick is successful, the try is "converted" into a goal and becomes worth 5 points. A player kicking

a goal with a drop kick during the run of play scores 3 points, provided no defender touches the ball in flight; a drop kick is made by a player in possession of the ball letting it fall from his hand or hands to the ground and kicking it at the first rebound as it rises. A player making a fair catch during the run of play off an opponent's kick or knock-on or throw-forward, digging his heel into the ground and simultaneously calling "mark" is allowed a free kick from behind that mark (his opponents being allowed to charge as soon as he moves to make his kick or the ball is placed on the ground for a place kick), and if with the free kick he place-kicks or drop-kicks a goal he scores 3 points for a goal from a mark. After certain offenses by his opponents a player is allowed a penalty kick at the spot of the offense and his opponents are forbidden to charge; if he place-kicks or drop-kicks a goal with the penalty kick he scores 3 points for a penalty goal.

A team normally is divided into eight forwards, one scrum half, one standoff half, four three-quarters and one fullback. The game is started, and restarted after a goal or at the beginning of the second half, by a place kick from the centre of the field; after an unconverted try it is restarted by a drop kick from the centre of the field. The ball may be propelled in any direction with any part of the body except the hands and arms; if it is propelled forward by hand or arm it is a throw-forward; if it rebounds forward from arm or hand it is a knock-on except where a player is in the act of charging down a kick. A player catching the ball or picking it up fairly may run with it in any direction and may pass sideways or back to one of his own side. If the ball is driven over a touch line it is brought back into play by an opponent of the player whom it last touched, or by whom it was carried; this opponent must throw the ball in straight across field from the spot where it entered touch, the forwards on each side forming a line

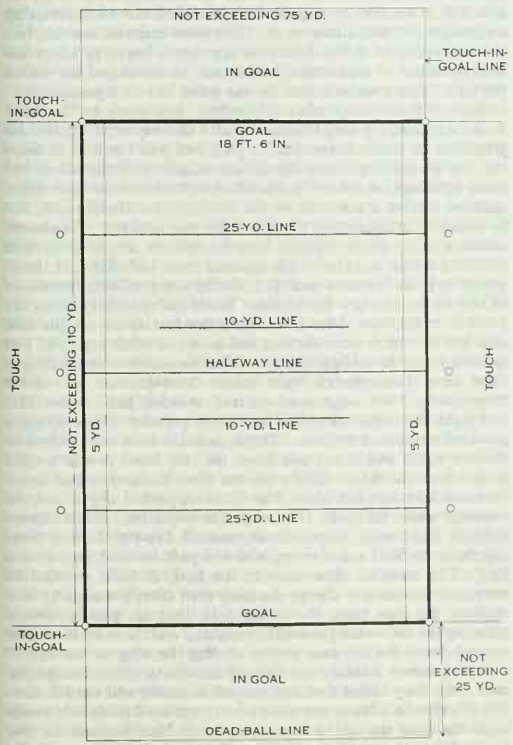


FIG. 12.—FIELD OF PLAY IN RUGBY FOOTBALL SHOWING DIVISIONS AND GOALS

straight across field and jumping for the ball when it is thrown to them; this is called a line-out and players in it may not barge opponents before or as they jump. If the ball is forced over a goal line by attackers and then is touched down first by a defender or forced over the dead-ball line the game is restarted by a member of the defending side with a drop kick from the 25-yd. line. But if the defending side carries or diverts the ball over its own goal line and the ball then is touched down by a defender or forced over the dead-ball line, play is restarted with a scrum five yards upfield from the goal line. A tight or set scrum also takes place after minor offenses.

A tight scrum is formed by the forwards on both sides forming down in two or more rows (three in the front row) and preparing to shove against each other as soon as the ball is put on the ground between the two front rows by the scrum half or some other player of the side which did not offend. The scrum half, or player acting as scrum half, must insert the ball quickly between the front rows, so that it first touches the ground immediately beyond the nearer first player. When the ball has touched the ground, any player in either front row may use either foot in an attempt to gain possession.

A loose scrum is formed when one or more players from each side close round the ball when it is on the ground. After a player is tackled, that is to say, being in possession of the ball is so held that he cannot pass it, he must let the ball go free as soon as possible. While a ball is in either a loose or a tight scrum no player may handle it.

A player is off side at a set scrum if, not being the player of either team who puts the ball in (the scrum half), he fails to retire behind, or advances either foot in front of, a line through the hindmost foot of the players of his own team in the scrum and parallel to the goal lines. A player is off side at a loose scrum if he advances either foot in front of the hindmost foot of the players of his own team in the scrum. A player is off side at any scrum if he enters it from his opponents' side. A player is off side at a line-out if: before the ball has touched a player or the ground he remains or advances with either foot in front of the line-out; after the ball has touched a player or the ground he, not being in possession of the ball, advances with either foot in front of the ball. While a line-out is taking place a player not participating in it is off side if he advances beyond a line ten yards behind the line of the touch and parallel to the goal lines. Any player is off side in general play if the ball has been kicked or touched or is being carried by one of his own team behind him. In the last case a player may become on side without penalty (provided he does not interfere with play while off side) when an opponent carrying the ball has run five yards or has kicked the ball or handled the ball intentionally without catching or gathering it; or when one of his own side has run in front of him either carrying the ball or having kicked it when behind him. Any player falling on the ball must get up immediately and play it or else roll away.

No player may charge or obstruct an opponent not holding the ball unless he himself is running for the ball, and he may only charge an opponent also running for the ball shoulder to shoulder. A penalty kick is awarded for such serious breaches of law as off side, obstruction, refusing to play the ball, handling the ball in a scrum, putting the ball in crooked at a tight scrum, illegal hooking for the ball in a tight scrum, deliberately striking an opponent with fist or foot, tripping and barging in the line-out. A penalty try under the crossbar is awarded if a proper try would probably have been scored had it not been for some exceptionally flagrant breach of the laws by the opposition. The game is controlled by a referee, who is sole arbiter. He signals his decisions with the aid of a whistle. He is assisted by two touch judges, armed with flags, whose chief duty is to signal when, where and by whom the ball is forced into touch.

The ball is 11 to 11½ in. long, has a 30 to 31 in. end-on circumference, 24 to 25½ in. sideways circumference and weighs 13½ to 15 oz. Slight variations are allowed in some countries to suit local conditions.

Changes in the Laws.—The original laws of the Rugby union in 1871 provided for a pitch 140 yd. long and 70 yd. wide, a match

of 45 minutes each way and sides of 20 players each, with the result depending on which scored the greater number of goals; one goal outweighed any number of tries. Goals, obtained as in today's game, could also be scored with a fly kick in the run of play (a field goal). The attempt to convert a try could be made from a point directly in front of the spot where the ball was touched down for a try, or one of the attackers could make a free punt out from the goal line in front of the spot where the try was scored to a friend standing in front of goal, and if a fair catch was made the kick at goal was from the spot where the catch was made; failure to make a fair catch forfeited the kick at goal. When a player in possession of the ball crossed his opponents' line they could try by any means to prevent him from touching the ball down, and this produced what was known as a maul-in-goal which theoretically could go on for the rest of the game and often did go on for several minutes in a most ferocious manner. It was only in 1871 that intentional hacking, or kicking of an opponent, was prohibited. The game was presided over by a neutral referee and two touch judges, one representing each side; it is easy to see how on many occasions these three officials formed as it were a law court, the referee acting as judge and the two judges acting as attorneys at the bar. At the same time, curiously, the captains of the two sides still were sole arbiters of all disputes.

The number of players was reduced to 15 a side in the 1876–77 season for all matches, Oxford and Cambridge having played a similar number a year earlier. In 1875 it was decided that when no goals were scored or each side scored the same number of goals a majority of tries should win a match. It was not until 1886 that a point system of scoring was adopted. This was adopted as a result of a county match in which Yorkshire lost to Middlesex because it could not convert any of a large number of tries while Middlesex scored one dropped goal through A. E. Stoddart in a breakaway. The value of the various scores was altered several times until the 1905–06 season when the field goal was abolished and new values were accepted for all except the dropped goal; this was worth 4 points until after World War II. During the summer of 1885 the rather ridiculous position of the referee and the judges was discussed and as a result the referee's authority was greatly strengthened. He was given a whistle while the judges were reduced to touch judges with flags and were put under the referee for disciplinary action in just the same way as any player. It was not until 1888 that a penalty goal could be scored from a penalty for off-side play and many other offenses were made punishable by a kick. At the same time the referee was given power to order a player off the field for rough play and to report to the union cases in which his decision was disputed. Later he could order a player off the field for the latter offense as well as for the former and also for persistent infringement of the laws.

Traveling expenses were first allowed in international games in 1880; hotel expenses were permitted soon afterward. Later a limited number of players playing for recognized club teams could receive traveling and hotel expenses for club matches away from home. The Rugby unions, however, remained constant in their opposition to any form of payment of allowances for loss of earnings suffered while playing or traveling to or from a match. Even presentations to players were strictly controlled, and there was a famous case in 1897 when A. J. Gould, a great three-quarter then at his best for Newport and Wales, was the beneficiary of the product of a large testimonial fund; this almost led to a breach of relations between the Welsh union and the other unions, but in the end bore better fruit in a new set of agreed laws defining acts of professionalism.

Development of Different Styles of Play.—In the 1860s the 15 or more forwards on each side concentrated on carrying the scrummage, as it was called, by superior weight and drive and considered it cowardly to scrummage head down in the modern manner. They hacked with a will and were hacked, tripped as often as they tackled, and usually went on enjoying their maul long after the ball had departed. Individually they could dribble well, but they rarely had a chance to make a combined dribbling rush because it was impossible for more than one or two at a time to disentangle themselves from a maul. Indeed, there was no attempt at combination in the modern sense between any parts of a side. The two halfbacks were complete individualists and it was considered unmanly to pass the ball rather than run with it until overwhelmed. The two backs guarded their goal and the solitary three-quarter roamed over the whole of the middle of the field seeking whom he might devour.

The first reform was achieved when a faster, more open game was found by certain clubs to be more profitable, even if it horrified some of their battle-scarred older members. The reduction in sides from 20 to 15, and consequently of forwards on each side from 15 to 10, was of great assistance to those reformers, who began to concentrate on combined dribbling, quick breaking from the mauls and scrums, and intelligent looking for the ball before entering a maul with a view to controlling its destination rather than overpowering the opposition by brute force. The Blackheath club in 1878 set up a new fashion on these lines which rapidly became popular among players. Their fast and agile forwards developed brilliant short passing movements and were largely responsible for 15 wins in 16 games and the scoring of 54 goals and 30 tries. To the disgust of many old gentlemen they also learned how to wheel a scrum. Among Blackheath's earliest and best imitators was Oxford university, and in 1881 Oxford had one of the greatest footballers of all time in H. Vassall, who probably was the first to recognize the full value of speed and insisted on his forwards using their hands and their brains as well as their brawn. In 1882 Vassall found a great assistant in A. Rotherham, a halfback who applied his methods to back play. During 1881–85 Oxford lost only two matches, both to Edinburgh university, and it was unbeaten in 1882, 1883 and 1884. The formation of the side was changed gradually during these years to one fullback, three three-quarters, two halfbacks and nine forwards. Rotherham conceived and proved the value of halfbacks who would act as a link to get the three-quarters into action, and he appreciated and taught halfbacks how to get their three-quarters moving fast before passing to them; finally as opponents began to adopt defensive tactics to answer his passing out, he developed the use of the feint to pass when in fact he was going to retain possession.

Almost immediately after Rotherham had come to the front R. Robertshaw, a young Bradford centre three-quarter, applied his principles to centre three-quarter play and was the first to show the way in which a centre should act as link with the wings and make openings for them. Robertshaw wanted to have four three-quarters, taking a man out of the forwards for the purpose, but he found little support for the idea in his own country. Welshmen, however, were quick to profit from his lessons, and in 1885 both the Cardiff club and the Welsh national team included four three-quarters, F. E. Hancock and A. J. Gould being brilliant exponents of how to use the new formation. Wales did not always reap the profit it might have done from being the first to accept the new idea but its merits were obvious and soon the other countries had to follow suit in self-protection. This formation—one fullback, right wing three-quarter, right centre three-quarter, left centre three-quarter, left wing three-quarter, standoff half, scrum half and eight forwards—remained the most popular. New Zealand provided notable exceptions. There, until the laws were altered in the late 1920s and it was laid down that the front row in a tight scrum must consist of three men, the New Zealanders had seven forwards and eight outsides. The forwards packed 2–3–2, and the outsides were fullback, left wing three-quarter, centre three-quarter, right wing three-quarter, second five-eighth, first five-eighth, scrum half and a rover, who was part forward, part scrum half. The essential differences in the back division are that in normal situations it is always the same man (first five-eighth) who receives the pass from the scrum half, that his pass is always taken by the same man (second five-eighth) and the same man (the centre) draws the last man before sending the wing on his way.

British teams, notably the Oxford university side, occasionally used what they called first and second or inside and outside centres in order to achieve the same effect; but no British side really made the same use of the formation, for in New Zealand the two five-eighths are peculiarly a unit, working and planning the attack, whereas in Great Britain in most cases the halfbacks look on them-

selves as one unit and the three-quarters on themselves as a second unit. New Zealanders regard the superiority of their system as self-evident and among other things point out that the duties of the third and fourth men behind the scrum (second five-eighth and centre) obviously are different and that certain players are better fitted for the one job than the other.

The only important modern development in back play after the general adoption of four three-quarters was the use of prearranged tactical maneuvers, involving return passes, reverse passes, scissors movements, various types of kick, etc., to force gaps in the middle of the defense, turn its flanks or defeat it by speed before it can turn round to get back to a cunningly placed ball. Between 1905 and 1914 the Harlequins became famous for their back play, but they did not in fact revolutionize back play; rather they assimilated and perfected much of the best shown by Wales and New Zealand in preceding seasons, put their faith in swift passing, running and backing up at all times, even when penned in their own quarter of the field, and had such fine players to carry out the plan as A. D. Stoop, H. Brougham, F. M. Stoop, J. G. G. Birkett, D. Lambert and H. J. Sibree. The basic tactics of back play hardly changed after the early years of the 20th century; they did not include the making of the fullback into a dangerous weapon of attack (see *Rugby League*, below) and they were affected only to a minor degree by the modern wing forward.

The modern wing forward is the degenerate descendant of D. Gallaher, captain and rover in the first New Zealand All-Blacks team to visit Great Britain and Ireland in 1905. He did not join the scrums and did not claim to be a forward; he put the ball into the scrum as often as did his scrum half and thereafter concentrated in the first place on strangling his opponents' attack at birth by helping his scrum half smother the opposing scrum half or intercepting his pass to the standoff half. The New Zealanders reckoned and proved that by packing 2–3–2 they could hold any other formation of seven or eight forwards in the scrums and so had a man over to be rover; Gallaher's side lost only to Wales by a disputed try and the second All-Blacks team in Great Britain won every match and soon after returning home routed South Africa. New Zealanders resented the change in the laws toward the end of the 1920s which made it obligatory to have three men in the front row of a scrum; with three men in the front row they had to have eight forwards against eight and lost their rover.

The modern wing forward, on the other hand, is neither flesh nor fowl. He is a forward and he packs down at scrums because his weight is needed. But often his shoving is little more than a pretense while he is saving himself in order to do the job of the rover; he tends to spend his time driving the opposing standoff half across field and in so doing reduced many a game to an untidy scramble; had he shoved harder like a genuine forward he might have crippled the enemy just as much either by enabling his own pack to get the ball or making the enemy's heel so slow that his own outsides had no difficulty in holding the consequent passing move. His concentration on the standoff half was due at least partly to a change of law, also in the late 1920s, which made it necessary to have both feet behind the ball instead of one while the ball is in a scrum; his chances of spoiling a good scrum half were greatly reduced and his attention diverted to the next link in the human chain. Also as a result of this change in law it would appear that the standoff's (and consequently the three-quarters') job was made more difficult because the relief afforded to scrum halves tended to make them much slower in passing and thereby give the wing forward and defending outsides time to close on their men. When a really good quick passer-out like H. Tanner (Swansea, Cardiff and Wales) was in action his outsides had just as much chance as ever to be brilliant in attack and the modern wing forward became a liability to his own side as his skirmishing no longer compensated for his failure to do his full share of scrummaging and mauling. However, in 1964 further law changes were made designed to give midfield players more room for attack. The side throwing in the ball at a line-out was given the right to decide the length of the line and so by shortening it could prevent wing forwards from marauding infield, and wing forwards were also restricted in their breaking from scrums. At the same time defending backs were not only forbidden to advance beyond the line of the back of their own scrum but were also required to remain 10 yd. behind a line-out, in each case until the ball was out.

Various theories arose as to how best to arrange eight men in a scrum. By a simple piece of mechanical calculation it can be shown that, all things else being equal, a pack of forwards arranged 3–2–3 should be able to outshove a pack using the 3–4–1 or 3–3–2 orders, but 3–4–1 became popular early in South Africa and New Zealand and later everywhere. The main reasons for this were: (1) in order to get the full benefit of 3–2–3 one must have two men of exceptional strength and ability in the second row capable of shoving themselves and transmitting on to the front row with a minimum of loss the shove applied to their own bodies by the back row; (2) in 3–4–1 heeling tends to be quicker; and (3) in 3–4–1 the wing forwards are a yard nearer their victims and the pack can disentangle itself more quickly.

The only marked tendency after World War II was for players in face of quick-breaking wing forwards to attempt to be clever without having the necessary basic equipment of technique, and for sides to concentrate on perfecting defense, always an easier art than attack for, strictly, if each defender is competent he will always tackle his man in an orthodox move and any move from a set scrum is likely to peter out tamely. A breach in the best defenses can be made, however, after a quick heel from a loose scrum when one or more defenders are on the ground or by introducing some element of surprise.

There was a considerable revival of back play in the British Isles in mid-20th century, which won approval during the British tours of New Zealand and Australia in 1950 and South Africa in 1955. The British showed that fast and accurate combined back play still could be effective as well as pleasant to watch, and in South Africa they won two of the four international games and

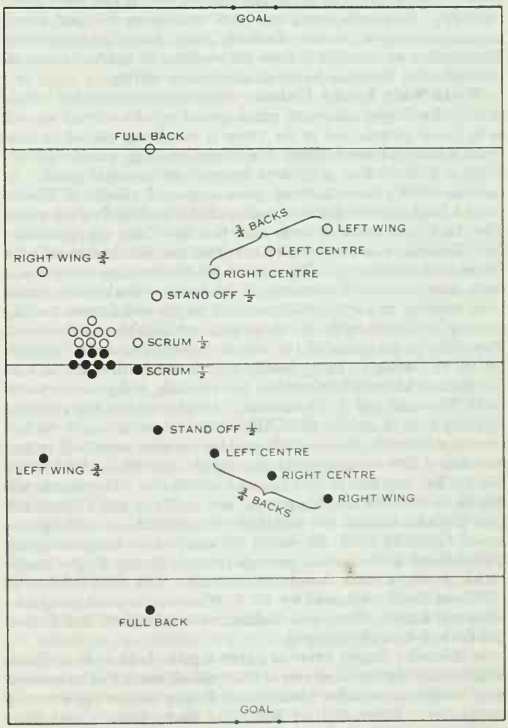


FIG. 13.—DIAGRAM SHOWING PLAYERS IN THE RUGBY FIELD IN POSITION FOR A SCRUMMAGE

attracted enormous crowds, especially at Johannesburg.

Government of the Game.—The formation of the Rugby union in 1871 was followed quickly by the founding of the Scottish Rugby union in 1873, the Irish Football union for southern Irish clubs in 1874, the North of Ireland Rugby union for northern clubs in 1875, the Welsh Rugby union in 1880 and the Combined Irish Rugby union in 1881. England first met Scotland in 1871, Ireland in 1875 and Wales in 1881. Scotland first played Ireland in 1877 and Wales in 1883. Ireland and Wales first met in 1882. The unions supported such matches wholeheartedly and the English Rugby union officially sanctioned a county championship in 1890, although Lancashire and Yorkshire had been meeting for 20 years. They strongly discouraged big cup competitions, however, and opposed leagues; the most famous cup competitions permitted are for the Yorkshire cup, the London Hospitals cup and the intercollege cups at Oxford and Cambridge; the winners of the England *v.* Scotland match hold the Calcutta cup.

The unions worked in harmony almost throughout. Early changes in the laws were agreed upon easily, the other three regarding the English Rugby union as the parent and supreme body and changes of law never altering the game from Rugby, whereas in the U.S. modern football has little relation with the original game. The first serious dispute arose over the scoring of a try by England against Scotland in 1884, as a result of which Scotland refused to recognize England's union as sole arbiter of the laws; when the English Rugby union introduced point scoring in 1886 all three other countries refused to play England in the following season and the matter came to a head. As a result of arbitration by Maj. F. A. Marindin (most famous of all F.A. cup final referees) and Lord Kingsburgh it was agreed in 1890 to form an international board to control laws as well as settle disputes of fact in connection with international matches; England was given six representatives on the board, and Scotland, Ireland and Wales were given two each. England's quota was later reduced to two and representation was given to New Zealand, South Africa and Australia. The election of all officials from the smallest to the highest in all the clubs and unions is based on democratic voting.

World-Wide Rugby Union.—Immediately after the formation of the Rugby union the game spread rapidly abroad as well as in Great Britain and in the 1870s it was being played in Australia, Canada, France, South Africa and the U.S., but it was only in New Zealand that it at once became the national game. As early as 1888 a New Zealand team composed chiefly of Maoris visited England and defeated many of the leading English clubs. The All-Blacks team of 1905 was the first fully representative New Zealand team to visit Great Britain and was beaten only by Wales by a solitary try. The second All-Blacks team in 1924 was even more successful, winning all its games. Both these teams were superior in basic technique, backing up and fitness, and by playing together regularly developed remarkable combination. The side of 1924 included two superb five-eighths in M. Nicholls and A. E. Cooke, an exceptionally strong and fearless fullback in G. Nepia, a Maori who played in every match, and great forwards in M. Brownlie and J. Richardson. Another Maori team visited England in 1926 and the third All-Blacks arrived in 1935; the latter was a fine side, but it was dogged by injuries, especially to key men like J. Oliver, a splendid five-eighth, and W. A. Hadlee, its best hooker, and lost to both England and Wales. The fourth All-Blacks to visit Britain, in 1953–54, lost to Wales and France, but beat England, Ireland and Scotland. It included one of the greatest of fullbacks in R. W. Scott; in addition to being a superb defender and kicker he was, perhaps through playing Rugby league in his youth, a most dangerous attacker. The fifth All-Blacks (1963–64) were captained by W. J. Whineray, a great prop forward and leader. They beat Ireland, Wales, England and France but drew, 0–0, with Scotland.

In Australia Rugby union acquired a great hold in New South Wales and a big following also in Queensland, but it had an unusual rival in Australian rules football and Rugby league was a strong competitor. Representative Australian teams visited Great Britain in 1908, 1927, 1947 and 1957. There was a steady improvement in their standards, though they never equaled the brilliance of the New Zealanders in back play. Notable members of these sides were A. C. Wallace, a former Oxford and Scottish international three-quarter, and A. T. Lawton, former Oxford standoff half, in 1927 and T. Allan, centre, and D. F. Kraefft, D. H. Keller and C. J. Windon, forwards, in 1947; in the latter tour they also brought C. C. Eastes, a wing three-quarter of most formidable bulk and speed but unfortunately badly hurt early in the visit. The 1957 side included A. J. Summons at standoff and J. A. Phipps, inside centre.

In South Africa Rugby union had a long struggle before it took first place over both association football and a local hybrid game which embodied points from both Rugby and association. British sides which visited South Africa in 1891, 1896 and 1903 found the opposition stronger each time. These visits were returned by South Africa in 1906 and 1912; in the first of these tours they were good in the backs but were beaten forward; South Africa never forgot the lesson and its later sides were noted for their hard scrummaging. The great Rugby heroes of South Africa were nearly all forwards like P. J. Nel and M. M. "Boy" Louw. Its back play had never made the same progress, though in a tour of Great Britain in 1931 it had a remarkable general at standoff half in B. L. Osler who, by nursing his forwards and sacrificing all thoughts of constructive back play, was largely responsible for the team's winning 23 games, drawing 2 and losing only to a combined Leicestershire and East Midlands team (when they were a forward short almost throughout the game). A South African team visited the British Isles and France in 1951–52 and won 30 of its 31 matches, including the 5 international matches against Scotland, Ireland, Wales, England and France. The side had an extremely powerful and skilful pack, which observed all the basic principles, and two brilliant halfbacks, P. A. du Toit and H. Brewis. Another South African team made a similar tour in 1960–61, beating Wales, Ireland, England and Scotland but drawing, 0–0, with France. British Isles sides visited South Africa in 1924, 1938, 1955 and 1962.

Rugby union reached France in the middle of the 19th century, but its development there was slow and it was not until 1906 that France met England in an international match; it began to play Wales in 1908, Ireland in 1909 and Scotland in 1910. For a long time it had little success in international matches but the spirited attempts of its players to play an open attacking game made its visits popular everywhere, and after World War II it was a serious contender for the unofficial international championship. In 1931 the British unions severed playing relations with France because they were dissatisfied with the control and conduct of the game in that country. Just before World War II, however, France was restored to its position in international football. The French announced themselves as a world power in the game when they went to South Africa in 1958 and drew the first and won the second of their two international matches.

The Fédération Internationale de Rugby Amateur, formed in 1934, supervises the game in many countries in the European area, and the game is also played in such places as Malaya, Thailand, Japan, Fiji (which has beaten the full Australian side), Hong Kong and Argentina. An important step was taken in 1964 when a Fiji representative side toured in Europe for the first time. It lost to a Welsh XV and to France in a full international match but played fast and open Rugby.

Largely because Canada and the United States have their own football games, both developed from Rugby, the parent sport has never been widely popular in those countries. There is some enthusiasm among the larger eastern universities in the U.S., in California and in British Columbia. A Canadian representative side visited Britain for the first time in 1962, and Scotland toured Canada in 1964. (L. M.; X.)

B. Rugby League

Rugby league, played mainly in the north of England, Australia, New Zealand and France, is a direct descendant of Rugby union. There was at first no difference in the playing laws, for the original 22 members of the Rugby Football league, or Northern union as it was called until the 1920s, seceded from the Rugby Football

union after and because a Yorkshire proposal to permit the payment of compensation for bona fide loss of working time by players had been defeated at the annual general meeting of the Rugby union in 1893. The majority of Rugby union clubs were then, as later, opposed to any proposal which appeared to prepare the way for the introduction of professionalism into the game. The Northern union clubs recognized professionalism in 1898, subject for a time to a condition that a professional must have another genuine job during the week; eventually this condition was dropped, but in practice almost every Rugby league professional continued to follow another trade or profession during the week, unlike the majority of professional association footballers in Great Britain. The Rugby league's rules governing the status of amateurs are as strict in their way as any put forward by the Rugby unions, and the backbone of the game in the second half of the 20th century was formed not only by the 30 professional teams of the Northern Rugby league but by more than 300 registered amateur teams in the three counties of Cumberland, Lancashire and Yorkshire. There were many cases of players playing as amateurs with the first teams of Northern league clubs.

The seceding clubs quickly established Northern and county league and cup competitions and gradually amended the old Rugby union laws in order to make play more attractive to spectators and, some stoutly maintained, more enjoyable for the players also. The main differences in the playing laws by the 1950s were: (1) there were only 13 men in a Rugby league side, two forwards having been cut out; (2) in Rugby league there was a scrummage instead of a line-out opposite the point where the ball entered touch; (3) from a kick the ball must touch an opponent or bounce on the ground inside the field of play before entering touch, except from a penalty kick or a kick traveling toward the kicker's own line, the penalty for failure to observe this proviso being that the scrum is formed back where the kicker was when he made his kick; and (4) that after a tackle the player with the ball is allowed to stand up and drop it so that it may be played with a foot. A try was still valued at 3 points, but any successful kick at goal after a try, with a penalty, or with a drop kick was worth 2 points. Most of the basic principles of strategy and technique remained much the same as those of Rugby union, but in the Northern Rugby league the standards of fitness and technical efficiency had been raised in the best clubs to a degree rarely seen in Rugby union and many tactical maneuvers had been developed to achieve the strategic end, especially moves making the fullback one of the most dangerous attackers on the field.

Professional players are recruited from the ranks of amateurs and overseas Rugby league teams as well as from Rugby union footballers all over the world but especially in the north of England, south and west Wales, Australia, South Africa and New Zealand. The sums given to players to induce them to change their status and those demanded by clubs for the transfer of registered professionals had increased enormously by the second half of the 20th century, reaching £6,000. The paying of such sums was beyond most clubs for, in the main, Rugby league was still played in the smaller northern England towns and the average attendance at Northern league games was only about 12,000, ranging from 2,000 to 3,000 at Featherstone, a little colliery town in Yorkshire, to about 25,000 at Wigan, where a quarter of the total population had become regular attenders. The export of players from New Zealand, Australia and South Wales had proved such a threat to the game in these countries that they asked for, and in the first two cases won, a part ban on recruitment by English clubs for a period. Naturally the wiser clubs turned more and more to the development of local resources and, of the great Wigan side which in 1949 won the Lancashire cup for the fourth time in succession, all except three were found in the Wigan district and trained to their high standard by the club.

The game was soon adopted in New South Wales and, to a lesser degree, Queensland, and test matches were played between Great Britain and Australia beginning in 1908; by the beginning of the 1955 season the British sides had won 33 and drawn 4 of the 54 games, and had retained the "ashes" from 1921 to 1950, when Australia won the rubber at home. Australia was handicapped by losing many of its best players to English clubs and not having them available for tours or international matches. New Zealand also took to the game early and had played 34 tests with Great Britain between 1908 and the beginning of the 1955 season, winning 10 and losing 24. In New Zealand, however, professionalism in the normal sense had never been obtained; players received free equipment, facilities and expenses but no regular wages. The game took root in France early in the 1930s, one of the main causes being the breach between the British Rugby unions and the French authorities in Feb. 1931. Rugby league acquired a big hold in the south and southwest of France, Toulouse, Bordeaux and Marseilles being the chief centres. Attempts were made to spread the game in Scotland, Northumberland, Durham, London and south and west Wales, but no great or permanent foothold was gained, chiefly because there had been no great popular demand and it had proved too expensive trying to create such a demand. The Rugby League Challenge cup final, however, has been played regularly for a number of years at Wembley stadium, London, and so many northerners make the occasion a holiday festival that by the second half of the 20th century the attendance had risen as high as 95,000 and the receipts to £31,000. In 1954 the final was drawn and the replay at Odsal stadium, Bradford, a natural but largely undeveloped amphitheatre, drew 102,575 spectators.

The first Rugby League World cup competition was played in France in 1954 and was won by Great Britain, the other entrants being Australia, France and New Zealand.

Of the 22 clubs which originally seceded from the Rugby union 15 were still among the 30 members of the Northern Rugby league in the second half of the 20th century: Batley, Bradford (reformed as Bradford Northern), Halifax, Huddersfield, Hull, Hunslet, Leeds, Leigh, Oldham, Rochdale Hornets, St. Helens, Wakefield Trinity, Warrington, Widnes and Wigan. Those which perished or were amalgamated were Brighouse Rangers, Broughton Rangers, Liversedge, Manningham, Runcorn, Stockport and Tyldesley. The leading clubs were those which concentrated on open attacking play, and the records of Huddersfield and Wigan were outstanding over many years. Between them, by 1952, they had been winners of the Northern Rugby league championship 14 times and runners-up 11 times and winners of the Rugby League cup 10 times and runners-up 5 times.

J. Sullivan, Wigan's fullback for 20 years and Great Britain's for 10, achieved the remarkable feat of kicking more than 100 goals in each of 18 successive seasons up to World War II and scoring almost 100 tries as well; he was one of the great defenders whose positional play was so good that he seemed to run only in attack, when his habit of intercepting one of his own side's passes on the burst baffled innumerable opponents. H. Wagstaff (Huddersfield) was a peerless centre according not only to almost every Rugby league enthusiast but also to many Rugby union players who played with or against him during World War I. A. J. Risman (Salford) was not perhaps so great a centre but as an all-round back he was in a class of his own, being equally expert at fullback, centre and standoff, and after 20 seasons of first-class football he was still greatly respected as player-manager of Workington Town. Among the wings A. Ellaby (St. Helens), a huge long-striding player, B. Bevan, who scored over 500 tries for Warrington, and S. Rosenfeld, Wagstaff's contemporary at Huddersfield, remain in the memory, and of standoff halves three Welshmen, Billo Rees (Swinton), Emlyn Jenkins (Salford) and W. T. H. Davies (Bradford Northern), and one New Zealander, C. Mountford (Wigan), were among the great. Jonathan Parkin (Wakefield Trinity) probably would be almost unopposed as scrum half for a world team, but after World War II a wonderful new combination in both attack and defense was worked out for Wigan by M. Ryan, fullback, and T. Bradshaw, scrum half, under the coaching of J. Sullivan which was something new to Rugby of any kind and which penalized the unwary kicker-ahead as never before. The fullback was never left alone to face a follower-up; instead, by brilliant interpassing and changing of direction, the pair turned defense into attacks of blinding speed.

Great forwards were numerous: M. Hodgson, Swinton's towering imperturbable giant; L. Prigg, a tireless, intelligent attacker

and deadly tackler from New South Wales; N. Silcock, a burly Widnes front-row man; K. Gee and J. Egan, another remarkable Wigan pair; D. Clarke (Huddersfield), famous also as a wrestler; T. Foster (Bradford Northern); and W. Burgess (Barrow) were only a few of them. Two others played as great a part as any individual player in the successes of their clubs. L. B. Todd, a former New Zealand and Wigan player, took over the management of Salford when it was in sore distress in 1928 and by his shrewdness, wise selection, instruction and leadership enabled it to win the Northern league championship three times and the Rugby League cup once in the next 11 years before he was injured fatally in a road accident. Dai Rees, the Bradford Northern trainer and coach, showed such unrivaled knowledge of tactics and ability to nurse injured and aging players that he took his club into five of six Rugby League cup finals between 1944 and 1949.

C. Glossary: Rugby Football

Dead.—The ball is temporarily out of play.

Defending team.—The team in whose half of the ground the stoppage of play occurs.

Drop-out.—A drop kick taken by the defending team after a touch down or after the ball has been in touch-in-goal or has touched or crossed the dead-ball line.

Dropped goal.—A goal scored by a drop kick during the run of play.

Fair catch.—A catch by a player of the opposing team direct from a kick, knock-on or throw-forward who at the same time makes a mark on the ground with his heel and exclaims "mark."

Field of play.—The area bounded by the inner sides of the goal lines and the touch (side) lines.

Free kick.—A kick allowed for a fair catch.

Goal.—Kicking the ball over the opponents' goal-post crossbar from the field of play by means of a place or drop kick (similar to U.S. field goal).

Grounding the ball.—The act of a player placing his hand or hands on the ball, while it is on the ground, so that he is able to exert on it a downward pressure.

Heeling.—Scraping the ball back with the heel from a loose or set scrummage in the direction of one's own backs.

In-goal.—The area at each end of the field bounded by the goal line, the dead-ball line and the two touch-in-goal lines.

Kickoff.—A place kick from the centre of the halfway line taken at the beginning of each half and after a goal has been kicked; also a drop kick taken at or from behind the centre of the halfway line after an unconverted try.

Knock-on.—Occurs when the ball, after striking the hand or arm of a player, travels in the direction of his opponents' dead-ball line.

Mark.—The place at which a free kick or a penalty kick is awarded.

No-side.—The end of a match.

Penalty goal.—A goal scored from a penalty kick.

Penalty kick.—A kick awarded to the nonoffending team by reason of an infringement of the laws of the game by their opponents.

Pitch.—The field of play.

Rebound.—Occurs when the ball, after striking any part of a player except his hand, arm or leg (from the knee to the toe, inclusive), travels in the direction of his opponents' dead-ball line.

Scrum.—Short for scrummage.

Scrummage.—The closing around the ball by one or more players on each team when it is on the ground (called a loose scrummage); a closed-up formation of players of each team in readiness to allow the ball to be put on the ground between them (called a set or tight scrummage), used to restart play after certain minor infractions.

Tackle.—Occurs when the holder of the ball in the field of play is held by one or more players of the opposing team so that while he is so held the ball comes in contact with the ground or there is a moment when he cannot pass or play the ball in any other manner. When tackled a player must release the ball immediately.

Throw-forward.—Occurs when the ball is propelled by the hand or arm of a player in the direction of his opponents' dead-ball line.

Touch.—Out of bounds between the two goal lines.

Touch down.—The act of a defending player first grounding the ball in his own in-goal (similar to U.S. touchback).

Touch-in-goal.—Out of bounds between a goal line and a dead-ball line.

Try.—Obtained by the act of an attacking player first grounding the ball in his opponents' in-goal (similar to U.S. touchdown).

VI. AUSTRALIAN RULES FOOTBALL

The game of football under Australian rules seems to be indigenous to Victoria and is said to have been played in Melbourne before Rugby ever was introduced to the continent. It became the favourite game in Victoria, South Australia and Western Australia. It is played on an oval field with a greatest width of 120 yd. and a greatest length of 180 yd. Sides are made up of 18 players, 15 of whom remain in more or less fixed positions and mark fixed opponents. The ball is much bigger than a Rugby ball, the circumference being 29½ in. over the long axis and 22½ in. over the short axis. A player may kick or punch the ball forward but may not run with it unless he bounces it every ten yards. There is no off side. Four posts of any desired height and with no crossbar are set up seven yards apart at each end of the field. Any punt, place kick or drop kick which goes between the two inner posts without being touched by a defender scores 6 points; any kick which goes between an inner post and an outer post or which goes between the inner posts after being touched scores 1 point. (L. M.)

VII. GAELIC FOOTBALL

Gaelic football is distinctly Irish and is reputed to be the roughest of all football games. It has no connection directly with Rugby or association, being of direct descent from the medieval mellays in which entire parishes would embroil for daylong battles over many square miles of country. (See *Early History*, above.) The game was without rules or restraint until 1884. Then two citizens of Carrick-on-Suir, Tipperary, Daniel and Mauric Davin, after watching a particularly bloodthirsty affray between 34 men of Tipperary and 34 of Waterford, decided that something must be done to restrain the ferocity of the players. With the aid of Michael Cusack of Clare and some of the leading players, they drew up a code of rules which slightly restricted brutality, and at a big meeting in Thurles, Tipperary, the same year these rules were accepted and the Gaelic Athletic association was formed and became the ruling body for the game throughout the world. The game is not played much outside Ireland except in the U.S.; the winners of the All-Ireland championship usually visit the U.S. each year to meet Gaelic representative teams in New York and other cities on the eastern seaboard. Sides are made up of 15 men each, who may not throw the ball but may dribble with hand or foot, punt or punch the ball toward their opponents' goal, which resembles a Rugby goal in that the posts are extended above the crossbar and an association goal in that there is a net fastened to the posts below the bar and to the bar. One point is scored for punching or kicking the ball over the bar and between the posts and 3 points for punching or kicking it between the posts and under the bar into the net. The game consists of two halves of 30 minutes each. (A. S. Bl.; W. J. Ch.)

VIII. SPECIAL (BRITISH) SCHOOL GAMES

The Eton Wall Game.—Though both Rugby union and association are played at Eton at certain times, the college has retained two entirely distinct games called the wall game and the field game. The wall game owed its origin to the presence of a high wall enclosing part of the college grounds along the road from Windsor to Slough. The area of play comprises a strip of ground running along the wall. At each end there is an area known as "calx" equivalent to the in-goal area in Rugby. One end is called "good calx" and the other "bad calx," and goals are marked at the back of each calx. The teams are of 11 a side, 5 players on each side forming down against the wall in "bully" or scrummage and the others taking up positions outside the bully. The ball is put into the bully at the start of the game and whenever it goes out of the area of play, and the object is to work the ball along the wall with the feet into the calx. When the ball has been forced into calx the attacking side tries to gain a "shy," which is accomplished by a player lifting the ball with a foot against the wall and touching it there. This achieved, the ball may then be "shied" at goal. A goal outweighs any number of shies.

The Eton Field Game.—In the field game the usual number of players is 11 a side but more may be included. The game is played on a large field with goals of a type similar to but smaller than association goals. The chief features of the play are the bully, resembling an attenuated Rugby scrum, dribbling by the forwards who form the greater part of the team and long and accurate kicking by the "behinds" or backs. A goal may be scored either by an ordinary shot or by forcing a "rouge." A rouge resembles a

try in Rugby, being scored by an attacker touching the ball down behind his opponents' goal line. The ball is then brought out and a bully formed in front of goal and the attackers endeavour to force the ball through the goal. A goal scores 3 points and a rouge from which no goal is scored 1 point.

The Harrow Game.—The Harrow game is comparatively simple in principle and play. It consists mainly of dribbling by the forwards and long kicking by the backs. Two sets of posts are set up at each end of the field but there are no crossbars and a goal or "base" as it is called is scored when the ball passes between them at any height. The ball may not be handled but it may be caught from a kick, after which the catcher must either kick it or drop it and begin dribbling it. Players must keep behind the ball; otherwise they are off side except in certain circumstances similar to those recognized in Rugby. The most skilful player is the one who can keep the ball under closest control when dribbling. Teams usually are 11 a side but may be increased or decreased according to circumstances.

The Winchester Game.—The pitch for the Winchester game is much smaller than those used for Rugby or association, being only about 80 yd. long and 25 yd. wide. There are no goal posts, a goal being scored when the ball is forced beyond the end lines. This is not as easy to accomplish as it sounds, for the ball may not be kicked more than five feet in the air except when it comes rolling or bouncing toward a player direct from an opponent, a player is off side if he is in front of the ball and passing is illegal. The main feature of the play is the "hot," which is rather like an old-time Rugby scrum and takes place at the start of play or whenever the ball goes out of play. Dribbling forms no part of the game and almost the sole business of the backs is to kick hard and straight. In spite of the small area of play the game is most exacting and calls for endurance, speed and quickness. (F. I. W.)

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(L. M.; A. DA.)

FOOTE, ANDREW HULL (1806–1863), U.S. admiral and Union commander during the American Civil War, was born at New Haven, Conn., Sept. 12, 1806. His father was Samuel Augustus Foote (1780–1846), a prominent lawyer and Whig politician who as U.S. senator moved in 1829 "Foote's resolutions" on public lands, in the discussion of which Daniel Webster made his "reply to Hayne." Andrew Foote entered the U.S. navy in 1822, and was commissioned lieutenant in 1830. After cruising around the world (1837–40) in the "John Adams," he was assigned to duty in Philadelphia and later (1846–48) to the Boston navy yard. In 1849 he was made commander of the "Perry," and engaged for two years in suppressing the slave trade on the African coast. In 1856, as commander of the "Portsmouth," he served on the East India station, under Commander James Armstrong, and he captured the Barrier Forts near Canton. From Oct. 1858 to the outbreak of the Civil War, he was in charge of the Brooklyn navy yard, becoming a full captain in 1861. In Aug. 1861 he was assigned to the command "of the naval operations upon the Western waters." His exploit in capturing Ft. Henry (on the right bank of the Tennessee river) from the Confederates, on Feb. 6, 1862, without the co-operation of General Grant's land forces, who had not arrived in time, was a brilliant success; but their combined attack on Ft. Donelson (12 mi. off, on the left bank of the Cumberland river), to which most of the Ft. Henry garrison had escaped, resulted, before its surrender (Feb. 16), in heavy losses to Foote's gunboats, Foote himself being severely wounded. In March–April he co-operated in the capture of New Madrid and Island No. 10. In June he retired from his command and in July was promoted rear admiral, and became chief of the bureau of equipment and recruiting. On June 26, 1863, he died in New York city.

See the *Life* (1874) by James Mason Hoppin (1820–1906).

FOOTE, ARTHUR WILLIAM (1853–1937), U.S. organist, pianist and composer, a prominent member of the Boston group of composers inspired by German romanticism, was born in Salem, Mass., on March 5, 1853. He studied with J. K. Paine at Harvard university and in 1875 was the first American recipient of a master of arts degree in music. He lived most of his life in Boston, where he was active as pianist, organist and teacher. Of his compositions the most enduring are the *Suite for Strings* in E major (1909) and *A Night Piece* for flute and strings (1914). He also wrote several cantatas (*The Farewell of Hiawatha, The Wreck of the Hesperus, The Skeleton in Armor*), three string quartets, two piano trios, a piano quartet, a piano quintet and a large number of songs. He died in Boston on April 8, 1937. His autobiography was privately published in 1946. (N. SY.)

FOOTE, SAMUEL (1720–1777), English actor, wit and playwright, who had an astonishing gift for mimicry, was born at Truro, the son of a prosperous Cornish magistrate. He attended Worcester college, Oxford, but left without taking a degree. Then, "designed for the law," he established residence in the Temple, but in 1744, having dissipated his inheritance, turned to the theatre. His first efforts as an actor were not successful, but while playing Bayes in the *Rehearsal* he demonstrated his ability as a mimic. In 1747, therefore, he opened the Haymarket theatre with a series of farcical entertainments called *Diversions of the Morning*, in which he ridiculed other actors and celebrities. Later, to avoid the restraints of the Licensing act, he called his entertainments "teas." After 1753 he returned occasionally to the regular stage, playing in Dublin and Edinburgh as well as in London; but again he was unsuccessful except in his own plays, which, like his "teas," depended on topical allusions and upon his gift for mimicry. Foote was adept in exploiting any event for his purposes, even his own misfortune. In 1766 he fell from a horse and broke his leg, which had to be amputated. Characteristically, he turned this to account by writing *The Devil on Two Sticks* and *The Lame Lover*. Another consequence of this misfortune was that the duke of York, who was responsible for the accident, secured for Foote a life-patent for the Haymarket, which permitted him to continue his performances there without resorting to subterfuge.

Foote was doubtlessly a man of many talents, but his mind was of such a cast that he was incapable of employing them except for purposes of savage attacks upon others. David Garrick, who frequently befriended him, avoided public ridicule only through flattery. Samuel Johnson, who considered Foote's wit "irresistible," was obliged to threaten physical chastisement. In 1777, however, he met his match. Agents of the notorious Elizabeth Chudleigh, duchess of Kingston, whom Foote had satirized in *The Trip to Calais* and *The Capuchin*, retaliated with such persistence that he was compelled to quit the stage. He died at Dover on Oct. 21, 1777, and was buried in Westminster abbey.

In addition to the plays mentioned, Foote's best-known productions are *The Author, The Minor, The Maid of Bath* and a piece for puppets entitled *Piety in Pattens*.

See M. M. Belden, *The Dramatic Works of Samuel Foote* (1929).

(M. RS.)

FOOTINGS: *see* FOUNDATIONS, STRUCTURAL.

FOOTSCRAY, a suburb of Melbourne, Victoria, Austr., lies on the Maribyrnong river. Pop. (1961) 60,734. It is an important manufacturing centre with sugar, flour and woolen mills, tanneries, an abattoir, chemical and engineering works, in addition to factories producing munitions, paint, rope, soap, clothing, household appliances, furniture and agricultural implements. The municipality, which was proclaimed a city in 1891, is named after Footscray in Kent, Eng.

FOPPA, VINCENZO (*c.* 1430–1515/16), Italian painter, leading figure in 15th-century Lombard art, was born at or near Brescia between 1427 and 1430. His earliest dated work is a dramatic painting of the "Three Crosses" in the Accademia Carrara at Bergamo (1456). Among the sources of Foppa's early style were the paintings of Jacopo Bellini and the Cremonese Gothic painter Bonifazio Bembio, and northern manuscript illuminations; after about 1460 he seems to have come in contact with the work of Andrea Mantegna at Padua. Patronized by Francesco and Galeazzo Maria Sforza, he was employed in 1463–67 at the Certosa at Pavia, and he completed, probably by 1468, the first and greatest Lombard fresco cycle in the Portinari chapel in S. Eustorgio in Milan.

A celebrated fresco of "The Martyrdom of St. Sebastian" (1485) from Sta. Maria di Brera, Milan (Brera gallery, Milan), inspired by Bramante, affords a measure of Foppa's success in forging a Lombard Renaissance style. As a panel painter on a monumental scale Foppa's development can be traced from a polyptych of about 1476 painted for Sta. Maria delle Grazie at Bergamo (Brera gallery), through altarpieces at Pavia (*c.* 1486) and Savona (1489/90), to the splendid "Adoration of the Magi" (about 1500; National gallery, London). Foppa died between May 3, 1515, and Oct. 16, 1516.

An artist of exceptional integrity and power, Foppa exercised a formative influence on the work of Butinone, B. Zenale, A. Borgognone and most of his younger Milanese contemporaries. In Milan his style was superseded by that of Leonardo da Vinci, but at Brescia, where he resided after 1490, its effect was more enduring, and it is reflected in the 16th century in the paintings of G. Savoldo.

See C. J. Ffoulkes and R. Maiocchi, *Vincenzo Foppa* (1909); F. Wittgens, *Vincenzo Foppa* (1945). (J. W. P.-H.)

FORAIN, JEAN LOUIS (1852–1931), French painter and graphic artist who succeeded Honoré Daumier as the outstanding illustrator of his day, was born at Reims on Oct. 23, 1852. As an artist he was largely self-taught. A protégé of E. Degas, he exhibited with the Impressionists, but was from the first more attracted by graphic media.

He made his first etchings in 1876 and, although from about 1890 it was lithography that principally occupied him, he returned to etching in 1908. His work was popular and well suited to reproduction in large numbers. He contributed satirical and humorous drawings to *Le Rire, L'Echo de Paris, Le Figaro, Le Monde Parisien* and other journals. Whatever the medium, Forain took his subjects from the world of the prosperous Parisian bourgeoisie —the exchange, the law courts, the cafés, the artists' studios, the theatres, the demimonde—with a particular emphasis on the disreputable. His attitude was critical, pessimistic and a little cynical, but human behaviour was endlessly fascinating to him. In style and subject matter alike, Forain remained deeply indebted to Degas, and to a lesser extent to Daumier. Toward the end of his life he etched and painted religious subjects. He died in Paris on July 11, 1931. (A. Bs.)

FORAKER, JOSEPH BENSON (1846–1917), U.S. political leader, was born near Rainsboro, Highland county, O., on July 5, 1846. After a farm boyhood and three years of military service in the American Civil War he attended Ohio Wesleyan university for two years and then transferred to Cornell university, where he graduated in 1869. He was admitted to the bar at Cincinnati in the same year. He served as a judge of the Cincinnati superior court from 1879 to 1882, governor of Ohio from 1885 to 1889 and U.S. senator from 1897 to 1909. His political life was marked by intense partisanship, a "fire alarm" oratory, a strong appeal to the soldier vote, and a long rivalry with Marcus A. Hanna, a fellow Ohioan. As senator he gave vigorous support to the Spanish-American War (1898) and to territorial expansion, and was author of the Foraker act of 1900 that provided civil government for Puerto Rico. He clashed with Pres. Theodore Roosevelt over the Hepburn act for the regulation of railroads and over the president's summary discharge of certain Negro troops after the Brownsville raid of Aug. 13, 1906. Newspaper charges in 1908 that he had improperly received money from the Standard Oil company led to his retirement from politics. He died in Cincinnati on May 10, 1917.

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FORAMINIFERA (FORAMINIFERIDA), a widespread order of essentially marine animals of the phylum Protozoa (*q.v.*). They are characterized by having filose and often anastomosing pseudopodia that extend from a uni- or multinucleated protoplasmic body encased within a test, or shell. Depending on the species the test ranges in size from minute to over two inches in diameter and varies in shape, number of chambers, chemical composition and surface ornamentation (fig. 1). An important constituent of the present-day planktonic (floating) and benthonic (bottom-dwelling) microfaunas, foraminifera have an extensive fossil record, which makes them particularly useful in the analysis and correlation of subsurface marine strata and, hence, in petroleum exploration. The name "Foraminifera" refers not to the external pores found in some species but to the "foramina" (larger openings, or apertures) left between adjacent chambers when a new chamber envelopes a previous one.

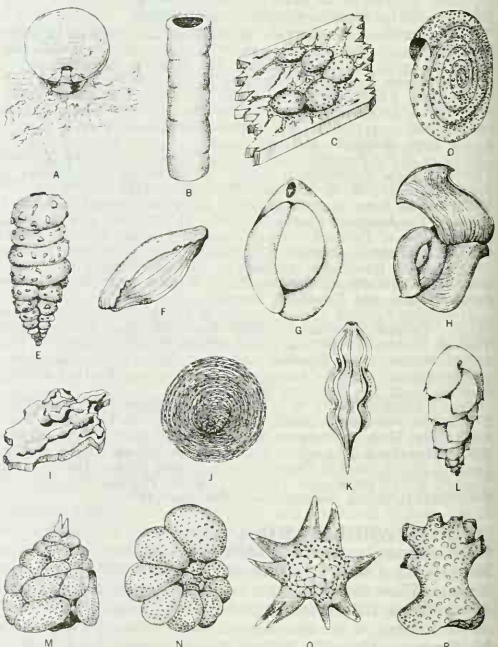


FIG. 1.—TYPES OF FORAMINIFERA

(A) Living animal with extended pseudopodia, single nucleus and transparent organic test (Allogromiidae, 0.2 mm.). B–P are empty tests; (B) agglutinated sponge spicules (Rhizamminidae, 20 mm.); (C–E) agglutinated sand grains (Saccamminidae, 2 mm.; Ammodiscidae, 2 mm.; Textulariidae, 0.8 mm.); (F) complex calcareous (Fusulinidae, 4 mm.); (G–J) calcareous imperforate (Miliolidae, 1 mm.; Ophthalmidiidae, 1.5 mm.; Ophthalmidiidae, 2.5 mm.; Peneroplidae, 1.5 mm.); (K–P) calcareous perforate (Lagenidae, 1.5 mm.; Buliminidae, 0.5 mm.; Discorbidae, 0.25 mm.; Rotaliidae, 0.3 mm.; Calcarinidae, 1 mm.; Homotremidae, 1.5 mm.)

DISTRIBUTION AND IMPORTANCE

Present Distribution.—Foraminifera inhabit practically all marine waters, but a few invade brackish waters and, very rarely, waters of negligible salinity.

Benthonic species live at almost all depths and on any surface that bears suitable food and affords protection for effective pseudopodial activity. A careful examination of the current-sheltered surfaces of rocks as well as of sessile plants and animals of shallow water and tide pools usually discloses hardy species of living foraminifera that are capable of surviving the rigorous environmental fluctuations they encounter there. The existing knowledge of the living organisms is based largely upon such species. Benthonic foraminifera, however, are most abundant in the offshore waters of medium depth that cover the continental shelf and upper part of the continental slope. With sufficient light for the abundant production of plant life, upon which all foraminifera are either directly or indirectly dependent, and with other environmental conditions generally more stable than in shallower waters, such communities often become so rich that at times conspicuous strand-line deposits and, occasionally, entire beach surfaces (Caroline Islands, Hawaii, Bali) are formed in large part of the empty tests of foraminifera washed ashore. At lower depths, where conditions are still more uniform but where food supplies are less abundant and diverse, the foraminiferan fauna contains both fewer species and fewer individuals. On the deep-sea floor further reduction accompanies the greatly increased pressure and the slight rise in acidity found there.

Planktonic species, representing only two families, are far less numerous than benthonic ones, but the number of individuals representing a given species may be enormous and far more widely distributed. They are most abundant in warm open seas and soon die when blown into shallow waters. Their empty calcareous tests, which rain down from surface layers, are a major constituent of the so-called "globigerina ooze" that covers about 30% of the present ocean floor, an area that would undoubtedly be extended if the tests did not dissolve at extreme depths.

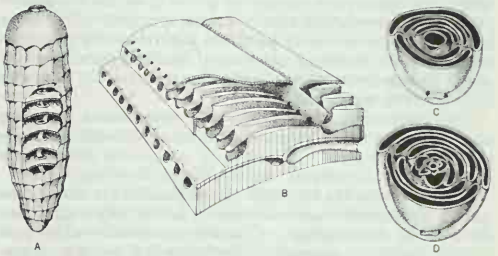
The major factors governing the growth, reproduction and distribution of foraminifera are the temperature, depth and salinity of the water; the availability of suitable food; the nature of the substratum; and the supply of oxygen. Some species are endowed with the ability to tolerate wider variations in these factors than are others. As a natural result of their hereditarily limited adjustment to the environment, the foraminiferan population of present seas consists of six recognizably different faunas, four in warmer and two in colder waters.

Geological Importance.—While living foraminifera are abundant and widespread in modern seas, their fossil occurrences are even more impressive. Their tests are found in many of the marine strata that underlie more than two-thirds of the world's existing land areas and often serve to indicate the surprising extent of past seas; for example, a 200-ft. thickness of Eocene foraminiferan limestone occurs at the 22,000-ft. level on Mount Everest. (See *Fossil Record*, below.)

In sequences of marine sediments individual fossils, and the distinctive combinations in which they occur, are frequently more valuable than the inorganic components of strata in deducing past geographic and environmental relationships, in identifying and distinguishing between lithologically similar strata and in correlating and assigning relative ages to strata. Specifically, fossils: (1) exhibit far greater interpretable diversity; (2) reflect more sensitively the environmental conditions under which they developed; and (3) are a part of an organic evolutionary sequence that by its very nature is more complex and can more readily be correlated with other environmentally or chronologically significant features of the sedimentary record. The foraminifera are frequently more useful than other fossils in such analyses, especially in those related to petroleum exploration, because of (1) their widespread and abundant occurrence, particularly in the fine-grained sediments of offshore, medium-depth origin, which are often devoid of larger fossils; and (2) their convenient size: sufficiently small to be recovered intact and in large numbers during oil drilling operations, yet not too small to be quickly and easily examined with relatively simple microscopical techniques. *See* also MICROPALEONTOLOGY; PETROLEUM.

STRUCTURE AND FUNCTION

The Test.—While the tests of most foraminifera are microscopic, or almost so, some are spectacularly large for Protozoa. Tests of a South Pacific species are large enough to be used as jewelry by oceanic islanders, but still larger ones occur as fossils; for example, the "nummulites" from the Eocene limestones of the Egyptian pyramids often exceed one or two inches in diameter.



(B) MODIFIED FROM M. REICHEL, "ECLOGAE GEOLOGICAE HELVETIAE," VOL. 24

FIG. 2.—INTERNAL FEATURES OF TEST

(A) Wall of *Siphogenerina* partly dissected to show chambers and supports; (B) small segment of complex megascopic test of alveolinellid foraminifer showing internal divisions of two chambers; (C) megalospheric test of *Pyrgo* showing large proloculus and biloculine chamber arrangement; and (D) microspheric test of *Pyrgo* showing small proloculus and changing plans of growth (multiformity)

The tests consist of from one to many chambers of basically globular, ovoidal, crescentic, annular or tubular form. In multichambered species these chambers are arranged about radial, rectilinear, spiral or irregular growth axes. Superimposed upon this diversity and that resulting from the innumerable combinations of test structure, form and composition, is a broad spectrum of superficial detail (ridges, spines, etc.) and an array of internal complexities (partitions, structural supports, wall laminations and canal systems). Some tests have a single major opening, or aperture, through which the protoplasm emerges, but others have several. In addition, the tests of many calcareous species are penetrated by smaller openings, or pores.

Simple organically composed tests appear in a few primitive species, but most species add inorganic materials as well, either by cementing foreign objects (sand grains, mica flakes, shell fragments) gathered from the sea floor by the pseudopodia to form tests of either haphazard or precise design (in agglutinating species) or by secreting calcium carbonate—rarely silica—upon the organic base of the test (in calcareous species). Foreign substances so selected, and the cements employed in their fixation, often impart a distinctive coloration to agglutinated tests, as do chemical impurities to the calcareous tests. The light-transmitting qualities of the test and the structure of its wall vary with the physical form and orientation of the secreted elements. Pores normally penetrate the inorganic layers of tests having radially arranged crystals of calcite but are lacking in those having walls of felted crystals.

The Living Animal.—The test is, for the most part, filled with actively streaming protoplasm that externally forms either a localized mass around the aperture(s) or a coating over the entire surface of the test. Pseudopodia may arise directly from the protoplasm contained within the test and then pass through the pores or the aperture(s), but they may also arise directly from the external protoplasmic layer or the mass that accumulates around an aperture. The pseudopodia are never lobose and lack axial stiffenings. Protoplasmic granules, moving along ever-changing pathways, flow in both directions, even at the attenuated extremities of the pseudopodia. Although the stream patterns are relatively simple within separate threadlike pseudopodia, those within intricate pseudopodial webs are among nature's most complex. The pseudopodial locomotion effected by most benthonic species, in marked contrast to the extensive passive dispersal of planktonic

species by oceanic currents, seldom exceeds a few inches per day or a few feet in the individual's lifetime; moreover, numerous forms lead a partially or totally sessile existence.

Food substances—unicellular algae, algal spores, bacteria, other microorganisms and organic debris—are collected and transported by the pseudopodia, which also participate prominently in test formation, respiration and excretion. While some species are most discriminating in their choice of food materials, others are omnivorous, occasionally even spectacularly subduing and ingesting active ciliates, worms and copepods. Digestion generally occurs within the test in most species but probably within the pseudopodia of species having restricted test apertures. The green, brown, orange or red colour frequently imparted to the protoplasmic body by its numerous inclusions of food and metabolic products is obvious through colourless, transparent tests but is masked by coloured or opaque ones.

The protoplasm contains from one to many nuclei, depending upon the individual's developmental condition. Though constantly swirled about and easily deformed by cytoplasmic currents, the nuclei are typically spherical or ovoidal, and often large.

Growth requires the formation of new chambers in multilocular species, but in the few unilocular species having only organic tests the envelope itself expands. Chambers are usually added periodically, frequently seasonally, a few hours to a day or more normally being required for the construction of one chamber. Most benthonic foraminifera partially or wholly bury themselves in accumulations of algae and organic debris upon which they feed and under the protection of which they construct new chambers and produce young.

While life's hazards are undoubtedly reduced by the habits many species display of burying themselves, squeezing into minute natural cavities and forming low-lying tests firmly affixed to flat surfaces, foraminifera, as part of the microfauna, are the natural prey of the many larger organisms that feed indiscriminately upon any available organic matter on the sea floor. Furthermore, foraminifera are often attacked by parasitic or scavenging bacteria, protozoans and nematodes. In tropical waters they often harbour algae that are presumably symbiotic.

THE LIFE CYCLE

Although some species reproduce exclusively by asexual means, both biological and paleontological evidence indicate that regular or occasional interpolation of a sexual generation is more usual.

Reproduction.—Reproduction usually occupies but one to three days of the individual's life span, which, in turn, varies with the size of the animal and the complexity of its development. Small species may complete an asexual or a sexual generation within a two-week period, both within a month, but larger species often require several months for each generation and a year or two for both. A regular alternation of generations, not infrequently on a seasonal scale, has been observed in several species. Although rare exceptions exist, reproduction normally terminates the parent's life, since all its protoplasm is generally devoted to the formation of young.

Asexual Reproduction.—Asexual multiplication by budding or by the fragmentation of the parental protoplasm and test is known in a few simple species, but multiple fission of the entire parental body, accompanied by the formation of new juvenile tests and the abandonment of the parental test, is more typical. The early chambers of new tests often develop before the young leave the parent.

Sexual Reproduction.—Sexual reproduction involves the division of the parental protoplasm into either flagellated or amoeboidal sex cells (gametes), which subsequently pair to produce an amoeboidal zygote from which the next asexual generation develops. Here, too, the parental tests are abandoned and new juvenile tests are formed about the developing zygotes. The adults of some species liberate their gametes haphazardly into the sea where their chances of successful union are often slim, but others pair first and jointly form a reproductive cyst or brood chamber into which their gametes are liberated and within which the young subsequently undergo their early development. Sexually pairing adults seldom

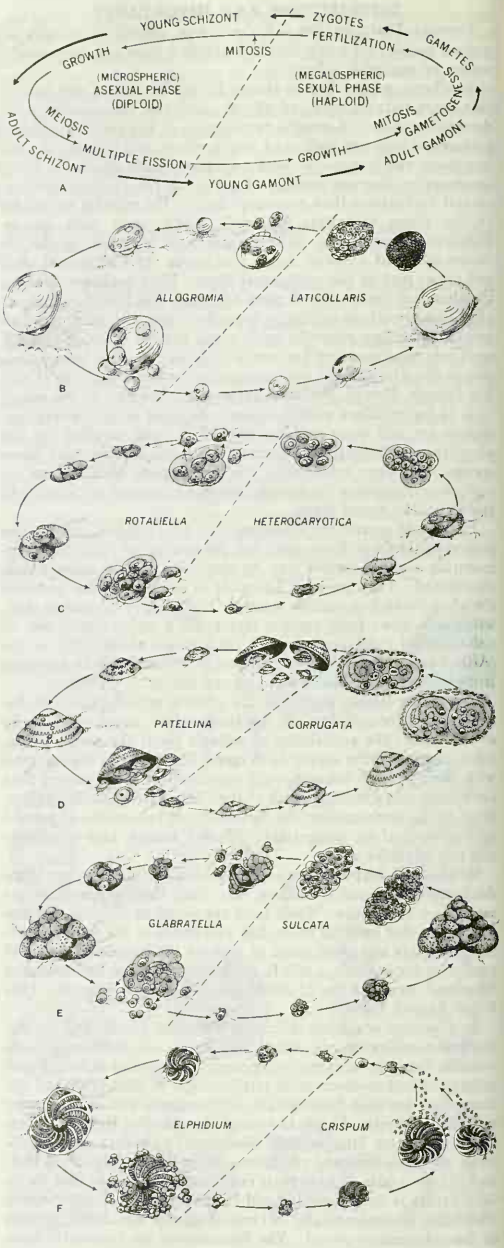


FIG. 3.—LIFE CYCLES OF FORAMINIFERA

(A) Generalized pattern of typical life cycle as illustrated in parts B–F: (B) singlechambered species with simple test and (C) multichambered species with calcareous test in which amoeboidal gametes from a single parent pair to produce young microspheric schizonts of the next (asexual) generation; (D–F) multichambered calcareous species in which adults either pair and produce amoeboidal gametes (D and E) or liberate free-swimming flagellated gamates that fuse externally to form young schizonts (F). After various authors

differ in general morphology, although they may differ in size. In addition, basic differences in their physicochemical constitution cause them to assume different roles in the sexual process. Moreover, while the gametes of a given species are identical in appearance, they too may vary functionally. In some species fusion occurs only between gametes derived from different parents; in others the gametes of a single parent routinely unite to initiate the new generation.

Alternation of Generations.—*Nuclear and Chromosomal Relationships.*—The complete life cycle, involving both a sexual and an asexual generation, includes one sequence of nuclear multiplication during which the chromosomal complement is reduced to the haploid number (meiosis) and two or more multiplications (involving either the haploid or the diploid complement) during which it remains unaltered (mitosis). In addition, these sequences are often embellished by the differentiation and usually spectacular demise of a somatic nucleus, which is separated from the reproductive nuclear lineage and becomes a conspicuous, though ephemeral, element of the protoplasmic body.

In the sexual generation intensive nuclear multiplication, involving no change in chromosome number, is immediately followed by the production of tens, hundreds or even thousands of gametes from an animal that is characteristically uninucleate throughout its vegetative life. Both the original nucleus and its numerous descendants—the entire sexual generation, in fact—contain the reduced (haploid) chromosomal number, since they develop from nuclei that undergo chromosomal reduction immediately prior to the asexual process of multiple fission by which alone a sexual generation may arise. As a result of the fusion of gametic nuclei during sexual reproduction, however, the next generation, with its invariably asexual reproductive destiny, initially bears the diploid number. The animals of the asexual generation, in striking contrast to those of the sexual generation, become multinucleate at or shortly after birth and remain so.

Although asexual reproduction inevitably follows reduction in chromosome number and both must precede a sexual generation, in some species one or more asexual generations may intervene before reduction occurs; indeed, in some forms reduction division and the subsequent sexual generation are lacking altogether.

Dimorphism.—While the tests produced during the asexual generation of some species, particularly the simpler ones, are indistinguishable from those of the sexual generation, those of an appreciable number of living species exhibit obvious differences in such features as the size of the initial chamber (proloculus), the number and arrangement of chambers (particularly the earlier ones) and the over-all size and external proportions of the test. In species exhibiting dimorphism, the test of the sexual generation is typically smaller but has a larger proloculus than that of the asexual; on the basis of the size of the proloculus the tests are termed "megalospheric" and "microspheric." Fossil associations of foraminifera often contain tests that differ only in the abovementioned features and are, on principle, considered to represent the two different generations within the life cycle of a single species.

Summary.—The life cycle of many foraminifera includes an alternation between morphologically and functionally different generations. The uninucleate megalospheric animals of the sexual phase are haploid and ultimately produce either amoeboidal or flagellated gametes that pair among themselves or with those from other adults, thus initiating an asexual generation, which is represented by multinucleate microspheric animals whose diploid nuclei undergo meiosis just before the multiple fission that initiates the next sexual generation. In principle, such a cyclic alternation between a haploid sexual and a diploid asexual generation parallels that encountered in numerous lower plants and plantlike Protista.

EVOLUTION AND CLASSIFICATION

Evolutionary History.—The exceptionally rich fossil record of the foraminifera portrays the gradual emergence of these animals from simple beginnings and depicts the full expansion of individual lineages at varying speeds into every available niche in the marine environment. It clearly records the existence of differences in the evolutionary potential of these lineages and in their sensitivity to their environment. Elaborate, highly specialized forms often rose to positions of dominance which they held for a time but dramatically relinquished to less spectacular but better adapted successors when environmental changes occurred to which the former were no longer adapted.

The history of the group is enriched by the not infrequent occurrence of parallel sequences of evolutionary changes in features common to two otherwise dissimilar and unrelated lineages. On occasion, too, it is complicated by converging changes to produce forms that superficially resemble one another in spite of marked hereditary differences. Since the individual foraminiferan test mirrors many aspects of the hereditary milieu from which it arose, its detailed examination frequently reveals clues to the evolutionary history of its lineage. This is particularly true of multiform tests (fig. 2[C] and 2[D]), those embodying two or more different plans of growth. Of these, the microspheric form, representing the diploid asexual generation, tends more faithfully to record past developments.

Fossil Record.—Pre-Cambrian records of this order are highly questionable, but from the early Paleozoic onward the record is clearer. Several distinctive lineages appeared in the early Paleozoic, but foraminifera, principally as agglutinating species, first became abundant in the Carboniferous period. With the rise of the fusulinids, often of megascopic dimensions, their numbers reached rock-building proportions over large areas during the late Paleozoic. Later, meagre Triassic faunas expanded in the Jurassic, but the widespread expansion of Cretaceous seas witnessed a phenomenal resurgence and diversification, particularly among calcareous species, that has not yet lost its momentum. The extensive chalk deposits of the Cretaceous (chalk cliffs of southern England, for example), composed largely of materials derived from foraminiferan tests, suggest that the pelagic life of Cretaceous seas was often dominated by minute planktonic foraminifera. Several species of large, highly specialized forms developed at this time but disappeared before the Cenozoic era. Two even more spectacular groups of large forms, the nummulites and orbitoids, flourished in warm Eocene seas, but these, too, were relatively short-lived. By Miocene time, smaller foraminifera were again dominant and the fauna was becoming unmistakably modern in many aspects.

Classification.—The order Foraminifera, which may be subdivided into 8 superfamilies, at least 50 families and about 1,000 genera, includes about 20,000 species, of which considerably more are known as fossils than as living organisms. There are differences of opinion among both zoologists and paleontologists as to the actual constitution of the order, but these must await the results of further research for resolution.

See also references under "Foraminifera" in the Index volume.

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FORBES, DUNCAN OF CULLODEN (1685–1747), Scottish statesman whose loyalty to the Hanoverian monarchy did much to ensure the collapse of the 1745 Jacobite rebellion, was born near Inverness on Nov. 10, 1685, the son of the genealogist Duncan Forbes. He studied at Edinburgh and Leiden, passed advocate (1709) and became sheriff depute of Midlothian (1714) and advocate depute (1716). The influence of the Argyll family and Forbes's loyalty to the Hanoverian cause during the rebellion of 1715 secured his rapid advancement and he became M.P. for Inverness burghs (1722), lord advocate (1725) and lord president of the court of session (1737).

On the first rumour of the 1745 rising Forbes hastened to Inverness. He kept the town loyal, and, partly through his influence with their chiefs, the clans of Macdonald and Macleod did not take the field for Charles Edward. After the battle of Prestonpans (Sept. 1745) and the departure south of Sir John Cope, commander in chief, Forbes was the main representative of government in the north. He worked hard to maintain order, but ad-

vances of arms and money were tardy and his own resources were not equal to the emergency. After the battle of Culloden (April 1746), his efforts to mitigate the punishment of the rebels brought him into disfavour in London. He died at Edinburgh on Dec. 10, 1747. His statue by Louis Roubillac stands in the parliament house, Edinburgh.

Some years before the 1745 rebellion Forbes had urged the government to form Highland regiments which should be commanded by colonels of impeccable loyalty but officered by native chieftains. In 1739, with the approval of Sir Robert Walpole, the original (1729) six companies, locally enlisted, of the Black Watch were increased to ten and were formed into what later became the famous "42nd" regiment of the line.

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FORBES, EDWARD (1815–1854), British naturalist who made an important analysis of the distribution of the plant and animal life of the British Isles as related to certain geologic changes. He was born at Douglas, Isle of Man, on Feb. 12, 1815. He studied medicine at Edinburgh, and in 1833 made a tour in Norway, the botanical results of which were published in J. C. Loudon's *Magazine of Natural History* for 1835–36. In 1836 he forsook medicine for natural science, and after a winter of lectures in Paris, he went to Algiers to study land and fresh-water Mollusca. In 1838 appeared his *Malacologia Monensis,* a synopsis of the species of Manx Mollusca, and in 1841 his *History of British Starfishes.* From 1841 to 1842 he investigated the botany, zoology and geology of the Mediterranean region, the results being made known in his "Report on the Mollusca and Radiata of the Aegean Sea, Presented to the British Association in 1843" and in *Travels in Lycia* (1847). In 1842 Forbes became curator of the museum of the Geological Society of London, in 1843 professor of botany at King's college and in 1844 paleontologist to the Geological Survey of Great Britain. Two years later he published in the *Memoirs* of the Geological Survey, i, 336, his important essay "On the Connexion Between the Distribution of the Existing Fauna and Flora of the British Isles, and the Geological Changes Which Have Affected Their Area," in which he maintains that the plants of Great Britain may be divided into five well-marked groups and that the majority of them, like the terrestrial animals, migrated to those islands over continuous land at three distinct periods, before, during and after the glacial epoch. In 1851 Forbes became professor of natural history to the Royal School of Mines, and in the following year published the fourth volume of Forbes and S. Hanley's *History of British Mollusca* and his *Monograph of the Echinodermata of the British Tertiaries* (Palaeontographical society). In 1854 he became professor of natural history at Edinburgh; he died on Nov. 18 of that year at Wardie, near Edinburgh.

See G. Wilson and A. Geikie, *Memoir of Edward Forbes* (1861); *Literary Papers,* ed. by Lovell Reeve (1855); *Forbes' Centenary Commemoration* by the London Manx Society (1915).

FORBES, JAMES DAVID (1809–1868), Scottish physicist, is best known for his researches on heat and on glaciers. He was born at Edinburgh on April 20, 1809. He studied at Edinburgh, became fellow of the Royal Society of Edinburgh (1828) and fellow of the Royal society (1832), professor at Edinburgh (1833–59), and principal of the United college at St. Andrews (1859–68). He died on Dec. 31, 1868.

Between 1836 and 1844 he published in the *Transactions of the Royal Society of Edinburgh* four series of "Researches on Heat," in the course of which he described the polarization of heat by tourmaline, by transmission through a bundle of thin mica plates, and by reflection from the surfaces of a pile of mica plates, and also its circular polarization by two internal reflections in rhombs of rock salt. In 1846 he began experiments on the temperature of the earth at different depths and in different soils near Edinburgh. Later he investigated the laws of the conduction of heat in bars, and his last piece of work was to show that the thermal conductivity of iron diminishes with increase of temperature. The Royal society awarded him the Rumford medal in 1838 and the Gold medal in 1843 for his work on heat.

He made several visits to Switzerland and also to Norway to study the flow of glaciers and developed a theory which involved him in some controversy with Tyndall and others.

FORBES, a municipal town of Ashburnham county, New South Wales, Austr., lies on the Lachlan river, 297 mi. W. of Sydney by rail. Pop. (1961) 6,826. The town has modern streets and buildings, playing fields, parks, churches, swimming pools and schools. There are sawmills, a flour mill, a butter factory, an animal food factory, light engineering works, regional abattoir and large cattle saleyards. The surrounding country provides good quantities of wheat, lucerne, wine, fruit and vegetables, and sheep and cattle are raised. Extensive irrigation from the Lachlan river has been carried out. (He. J. D.)

FORBES-ROBERTSON, SIR JOHNSTON (1853–1937), English actor who was considered the finest Hamlet of his time, was born in London on Jan. 16, 1853, the son of John Forbes-Robertson of Aberdeen, an art critic. Educated at Charterhouse school, he studied art before turning to the theatre in 1874, when he first appeared on the London stage as Chastelard in *Mary, Queen of Scots.* He acted with Samuel Phelps, the Bancrofts and John Hare, played opposite Mary Anderson in England and the United States and for some time was a leading member of Sir Henry Irving's company at the Lyceum. His first outstanding success was in Sir Arthur Pinero's *The Profligate* at the Garrick theatre in 1889, under the management of Hare. In 1895 he took over the management of the Lyceum, with Mrs. Patrick Campbell as leading lady, giving memorable performances of *Romeo and Juliet, Hamlet, Macbeth,* etc., and also producing John Davidson's *For the Crown* and Maurice Maeterlinck's *Pelléas and Mélisande,* in both of which his romantic style of acting was highly successful. In 1900 he married Gertrude Elliott, who became his leading lady, appearing with him in many plays, such as *The Light That Failed,* Madeleine Lucette Riley's *Mice and Men,* George Bernard Shaw's *Caesar and Cleopatra* and, one of his biggest successes, Jerome K. Jerome's *The Passing of the Third Floor Back.* Forbes-Robertson was knighted in 1913 and, after occasional appearances and a farewell tour in Canada and the United States, retired in 1915. He died on Nov. 6, 1937. His daughter Jean Forbes-Robertson (1905–62) became a distinguished actress. (W. J. M.-P.)

FORBIN, CLAUDE DE (1656–1733), French naval officer remembered for his brilliant exploits in Louis XIV's wars, was born at Gardanne in Provence on Aug. 6, 1656, of an old noble family. He began his career at sea on a galley belonging to a cousin. He was grasping, oversensitive of his honour and quarrelsome, but he was a magnificent fighter and a fine leader. After some experience in the Dutch War (*e.g.,* at Messina in 1675) and with Abraham Duquesne's expedition against Algiers (1683), he went on the French mission to the king of Siam, whom he served as grand admiral for two years (1685–87). Returning to France, he was commandant of a frigate at Dunkerque in (1689), when he was taken prisoner with Jean Bart (*q.v.*) by the English; they both escaped from Plymouth. With the rank of captain, Forbin took part in the comte de Tourville's battles at Barfleur, at La Hogue and at Lagos (1692–93). In the War of the Spanish Succession his squadron in the Adriatic cut the supply line of the imperial forces in Italy. He was then transferred to the Northern squadron based on Dunkerque (1706). He played havoc with the Dutch Baltic convoy off the Dogger bank in Oct. 1706; seized 22 English merchantmen and 2 men-of-war in May 1707; and captured 34 ships of the Dutch Muscovy convoy, which he claimed to have pursued as far as the Lapland coast, in June. In Oct. 1707, however, when he and René Duguay-Trouin attacked a large Anglo-Portuguese convoy off the Lizard point, the victory was incomplete and Forbin was accused of failing to co-operate. Finally, in 1708, he was given command of the fleet to carry James the Old Pretender to Scotland, though he thought the expedition inadequately prepared. When the enterprise came to nothing, his resignation was accepted. Forbin then retired to St. Marcel, near Marseilles, where he died on March 4, 1733. His lively but not always objective *Mémoires* were first published in 1730 (Eng. trans. 1731). (L. Ni.)

FORCE, in physics, may be defined, in a primitive appeal to muscular experience, as a push or a pull. Much of the world's work is done by force ingeniously applied and multiplied through ropes and rods by muscles or machines. Force has been defined more precisely as (1) the time rate of change of momentum, according to Sir Isaac Newton's principles of mechanics; or (2) the space rate of change of energy, a concept arising after Newton's time. The space-rate notion is particularly useful with respect to electric and magnetic fields, and gravitation. This article will treat broadly of mechanical and gravitational force, and more briefly of electromagnetic and nuclear force. More detailed discussions of force as related to specific fields may be found in MECHANICS; DYNAMICS; ENERGY; MECHANICS, FLUID; MOTION, PRINCIPLES AND LAWS OF; GRAVITATION; PARTICLES, ELEMENTARY; NUCLEUS; VALENCE; ELECTRICITY; MAGNETISM; QUANTUM MECHANICS.

Newton called the product of mass m and velocity v the quantity of motion, or momentum mv. He stated that the rate of change of momentum $d(mv)/dt$ (where t is time) is proportional to the net force F and takes place in the direction of the unbalanced force. With due respect to units of measurement, force may be expressed as $F = d(mv)/dt = m(dv/dt) + v(dm/dt)$. For objects moving at low speed, the rate of change in mass dm/dt may be regarded as vanishingly small, since the relativity increase of mass with velocity is negligible. This leaves $F = m(dv/dt) = ma$, where a is acceleration (the rate of change in velocity dv/dt).

Thus, in c.g.s. units, the unit force is the dyne, defined as imparting an acceleration of one centimetre per second per second to a mass of one gram. The unit force in the metre-kilogram-second system is the newton, which accelerates a mass of one kilogram at a rate of one metre per second per second (1 kg.-m./sec.^{2}). Another common unit, the pound-force, used by English-speaking engineers, is a force that imparts to a freely movable one-pound mass an acceleration of 32.17 ft./sec.^{2} The pound-force is also the weight (pull of earth's gravity) of a one-pound mass at sea level and standard latitude (45°).

Newton's law of action and reaction states that forces always act in pairs on different objects. The law denies the idea of force acting to accelerate only one object, even though it may be convenient to fix attention on an object as if it were isolated from its surroundings. By the principle of equal action and reaction, if two objects of mass m_1 and m_2 interact, as through a spring or by an explosion between them, there are produced mutually contrary accelerations a_1 and a_2 such that m_1a_1 equals the negative of m_2a_2. This fact is the basis for the important principle of conservation of momentum, fundamental in understanding the movement of such vehicles as rockets and jet aircraft.

Gravitation (unless viewed from the standpoint of general relativity) postulates a force of attraction between every pair of particles in the universe. Newton's law of gravitation states this succinctly as $F = G(m_1m_2)/r^2$, where G is the so-called universal constant of gravitation and r is the distance between particles of mass m_1 and m_2. This equation defines force in terms of the gravitating properties of objects, while the earlier (apparently independent) defining equation for force, $F = ma$, relates force to the inertial properties of objects. Yet, Newton showed by experiment that inertial and gravitational mass are equal, a fact verified to one part in 10,000,000,000 by R. Eötvös. Albert Einstein made the principle of equivalence of these two responses of matter a key postulate of his theory of general relativity, stating that it is impossible to distinguish between the effects of an acceleration and of a gravitational field.

Since the advent of man-launched satellites, much has been said about the condition of weightlessness encountered in space travel. Throughout its trajectory, any object in free flight is weightless, at least in the sense that the attractive force between earth and object is fully utilized in producing contrary accelerations in the attracting bodies. Within a space craft, a man experiences weightlessness whenever the accelerating force relating his body to the space craft is zero. Similarly, buoyancy vanishes in a vessel of liquid in free flight; a cork submerged in a vessel of water and released at the instant the vessel is dropped does not rise to the surface during the free fall of the vessel. Buoyancy depends upon the weight of the liquid.

Electric charges exert forces on other electric charges; masses gravitate to other masses. The concept of field, electrostatic or gravitational, has been found useful in treating these two types of force. At any point in the region of an electric charge or of a mass, a vector of field strength can be used to represent the force that would act on unit charge or unit mass placed at that point. The work done to move charge or mass in such fields depends only upon the change of position of a particle or object and not upon the path followed; such a field is said to be conservative and to have a potential. The field strength may be found by determining the gradient of the potential: the space rate of change of potential in any direction is a measure of the component of field strength in that direction. For example, the gravitational field strength of the earth near its surface is about 9.8 newtons per kilogram in a vertical direction, varying slightly with latitude, and becoming less intense as the distance from the earth's centre is increased (in keeping with the inverse r^2 in the law of gravitation).

The work done to move an object from point A to B against resistance, whether or not the field is conservative, is found as the line integral of the force F over the path followed:

$$\text{Work} = \int_A^B F ds \cos\theta$$

Here, ds is an increment of displacement; θ is the angle between F and the direction of displacement. Clearly, there are close relationships among force, work and energy which become especially important in dealing with nuclear forces, where direct measurement of force is impossible and where force must be specified in terms of energy changes.

When two or more forces act on a particle, their combined effect is found by vector analysis. Thus, forces $\mathbf{F}_1$ and $\mathbf{F}_2$ (fig. 1[A]) acting at O are equivalent to a single resultant force $\mathbf{R}$, as shown by vectors drawn to appropriate scale. Conversely, any force vector $\mathbf{F}$ may be resolved or broken down into two or more components whose net effect is that of the original force. Addition of forces by successive applications of this parallelogram method leads to a unique resultant. On the other hand, a force may be resolved in many ways, depending upon the choice of co-ordinate axes as in fig. 1(B), where the force vector $\mathbf{F}$ is shown resolved into three components, $\mathbf{F}_x = \mathbf{F}\cos\alpha$, $\mathbf{F}_y = \mathbf{F}\cos\beta$, and $\mathbf{F}_z = \mathbf{F}\cos\gamma$. If the coordinate axes were changed in direction, these individual components might change, but their resultant would remain unchanged.

Jean d'Alembert introduced the concept of inertial reaction forces, pseudoforces which reduce many problems in dynamics to problems in statics. The difference between the dynamic and static views may be seen where a pendulous ball of mass m is displaced from vertical by angle θ because of acceleration of a cart to which it is attached. For a stationary observer (fig. 2[A]), if g represents the acceleration of gravity, the tension T in the cord provides by its vertical component a force sufficient to support the weight mg, and by its horizontal component a force ma required to accelerate the ball. (Hence, tangent $\theta = a/g$.) However, for an observer moving with the cart (fig. 2[B]) the tension T, weight mg and reversed effective force $-ma$ are regarded as three forces in static equilibrium. Disregard of the earth's rotation by the

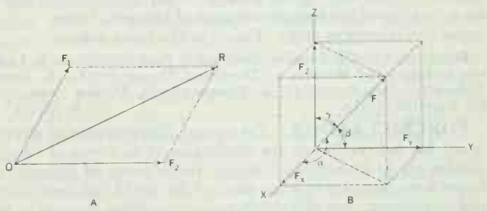

FIG. 1.—(A) COMPOSITION OF TWO FORCES; (B) RESOLUTION OF A SINGLE FORCE

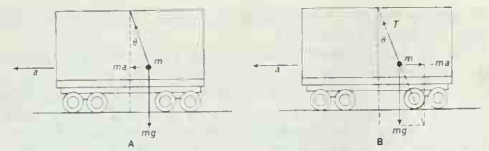

FIG. 2.—ANALYSIS OF FORCES (A) FROM THE POINT OF VIEW OF A STATIONARY OBSERVER; (B) FROM THE POINT OF VIEW OF AN OBSERVER MOVING WITH THE OBJECT

earth-bound observer leads in the D'Alembertian viewpoint to the invention of useful but fictitious centrifugal and Coriolis forces that permit exact description of motions in the rotating frame of reference as if it were an inertial frame in which Newton's laws of motion hold (*see* RELATIVITY: *General Theory of Relativity*).

Although many sensitive devices have been made for measuring forces, such as the Cavendish balance for measuring the interaction of feeble gravitational forces of masses in the laboratory, generally the forces of interaction among atoms and molecules cannot be measured directly. These forces, together with the much larger forces of interaction among nucleons (neutrons and protons) in the atomic nucleus, can only be inferred from measured energy changes. Since force is believed active in causal relations, efforts to explain the common forces of nature have been made in many ways. For example, the forces holding atoms together in molecules have been explained chemically in terms of valence.

Modern physicists view natural forces as falling into four apparently distinct categories. Two of these are the familiar gravitational and electromagnetic classes. All forces encountered in ordinary experience are held to belong in one or the other class. It has been one of the great achievements of quantum mechanics to show that the forces holding an atom together, the forces binding atoms into molecules and molecules into liquids or solids, and the contact forces affecting macroscopic bodies are all electromagnetic.

The remaining two force classes are felt to exist only on the subatomic scale. The forces which hold atomic nuclei together are said to fall in the so-called strong interaction class. These nuclear forces, with a very short range of action, are extremely powerful, as evidenced by nuclear binding energies that are millions of times greater than atomic or molecular binding energies. In 1935 the Japanese physicist Hideki Yukawa predicted that the nuclear forces might be found to arise from an elementary particle which binds nucleons together. The π-mesons discovered over a decade later seem to satisfy his prediction. (*See* PARTICLES, ELEMENTARY: *Breakdown of Electrodynamics; Mesons.*)

The fourth force category is the so-called weak interaction class, responsible for the radioactive β-decay of nuclei, the radioactive decay of π- and μ-mesons, and various decay processes involving K mesons and hyperons. There are many indications for a hypothesis (the universal Fermi interaction) that the weak interactions responsible for this wide range of phenomena are closely related to one another. Weak interactions are the only ones known which fail to conserve the spatial symmetry property known as parity (*see* PARITY, LAW OF CONSERVATION OF).

The four classes of force can be ranked as follows in order of decreasing strength: nuclear (or strong), electromagnetic, weak and gravitational. Gravitational force, the first to be recognized explicitly, is intrinsically the weakest by far, and its gross effects are a function of the enormous masses of heavenly bodies.

See also references under "Force" in the Index volume.

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FORCED LABOUR. The virtual disappearance of slavery (*q.v.*) has not resulted in the elimination of all forms of forced, involuntary or compulsory labour; various forms of compulsory labour have persisted in many parts of the world and their extent and significance were still matters of international concern in the second half of the 20th century.

The problem has many sides to it, but it has aroused the most controversy in two forms: forced labour has demonstrably been used for a variety of reasons in totalitarian countries (*e.g.*, Nazi Germany, Communist China, Soviet Russia and the satellite countries in the Soviet orbit); forced labour has also been employed in the nonmetropolitan territories of colonial powers.

It is very difficult to distinguish on moral grounds between these two broad types. Whatever its type and whatever the purpose, political or economic, which it is deemed to further, there can be little doubt that recourse to forced labour is in sharp conflict with the basic requirements of both political and social democracy. The period after World War II was marked by a growing sense of this conflict; whether the fruits of forced labour were measured in terms of national development or private profit they were deemed to be reprehensible.

In creating this climate of opinion the International Labour organization (*q.v.*) played a leading and invaluable role. Its investigations did much to measure the extent to which different countries resorted to or condoned compulsory labour. Its work has, of course, met with difficulties and controversy. Governments have not all been uniformly willing to admit an independent inquiry into labour practices which might be adversely interpreted. The governments of the Soviet Union and most of its eastern European allies have never accorded open facilities, and much of what is known about forced labour in such countries has been elicited from private sources and from the scrutiny of official material. The Soviet Union, while persistently denying that forced labour has been an integral part of its political and economic system, has been active in pointing to the incidence of forced labour in nonmetropolitan and colonial territories. It has also, of course, joined with other powers in condemning the use of forced labour by the German Nazi government during World War II.

The uses to which forced labour is put cannot be exhaustively classified, nor indeed is it easy to provide a definition which does not bring in forms of compulsion (*e.g.*, prison labour or compulsory military service) which are generally accepted as being within the legitimate prerogative of modern governments.

The International Labour organization (ILO) since its foundation has been concerned with the problems of forced labour and has passed two conventions (international treaties), in 1930 and 1957, "outlawing" its use. In its 1930 convention no. 29, convention concerning forced or compulsory labour, it excluded from the category of forced labour: compulsory military service and, later, national service required of conscientious objectors; normal civic obligations and "minor communal services"; prison labour performed "under the supervision and control of a public authority"; and work in the case of *force majeure*. This term relates to work exacted "in the event of war or of a calamity or threatened calamity, such as fire, flood, famine, earthquake, violent epidemic or epizootic diseases, invasion by animal, insect or vegetable pests, and in general any circumstance that would endanger the existence or well being of the whole or part of the population."

The convention defined forced labour as "all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily." A similar approach was taken by the Dutch scholar, W. Kloosterboer, in the introduction to her comprehensive study *Involuntary Labour Since the Abolition of Slavery:* "We will term that labour compulsory from which the labourer cannot withdraw if he so wishes without being liable to punishment and/or for which he has been accepted without his willing consent. The motive for the imposition of this labour must moreover be to gain profit or have profit gained."

Two new developments after World War II in the continuing effort to suppress forced labour were the report in 1953 of the UN *ad hoc* Committee of Three and the 1957 ILO convention no. 105, convention concerning the abolition of forced labour. The 1953 report noted that more than 20 nations had been accused of resorting to forced labour for economic or political reasons. These countries included the United Kingdom, the U.S., South Africa, the U.S.S.R., Czechoslovakia and Communist China. It was observed that systems of forced labour existed in South Africa; that

forced-labour punishment was taking place in Spain; that in Malaya, Kenya and the then Belgian Congo rules existed which, if broadly applied, might give rise to a system of forced labour. Very careful attention was also given to the situation of the U.S.S.R. and in eastern Europe. The Soviet bloc boycotted the committee's work, but it was established on the basis of official Soviet publications that forced labour was an important instrument, not only of political coercion, but also of the economic structure. The committee could not investigate the situation in Communist China because copies of the appropriate rules and laws were not made available to them.

It should be noted, however, that after the *ad hoc* committee's report some of the severer features of the Soviet labour system were mitigated. Soviet sources indicate that about one-third of the corrective labour camps were converted, in 1956, to the relatively milder corrective labour colonies, following a series of rebellions and strikes in the main camp areas between 1953 and 1955.

The ILO convention passed in 1957 had been ratified by 57 member-states by the early 1960s and made applicable to 52 nonmetropolitan territories. It condemned the use of forced labour (1) as a means of political coercion or education or as a punishment for holding or expressing political views, or views ideologically opposed to the established social, political or economic system; (2) as a method of mobilizing or using labour for purposes of economic development; (3) as a means of labour discipline; (4) as punishment for having participated in strikes; (5) as a means of racial, social, national or religious discrimination. Of the Communist countries, only Poland had ratified the 1957 convention by the early 1960s.

The 1962 review by the ILO upon the operation of the convention observed that, despite various improvements, forms of forced labour "are still rife in many countries." Countries were cited in which "the expression of political opinions which do not conform to those held by the organization in power (or at least in one case on certain fundamental questions) is prohibited by various legal provisions which entail forced labour, contrary to the convention." These countries were the Republic of South Africa; Spain; the U.S.S.R.; and the United Arab Republic. In another group of countries (Burma; China; Republic of the Congo; Fiji; Kenya; Liberia; Northern and Southern Rhodesia; Portugal [overseas provinces]; Ruanda-Urundi [divided in 1962 into two separate nations, the Republic of Rwanda and the Kingdom of Burundi]; Solomon Islands; Sudan; and Swaziland) the law "expressly provided for the possibility" of compulsory labour in normal times on public works. The ILO declared that such requirements should be terminated.

Another section of the report pointed out that a group of countries—principally nonmetropolitan areas but including Denmark and India—provided in legislation for forced labour in public works in ways which unduly widened the concept of work for "minor communal services." In such cases work was permitted which was only indirectly of benefit to "the members of the community" from which the labour is exacted or which "is for the benefit of more than the village community." Clearly there is scope for detailed debate in each case on the problem of borderline instances of alleged forced labour.

Clearer instances of what falls, without much controversy, into the category of forced labour may be found in the changing pattern of usage; *e.g.*, forced labour used for transport in Asia and Africa. Progressively in the years following the 1957 convention such practices were suspended in, for example, Tanganyika and Gambia; but in India it appears that a regulation was imposed in 1953 (well after the end of British rule) permitting the use of compulsory labour for porterage in the Naga Hills.

The thoroughness of the ILO in dealing with the phenomenon may be gauged from the 1962 report of the committee appointed to examine charges made by the Ghana government concerning the use of compulsory labour in Portuguese Africa: Portugal had ratified the 1957 convention in Nov. 1960. The investigating committee found that in many fields the Portuguese authorities had since that date terminated labour recruitment through administrative authorities. But it observed that the Diamond company of Angola had continued to recruit labour "in a manner liable to involve compulsion and therefore to constitute forced labour." It could come to no firm view upon "the extent to which forced labour may have been used for road construction and maintenance."

Great importance was attached by the ILO to the development of competent forms of labour inspection as a way of reducing the possibility of undetected forced labour.

See also CONTRACT LABOUR; CORVÉE; FEUDALISM; SERFDOM.

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FORCELLINI, EGIDIO (1688–1768), Italian philologist known for his great lexicon of the Latin language, was born on Aug. 26, 1688, at Fener, Treviso, and studied at Padua under Jacopo Facciolati (*q.v.*). From 1724 to 1731 he held the office of rector of the seminary at Ceneda, and from 1731 to 1765 that of father confessor in the seminary of Padua. He died at Padua on April 4, 1768, before the completion of the vast Latin lexicon (*Totius Latinitatis Lexicon*, four volumes, 1771) on which he had collaborated for 35 years with Facciolati and which has since formed the basis of all similar works.

FORCHHAMMER, PETER WILHELM (1801–1894), German classical archaeologist noted for his works on topography and classical mythology, was born in Schleswig on Oct. 23, 1801, and was educated at Lübeck and the University of Kiel. In 1830–34 and 1838–40 he traveled in Italy, Greece, Asia Minor and Egypt. While in Turkey he joined a party of British naval officers in making a topographical survey of the plain of Troy, which was published with his observations by the Royal Geographical society of London in 1842, a generation before Heinrich Schliemann's expedition. He identified Homer's Troy with the heights above Bunarbashi, about six miles south and east of the mound of Hissarlik (Schliemann's Troy), as the site agreeing closely with the descriptions in the *Iliad*.

In 1837 he published his *Hellenika: Griechenland im neuen das Alte*, in which he put forth his theory that the Greek myths have their origins in local (especially aquatic and atmospheric) phenomena. He wrote also on Athenian topography and on Homeric subjects, and from 1843 until his death was professor of philology at Kiel. He died in Kiel on Jan. 8, 1894.

A full list of his writings is given in the biography by A. Hoeck and L. Pertsch, *P. W. Forchhammer* (1898). (M. I. W.)

FORD, EDWARD ONSLOW (1852–1901), distinguished English portrait sculptor, was born at Islington, London, on July 27, 1852. He was educated at Blackheath, near London, and studied art at Antwerp and Munich. He returned to England in 1874 and attracted attention with a bust of his wife which he sent to the Royal Academy in 1875. Ford's best-known statues are Sir Rowland Hill (1882) outside the general post office in London; Gen. Charles Gordon (1890) at Chatham and at Khartoum, and the Shelley memorial (1892) at University college, Oxford. Ford's busts include W. E. Gladstone (1883), Sir Henry Irving (1885), A. J. Balfour (1892), Sir Laurence Alma-Tadema (1896), Herbert Spencer (1897), Queen Victoria (1899) and Lewis Waller (1900).

His bronze statuette of "Folly" is in the Tate gallery, London, and in 1897 he made the Jowett memorial for Balliol college chapel. Ford was elected associate of the Royal Academy in 1888 and academician in 1895. He died in London on Dec. 23, 1901. (R. Gs.)

FORD, FORD MADOX (originally FORD HERMANN HUEFFER) (1873–1939), English novelist who, as founder and editor of the *English Review*, exerted great influence in encouraging literary talent. Born at Merton, Surrey, on Dec. 17, 1873, he was the son of a German, Francis Hueffer, and grandson of Ford Madox Brown, the pre-Raphaelite painter. At 17 he wrote *The Brown Owl* (published 1892), a fairy story which was very well received. Conversations with Joseph Conrad, whom he met in 1897, prompted

their collaboration in *The Inheritors* (1901) and *Romance* (1903). The first number of the *English Review* (Dec. 1908) included articles by Thomas Hardy, Conrad, John Galsworthy, W. H. Hudson and H. G. Wells. Among Ford's discoveries were P. Wyndham Lewis, Ezra Pound, D. H. Lawrence and H. M. Tomlinson. As editor of the *Transatlantic Review* (1924) he was first to encourage Ernest Hemingway.

Between 1905 and 1908 Ford had shown his own literary ability in a trilogy of Tudor novels, *The Fifth Queen* (1905), *Privy Seal* (1907) and *The Fifth Queen Crowned* (1908), written, with 22 others, under the name of Hueffer. He admired the techniques of Stendhal and Flaubert and his first important novel, *The Good Soldier* (1915), has been described as "the best French novel in the English language." Of over 70 published works those on which his reputation mainly rests are the Christopher Tietjens tetralogy *Some Do Not* (1924), *No More Parades* (1925), *A Man Could Stand Up* (1926), *Last Post* (1928; collected in the U.S. as *Parade's End*, 1950), which vividly and realistically depict characters and scenes from World War I in which he fought. Foremost among his later novels are *The Rash Act* (1933) and *Henry for Hugh* (1934). His criticism includes *Ford Madox Brown* (1896), *Joseph Conrad* (1924), *The English Novel* (1930) and *The March of Literature From Confucius to Modern Times* (1939). He died at Deauville, France, on June 26, 1939.

See *The Bodley Head Ford Madox Ford*, ed. by Graham Greene, 2 vol. (1962); R. A. Cassell, *Ford Madox Ford: a Study of His Novels* (1962).

FORD, HENRY (1863–1947), U.S. industrialist who became within his lifetime the one person most universally identified as the creator of modern mass production, was born July 30, 1863, on a farm near Dearborn, Mich. The principal manufacturing innovation credited directly to Ford is the assembly-line method of automobile production, which he first employed in 1913. However, other technical advances and new ways of planning, organizing and controlling production that were developed during the more than 40 years that he ran the Ford Motor company also came to bear the "Ford label," as much attributed to the man as to the firm. Willingness to depart from previous practice—as by standardizing processes and products, integrating supplying industries, building assembly plants at dispersed locations and organizing manufacturing around continuous line-to-line flow of product components—was a significant factor in the company's success.

Ford's industrial philosophy was simple. Reduce the price of the product, increase the volume of sales, improve production efficiency, increase output to sell at still lower prices, and so repeat the cycle indefinitely. Contemporaries, viewing the automobile as a luxury item or rich man's plaything to be custom-produced for a restricted market, regarded Ford's policies as heretical. While in the company's formative years his ideas were pushed into practice against the resistance of his associates and stockholders, the workability of those ideas was demonstrated vividly by the growth of the Ford Motor company from a firm nominally capitalized at $100,000 in 1903 to an industrial giant with a surplus balance alone of nearly $700,000,000 in 1927, when the last of more than 15,000,000 of the famous Model T's built between 1908 and 1927 rolled off the assembly line.

There was a curious mixture of 19th and 20th century in Henry Ford, and his was a strong and contradictory personality. Though he rejected many of the doctrines of business and economics of his day, on some subjects he clung to anachronistic ideas. In 1914, when workers in U.S. manufacturing industries were making about $11 a week on the average, he announced that every Ford worker would start receiving at least $5 a day through minimum wages about 15% higher than those paid elsewhere for the same types of work, as well as through participation in a profit-sharing plan. The impact of the move, both damned and praised in the press, naturally was great. It brought for Ford a reputation as a trail blazer. Yet at the same time Ford tightened his paternalistic labour policy, establishing sobriety and thrift on the part of the workers as conditions for sharing in the distribution of profits.

Ford always displayed concern for the welfare of workers and believed firmly in the dignity of work. But he resisted unionization for his employees, seemingly thinking unionism would pass away or that agitators were misleading his men. The company police in his plants for years waged a repressive campaign against union membership. Ford remained nonunion for several years after his competitors had concluded agreements with unions. Yet after he had lost a union-recognition election conducted by the National Labor Relations board in 1941, he signed the first union-shop and checkoff contract in the automotive industry with the United Auto Workers.

Ford was a prophet of the new industrial order, yet he was reluctant to use new devices to achieve it. He had a profound distrust of bankers and of Wall street, preferred financing expansion from earnings rather than by selling stock, and borrowed only when it was unavoidable. In 1917 he fought a suit brought by stockholders to force a distribution of most of the company's accumulated surplus, to compel future distribution of earnings and to enjoin the company from expanding its plant. The outcome was that a special dividend had to be paid, but the right of the company to use its capital for expansion was unimpaired. As he was able, Ford bought out the other stockholders and eventually attained complete control. He thereafter operated to suit himself, and his company ultimately became the only one of comparable size individually owned—a personal empire whose worth was estimated in billions of dollars.

Though Henry Ford showed great vision and "put America on wheels" with the Model T, the first car designed for a mass market, he later failed to appreciate the dynamic character of that market. Against the advice of his management he held out for the planetary transmission against the conventional gearshift, the mechanical against the hydraulic brake, the four-cylinder against the six- or eight-cylinder engine and a single colour, black, against the colour variety offered by other manufacturers. However, when finally convinced in 1927 that the Model T had seen its day, he retooled completely and produced in the Model A an entirely new car. In 1932 he repeated the process in bringing the V-8 on the market. Nonetheless his adjustment to consumer demand for comfort, style and convenience was too tardy to prevent losing first position in the industry to General Motors.

Ford attended school only to the age of 15. From an early age he showed a keen interest in things mechanical, an interest that never waned. Even after he had reached the apex of an industrial empire, he delighted in disassembling the watches of his friends or joining the mechanics in his plant in a greasy repair job. He was an empiricist, impatient of theory.

Diet faddist, foot racer, folk-dance enthusiast, collector of early Americana, philanthropist, practical joker, not always consistent—Ford was all these. He endowed a modern hospital and subsidized a newspaper that specialized in anti-Jewish articles. During World War I he chartered a ship and sailed with an oddly assorted list of pacifist passengers to appeal to heads of state to "get the boys out of the trenches by Christmas," and during both World Wars I and II his company was a major producer of war materials. He ran for the senate and lost and thought about running for president. He played his executives off against each other and banned smoking in his plants. Most important, he was a man who could make an auto in his barn with his own hands and could also make the principles of mass production work on a scale unparalleled before his time. He died April 7, 1947, at Dearborn.

BIBLIOGRAPHY.—No definitive biography exists. Much information can be found in *My Life and Work* (1922) and *Today and Tomorrow* (1926), written by Henry Ford in collaboration with Samuel Crowther. *See* also Samuel S. Marquis, *Henry Ford: an Interpretation* (1923); William A. Simonds, *Henry Ford: His Life, His Work, His Genius* (1943); William C. Richards, *The Last Billionaire, Henry Ford* (1948); Keith Sward, *The Legend of Henry Ford* (1948); Harry H. Bennett, *We Never Called Him Henry* (1951); Allan Nevins and F. E. Hill, *Ford: the Times, the Man, the Company* (1954). (J. D. Rs.)

FORD, JOHN (1586–1639?), one of the chief English dramatists of the Caroline period. An exponent of the popular "tragedy of blood" in its most refined form, Ford also attempted other dramatic kinds. His plays have frequently been instanced as typical of the "decadence" of Caroline drama, but 20th-century criticism has tended to stress his insight into the human passions and the austere beauty of certain of his scenes.

Of an old Devonshire family, Ford was baptized at Ilsington (near Newton Abbot), Devonshire, on April 17, 1586. In 1602 he was admitted to the Middle Temple, where his great-uncle Lord Chief Justice John Popham and other relations already were, and he remained there, except for a period of suspension (1606–08), until at least 1617. He published an elegy on the earl of Devonshire and a prose pamphlet in 1606, and a few other minor nondramatic works have been attributed to him during this period. It is not certain that he wrote for the stage until his collaboration with Thomas Dekker (*q.v.*) in 1621. From 1625 to 1638 he worked alone (mostly for private theatres) but the sequence of his eight extant plays cannot be precisely determined. There are a few contemporary references to Ford, including William Hemminge's well-known distich (*c.* 1632): "Deep in a dump Jack Ford alone was got / With folded arms and melancholy hat," but nothing is known for certain of Ford's personal life. There is no certain record of him after 1639.

The Canon.—There has been many an attempt to assign to Ford, Dekker and William Rowley their shares in *The Witch of Edmonton* (performed at court, Dec. 29, 1621), but no general agreement. A simple and terrible domestic tragedy, it reveals much about the rural life of the time and contains a deeply persuasive study of an Elizabethan witch. Ford also collaborated with Dekker in *The Sun's Darling* (1624), perhaps in *The Welsh Embassador* (1623) and in probably three other plays, now lost, of about the same date; his hand has been seen in Middleton's and Rowley's *Spanish Gipsy* (1623), Fletcher's *Fair Maid of the Inn* (1626) and some other plays of the Beaumont and Fletcher canon (*see* BEAUMONT AND FLETCHER).

Ford's extant unassisted plays, only two of which can be definitely dated, were written between *c.* 1627 and *c.* 1638: *The Broken Heart*, *The Lover's Melancholy* (1628), *'Tis Pity She's a Whore*, *Perkin Warbeck*, *The Queen*, *The Fancies Chaste and Noble*, *Love's Sacrifice* and *The Lady's Trial* (1638). His reputation rests mainly on the first four of these.

Reputation.—It has been argued that Sir Robert Howard's *The Great Favourite, or the Duke of Lerma* (1668) was based on a lost play by Ford. Two of Ford's plays (*'Tis Pity She's a Whore* and *The Lady's Trial*) were revived at the Restoration (1661 and 1669), two more (*Perkin Warbeck* and *The Lover's Melancholy*) in 1745 and 1748, and Robert Dodsley reprinted *'Tis Pity She's a Whore* in 1744, but otherwise he was long almost forgotten. William Hazlitt, writing in the early 19th century, regarded Ford as an instance of the decline of drama; Charles Lamb, however, was deeply impressed by his work: "He sought for sublimity . . . directly where she has her full residence in the heart of man; in the actions and sufferings of the greatest minds." The first complete edition by H. Weber was discussed by Francis Jeffrey in the *Edinburgh Review* (1811), and Shelley and Mary Shelley knew the plays; there were further editions in 1827, 1831 and 1840. Ford's repute has never been beyond controversy; the opposition between Hazlitt and Lamb recurred, Swinburne in *Essays and Studies* (1876), Havelock Ellis (1888) and Taine in his *Histoire de la Littérature Anglaise* (1892) esteeming him very highly, Saintsbury in *Elizabethan Literature* (1887), A. W. Ward in *A History of English Dramatic Literature* (1875) and others thinking him morbid, dangerous and unnatural, a tradition which has continued in the stress placed by S. P. Sherman (1915) and G. F. Sensabaugh (1944) on a theory that Ford was concerned to write problem-plays attacking established moral values. But judging from both the volume and direction of mid-20th-century criticism Ford is ranked above all other Caroline playwrights and regarded as the last major writer in the Elizabethan dramatic mode.

The Plays.—*'Tis Pity* concerns the incestuous love of Giovanni and his sister Annabella. When Annabella is found to be pregnant she agrees to marry her suitor Soranzo; the lovers' secret is finally discovered, but Soranzo's plan for revenge is outpaced by Giovanni's murder first of Annabella and then of Soranzo, at the hands of whose hired banditti Giovanni himself finally dies. In the relationship between the two star-crossed lovers, Ford has presented us with an image "simple, passionate and complete" (Havelock Ellis, in his edition of the plays). There is no sense that Ford is arguing a case for unlawful love, but there is an eloquent and glowing sympathy for the lovers, "so young, so rich in Nature's store" and yet set apart from all others by the nature of their union, their consciousness of their sin and, after a first bewilderment, their sensual and at times even arrogant acceptance of it. Ford's other masterpiece, *The Broken Heart*, contrasts in mood and style with *'Tis Pity* and is to be grouped with *Love's Sacrifice* and *Perkin Warbeck*, plays which are "remarkable in their comparative indifference to event, in their cultivation of the static scene, in their approach to uniformity of mood throughout the drama, and above all in their suggestion of a total vision of human life in which vicissitude has become irrelevant" (C. Leech, *John Ford and the Drama of His Time* [1957]). *The Broken Heart* tells how Penthea, forced by her brother Ithocles to marry the jealous Bassanes after she had plighted her legal troth to Orgilus, goes mad and dies; she is revenged by Orgilus who, by murdering Ithocles, becomes responsible for his own death and for the "broken heart" of Ithocles' mistress, the Princess Calantha. Interest attaches especially to Penthea, torn between her plighted troth and her enforced marriage—a theme already established in earlier domestic tragedy; but the death of Calantha is a famous scene of grace and fortitude presented with the austere calm of expression of which Ford was specially a master. *Perkin Warbeck* compares in excellence with Shakespeare's history plays; especially in its portrayal of the hero there is insight of a Shakespearean rather than a Fletcherian kind. Ford's remaining plays, of which the best is probably *The Lover's Melancholy* (much influenced by one of his favourite books, Robert Burton's *Anatomy of Melancholy*, 1621), are all tragicomedies; he again departed from the Fletcherian mode, exploring human passion and states of mind in a way incompatible with Fletcher's concentration on piquant episode and narrative surprise. Ford's plays are frequently overloaded and his austerely powerful themes blurred by minor characters and bad comedy; he would perhaps have been happier in a period when plays were shorter and more classically disciplined, but his insight into character, the nature of his theatrical effects and the dignity and stillness of some of his dramatic poetry show that he was consciously seeking, and largely achieved, independence from the worst faults of the drama in decline.

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FORD, PAUL LEICESTER (1865–1902), U.S. editor, bibliographer, historian and novelist, was born in Brooklyn, N.Y., on March 23, 1865, the son of Gordon Lester Ford, a successful businessman and book collector. Paul Ford, whose health was poor, was privately educated and spent long hours in his father's library, then one of the finest collections of Americana in the world. His interest was stimulated by his father and by his brother Worthington C. Ford. The environment of a select social circle and extensive travel on both American continents and in Europe fostered and intensified his cultural interests. At the time of his death, when only 37 years of age, his edited works and writings totaled more than 70 volumes. One major undertaking was his editing of *The Writings of Thomas Jefferson*, published in 10 volumes between 1892 and 1899. In American literature he is most famous for his historical novels, *The Honorable Peter Stirling* (1894) and *Janice Meredith* (1899). He was shot to death on May 8, 1902, by his brother Malcolm, who in turn committed suicide.

FORDE, FLORRIE (née FLORENCE FLANAGAN) (1876–1940), British music hall artiste and comedienne who introduced many songs that continue to be household ditties. These include "The Old Bull and Bush," "Pack up Your Troubles," "Has Anybody Here Seen Kelly?" and "Tipperary," which became the nostalgic British "theme song" of World War I. Born in Australia,

she was in pantomime in Sydney in her teens, and on her first appearance in London during the August Bank holiday 1897 she sang in three famous "halls" on the same evening. She died on April 18, 1940. (A. H. D.)

FORDHAM, formerly a village of Westchester county, N.Y., and now a part of the Bronx borough of New York city, lies on the mainland, along the eastern bank of the Harlem river, east of the northern end of Manhattan Island. It is the seat of Fordham university (Roman Catholic), opened in 1841 as St. John's college and since 1846 conducted by the Society of Jesus. In 1907 the institution was rechartered as Fordham university. Fordham college and some schools and departments are in Fordham. The other schools are located at three sites in Manhattan. The university comprises, in addition to the undergraduate Fordham college, colleges and schools of pharmacy, business, law, education, social service and general studies; a graduate school; and an Institute of Contemporary Russian Studies. About 10,000 students are enrolled annually.

FORDUN, JOHN OF (d. after 1383), Scottish chronicler, the first man to attempt a continuous history of Scotland, may have been born at Fordoun, Aberdeenshire. The only evidence about his life is found in prologues to Walter Bower's *Scotichronicon*. According to one he was "chaplain of the church of Aberdeen"; in another he was a priest and not a graduate of any school. He may have been a chantry priest in Aberdeen cathedral, but is not named in any of its cartularies. Another account of how, moved by the destruction of Scotland's records by Edward I, Fordun wandered through Britain like a curious bee, collecting materials, does not square with his supposed occupation as chantry priest. But internal evidence suggests that he was in Ireland and, between 1363 and 1383, in England. Books v (Scotland, 1057–1153) and vi (England before 1066, a fragment) of his chronicle seem to have been composed first. The true continuation of book v is his *Gesta Annalia* (Scotland, 1153–1363), a bare narrative intended, no doubt, to be worked up into a literary form. These were all completed by 1363; thereafter Fordun traveled until 1383, wrote books i–iv (books i–iii legendary; book iv, A.D. 814–1057) and brought the *Gesta Annalia* down to 1383. Fifty years later his chronicle and annals were expanded and continued by Bower in his *Scotichronicon*. Fordun's work, nationalistic in attitude, is reliable where not legendary. His chronicle was edited, with translation, by W. F. Skene in *Historians of Scotland*, vol. i and iv (1871–72). (A. A. M. D.)

FORECLOSURE, in law, a method of extinguishing the mortgagor's equity of redemption—that right of the mortgagor, after default, to secure a reconveyance or to free the property from the mortgagee's lien by paying the mortgage debt and interest. In England this equity of redemption can be defeated by the mortgagee's taking possession of the mortgaged property and retaining it for 12 years without acknowledging the mortgagor's title, by the court's decreeing a foreclosure or sale, or by, what is now the most common method of foreclosure, a sale by the mortgagee under an implied statutory power.

In the United States the typical foreclosure is by a court-decreed sale of the mortgaged property to the highest bidder, who often is the mortgagee. The proceeds of the judicial sale are first used to satisfy the debt; the surplus, if any, is paid to other creditors with subordinate claims on the same property and then to the mortgagor. If the proceeds are insufficient to pay the debt, the court gives the mortgagee a deficiency judgment. Strict foreclosure, by which the mortgagor's equity of redemption is extinguished without a sale, is now rarely used. In several states foreclosures are effected by out-of-court sales by the mortgagee or by a trustee pursuant to an express power of sale in the mortgage deed or in the deed of trust.

See MORTGAGE. (E. G. S.)

FOREIGN AID PROGRAMS. Economic aid from one government to another and from international organizations to governments has grown from a temporary device adopted by the western Allies in World War II to a permanent feature of international economic relations. It is sometimes called international aid rather than foreign aid. In its evolution, the experience of the United States has been dominant, although other countries have also extended such aid. The dominions, for example, aided the United Kingdom during and after the war. Commonwealth and other countries extended aid to Asian countries under the Colombo plan after 1950. Soviet aid to underdeveloped countries since 1955 has led to competition in assistance. Many states have co-operated in giving aid through the United Nations and other international organizations.

The United States has used foreign aid for a variety of purposes: to transfer military equipment and civilian supplies to Allies during World War II; to assist relief and reconstruction after the war; to buttress resistance to communist aggression, both actual and potential; to meet emergencies of many kinds, such as natural disasters; to help refugees from behind the "iron curtain"; to clear the Suez canal; and to provide technical assistance and economic aid for countries engaged in programs of economic development. The total amount of U.S. aid in the 20 years from 1940 to 1960 amounted to more than $114,000,000,000.

Lend-Lease.—Mindful of the problem created after World War I by war debts owed to the United States by European Allies and not paid, Pres. Franklin D. Roosevelt in early 1941 devised the principle of lend-lease under which the United States agreed to provide supplies to countries engaged in fighting Germany (and later Japan) on a basis to be determined after the war. The equipment might be returned, paid for or regarded as a contribution. In return, these Allies aided U.S. troops when the United States entered the war; this so-called reverse lend-lease amounted over the period of the war to 16% of the value of lend-lease from the United States. The bulk of the lend-lease transfers were settled as grants. A few ships, airplanes and similar items of equipment were returned in kind at the end of the hostilities. (*See* WAR DEBT; WAR FINANCE: COST OF WORLD WARS I AND II.)

Relief.—Lend-lease was restricted to Allies engaged in the war against Germany and Japan. But other aid was necessary for liberated countries, both for humanitarian reasons and to prevent disturbances in the areas through which military supply lines ran. Later, when Italy came over to the Allied side and Austria was liberated, civilian supplies were required for them. Finally, in occupied Germany and Japan, it was necessary for several years to provide minimum diets to prevent "disease and unrest in occupied areas such as might endanger United States forces."

Another quasi-military form of assistance rendered after the war by the United States was the disposal of surplus military stocks, including goods suitable for civilian use, at reduced prices and on long-term credit. Ships represented a special program of surplus disposal.

In 1943, while the war was still in progress, the United Nations created the United Nations Relief and Rehabilitation administration (UNRRA). The United States was the most important contributor, bearing originally 72%, later 78%, of the cost. The agency was established with money and with surplus military stocks, and operated originally in eastern Europe and China. Later, in 1946, it took over from military responsibility the relief of Austria and Italy.

After the abrupt termination of lend-lease in 1945, following the defeat of Japan, aid to United States Allies was initially expected to be given by the International Bank for Reconstruction and Development established at an international conference at Bretton Woods, N.H., in 1944. (*See* BANK FOR RECONSTRUCTION AND DEVELOPMENT, INTERNATIONAL.) Pending the functioning of this organization, and its sister agency, the International Monetary fund, designed at Bretton Woods to smooth out international payments difficulties, several expedients were used. The capital of the Export-Import Bank of Washington was raised by $3,000,000,000 in 1945. In 1946 a loan of $3,750,000,000 was made to Britain to assist in its reconstruction, but also to enable the pound sterling currency to become convertible into dollars.

These devices, however, proved insufficient. The extent of Europe's need had been seriously underestimated. With the removal of wartime economic controls in the United States in July 1946, prices rose so that the dollar amounts provided bought substantially fewer goods. A hard winter in 1947 compounded Euro-

pean difficulties. In the spring of 1947 western Europe appeared to be headed for economic collapse from which the Communist parties alone would benefit. In this circumstance, Secretary of State George C. Marshall on June 5, 1947, in a commencement address at Harvard university, indicated that if the countries of Europe were prepared to co-operate in a renewed effort toward recovery, the United States would be willing to assist. This was the origin of the European Recovery program (E.R.P.), popularly known as the Marshall plan.

Marshall Plan.—The European Recovery program consisted of an effort by 17 countries of western Europe—broadly defined—to harmonize their recovery efforts and to indicate, on an agreed basis, what assistance would be necessary from the United States. The countries were Austria, Belgium, Denmark, Eire, France, Greece, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey, the United Kingdom and western Germany. An organization for European economic co-operation was created with its seat at Paris. While plans were being formulated, a program of interim aid was voted by congress. Finally, on April 3, 1948, the Economic Cooperation act of 1948 was signed, setting in operation United States aid for economic reconstruction in Europe. A total of $5,600,000,000 was appropriated for the first 15 months (to the end of the fiscal year on June 30, 1949.) It was expected that United States aid, amounting in all to some $17,000,000,000, would be eliminated at the end of four years.

Greek-Turkish Aid.—In Feb. 1947, before Secretary Marshall's speech, the British government had informed the United States that it was unable to continue financial support to the Greek government, which was engaged in resisting Communist aggression based in Yugoslavia. President Truman responded with the Truman doctrine under which military and economic assistance was made available to Greece and also to Turkey, which was similarly threatened. This was the beginning of peacetime military assistance, apart from post-hostilities aid given to forces of the Chinese Nationalists on Formosa.

Korean War.—In 1950, however, with the outbreak of aggression in Korea and the intensification of the cold war, economic aid became overshadowed by military aid, which took many forms. Loans of military equipment, patterned after lend-lease, took place on a limited scale. Military aid consisted of grants of matériel to countries struggling against aggression, particularly South Korea, French Indochina and the Republic of China (Nationalists). The United States also assisted its western European allies, organized with Canada and the United States into the North Atlantic Treaty organization (NATO). The NATO defense plan called for the construction of some common military installations, to which the United States contributed. With the stationing of United States troops in the far east and Europe, a form of indirect assistance, but one not recorded as such, was the local purchase of supplies, equipment and buildings for defense or personal use by troops.

Point IV and Economic Development.—In his inaugural address of Jan. 1949, President Truman listed as Point IV of his program a plan to make assistance available from the United States to underdeveloped countries. The United Kingdom had long been helping its colonies in this manner, and the world-wide agreement to create the International Bank for Reconstruction and Development had been reached with this end in mind. Export-Import bank loans which promoted U.S. sales of capital equipment to underdeveloped countries were frequently related to development projects. But with the enunciation of Point IV, a new chapter in foreign aid began.

While it was unclear at the outset what form aid to underdeveloped countries would take, emphasis quickly was placed on technical assistance, largely in the fields of agriculture, public health and education. To private capital, on a remunerative basis, was left the task of providing public structures and resources needed in industry. Some technical assistance was furnished through specialized UN agencies, including the World Health organization (WHO), Food and Agriculture organization (FAO) and United Nations Educational, Scientific and Cultural organization (UNESCO). Most, however, was provided directly by the United States on a bilateral basis, frequently through the device of contracts with United States business and educational organizations.

Several new national and international organizations were created or planned to contribute to various aspects of the development problem. In 1956, for example, the International Finance corporation was formed as an offshoot of the International bank. Its task was to invest equity capital in private enterprises in underdeveloped countries. The next year the United States regularized its lending operations for development by the creation of a Development Loan fund for long-term credits. In 1958, the capital of the Export-Import bank was raised by $2,000,000,000; the UN established a Special fund of $100,000,000 annually to make grants or loans on special conditions to countries needing capital for basic projects; the United States proposed an increase in the capital of the International bank, enlargement of quotas of the International Monetary Fund and the establishment of an International Development association. This last proposal was for an organization which could relend to developing countries some of the local currencies received by the United States as repayments of previous loans not received in dollars.

In 1958 the congress also increased by $2,500,000,000 the authority of the United States under Public Law 480 (1954) to make loans to underdeveloped countries in surplus agricultural commodities repayable on easy terms.

It can be seen that the character, scope and direction of the foreign aid program of the United States have been continuously evolving—from military support during the war to reconstruction aid for Europe, then military support for Asian countries subject to aggression, and finally to economic aid for underdeveloped countries. During 1960 increasing attention was given to proposals for long-range aid to Latin American countries wherein poverty offered fertile ground for the growth of communism.

Forms.—Aid to foreign countries by the United States has consisted primarily of U.S. goods and services—military equipment, civilian supplies, the services of technicians, the education of foreigners in the United States, surplus commodities, etc. But not all such aid has been of this kind. The British loan was made in money that could be spent anywhere. The purpose of the loan was to assist world trade through Britain by enabling the British to pay for imports from other countries in dollars. This helped the other countries with their payments difficulties. In the early stages of the Marshall plan some aid consisted in offshore purchases of goods, as, for example, in Canada or Latin America. These purchases provided goods that Europe needed and dollars sought by the seller.

Most assistance to Europe was given directly to individual countries. Some aid, however, was made conditionally to one country provided it would agree to make certain surplus goods available to a third country. In this way both countries were assisted. This method, designed to stimulate intra-European trade, was abandoned in 1950 in favour of a loan of $526,000,000 to a newly created European Payments union which cleared intra-European payments. It provided, moreover, that if payments did not exactly balance, debtors would receive some credit and pay some dollars, while creditors would receive some cash and extend some credit. Since the creditors received more dollars at times than the debtors paid in, the U.S. loan was temporarily needed to balance the position.

The United States has searched for opportunities to promote intra-regional trade in other parts of the world by reshaping its economic aid. It offered $200,000,000 to the Simla conference in India in May 1955, contingent upon the Asian participants preparing an adequate plan for its multilateral use. But no agreement on such a plan could be obtained.

Conditions of Aid.—Under lend-lease, aid was given on the condition that the receiving country use it and its own resources efficiently to defeat the enemy. In addition, the countries were asked, under art. vii of the lend-lease agreement, to subscribe to certain broad objectives of U.S. policy in the economic field, including the establishment of a freely trading world with equal access to materials and most-favoured-nation treatment of customers. The first condition gave rise to some difficulties of inter-

pretation, particularly in connection with how rapidly Britain should run down its holdings of securities and how much it should maintain in wartime its export connections with an eye to its post-war position.

During the relief phase an objective determination of need was presumably possible. In actuality, however, the United States was reluctant to extend post-UNRRA relief to Yugoslavia, which was firing at U.S. airplanes, or to Poland or Hungary after the Soviet coup in Czechoslovakia which intensified the cold war.

In the E.R.P., United States stipulated that each recipient country should co-operate with other European countries and exert a maximum effort toward its own recovery. These criteria were again difficult to interpret. Moreover, they posed a dilemma which runs through all foreign aid: the more realistic and effective a country is in meeting its requirements, the less aid it needs, but the more it may be said to deserve. Conversely, the less able a country is to meet its domestic problems and the more ambitious its plans of expansion, the less aid it deserves and the more it needs.

Soviet Aid.—A particular form of this dilemma was furnished by the entry of the Soviet Union into the aid field. This aid was not, as a rule, in the form of grants but consisted of low interest-bearing loans or credits in barter deals. Soviet aid to the Communist bloc was estimated in 1958 at $7,000,000,000 (*see* MUTUAL ECONOMIC ASSISTANCE, COUNCIL FOR); and almost $2,000,000,000 in aid was pledged to other countries, largely to Egypt. Yugoslavia, Syria, India, Afghanistan and Indonesia. The $465,000,000 pledged to Yugoslavia, however, was held in abeyance. Soviet loans presented a dilemma for the western powers. If a country's economic needs were being met by the Soviet Union, its assistance from the west could be reduced. But this was considered politically undesirable. The receipt of Soviet aid, therefore, usually enabled a country to get more, not less, aid from the west.

Voices in the United States were raised calling for the imposition of certain conditions of aid, such as the abandonment of socialist forms of enterprise; alignment of the receiving country with the United States in NATO or the Southeast Asia Treaty organization (SEATO); membership in the Baghdad pact; or the repression of anti-American sentiments. These political conditions of aid were not enacted or enforced.

Bilateral versus Multilateral Aid.—Another recurring issue was whether aid should be given bilaterally or through international agencies. This problem goes back at least to UNRRA where the United States, with one voice in 17 on the council and bearing 72% of the cost of the program, sometimes found itself forced to make aid available against its wishes.

An entirely bilateral program is politically difficult in that it focuses all dissatisfaction with amounts of aid on the donor. For this reason the United States encouraged the preparation of multilateral programs in the E.R.P., and under NATO, and the British and the United States supported the creation of the Colombo plan (*q.v.*) in southern Asia. In the Colombo plan all aid is in fact conducted on a bilateral basis, between the several donors and recipients. Under the Marshall plan, there was at the same time an agreement between the United States and the Organization for European Economic Cooperation (O.E.E.C.) and separate agreements with each recipient. In the division of aid, however, the United States followed the recommendations of the O.E.E.C.

The remaining problem, however, is between UN and bilateral arrangements for technical assistance and development loans. In the International bank and Monetary fund, the United States has put up the majority of the resources and retains a controlling voice in the operation of the fund and in the choice of the people running the bank. In the UN, it has far less share of decision-making power in the Economic and Social council (ESC) or the general assembly. Meanwhile, however, the retention of bilateral arrangements for technical assistance and development loans assures the United States that foreign aid cannot be distributed entirely by a logrolling or politically dominated process in the UN contrary to its political interest or its view of the objective requirements.

See also FOOD AND AGRICULTURE ORGANIZATION; WORLD HEALTH ORGANIZATION; ECONOMIC DEVELOPMENT; EXPORT-IMPORT BANK OF WASHINGTON; UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION; ECONOMIC PRODUCTIVITY.

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(C. P. K.)

FOREIGN EXCHANGE: *see* EXCHANGE, FOREIGN; INTERNATIONAL PAYMENTS.

FOREIGN INVESTMENT: *see* CAPITAL, EXPORT OF.

FOREIGN LANGUAGES, TEACHING OF. Techniques for teaching modern languages are of relatively recent development. For centuries royalty, diplomats and merchants learned modern languages either by residing in a foreign country or by daily conversation with a native assigned to their household. Learning to read or write the language or the study of its grammar was incidental. This article outlines the backgrounds of the main methods of teaching modern languages and traces 20th-century developments in the United States (including language laboratories, audio-visual aids and programmed courses) and Great Britain (with special attention to the British Broadcasting corporation's radio teaching program).

BACKGROUND

There was a great interest in language study in Germany and France in the late 18th century, but before the 19th the universities of Europe and the Americas were still teaching modern languages through the medium of Latin. Their grammatical construction was studied by comparison with the ancient tongues. This later developed into the so-called grammar-translation method which stressed the syntactical elements of foreign language and taught vocabulary only to facilitate translation of the French or German classics.

In the late 1700s and early 1800s Johann Meidinger, Heinrich Gottfried Ollendorff, Jean Joseph Jacotot and James Hamilton sought to improve language teaching, the two former by stressing grammatical rules, the two latter by carefully analyzing French prose to learn grammar and vocabulary. Hamilton developed an interlinear translation method which gained favour in the United States as well as in France and England. Little attention was paid, however, to the correct pronunciation of the foreign tongue until after 1833 when the German physiologist Johannes Peter Müller published results of his research on the functioning of the organs of speech and hearing. This led by 1869 to studies of English sounds first by A. J. Ellis, then by Henry Sweet and eventually to the science of phonetics (*q.v.*).

As early as 1841, however, Gottlieb Heness had experimented with a natural method of teaching German, introducing an oral-aural (now oral-lingual) approach, eliminating all translation and teaching grammar functionally. Heness went to the United States, was joined there in 1868 by Lambert Sauveur, and together they initiated a great vogue of language learning. Their disciples, through their private schools, met the need of wealthy Americans to learn foreign languages for travel abroad. These schools taught primarily French, German, Italian and Spanish.

In 1880 great stimulus was given to language study by the publication of François Gouin's *L'Art d'Enseigner et d'Etudier les Langues*. Victor Betis and Howard Swan's translation into English, followed by a widely publicized teaching demonstration in

1892, gave the English speaking world the psychological method. This was a completely oral method using a series of sentences centred about verbs, describing a unit of action to be acted out by the pupil. Pupil dialogue and dramatization were henceforth part of language teaching.

At approximately the same time the German philologist Wilhelm Viëtor (1850–1918), who taught in England in 1872–74, issued a vigorous plea for an oral-lingual approach to replace the grammar-translation method. Paul Passy, the great phonetician, seconded him in Paris and in 1901 the direct method, teaching pronunciation through phonetics, became the official method in all French schools. In 1902 German schools adopted the same method. It was wholly oral and taught every new word by direct association with an object, every new sentence with an idea. Every vowel or consonant sound was taught by charts explaining its physiological formation.

THE UNITED STATES

Meanwhile, in the United States, C. Grandgent of Harvard, chairman of the Committee of Ten (1892), outlined a program for U.S. secondary schools based on the study of grammar, stressing translation but also suggesting the introduction of French and German for ten-year-olds in the elementary schools and some oral-aural use of the language. In 1901 the Committee of Twelve established standards for language teaching in the United States by calling for five periods of study a week for the first two years (called elementary), followed by a third and a fourth year (intermediate and advanced). It proposed a fourfold aim: speaking, understanding, writing and reading; the last was considered the most attainable. Only direct method proponents insisted on the oral-lingual approach.

In 1911, with the arrival in New York of Max Walter, a disciple of Viëtor's, great impetus was given to the direct method, which continued to be popular in the eastern and some middle western states until 1927, for many American soldiers returning from France had found their oral training valuable during World War I. But Americans were still not agreed as to their objectives, and the American Council of Education and various language associations sponsored a national investigation. More than 30 volumes (*The Modern Language Study*) were published from 1927 to 1937 under the chairmanship of Algernon Coleman. Finding that 87% of the students pursued language study only two years, he reasserted the reading aim. A new reading method was advocated with controlled vocabulary and idiom study based upon word frequency as found in selected texts and periodicals. Grammar was studied only as an aid to reading, and oral training was virtually abandoned. Opponents of the reading method maintained their confidence in the eclectic method, which had retained the most effective features of the direct and other previously popular and successful methods. But language study waned and by 1940, when the United States needed interpreters, for the armed forces, relatively few were available. Germany, by contrast, had whole armies proficient in several foreign tongues.

Impact of World War II.—To meet this challenge the United States government set up, under the direction of J. Milton Cowan of the American Council of Learned Societies, intensive language programs to teach not only French, German and Italian but Japanese and Russian as well. Their main characteristics were: (1) insistence upon small drill sections with a native speaker or an informant, for 15 to 20 hours a week instead of the usual five; (2) grammar reduced to a minimum; (3) less emphasis on reading and writing; and (4) area studies to acquaint students with the geography, history and customs of the country of the language studied. Language specialists as well as other military personnel were trained. The success of these courses in oral-lingual mastery of the language was such that at the conclusion of World War II attempts were made to apply the techniques of these intensive programs to U.S. secondary schools and colleges. Concentrated six or eight months' courses were organized to offer approximately the same work as four to eight years of traditional classes.

Concurrently, techniques of drill in patterns of foreign speech began to replace the study of isolated words and idioms; the use of phonemes—the actual sounds of normal speech with pitch, stress and transition contrasts, as spoken by a native—was replacing the exclusive use of phonetics to teach pronunciation. (*See* PHONETICS.) Many colleges and universities introduced informant-drill techniques in small classes of 8 to 12 students, at least as parallel courses. With the increased availability of mechanically-equipped language laboratories (*see* below), tape recorders often replaced the native informant. Secondary schools were slow in adopting the new methods, but the growing need for mastery of at least one foreign language for use in diplomacy, commerce and travel led the federal government to subsidize a number of language institutes for the special training of teachers as well as for concentrated language study. After World War II the oral-lingual method also was used very effectively in elementary schools, beginning with the third grade. Although language teaching in the elementary and junior high school had been part of the public school curriculum in Cleveland and a number of other cities for some time, the new program in elementary schools grew to include nearly 500,000 pupils in hundreds of communities.

Great improvements were made in audio-visual aids, including motion picture and television programs adapted to classroom use. (See *Great Britain: Radio Teaching* below.) In the United States television language programs for the classroom use a combination of the traditional and aural-lingual methods. The shortcoming of such programs has been the inability of the classroom teacher to repeat the lesson when needed. Colour slides and filmstrips became widely used to stimulate conversation. Language teaching also was brought into the home by planned radio and television programs and by carefully prepared phonograph recordings, with accompanying texts for home study, which filled the needs of growing numbers of adult foreign language students.

(E. A. M.)

Language Laboratories.—To help accomplish the aims of the concentrated courses, language laboratories equipped with audio-visual aids were developed to improve pronunciation and intonation and aid in more effective study. The language laboratory is essentially a study room in which students can use mechanical sound reproduction devices (usually magnetic tape recorders) in such a way that one student does not disturb others while listening to or recording his own voice. In addition, in most laboratories a teacher at a master control board can listen to and correct any student individually. Many good language laboratories are equipped for the use of tape recorders, slides and motion pictures simultaneously. Some observers noted, however, an early tendency toward making laboratories unnecessarily elaborate.

Language laboratories have been installed in colleges and universities throughout the United States, and many high schools and even elementary schools have introduced similar equipment and methods. The National Defense Education act (1958), designed to promote better teaching of science, mathematics and modern foreign languages, included provisions for grants to states and loans to nonprofit private schools for the purchase of such equipment.

The language laboratory at Otterbein college, Westerville, O., may be cited as an illustration of a simple but efficient installation. In it students of French, for example, can study a lifelike situation in France captured on sound and film and then continue to learn by drilling the phrases with the help of tape recordings and by answering questions relating to what they have seen. The film and the tape recordings, both made in France, bring the native speech into the classroom and enrich the learning with a variety of voices and situations, always against the cultural background of the respective country. This use of many voices is an important feature of the Otterbein method; in other methods the student is exposed to one voice, or two, or maybe three different voices at the most. With the facilities of the laboratory, tests can be given in writing, or orally on magnetic tape, so that the teacher can listen to the tests after hours. The Otterbein method is known as *Je Parle Français* film-and-text method and is released by Encyclopædia Britannica Films.

Programmed Courses and Teaching Machines.—Programmed language teaching is essentially a method which breaks up the material to be taught into the smallest learning segments possible. These are then arranged into teaching sequences, with

periodical examinations on the material covered, and printed either in the form of a programmed textbook or of an instructional program for use in a teaching machine. The student is supplied with a set of tape recordings and a programmed textbook or instructional program, while the teacher works from a carefully integrated teacher's guide including an explanation of methodology, suggestions for mechanical handling of the text and, above all, elaborate samples for use in testing. Often pictographs are used to stimulate the student to describe pictures. The tape recordings, of a native speaker, provide a continuous control for the student so that mislearning is avoided at every step. That this method was an important addition to modern language teaching was indicated by the popularity of the first public use of the programmed courses in beginning German and beginning Spanish produced by TEMAC (from "teaching machine") and released through Encyclopædia Britannica Films. (M. He.)

GREAT BRITAIN

In Great Britain as in the United States, the technique of teaching modern languages became a scholastic battleground during the first quarter of the 20th century. Even after Wilhelm Viëtor made his famous plea in *Der Sprachunterricht muss umkehren* (1886) for methods more rational than those used in the study of Latin and Greek, the dead hand of the classics rested heavily upon modern-language teaching in British schools. The contributions of Viëtor's disciples, Paul Passy in Paris and Daniel Jones in London, in the field of phonetics, made teachers realize the importance of pronunciation and of an oral approach in the classroom. The idea of giving all instruction in and through the foreign language soon gained ground, and what is termed the direct method came into being. Despite its great vogue it achieved only a partial success. But its fundamental idea, that a modern language should be taught as a living tongue, has become generally accepted. The early direct methodists, in their zeal to remain true to the idea of never using a single English word in their lessons, even by way of explanation, created serious difficulties for themselves and their pupils. Brilliant specialists with selected pupils on a generous allowance of teaching time ensured a measure of success. With vastly increasing numbers of merely average pupils as a result of the great expansion of secondary education from 1918 onward, the direct method showed its failure to secure for large classes firm foundations of language structure and a sufficient amount of reading in the foreign language. Fruitless dramatization and parrot-like repetition wasted much time, with the result that the content of firm, consolidated linguistic knowledge was often much too thin. Shaky grammar deprived oral and written exercise of accuracy. Lack of reading restricted the pupils' vocabulary. Despite these criticisms, the direct method established heightened standards of pronunciation and a consciousness of the need for some knowledge of life as lived in the foreign country.

The demands of the British universities, imposed through their external examinations, which pupils take while still at school, required some modification of the direct method. Teachers agreed that there could be no return to formal grammar grind and were inclined to a compromise. The compromise that eventually emerged is called the oral method. This presentation aims at teaching the subject in a realistic atmosphere, the teacher using as much of the foreign tongue as is safely possible, avoiding blurred impressions in the pupils' minds and the blankness of noncomprehension. It is held to be no crime to explain a difficulty in English, but the need for the foreign language to be the main vehicle of instruction is strenuously upheld. A good teacher, without recourse to English, can ensure comprehension by gesture, dramatization, blackboard sketches, paraphrase and the use of contrary expressions already known to the pupils. With or without the aid of phonetic script—there teachers are divided—pronunciation and intonation receive due stress, oral work is fostered from the very start and remains an integral part of every lesson, and the basic foundations of language structure, often by means of memorized colloquial patterns, are firmly laid. Because of American research on word frequency, teachers give much thought to the selection of vocabulary and distinguish between their pupils' "active" and "passive" knowledge of words and phrases which come from their carefully graded course of reading material, prose and verse, designed for intensive or rapid treatment. Written exercise aims at creating an accurate linguistic sequence through dictation, free composition, formal prose composition and translation, rather than through the wasteful *non sequitur* of unrelated sentence work. Nor is the foreign country forgotten, its songs, its customs, its geography, its people. Older pupils naturally study its literature against social and historical background.

As supplementary visual and aural aids considerable use is made of films, filmstrips, libraries, modern language rooms (with posters, periodicals and other materials), radio lessons and phonograph records. In Great Britain and Northern Ireland a fine contribution comes from a plan by which young "assistants" give part-time service for one year in British schools before teaching English in their own country. Exchanges of experienced teachers on a full-time basis are also effected. Many schools organize collective holiday visits, particularly to France and Germany. Of even greater value are individual exchanges of pupils, the linking of foreign schools with their British counterparts and correspondence. (H. F. C.)

Radio Teaching.—Language teaching by radio may be considered either as direct lessons or as a supplement and extension of classroom teaching, though neither is of great value without preparation and following up.

The British Broadcasting corporation's series for schools are intended as an aid to and extension of teaching in class. Direct teaching is unsuitable for children because there is no pupil-teacher relationship, because it is impossible to supervise private study and, above all, because there is insufficient time on the air. Supplementary programs, however, can contribute advantages not found in the classroom; pupils can hear a variety of native accents spoken in natural and entertaining situations. This consolidates their knowledge, increases their comprehension and gives them some understanding of the people and country which form the natural background to the language; this, in turn, is a stimulus to further study.

Each series relates the level of linguistic difficulty to the listeners' achievements and ability; speaking is slow and clear, but the natural rhythms of the language are preserved.

While school broadcasting has many years of language teaching to its credit, and the BBC's "English by Radio" programs, addressed to listeners of many nationalities, started during World War II, postwar language lessons for adults, on the domestic Home Service, began in 1954. Lessons are broadcast in French, German, Italian, Spanish and Russian at three levels: for beginners, intermediate and advanced students. Four programs and one repeat can be heard in any one week. Programs at first only 10 minutes long were extended to 20 minutes with repeats and with printed primers and discs giving guidance on pronunciation.

Unlike school broadcasting, these programs go out to a diverse audience and when the series first started great efforts were made to attract listeners by making broadcasts entertaining. It became evident, however, that there was a willing public prepared to spend time in studying a language, in order to read its literature or in preparation for a foreign holiday. Because of the diversity of its public, the BBC studies listeners' needs and interests, and experimental programs played to sample groups have directly affected both the pace and presentation of Russian and Italian lessons.

As in school broadcasting, all language teaching is set in the life and culture of the country concerned, and listeners who follow the programs consistently gain something more solid than a phrase-book knowledge.

Radio lessons do not provide the give-and-take of classwork, but, apart from big cities, few places can provide teachers in five different languages, and there is often a shortage not only of teachers but of native speakers with good accents. Radio can fill this gap and, by imposing an aural concentration on those prepared to listen seriously, is peculiarly qualified to give keenness of ear for pronunciation and speech rhythms. (R. A. Es.; J. W. Ro.)

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FOREIGN LEGION, FRENCH. The French Foreign Legion (*Légion Étrangère*) is a mercenary military corps consisting chiefly of foreign volunteers in the pay of France. Its officers are nearly all French and a legionnaire becomes eligible for French citizenship after serving one enlistment (five years) with good conduct. Upon enlistment the recruit takes an oath to serve, not France, but the legion, and the organization's unofficial motto, "Legio Patria Nostra" (the legion is our fatherland), further tells the legionnaire where his first loyalty lies. Often romanticized by novelists who pictured the legion as a haven for criminals, forlorn lovers, and unhappy noblemen serving under assumed names, the organization is actually a highly disciplined professional army that has been in almost continuous combat since its founding. Because the legion keeps secret a volunteer's past, it has had more than its share of the above-mentioned types, but the man who wears the traditional white kepi headdress is more likely to be a European professional soldier who prefers fighting with the legion to garrison duty with his own army. Every major European war since the 1830s has swelled the legion's ranks with volunteers from the defeated forces.

Founded by King Louis Philippe in 1831 as an aid to controlling French colonial possessions in Africa, the legion established its headquarters at Sidi-Bel-Abbès, Algeria. During its history it has fought in Spain, the Crimea, Italy, Mexico (where it supported the ill-fated emperor Maximilian), Dahomey, Morocco, Syria and Indochina. Although prohibited from being stationed in metropolitan France during peacetime, it did serve there in both world wars. After the French collapse in World War II units of the legion escaped to join Gen. Charles de Gaulle's Free French forces. In 1961 one regiment of the legion supported insurgents in Algeria against the French government and, despite its outstanding combat record, was disbanded in disgrace. In 1962, with the coming of Algerian independence, the legion for the first time moved its headquarters to metropolitan France.

See Howard Swiggett, *March or Die: the Story of the French Foreign Legion* (1953).

FOREIGN SERVICE. Foreign affairs are of such vital importance in the modern world that most nations have established professional foreign services to represent the home government's interests abroad and to provide the necessary information on which foreign policy is based.

There is a marked similarity in the foreign service organizations of most countries. Diplomatic and consular functions are generally performed by a single service which is expected to serve at home or abroad, enabling interchangeability of consular and diplomatic officers (*see* Consul and Diplomacy). The merger of the two functions came about when many European countries, beginning with France in 1880, recognized that the consular service, although less dependent on ceremony and prestige, could not be entirely separated from diplomatic affairs. With the passage of the Rogers act in 1924 the United States followed suit as did the United Kingdom with the promulgation of the so-called Eden reforms of 1943, which combined the diplomatic, consular and commercial diplomatic services into a single foreign service. The United Kingdom had already in 1919 established the interchangeability of personnel in the foreign office and in the diplomatic corps serving overseas following the report of a royal commission on the civil service, 1912–14. The United States was slower to integrate officers in its foreign service, serving primarily abroad, with civil servants in the department of state, and a vigorous "integration" program was not forthcoming until the adoption during 1954–56 of the proposals of the secretary of state's public committee on personnel, headed by Henry M. Wriston.

Recruitment.—Beginning in the middle of the 19th century steps were taken in most countries to establish a professional corps with entrance open to young men and women by competitive examination, advancement by merit and retirement by law at specified ages through a rigorous "selection up or selection out" procedure. Personnel are generally commissioned as foreign service officers and classified into established grades according to salary. Promotion is by commission to a higher class rather than by appointment to a post of higher salary grade.

Although diplomatic officials were once members of royal or noble families and served as the personal representatives of sovereigns who wielded supreme power in kingdoms or empires, private wealth and political connections are no longer essential for a professional foreign service career. When governmental authority came to reside in institutions other than monarchs, diplomats (or diplomatists in British usage) became the representatives of the government in power. As such, they were for a long time drawn primarily from wealthy governing and aristocratic classes. Prior to World War I candidates for the British diplomatic service, for example, had to show that they had an independent income. In the United States, despite the absence of an aristocracy or governing class, wealth and political connections were once important prerequisites because of low salaries and meagre representation (entertainment) allowances. In France under the third republic the diplomatic service remained largely in the hands of prosperous upper middle-class citizens and those members of the aristocracy whose wealth remained relatively intact. In imperial Germany and Russia the diplomatic services were almost exclusively in the hands of the aristocracy and high reserve officers of the army and navy. Conditions did not markedly change until after World War I although competitive examinations, notably in Great Britain as early as 1871, made professional competence also a criterion of selection.

More and more, however, recruitment was placed on a broad and democratic basis with the important qualification that a high degree of education and intellectual ability came to be regarded as essential. The modern foreign service officer is usually a university graduate of superior talents who draws sufficient salary and allowances to maintain a relatively high standard of living. Required intellectual and personal standards no longer imply a class bias because the implications of a university degree have been modified sharply by governmental and private scholarship programs. Whereas traditional diplomacy was once the prerogative of the privileged few, it became the responsibility of a professionally trained elite drawn from many segments of society. The means of selection necessarily differ from country to country, however, and generalizations are particularly risky with respect to communist totalitarian states.

Status.—Foreign service officers adhere to rules and customs that are of long standing and have proved indispensable to governments in conducting their international relations. Modern practice dates principally from the congress of Vienna in 1815 and immediately subsequent congresses, and includes the category of diplomats (ambassador, minister and chargé d'affaires, etc.) and rules of precedence, which depend for all occasions on the priority of the ambassador's appointment to his post in the country to which he is accredited. Several newly established nations, in an effort to disassociate themselves as much as possible from a distasteful past, once sought to dispense with much of the custom and some of the rules of established practice, only to fall in step as experience suggested the utility of generally accepted standards. In varying degrees, for example, this development took place in the newly established United States, in republican France and Soviet Russia.

Under international law and usage personnel in missions abroad (usually embassies, legations and consulates), including members of their households, are immune from the jurisdiction of the government to which they are accredited, and the mission itself has the status of extraterritoriality and as such is considered legally

a part of the home country. Personnel may not be sued in civil action or compelled to testify as witnesses, or compelled to pay taxes to the host country. Their official position does not sanction the evasion of private debts, however, and their private property is subject to local municipal law. An officer or staff member who does not conform to local regulations or who is otherwise unacceptable to the government to which he is accredited may be declared unacceptable (*persona non grata*) and his recall requested, a demand that is invariably obeyed. Accreditation of ambassadors or other chiefs of mission is handled in accordance with internationally accepted procedures, but appointment of both ambassadors and other officers follows the constitutional practice of individual states. In the United States the president, usually with the advice of his secretary of state, nominates a candidate who must then be confirmed by a simple majority of the senate. In the United Kingdom the foreign secretary, with the assent of the prime minister, submits the name of the candidate to the crown, and approval constitutes ratification of the appointment.

A guild spirit tends to characterize all foreign services as a legacy of the past and as a consequence of circumstance. The various services are small in comparison with home civil services, and entrance requirements are both different and generally more rigorous. Service for the most part is abroad and involves both hardships and rewards not characteristic of other careers. Above all, foreign affairs involve the interplay of national interests including matters of state not infrequently of the highest importance. Since French is no longer the sole language of diplomacy, foreign service officers usually learn several tongues during the course of their careers. Traditionally foreign affairs were relatively distinct from domestic concerns, and diplomats inevitably stood rather apart from the main stream of national life. When the obligations of service and the skills required are taken into account, including knowledge of languages, economics, politics, science and sociology, to name but a few, it is no wonder that foreign service personnel regard themselves as a dedicated elite. Like members of the armed services they are subject to assignments that may on occasion be difficult or even distasteful, and they must bring to their task not only highly trained knowledge but unfailing loyalty and devotion. They can never escape the responsibility of maintaining their country's dignity and prestige in both official and private life, and they are inevitably conscious that foreign policy is the first line of defense.

Nonetheless, although a corporate spirit continued, a foreign service career changed somewhat from what it was before World War II. Service abroad is scarcely as remote as it was before the development of regular and rapid air transportation. Foreign and domestic affairs are no longer considered to be unrelated, and minimum periods of service in the home country are generally required so that diplomats may effectively represent their country's interests abroad. Foreign policy must run the same course as domestic policy in its formulation, and, in the United States, foreign service officers maintain close relations not only with the state department but with other governmental agencies and with members of the congress itself. A modern diplomat, in short, executes national policy that often involves both foreign and domestic considerations and which is formulated with regard to its economic, military and political ramifications.

It is sometimes asserted that professional diplomats do not make foreign policy. This is true only in the sense that they carry out foreign policy without hesitation once it is established by the national government. But it is equally true that reports from the field and judgment placed on reported facts by individual officers are highly influential in shaping policy, particularly since the views of a foreign minister in any government are heavily dependent on the information presented to him by his "desk" officers. To conceive of foreign service officers as messenger boys walled off from important decisions is to misconstrue the case. How they influence policy, however, varies considerably from country to country.

U.S. Foreign Service.—The foreign service of the United States was established on a professional career basis by the act of congress of May 24, 1924, and was reorganized with the passage of the Foreign Service act of 1946 and subsequent amendments and executive orders providing for the classification of officers including career ministers; the establishment of certain branches including a foreign service reserve which is composed of specialists serving for limited periods of time, and a foreign service staff which provides technical and clerical services; and the creation of the Foreign Service institute to train personnel progressively throughout their careers. The service is administered by a director-general and the board of the foreign service including, in addition to state department officers, representatives from the agriculture, commerce and labor departments which are also served by the service.

Admission is open to United States citizens, both men and women, who take competitive examinations, usually for the lowest grade depending upon age levels. They serve in the state department as permanent career officials under the direction of the secretary of state, who is the senior member of the president's cabinet, and his undersecretaries and assistant secretaries who, like their chief, are political appointees of each presidential administration. (*See* GOVERNMENT DEPARTMENTS: *United States: Foreign Affairs.*)

British Foreign Service.—The modern British foreign service was established by the Eden reforms of 1943 as noted above. In addition to unifying all main branches of foreign affairs work, the reforms provided for changes in recruitment, training and pay so that the service was opened to wider competition among men and women of outstanding ability. Four branches of the service were established, each containing several grades: branch A is the senior and political branch, providing the ambassadors, ministers, counselors, secretaries, senior consular personnel and the higher officials of the foreign office; branch B includes personnel of junior grade who enter by less rigorous examinations, who may compete for promotion to branch A and who perform both technical assignments and consular work; branches C and D include typists, messengers and comparable personnel who receive appointment by appropriate civil service examinations. With the exception of branch D, which serves abroad, personnel in all branches are liable to service at home or overseas. In-service training is provided, and pensions and allowances permit suitable standards of living. Nowhere is the foreign service more highly professional or more respected than in Great Britain. Although deliberately differentiated from political appointees, such as the foreign minister (secretary of state for foreign affairs) and two assisting parliamentary ministers, called minister of state and parliamentary undersecretary of state respectively, members of the career service hold crucially important administrative positions, including the post of permanent undersecretary for foreign affairs, who is chief adviser on foreign policy and administrative head of the foreign service. Important diplomatic assignments likewise go normally to the most highly qualified members of the permanent service who, under the foreign minister's instructions, carry out foreign policy for which the cabinet is collectively responsible to parliament. The permanent officials, however, do not assume public responsibility for governmental policy, and questions or attacks in parliament are directed at the ministers and not at members of the foreign service. For a historical discussion of the British foreign office, *see* GOVERNMENT DEPARTMENTS. (D. S. C.)

Corps of the Queen's (King's) Foreign Service Messengers. This is a body of about 40 men attached to the communications department of the British foreign office who carry secret and confidential dispatches. Queen's messengers existed in the time of Queen Elizabeth I and before the Civil War they were established as a definite corps which was reconstructed after the Restoration. Horsemanship and swordsmanship were necessary qualifications and the service has long been both a real, and fictional, setting for high adventure. In the 17th and 18th centuries each messenger traveled abroad in his own coach but, with the coming of railways, the private coach was superseded by the reserved sleeping compartment. In the 20th century, from the time of World War II, the use of the airplane became standard, making it possible for a messenger to visit many parts of the globe weekly.

Queen's messengers have the status of a first secretary and carry a special red passport, embossed with the words "Queen's Messen-

ger, Courrier Diplomatique" in gold. Queen's messenger escort or traveling security officers accompany messengers on certain journeys by train and are posted to missions where a messenger is not necessary.

The service attracts heavy competition and retired officers from the fighting services are usually selected. A minimum age limit in the mid-40s ensures that each man has proved himself by a long period of excellent service.

The badge of the corps is worn around the neck on a Garter-blue riband and consists of a silver greyhound courant suspended from the royal cipher in silver gilt encircled by the Garter motto in blue enamel. It is worn with civil uniform of 4th class or decorations.

No other country has a comparable body, though the United States has more than 100 state department couriers, mostly young men aspiring to the U.S. foreign service itself. (M. J. O'B.-T.)

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FOREKNOWLEDGE. For divine foreknowledge *see* FREE WILL; PREDESTINATION; also FATE. For divinely inspired foreknowledge *see* ORACLE; PROPHET. For other manifestations of human foreknowledge *see* PARAPSYCHOLOGY and articles there cited; also DIVINATION; and, for scientific calculation, PROBABILITY.

FOREL, FRANÇOIS ALPHONSE (1841–1912), Swiss geographer and naturalist, founder of the science of limnology, the study of lakes, was born at Morges on the Lake of Geneva (Lac Léman) on Feb. 2, 1841. While lecturing in physiology and anatomy at Lausanne university, he took up the scientific investigation of Swiss lakes, and of the Lake of Geneva in particular, the results of which were published in *Le Léman Monographie limnologique,* three volumes (1892–1904), and in his standard work on limnology, *Handbuch der Seenkunde* (1901). This included a study of the hitherto unexplained movement of lake waters known as seiches (*q.v.*). Forel's researches also embraced seismology and the study of Swiss Alpine glaciers. He died at Morges on Aug. 7, 1912. (H. M. Ws.)

FORENSIC PSYCHOLOGY: *see* PSYCHOLOGY, APPLIED: *Other Areas of Applied Psychology: Forensic Psychology.*

FORESHORE is defined as "the shore and bed of the sea, and of any tidal water, below the line of the medium high tide between the spring tides and the neap tides" (Limitation act, 1939, s. 31). In Great Britain, the property in it normally and prima facie vests in the crown, except where it may vest in a subject by ancient grant or charter from the crown, or by prescription from which a grant may be presumed. It forms part of the adjoining county, whose justices have jurisdiction over offenses committed there, whether it is covered with water at the time or not. It also forms part of the adjoining parish. The Public Health act, 1936, ss. 231–234, deals with the powers of local authorities to make by-laws for public bathing and allied purposes.

The chief acts showing title to foreshore are taking wreck or royal fish, right of fishing, mining, digging and taking sand, seaweed, etc., embanking and enclosing. There is a public right of user in that part of the foreshore which belongs to the crown for the purpose of navigation or fishery, but there is no right of passage over lands adjacent to the shore, except by a particular custom. In order, therefore, to make the right available, there must be a highway or other public land giving access to the foreshore. Thus it has been held that the public have no legal right to trespass on land above high-water mark for the purpose of bathing in the sea, though if they can get to it they may bathe there (*Blundell* v. *Catteral,* 1821, 5 B. & Ad. 268).

There is no right in the public to take sand, shells or seaweed from the shore, nor, except in certain places by local custom, have fishermen the right to use the foreshore or the soil above it for drawing up their boats, or for drying their nets or similar purposes. Improvements made by a tenant under the Landlord and Tenant act, 1927, must not infringe the rights of the public. (For foreshore protection *see* BREAKWATER.) (X.; W. T. Ws.)

In the United States, until 1947, the foreshore was considered to belong to the coastal state rather than to the federal government. The United States supreme court had stated in 1845 the rule which was to prevail for more than a century: "The shores of navigable waters, and the soils under them, were not granted by the Constitution to the United States, but were reserved to the States respectively."

However, in 1947 the supreme court decided against California in the federal-state controversy over rights to tidelands oil, holding that the federal government had paramount rights and power over the resources of the soil under the water area three miles from shore. Similar suits were decided against Louisiana and Texas in 1950.

Congress overrode these supreme court decisions in 1953 by passing the Submerged Lands act, which restored to the coastal states full rights of ownership to the foreshore and lands under territorial waters, subject only to the federal powers of regulation and control of the said lands for purposes of commerce, navigation, national defense and international affairs, all of which are considered paramount to, but not to include, proprietary rights of ownership. (C. M. FN.)

FORESTS AND FORESTRY. The word "forest" has not always had its modern meaning. Toward the end of the 8th century A.D. it denoted the royal woods in which the right to hunt was reserved by the king, although the right to cut wood and to clear for agricultural use or for pasture remained free to all. A century later it referred to a large tract including woods, pastures and even whole villages in which the rights of chase were reserved to the king while other rights of use were limited. The famous forests of old England were tracts of this kind set aside by the Norman kings.

Eventually the royal hunt prerogative waned, the old legalistic meaning disappeared and forest came to refer to wild land covered mainly by tree growth rather than meadows and fields. Forests are defined by the Food and Agriculture Organization of the United Nations (FAO) as "all lands bearing vegetative associations dominated by trees of any size, exploited or not, capable of producing wood or of exerting an influence on the local climate or on the water regime." Lands from which forests recently have been clear cut or burned out but which will be reforested in the near future are included, but not brushlands, groups of trees outside the forest or trees along roads, on agricultural lands (such as orchards) and in parks.

This article is divided into sections and subsections covering the principal aspects of forests and the science of forestry. In addition to the cross references to related articles given throughout this article *see* ARBORICULTURE; LUMBERING; WOOD; and TREE. Additional information about diseases and pests will be found in the articles ENTOMOLOGY: *Applied Entomology* and PLANT AND PLANT SCIENCE. The various species of trees are treated under their individual titles. The economic role of forests is indicated in articles on individual states and countries.

Following are the main divisions of this article:

I. Forests
  1. Forest Values
  2. Forest Resources
  3. Growing Stock, Growth and Drain
  4. World Trade
  5. Ownership
II. Forestry
  1. Beginnings of Forestry
  2. Modern Forestry
  3. Forest Protection
  4. Timber Management
  5. Range Management
  6. Watershed Management
  7. Wildlife and Recreation Management
  8. Education and Research

III. World Survey
1. Government and Forestry
2. Protection Forests
3. Forestry in Europe
4. Forestry in the U.S.S.R.
5. Forestry in North America
6. Forestry in Latin America
7. Forestry in Africa
8. Forestry in Asia
9. Forestry in the Pacific Area
10. Outlook

I. FORESTS

1. Forest Values.—Several aspects of the modern concept of the forest deserve emphasis. It is essentially a community in which trees are the dominant form of vegetation but in which other plants, animals and the soil all play an important role. Trees, shrubs, herbs, fungi, insects, birds, mammals, worms, the humus in the forest floor and the organic matter in the soil all are an integral part of the forest and all react on each other. Like any other community—a city, for instance—a forest is an organism which is much more than the sum of its individual constituents. Also, like most communities, it produces a wide variety of goods and services. Of these the most conspicuous is wood with its many derivatives and manufactured products, but minor forest products such as turpentine, tar, pitch, naval stores, rubber, cork, tanbark, dyestuffs, maple sirup, lac and oils are also important. They are estimated by FAO to have an annual value of between $3,000,000,000 and $4,000,000,000, or more than a tenth of the estimated value of primary wood products of approximately $30,000,000,000. Of the latter value, 51% was contributed by lumber, 31% by pulpwood and 7% by fuel.

Among the important services rendered by the forest are control of soil erosion, protection of watersheds, amelioration of local climate and the provision of opportunities for physical and mental recreation and spiritual inspiration. The forest canopy breaks the force of violent rainfall on the soil. The decaying leaves and twigs make the soil more porous and, therefore, a more effective reservoir for the storage of water. The layer of humus which the leaves form delays and reduces surface runoff by preventing the formation of drainage rills and by absorbing large quantities of water, which seeps slowly into the underlying soil. Furthermore, the roots of forest trees help to hold the soil in place.

Much difference of opinion exists as to the influence of forests on the broader aspects of climate, which is controlled chiefly by latitude, elevation and meteorological forces that operate over wide areas. There is, however, general agreement that they reduce wind movement, moderate the temperature of the air, particularly in summer, increase the relative humidity of the air and reduce evaporation from the soil both under their immediate cover and to some distance in their lee. The net effect of these influences is to temper the local climate so as to add to man's comfort and to increase crop production in the lee of shelter belts.

Forests provide attractive opportunities for hunting, fishing, picnicking, camping and other forms of relaxation. They are a recreational asset that increases in value as increasing urbanization, industrialization and the mounting tensions of modern life create a need to "get away from it all."

2. Forest Resources.—Forests constitute one of the most prominent geographic features in the world. They are broadly restricted to parts of the earth where the winter season is not so long and cold as to make tree growth impossible. In general, these areas have an average temperature of at least 50° F. (10° C.) for the summer months. Within the zone of favourable temperatures the occurrence of forests is sharply limited by precipitation, but the limiting amount is difficult to define since it varies with temperature and length of the growing season. Thus, the tropical forests require more water than those of the far north. In the temperate zone, where the subject has been most completely studied, about 16 to 20 in. of annual rainfall seem to be necessary for forests to exist on the well-drained uplands.

By the second half of the 20th century, forests occupied 33% of the land area of the world; another 25%, much of which was once forested, was devoted to agriculture; and about 40% consisted of brushlands, deserts, mountaintops, towns and cities, roads, etc. The percentage of the world's forest area which occurred in each of the seven broad regions recognized by FAO is shown in Table I, as is also the percentage of the total land area in each region occupied by forests.

Latin America and Africa together accounted for 40% of the total forest area, the U.S.S.R. and North America (Canada and the United States) for 43%, and Europe for only 3%. Within regions, Latin America, the U.S.S.R. and North America were well above the average for the world as a whole, while Europe, Africa and Asia were slightly below, and the Pacific area far below, that average. The reduction in the original forest area as a result of settlement and cultivation has been greater in Europe than in any other region.

In the second half of the 20th century 62% of the forest area of the world was accessible, and of the accessible area 54% was

TABLE I.—*Distribution of Forests by Region*

Region	% of world forest area	% of region in forests
Europe	3	30
U.S.S.R.	26	51
North America	17	39
Latin America	23	46
Africa	17	25
Asia	12	19
Pacific area	2	11
World	100	33

Source: Adapted from the Food and Agriculture Organization of the United Nations, *World Forest Inventory, 1958* (1960).

in actual use. In other words, the world's entire production of wood for fuel and industrial use was coming from 33% of its forest area. Figures for the different regions are given in Table II. The U.S.S.R. had both the largest area of accessible forest and the largest area in use. Latin America had the second largest total forest area, but only 32% was accessible and only 9% in use. In Europe 98% of the total forest area was accessible and 96% in use.

From the point of view of composition, the forests of the world are divided into two main classes—conifers, often called softwoods, and broadleaf trees, often called hardwoods although many of the species are softer than some of the conifers. The broadleaf trees in turn are divided into temperate hardwoods and tropical hardwoods, which commonly differ markedly in the character of their woods. There are extensive areas in which conifers and temperate hardwoods occur in mixture.

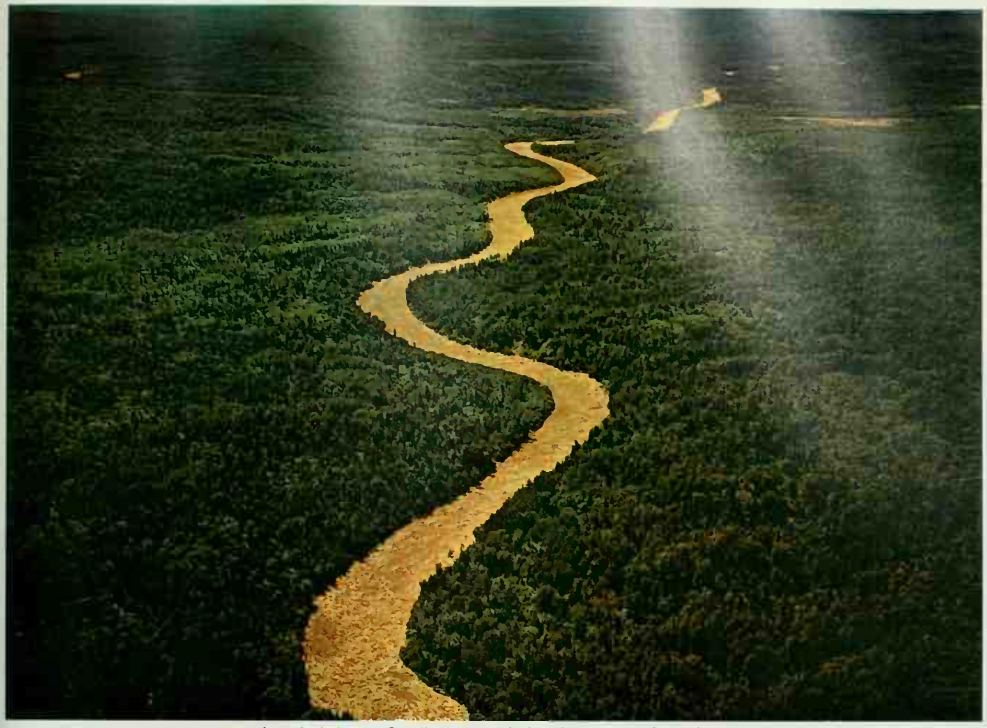
The percentage of the total forest area in the various regions

TABLE II.—*Accessible and Inaccessible Forest Areas of the World*

Region	Total	Accessible		In use		Inaccessible	
	(000,000 ha.)	(000,000 ha.)	% of total	(000,000 ha.)	% of total	(000,000 ha.)	% of total
Europe	141	138	98	135	96	3	2
U.S.S.R.	1,131	1,131	100	459	41	—	—
North America	733	400	55	400	55	333	45
Latin America	1,031	332	32	90	9	699	68
Africa	753	380	50	125	17	373	50
Asia	520	326	63	236	45	194	37
Pacific area	96	26	27	20	21	70	73
World	4,405	2,733	62	1,465	33	1,672	38

Source: Adapted from the Food and Agriculture Organization of the United Nations, *World Forest Inventory, 1958* (1960).

occupied by coniferous forests and broadleaf forests is shown in Table III. The preponderance of broadleaf forests in the world as a whole and of coniferous forests in the northern hemisphere is striking. Particularly noteworthy is the scarcity of coniferous forests in Latin America and their virtual absence in Africa. In spite of the fact that conifers comprise little more than a third of the forests of the world, about 50% of the forests in actual use consist of coniferous trees. This situation results from the fact that conifers are in general preferred to broadleaf trees for such purposes as construction, transport, timber fabrication and pulp, and that they occur chiefly in regions of relatively high industrial development. Economic and cultural progress in the less-developed regions and technological progress in the use of broadleaf trees for a wider variety of industrial products are bound to



Logs float down a Canadian stream winding through a coniferous forest to a pulp mill at Marathon, Ont.

California redwood trees (*Sequoia sempervirens*) near Eureka, Calif., in morning mist and sunlight

Moss-festooned maple trees of the Olympic rain forest on Olympic peninsula, Wash.

FOREST SCENES

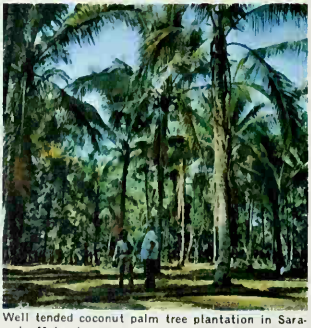
BY COURTESY OF (BOTTOM LEFT) U.S. FOREST SERVICE; PHOTOGRAPHS, (TOP) PHOTOGRAPHIC SURVEY CORPORATION, (BOTTOM RIGHT) RAY ATKESON—PUBLIX

FORESTS AND FORESTRY

Year-old larch seedlings grown in a Japanese nursery are dug for transplanting in reforestation area

Collecting seed for propagating improved forest trees

MANAGEMENT OF FORESTS



Well tended coconut palm tree plantation in Sarawak, Malaysia

Collecting resin for naval stores from a pine forest in Georgia

Felling deadened teak tree (*Tectona grandis*) on a plantation in Indonesia

BY COURTESY OF (TOP) JAPANESE FORESTRY AGENCY, (CENTRE) FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS, (CENTRE RIGHT) U.S. FOREST SERVICE; PHOTOGRAPHS, (CENTRE LEFT) LAWRENCE S. HAMILTON, (BOTTOM) W. A. HUBERMAN

U.S. forest service B-26 tanker plane drops a mixture containing ammonium sulfate on a forest fire in the coastal area of Mississippi

FOREST PROTECTION

Pine tree seedlings are planted in an eroded gully to control water runoff

Forester spraying a felled ponderosa pine to control bark beetle (*Dendroctonus brevicomis*) reinfestation. Solution is 1½% lindane mixed with diesel fuel

A forest fire is isolated by plowing around it prior to backfiring to burn combustibles in its path

BY COURTESY OF (ALL) U.S. FOREST SERVICE

FORESTS AND FORESTRY

Patch cutting in old growth of Douglas fir. Adjacent timber should reproduce naturally to cover the cleared areas

Second growth of eastern white pine and an understory of red spruce and eastern white pine in the Machias river drainage area, Maine

First forestry school in the U.S. was established early in the 20th century on this 70-year-old white pine plantation at Biltmore estate, Asheville, N.C.

TIMBER MANAGEMENT

Selective cutting in ponderosa pine, Oregon

A 19-year-old stand of red pine, thinned in rows to leave adequate area for noncompetitive growth of top quality trees

BY COURTESY OF (TOP, CENTRE LEFT, CENTRE RIGHT, BOTTOM RIGHT) U.S. FOREST SERVICE PHOTOGRAPH, (BOTTOM LEFT) LAWRENCE S. HAMILTON

TABLE III.—*Coniferous and Broadleaf Forests of the World by Region*

Region	Coniferous forests			Broadleaf forests		
	(000,000 ha.)	% of region	% of world	(000,000 ha.)	% of region	% of world
Europe	84	59.6	5.2	57	40.4	2.0
U.S.S.R.	896	79.2	55.1	235	20.8	8.4
North America	497	67.8	30.5	236	32.2	8.5
Latin America	28	2.7	1.7	1,003	97.3	36.1
Africa	3	0.4	0.2	750	99.6	27.0
Asia	110	21.1	6.8	410	78.9	14.8
Pacific area	8	8.3	0.5	88	91.7	3.2
World	1,626	36.9	100.0	2,779	63.1	100.0

Source: Adapted from the Food and Agriculture Organization of the United Nations, *World Forest Inventory, 1958* (1960).

bring about a steadily increasing utilization of the tremendous area of broadleaf forests, still largely inaccessible and unexploited.

3. Growing Stock, Growth and Drain.—Statistics concerning the amount of standing timber—growing stock—in the forests of the world are even less satisfactory than those for forest area. In large areas, particularly in the tropics, no systematic sampling has been done and methods of estimation vary widely. On the basis of the best obtainable information, FAO has estimated that the total growing stock in forests in use is 121,000,000,000 cu.m. (1 cu.m. = 35.3 cu.ft.) with bark. Only fragmentary figures are available for forests not in use.

Large but unknown volumes, chiefly of hardwoods, occur in regions where the percentage of forest in use is low. Latin America, for example, has 23% of the total forest area of the world but only 8% of the growing stock in forests in actual use, with large reserves in unexploited forests. Conifers comprise 55% of the total growing stock in forests in use and nonconifers 45%. Stands per hectare (2.471 ac.) average respectively 90 and 85 cu.ft., with an average for all species of 88 cu.ft. The stand per hectare is considerably higher in the U.S.S.R. than in Europe and North America, in all of which coniferous forests predominate, because of the higher proportion in the U.S.S.R. of trees that are mature or nearing maturity.

The growing stock of marketable species of trees of merchantable size controls the amount of material available for current exploitation. The growth which takes place on the smaller timber and on the young trees which follow the cutting of mature stands controls the amount of material that will be available for future exploitation. Accurate information on both growing stock and growth is therefore essential for intelligent forest management. Gross growth in the forests of the world in use is estimated by FAO at 2,400,000,000 cu.m. (with bark) on the basis of the incomplete and often noncomparable information at its disposal. This figure represents 2.4% of the total growing stock in forests in use, with 45% in the form of conifers and 55% in nonconifers.

Net growth, which represents the amount of wood actually available for utilization, is determined by subtracting losses from fire, insects, diseases, windstorms and other causes from the gross growth. In Europe, where climatic conditions are favourable and the standard of forest management is high, natural losses are estimated at about 5% of gross increment. In the United States, including coastal Alaska, the forest service estimated at the beginning of the second half of the 20th century that losses due to mortality over a period of years averaged about 20% of the annual gross increment, plus a large additional loss due to the deterioration of standing timber. Similar figures are not available for other regions.

FAO estimates placed the annual removal of roundwood (wood without bark) from the forests of the world in use at about 1,600,000,000 cu.m. This figure was lower than actual removals since it did not include unrecorded and illicit fellings in countries for which no official estimates had been made. Industrial wood comprised about 59% of all removals and fuelwood about 41%. Conifers contributed 78% of the industrial wood but only 27% of the fuelwood.

More detailed estimates are given in Table IV. Two-thirds of the total removals came from North America, the U.S.S.R. and Europe. Industrial wood comprised about 60% of the total, with the same three regions leading in the same order of importance. Fuelwood comprised about 90% of total removals in Africa, 84% in Latin America and 55% in Asia. Per capita consumption of roundwood, sawnwood, plywood and paper was considerably greater in North America than in any other region.

Sawnwood (chiefly lumber) has long been the most important forest product in terms of both volume and value. Following World War II, however, its production was relatively stationary as compared with that of plywood, which in a ten-year period increased more than 200%, and that of wood pulp, which increased more than 80%, in a group of major producing countries. Although the use of fuelwood tends to decline as greater use is made of mineral fuels and hydroelectric power, it continues to be an important forest product in all regions. Moreover, the reported production is undoubtedly an underestimate since many removals are not reported and much fuelwood is derived from other sources

TABLE IV.—*Removal of Roundwood from the Forests of the World*

Region	Total		Industrial wood		Fuelwood	
	(000,000 cu.m.)	%	% of world	% of region	% of world	% of region
Europe	298	17.9	11.6	65.1	6.2	34.9
U.S.S.R.	397	23.8	16.1	67.8	7.7	32.2
North America	406	24.3	21.0	86.5	3.3	13.5
Latin America	176	10.5	1.6	15.3	8.9	84.7
Africa	122	7.3	0.8	10.7	6.5	89.3
Asia	249	14.9	6.7	44.6	8.3	55.4
Pacific area	22	1.3	0.9	68.2	0.4	31.8
World	1,670	100.0	58.7	58.7	41.3	41.3

Source: Adapted from UN Food and Agriculture Organization, *Yearbook of Forest Products Statistics* (1960).

such as residues from logging and manufacturing and salvage from buildings and fences.

The steadily increasing use of wood resulting from an expanding population and a rising standard of living tends to put a severe strain on the forest resources of the world. Although fully reliable information on the subject is lacking, FAO, in a report on the world's forest resources, concluded that growth and drain were about in balance in the 600,000,000 ha. of coniferous forests in use and that growth somewhat exceeded drain in the 540,000,000 ha. of broadleaf forests in use. On the other hand, the management of a large part of the forests of the world leaves much to be desired from the standpoint of their ability to meet permanently a continually mounting demand for timber products.

Such information as FAO has been able to obtain indicates that by the second half of the 20th century only 27% of the total area of forests in use was being managed under working plans. The estimates ran from lows of 6% in Latin America and 13% in Africa to highs of 42% in Europe and 54% in Canada and the Pacific area. Cutting practices for the world as a whole were described as good for 25% of the forests in use, fair for 35% and poor or destructive for 40%. Wide differences, of course, exist between countries and individual properties. In Sweden and Switzerland cutting practices were said to be good in 90% of the forests in use, as compared with 15% in Spain and 13% in Argentina. If properly handled, the forests already in use and those still to be exploited, in spite of the relatively poor quality of many of the latter, could support a much heavier drain than that to which they have so far been exposed.

4. World Trade.—International trade in timber products is active. In the second half of the 20th century estimated annual exports of industrial wood, as a percentage of removals, ran from 3% in the U.S.S.R. and the Pacific area to 39% in Europe and 40% in Africa. Much of the trade for Europe was intraregional, while practically all of that for Africa was interregional. European exports were valued at $2,461,000,000 and African exports at $119,000,000. North America was not far behind Europe, with total exports of $1,970,000,000. Both Europe and Africa were also heavy importers of timber. Only North America and the U.S.S.R. were net exporters.

Coniferous species comprised the bulk of the world trade in sawnwood, with Canada the largest exporter. World trade in broadleaf species was, however, increasing and constituted 10% of world exports. The leading exporters of plywood were Japan,

Finland and Canada. Sweden accounted for more than 30% of world exports of wood pulp, Canada for about 25% and Finland for 17%. The United Kingdom and the United States were the heaviest importers, with well over half of the total. The main lines of trade in wood pulp are from Canada to the United States and from northern European countries to western Europe.

5. Ownership.—Information as to forest ownership is fairly complete for Europe, the U.S.S.R. and North America, but far less so elsewhere. In the less-developed regions, and particularly in the remoter areas, considerable tracts of forest are unmapped, unsurveyed and without established titles. This situation reflects both lack of knowledge as to the location and extent of the forest resources and failure to appreciate their future, if not present, value. The division of ownership among different classes of owners as reported to FAO for the accessible forests of the world is presented in Table V.

For the world as a whole, 76% of the accessible area was in state and communal ownership and 24% in private ownership. The U.S.S.R. was the only region in which the entire area was in public ownership, although Asia was not far behind. Private ownership was most conspicuous in Europe (55%) and North America (43%). The division of ownership between different classes of owners varied widely by countries within any given region. In Europe, for example, private owners held none of the accessible forest in Bulgaria, 12% in Poland, 64% in France and 96% in Portugal. In Latin America, private ownership amounted to 17% in Colombia, 49% in Mexico and 93% in Paraguay. In many countries, including the U.S., private holdings are often in tracts of such small size as to make intensive management difficult.

TABLE V.—*Ownership of Accessible Forests by Region*

Region	Per cent of ownership in		
	State forests	Communal forests	Private forests
Europe	33	12	55
U.S.S.R.	95	5	
North America	18	39	43
Latin America	53	5	42
Africa	65	21	14
Asia	84	9	7
Pacific area	59	1	40
World	64	12	24

Source: Adapted from the Food and Agriculture Organization of the United Nations, *World Forest Inventory, 1958* (1960).

II. FORESTRY

1. Beginnings of Forestry.—Planned management of forests with the aim of perpetuating and improving them is a relatively new development. From earliest times, man's activities have tended to reduce the area occupied by forests and to impair their productivity. Large areas were burned, often repeatedly, to improve hunting; fire, girdling and cutting were used to clear the way for farms and pasture; and heavy inroads were made for fuelwood and construction material.

The process of destruction and deterioration was encouraged by the almost universal belief that the forests were inexhaustible, if not in the immediate vicinity of settlements, at least regionally and for the world as a whole. Forests were often a nuisance, and where they were clearly an asset lavish use was the order of the day. Always beyond the horizon were untouched resources. Even in the second half of the 20th century the 70% of the world's forest area that is not in use because of inaccessibility, or for other reasons, helps to maintain the myth of inexhaustibility.

Nevertheless, local shortages of wood long ago led to occasional, usually ineffective, action to assure future supplies. About 450 B.C. Artaxerxes I attempted to restrict the cutting of the cedars of Lebanon. Efforts to prevent the use for other purposes of trees suitable for ship timbers were made in the time of the Roman empire and much later in England. During the 12th and 13th centuries, in Germany, more drastic restrictions were imposed, such as limiting the amount that could be cut by each family and prohibiting the use of live trees for fuel. As time went on, the practice of leaving seed trees, making cuttings so as to avoid wind throw of the remaining trees, and other applications of good sense to the management of the forest began to make their appearance.

Then in the middle of the 18th century a sudden change in attitude and practice occurred in central Europe. Among the factors responsible for the change were local timber famines resulting from the destruction accompanying the wars of the 17th century, the gradual shift of interest from game to wood as the chief product of the forest, and the growth of a group of writers and state officials known as cameralists who were essentially political economists interested in the money-making capacities or public revenue of the principalities with which they were connected. Books dealing with many phases of forest production began to appear, and both public and private landowners became active in developing the capabilities of their lands. During the next century the movement toward modern forestry steadily gained momentum in Europe and spread to other parts of the world, particularly those most affected by the Industrial Revolution.

2. Modern Forestry.—Forestry has been defined in many ways. In essence, it is the management of forests and forest lands for the continuous production of goods and services. It is an art based on scientific information applied with due regard to economic and social considerations. The biological, physical and social sciences, mathematics, engineering and even philosophy all make substantial contributions to its successful practice. It has, in short, developed into a profession for which a broad and intensive training is required.

Several features of forestry deserve emphasis. It deals with production as well as exploitation, with the future as well as the present, with services as well as goods and with intangible and social as well as tangible and economic values. It must compare the value of products and services for which there is no common measuring stick, such as the lumber and pulp produced from wood and the pleasure and inspiration afforded by recreation; it must convert anticipated returns into present worth. This responsibility requires foresight and sound judgment in the development of plans and technical skill in their execution.

Two important aspects of modern forestry are multiple use and sustained yield. Multiple use means the management of any given area (usually an administrative unit of considerable size) for several different purposes, such as timber production, watershed protection and recreation. Since some uses are incompatible under certain conditions and since maximum yields from all uses are a physical and biological impossibility, a decision must be reached as to which uses shall be given priority. In effect, this means determining the use or combination of uses to which the different parts of a forest are best adapted in the light of the natural environment and of economic and social considerations.

Sustained yield implies the continuous production and use at a given level of some product such as wood or wildlife or the maintenance without impairment of some service such as watershed protection or the values afforded by wilderness and other recreational areas. Of major importance is the level at which the yield is to be sustained, with constant pressure for higher and higher levels as population increases and standards of living rise. The technical difficulties of attaining such higher levels for products and services of various kinds mount rapidly and complicate the problem of multiple use.

The first steps in placing a forest under management are to establish its boundaries, to map its topography and other physical features, to determine the kind and amount of its various resources and to provide for its protection from fire, insects and disease. These are basic activities that must be undertaken whatever the specific objectives of the owner.

3. Forest Protection.—*Fires.*—The danger from fire varies widely depending upon the climate and the nature of the forest. Coniferous forests, for example, burn more readily than broadleaf forests. Fires are virtually unknown in the tropical rain forests but are common even in broadleaf forests wherever there is a long, dry season, as for example, in parts of Latin America and Africa. The danger is slight where the forest is broken into small, more or less isolated holdings, as is the case in much of central Europe. On the other hand, it is great in the broad coniferous forests of North America and Asia, where conflagrations are not uncommon,

particularly in portions subject to thunderstorms accompanied by little rainfall. Despite growing concern and increased control efforts in the United States forest fires continue to occur at an average rate of 100,000 per year, but due to the efforts of both federal and state forestry agencies only a small percentage become large enough to cause material damage.

In much of the world fire is still regarded as the most serious enemy of the forest. Although there are circumstances under which it may prove a useful tool in forest management, when out of control it kills and weakens trees of all sizes, destroys wildlife, paves the way for attack by insects and diseases, results in deterioration of the soil and increased surface runoff of water and reduces recreational values. Protection from fire is, therefore, an essential part of forestry and a prerequisite to the actual management of the forest resource. (S. T. D.)

A large majority of forest fires are caused by human carelessness. Careless disposal of cigarettes, matches, etc., by campers and tourists passing through forest areas account for more fires than any other cause. Lightning, as mentioned above, and camp and cooking fires also are common causes.

Factors which determine the fire susceptibility of a particular forest area and the probability of extensive spreading of fire are generally considered to be the moisture content and arrangement of the trees, atmospheric temperature and relative humidity, wind and topography. Atmospheric temperature and humidity and the moisture content of trees, fallen timber and underbrush are of course interrelated, and in many forest areas an extended dry, hot spell is referred to as the "fire season." Wind is the single most important weather factor once a forest fire has begun to spread. Unexpected changes and shifts and the dropping of flaming embers ahead of the fire all present critical problems to fire fighters. Research has indicated that wind conditions in the upper atmosphere are as important as surface winds in their effect on mass fires. Forest fires also are affected by the topography of the burning area. The most dangerous condition occurs on steep slopes, where a single fire can often have a vertical dimension of as much as a mile due to the relative position of the fuel bed and flame front and the channeling and turbulent effect of wind flow. The type, arrangement and density of the fuel bed is of course also an important factor in the mass fire potential of a given area. The U.S. forest service has developed a method whereby the various factors having a bearing on the potential fire problem can be evaluated and a "fire load index" computed to provide a measure of the potential fire danger for any given forest area over a particular period of time.

Unless a forest fire can be attacked in its initial stages, it is normally impossible to control it successfully on its windward side. Instead, the fire must usually be fought on its flanks and leeward side and driven to an area where it can be surrounded and controlled or will burn out. Techniques used to contain forest fires include the use of firebreaks, consisting of wide swaths from which combustibles have been removed, and the use of backfiring, which consists in starting a fire to burn back toward the main fire and thus eliminate combustibles in its path. Other techniques include dropping solutions of water and fire-retardant chemicals from aircraft, the use of high-capacity air blowers to attempt to control wind direction and the application of various types of fire-retardant solutions to potentially dangerous areas.

(G. L. Ma.)

Insects and Diseases.—Insects and diseases are other enemies that must be controlled, particularly as the resources at stake increase in value. Even normal, endemic populations may cause serious losses, and the danger becomes acute when these populations swell, often rapidly, to epidemic proportions. In North America forests have been virtually wiped out over vast areas by bark beetles and by the spruce budworm, while the imported chestnut blight has eliminated the native chestnut as a commercial species. The forest service estimates that by the second half of the 20th century the mortality on commercial forest lands in the U.S. caused by insects and diseases was, respectively, more than four times and more than three times that caused by fire, with still larger additional losses of wood from heart rot in living trees.

Methods of protection vary widely depending on the characteristics of the particular organism involved. Leaf-eating insects such as the spruce budworm and the hemlock looper can be controlled by spraying with poisons from airplanes, but bark-boring beetles can be controlled only by logging operations. Biological control by the introduction of parasites and predators that live on the destructive insects is feasible in some cases. White pine blister rust can be controlled by the eradication of all currant and gooseberry bushes, on which the fungus spends part of its life, in the neighbourhood of pines. There is no known method of control for some diseases, such as the chestnut blight. In general, the most effective and permanent control for most forest pests lies in the production of stands composed of thrifty trees of more than one species and harvested at maturity; in other words, in management of the forest, not of the pest.

4. Timber Management.—Although forests are commonly used for more than one purpose (multiple use), it is convenient to consider separately their management for their major products and services. Of these, timber is by and large the most important, and the technique for its production is the most highly developed.

One of the first things a forest manager must determine is how much timber of different sizes the forest contains, how fast it is growing and what yields can be expected at various future dates under whatever methods of cutting and utilization he may adopt. He must then develop a working plan which will enable him annually or periodically to harvest the same amount of timber (sustained yield), with sufficient provision for flexibility to enable him to adjust cutting operations to changing market conditions and to unexpected occurrences such as fires or insect attacks. For convenience of administration the tract is divided into a number of smaller units, often on the basis of small drainages or other topographic features. Cutting operations are allocated to these units in accordance with their productive capacity and consequent ability to yield the harvests called for in the working plan.

Silviculture, literally "care of the forest," includes practices designed (1) to maintain a vigorous, productive forest of the desired species and sizes; and (2) to provide for the replacement of stands as they are harvested, either by natural means or by tree planting or seed sowing. The first objective is attained chiefly by the removal of trees that are undesirable because of species, shape, injury or other defect (weed trees), and by thinning out stands that are too dense so that growth will be concentrated on a smaller number of high-class trees whose growth will be stimulated by the reduction of competition. Weedings are usually conducted at a current net cost, but thinnings may yield a substantial net income where there is a market for small material.

Silvicultural systems for obtaining reproduction after cutting by natural means are divided into several conventional classes. Clear cutting of all merchantable trees may be done in narrow strips or in small patches, with the expectation that the area will be reforested by seeds from the adjacent uncut stands, or enough scattered seed trees may be left on the cutover area to provide for its reforestation. The shelterwood method involves a series of cuttings several years apart in which the stand is first opened sufficiently to permit reproduction to come in under the shade of the overwood and is later removed after the reproduction has become established. These two systems are best suited to even-aged stands, in which the trees do not vary in age by more than about 20 years.

The selection system involves the harvesting of individual trees and is much better adapted to uneven-aged forests. The entire forest is gone over at regular intervals and the trees that have matured or reached a specified size since the previous cutting are removed. This procedure always leaves uncut a part of the stand from which reproduction is expected to take place, but the process is somewhat uncertain, and undesirable species may tend to dominate. Another system depends on reproduction by sprouts from the stumps of the cut trees. With a few exceptions, such as redwood, it is applicable only to broadleaf trees. It usually results in gradual deterioration of the stand and should be supplemented by provision for the establishment of seedlings.

Modifications and combinations of these various methods are common. When they fail to obtain adequate reproduction or when the forest is destroyed by fire or other catastrophe, recourse must be had to artificial reforestation. Planting of young, nursery-grown trees is the method generally used, but direct seeding is possible and has the advantage of cheapness where climatic conditions are favourable and protection of the seeds from destruction by birds and rodents is feasible. Planting machines drawn by tractors are increasingly used where the ground is not too steep or too stony. The rate of planting has risen markedly and there is a growing tendency to use artificial reforestation immediately after cutting as a means of obtaining prompt restocking with desirable species, even where the prospects for natural reproduction are reasonably good.

Efficient harvesting of the timber by logging requires a carefully planned network of permanent forest highways together with many temporary woods roads or trails over which the logs are hauled out. Logging methods vary widely in different countries and in different forest types. Throughout the world there is a tendency toward increased use of heavy bulldozers and graders for road construction, of power saws for tree felling, of tractors for moving logs from the stump to the log yard and of trucks for transporting the logs to the mill. Where close utilization of the tops and branches is impracticable, it may be necessary to treat the debris, or slash, by burning, piling or scattering so as to reduce the danger from fire or insects or to prevent the smothering of established reproduction.

Manufacture of timber into lumber, veneer, furniture, containers, pulp, paper and innumerable other products is not a part of forestry, but it is an activity in which the forest manager has a keen interest. These products not only furnish a market for the forest crop, but they determine the kind and amount of material for which there will be a demand. Making wood go twice as far has the same effect as doubling its production. For many reasons wood technology exercises a profound influence on forestry and is a field with which the forest manager must be well acquainted.

5. Range Management.—In many parts of the world grassy meadows and other range lands are so intermingled with forest lands that the two classes of land must be managed together. Furthermore, there are some forest types, as in the coniferous forests of the western United States, in which much forage suitable for use by domestic livestock occurs within the forest itself. In such situations the forest manager must have sufficient knowledge of range management to assure full use of the range resources, both in the open and in the forest, without overgrazing and consequent damage to the forest, to the water supply, to recreational values or to the range itself.

A different situation exists in forests of broadleaf trees, where grazing by domestic livestock is nearly always injurious. Trampling packs the soil and exposes tree roots, while browsing kills off the young growth and prevents reproduction. Here the problem is primarily one of exclusion rather than control of grazing. (*See* also RANGE [IN AGRICULTURE].)

6. Watershed Management.—In hilly and mountainous country, a primary responsibility of the forest manager is to reduce the surface runoff of water so as to minimize erosion and to regularize the flow of springs and streams. Where clear cutting of any considerable area is avoided, the occurrence of organic matter in the soil, the accumulation of litter on the forest floor and the presence of herbs, shrubs and trees are ordinarily adequate to attain this result.

In arid and semiarid regions, the total amount of water available for domestic, municipal and industrial use, for irrigation and for power is another item of major concern. Here the influence of the forest may be adverse because of the large amounts of precipitation which it intercepts and the large amount of water which it transpires. There is some experimental evidence that the opening up of a forest by small clearings or in other ways may substantially increase the total runoff of water, but far more research is needed to determine how and to what extent such openings can be made without unduly increasing the danger of soil erosion. And there is always the further question as to whether the water or the timber is the more valuable.

7. Wildlife and Recreation Management.—Wildlife is an ever-present component of the forest in which hunters, fishermen and nature lovers have a special interest. Since many animals, such as deer, prefer edge conditions where forest and open land meet, the forest manager must face the problem of creating such conditions without undue interference with timber production.

Other forms of recreational use of the forest, such as picnicking and camping, are steadily increasing in importance and occasionally come in conflict with uses such as timber management and range management. Here again, much needs to be learned about ways and means of reconciling the different uses and about the relative values involved. Of particular urgency is decision as to the extent to which forests should be set aside as wilderness areas and how they should be managed to best serve the purposes for which they are established.

8. Education and Research.—Formal schools for the training of foresters were first started in Russia, Germany, France and Sweden in the early 1800s. Other schools followed gradually, first in Europe and later in other parts of the world. Professional instruction in forestry was not undertaken in the United States until 1898 but thereafter developed rapidly. In most countries the trend has been toward the broader training of general practitioners and the more intensive training of specialists.

Experiment stations for the conduct of forest research were established in Germany in the 1860s and 1870s. Other countries gradually followed suit, and research has received steadily increasing attention as forest problems have grown in importance and in complexity. That developments are not keeping up with needs, however, is indicated by a study made by a committee of the Society of American Foresters which recommended that annual expenditures of $45,400,000 in the 1950s for research in timber management and related fields (including wood technology) be increased to $200,000,000 over a 25-year period. Governments are generally the leaders in the research field, but substantial contributions are made by educational institutions and private organizations.

III. WORLD SURVEY

1. Government and Forestry.—Forests are of such vital significance in the economy and general well-being of a nation that governments have long recognized a responsibility to see that they are so managed as to promote, or at least not to jeopardize, the public interest. Governmental participation in forestry affairs may take the form of ownership of forest lands, of control of the activities of private owners or of assistance to private owners All three approaches are commonly used in the same country, with wide differences in the reliance placed on each.

With 78% of the accessible forests of the world in public ownership, governments are clearly in a position to exercise direct control over the bulk of the world's forest resources. Such control does not, however, necessarily result in efficient forest management, particularly in countries with relatively small industrial development. Outside of the U.S.S.R., where all of the forests are in public ownership, forestry has made the most progress in Europe and North America, where 55% and 43% of the accessible forests are in private ownership.

2. Protection Forests.—Public regulation of the management of their forests by private owners is of long standing in Europe, particularly in the case of protection forests, which include those so located that mismanagement is likely to result in serious damage to the community from such causes as soil erosion, floods, avalanches and the encroachment of sand dunes. Any general regulation of the management of other private forests is a later development, which perhaps has gone farthest and been most successful in Sweden, Norway and Finland. In the United States, a few states have enacted regulatory legislation of this character.

Public assistance to private owners is extended in a wide variety of ways. It may take the form of partial or complete assumption of the responsibility for protection from fire, insects and disease, of payments for the adoption of improved forest practices, of tax concessions, of credit under favourable terms, of the provision of

nursery stock at or below the cost of production, of education and of free or low-cost service in the management of forests and in the harvesting and marketing of forest products. Research by public agencies, much of which deals directly with private lands, also may be regarded as falling in this category.

3. Forestry in Europe.—The development of forestry throughout the world can be illustrated by a brief presentation of the policies and practices of a few selected countries in the various regions. Forestry as an art with a sound scientific foundation was first developed in Germany, and German-trained men played an important part in early developments in Scandinavia, Russia, the British Commonwealth and the United States. Special emphasis was placed on the technology of forest management, on financial considerations and on the organization of forest properties for sustained yield. Theories and formulas commanded much attention and were rather rigidly applied in practice. Policies with respect to private forests have swung between the two extremes of strict controls and virtually free enterprise. From World War II private forests in west Germany have been largely under state supervision, while those in east Germany are all managed by the central administration.

France became interested in forestry at an early date. In 1669 Jean Baptiste Colbert, Louis XIV's great minister, promulgated a comprehensive forest code which set up a complete administration for all the forests of the country and prescribed many detailed silvicultural practices. This code was abrogated by the French Revolution, but in 1827 a new Code Forestier prescribed in detail for the management of public forests and provided severe penalties for trespass and for starting fires on any forest land. Except that the clearing of forest land without permission was prohibited, private owners were otherwise left practically free of public control, as is still the situation. Among France's outstanding achievements are the control of mountain torrents, the stabilization of extensive sand dunes and the reforestation of large areas of waste lands.

The forests of the Alps are important to Switzerland both as a source of timber and as a scenic and protective asset. A law of 1902 authorized the federal government to designate protection forests, a fourth of which proved to be in private ownership, and provided for such public control over their management as necessary to prevent impairment of their protective function. Subsidies are granted the private owner to aid in reforestation, the construction of dams and other measures to control torrents. In general, the technical management of Swiss forests is of a high order. The city forest of Zürich (*Sihlwald*) has been under management with a definite working plan since about 1680, making it the oldest continuously managed forest in the world.

Sweden's extensive forests, largely located on rivers which provide cheap power and log transportation, long have enabled it to be a heavy exporter of lumber and of wood pulp and paper. The public forests were placed under the supervision of trained personnel toward the middle of the 19th century, and about 50 years later intensive management practices began to be adopted by the larger private owners, particularly in the pulp and paper industry. Public control over private forests was established by the law of 1903, which was revised and strengthened in 1923 and 1948.

The 1948 law provides that "Forest land together with the forest growing thereon shall, through suitable use of the productive capacity of the soil, be so managed that a satisfactory economic return is obtained and, so far as possible, substantially sustained yield." Responsibility for supervising the management of forests in accordance with the law is lodged in county boards of forestry. These boards usually consist of three members of whom the chairman is appointed by the king and the others by the county council and the county agricultural society. They must be well acquainted with forestry and forest conditions in the county and are typically forest owners. The county forestry boards are in turn supervised by a private forestry board in the department of agriculture which exercises general federal leadership with respect to private forestry. Educational and service, as well as regulatory, activities are conducted by the county boards through their technical staffs, and under certain conditions owners may receive grants to aid in undertaking measures that are desirable but too costly to promise satisfactory economic returns.

The Swedish system of controlling the management of forest lands in private ownership places the determination of policy at the national level and administration of the policy at the county and district levels. It meets with almost universal approval in theory and in general works well in practice. Although it has greatly improved the handling of the small farm wood lots, which comprise more than three-fifths of the total area in private and community ownership, it has fallen considerably short of getting them all under really satisfactory management. Management of the forests in the hands of the larger companies, on the other hand, compares favourably with that of the national forests. In Sweden, as in many other parts of Europe, forest owners, co-operative associations and forest management associations exert a constructive influence in the management of the smaller forest properties.

Great Britain, once densely wooded, was gradually deforested until by the outbreak of World War I it was almost wholly dependent on imports for its wood supply. The virtual stoppage of these imports by German submarines awakened the nation to the importance both of wood and of building up a domestic supply on which it could rely in time of crisis. Little progress had been made in this direction when World War II created a second and even more drastic emergency. As a result, parliament in 1945 adopted a plan for the creation of 5,000,000 ac. of forest in the next 50 years, partly by national purchase and planting and partly by regeneration of badly depleted private woodlands. A unique arrangement for encouraging action by private owners was embodied in subsequent legislation (1947) and in agreements entered into between the government and associations of forest owners. Under these agreements private owners, in return for heavy public subsidies, voluntarily covenant to dedicate their lands permanently to forest production.

4. Forestry in the U.S.S.R.—Interest in the perpetuation of the forests of European Russia developed in the 17th century, and from then on sporadic attempts were made to check devastation, particularly in protection forests. In 1888 a comprehensive law provided for the conservation of forests, public and private alike.

Following the fall of the tsar, the U.S.S.R. in 1918 ended all private ownership in land, water and forests. Since then the forests have been managed, and production from them tremendously increased, under the various five-year plans. The volume of timber cut has not been limited to the annual growth but has been determined by the economic and industrial needs of the country.

Much stress is laid not only on the economic value of the forests but on their influence on climate, erosion, streamflow and health. Large areas have been set aside around health resorts and industrial areas; protection forests, in which cutting is forbidden or restricted, have been established on critical watersheds and along the banks of the larger rivers; and the forest area has been extended by large-scale planting operations. A particularly ambitious project is the erection of a forest barrier about 3,300 mi. in length in the path of hot southeast winds and the planting of nearly 6,000,000 ha. of shelter belts around cultivated fields.

The U.S.S.R. has 12 institutes of university grade for the training of students in all branches of forest management and forest utilization. These schools graduate between 2,500 and 3,000 students each year. Many vocational schools also are training forest personnel. Research is conducted at the professional schools of forestry, at 15 special forest research institutions and at scores of experimental stations and laboratories.

5. Forestry in North America.—With some minor exceptions, practically uncontrolled exploitation of the forests of the United States continued until the end of the 19th century, when acts passed in 1891 and 1897 authorized the president to reserve portions of the public domain from alienation.

Then, in 1911 and 1924, congress authorized the purchase of forest lands by the federal government for watershed protection and, under certain conditions, for timber production. By the second half of the 20th century national forests reserved from the public domain and acquired by purchase totaled about 180,000,000 ac.

in the U.S., including 21,000,000 ac. in Alaska, all of which were handled under the multiple-use principle. There was an additional 225,000,000 ac. of public land in Alaska, much of it in forest, which received inadequate protection from fire and was otherwise unmanaged. Most of the other states (notably Michigan, Minnesota, Pennsylvania and Washington) had state forests which aggregated 19,000,000 ac., or 4% of the commercial forest area of the country. An additional 8,000,000 ac. was in county and municipal ownership. Each state has its own system of forest fire protection and co-operates with private owners in educational and service activities. Grants-in-aid for these purposes are received from the federal government.

Private forestry started on a small scale in the early years of the 20th century, but it was not until after 1940 that the movement gained real momentum. The change in attitude and practice was due to a variety of factors, among which increased timber values, improved technological processes and the need for adequate permanent supplies of raw material to safeguard heavy investments in plant and equipment were of prime importance. A helpful influence was the tree farm program initiated by industry in 1941. In less than 20 years more than 11,000 forest owners in 45 states with a total of 45,000,000 ac. were participating in the program. Its purpose is to encourage better forest practices by formal recognition of owners who meet certain specified standards of practice. As elsewhere throughout the world, the management of farm wood lots and other small tracts is much less satisfactory than that of large properties. A few states exercise some control over the management practices of private owners, but there is no federal legislation on the subject.

Because of adverse climatic or soil conditions only three-fifths of Canada's forest area is classified as capable of producing crops of merchantable timber and of this area 30% was considered inaccessible for commercial purposes. In spite of these handicaps forests play a major part in the economic life of the country. Exploitation ran about the same course as in the United States, with planned management on any considerable scale not taking place until well into the 20th century.

Of the total forest area, 73% is owned by the provinces and 21% by the federal government. Private ownership constitutes 50% or more only in Prince Edward Island, Nova Scotia and New Brunswick. Forests in the provinces are administered by the provincial governments, with financial assistance from the federal government. Cutting is done by private operators under timber licences, which may contain detailed requirements as to the amount to be cut and the methods of cutting. Increasing emphasis is being placed on silviculture, sustained yield and integrated utilization of all merchantable wood. Steady progress toward well-planned, long-range management is being made under the combination of public ownership and private operation.

6. Forestry in Latin America.—Throughout Latin America, utilization and management of the forests have been complicated and delayed by their inaccessibility and by the enormous number of species of which they are composed. For the majority of these species, little is known as to the characteristics of the trees and the properties of their woods, and still less as to their growth, yield and management. The more accessible forests have deteriorated greatly as a result of temporary clearing for agriculture, culling of the more valuable species and overutilization. In general, drain considerably exceeds growth.

The division of the forest area between public and private ownership varies tremendously in the different countries. With both classes of ownership, only a small start has been made toward satisfactory forest management. Forestry is officially recognized in the central governments of all the Latin-American republics, but the forest services lack stability, financial support and professional training of their personnel. Legislation dealing with the control of cutting by private owners and operators is not uncommon, but is more honoured in the breach than in the observance.

In spite of these difficulties, forestry, in the second half of the 20th century, was making considerable progress. Mexico and the European territorial possessions were the first to inaugurate substantial forestry programs, but promising developments were occurring in other countries throughout the region. Far greater emphasis on education and research, greater stability and financial support of governmental agencies and the introduction of sound practices in the utilization of the forests are essential to enable them to play the part which they should in the economy not only of the region but of the world. FAO's Latin-American forestry commission exerts a helpful influence in these directions.

7. Forestry in Africa.—The rain forests of Africa constitute a vast reserve, full utilization of which probably will come slowly because of their relative inaccessibility, the high cost of harvesting and transportation to world markets and the preponderance of hard and very hard woods. Exploitation in general, as late as the 1960s, was promoting deforestation, with which the local governments were unable to cope in spite of good intentions and the establishment of limited areas of forest reserves. The dry forests were cut almost entirely to meet local needs, chiefly for fuel. Because of the unfavourable climate and the prevalence of fires, their continued deterioration seemed probable.

In South Africa, the true forest of evergreen hardwoods, never extensive, has been pushed back until by the second half of the 20th century it occupied only about 0.5% of the land area. In 1876 the government undertook to control unconsidered exploitation, but without much success. Since 1913 cutting has been much restricted with a view to keeping the drain within the annual growth. Planting, chiefly of pines from other parts of the world, has been extensive and is being continued on an increasing scale.

8. Forestry in Asia.—Forestry in India had its beginnings in the middle of the 19th century, when the British organized an Imperial forest department. Forests were classified as "reserved" because of the vital role they play in the national economy, in which only well-defined and limited private rights were recognized, and as "protected," in which only such restrictions were imposed as were in the interest of the right-holders themselves. Neither these provisions nor those of the Indian Forest act of 1927 were adequate to prevent continuing destruction of the private forests. A "New Policy" adopted by the Indian government in 1952 designated those private forests over which governmental control was to be exercised and provided for their management in accordance with approved working plans. Special attention is paid to the preservation of protection forests. Professional education and research have occupied a prominent place in forestry affairs in India since the establishment of a forest rangers' school at Dehra Dun in 1878.

In the Philippines forestry started with the establishment of the bureau of forestry by the United States in 1900. With 96% of the accessible forest area in public ownership, the government has been able to exercise virtually complete control over the utilization and has made steady progress in the development of working plans and the application of sustained yield. Lumbering, which is one of the main industries of the islands, is not permitted in areas classified as protection forests.

Japan is a mountainous country in which forests occupy 62% of the land area. As elsewhere throughout the world, they were long exposed to destructive utilization in spite of sporadic governmental efforts at control. Although there is evidence that the relationship between forest devastation and destructive floods was recognized early in the Christian era, well-defined national efforts to correct the situation did not appear until 1878, when a bureau of forestry was organized. Since that time progress toward improved forest management has been steady and in places intensive forest practices are in force. However, the heavy post-World War II need for wood resulted in enormous demands on the forests which led to overcutting. The greatest drain has been on the coniferous forests, estimated early in the second half of the 20th century at more than two and one-half times the annual growth. The problem of soil stabilization and flood prevention in the mountains is receiving intensive study but has not yet been solved. A promising development was the formulation by the U.S. occupation force of forestry programs which are being effectively carried out by the Japanese government.

Except during the Chou dynasty (1122?–256 B.C.), forest destruction in China continued unabated until, by the middle of the 20th century, its once "boundless stretches" of forest had been reduced to 9% of the land area. Even this diminished area, all of which is theoretically in government ownership, provides considerable wood for lumber, pulp and fuel. Forestry, first given official recognition in the government in 1911, was elevated to the status of a ministry in 1951. A comprehensive national forest law provides for the recognition and maintenance of protection forests and requires the reforestation of all cutover areas, but its enforcement is another matter. Planting has been done rather extensively, but no long-range plans for forest management have been developed.

9. Forestry in the Pacific Area.—The forests of Australia, which are confined to a relatively narrow belt along the coast, comprise nearly one-half of the total forest area of the Pacific area and more than three-fourths of the accessible forest area. They consist predominantly of evergreen hardwoods, among which *Eucalyptus* is the characteristic genus. To help remedy the deficiency in coniferous timber extensive plantations, largely of Monterey pine, have been made. Approximately 65% of the productive forest area is under some form of reservation. The individual states are autonomous in forestry matters, but there is a central forestry and timber bureau which is concerned chiefly with education, research and advising the administrations of the commonwealth territories on forest management. The application of intensive silviculture and the practice of sustained-yield management is likely to be slow until fire control becomes much more effective.

New Zealand's forests, once regarded as inexhaustible, have been greatly reduced in area by the use of fire for land clearing. Fire and exploitation have resulted in deterioration of a considerable part of the remaining forest and the beautiful and famous kauri pine (*q.v.*) is no longer of major economic importance. Forestry activities have been largely concentrated on the planting of exotic conifers.

10. Outlook.—Accurate information is not available as to the area, volume, growth and use of the forest resources of the world. Indications are, however, that these resources, if properly managed, are adequate to meet the world's needs for wood and other forest products for an indefinite period. Although progress is being made in many countries, there is as yet no assurance that effective management will be attained. Much remains to be done in securing the adoption and execution of policies and practices that will assure the contribution of which forests are potentially capable to the economic and social well-being of people everywhere, a process in which education, research and constructive legislation must play a prominent part.

See also references under "Forests and Forestry" in the Index volume.

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FOREZ, an ancient region of France, lying on the eastern side of the Massif Central and included within the modern *département* of Loire (*q.v.*). The name is derived from that of the title town of Feurs (Forum in Roman times), midway between Roanne and St. Étienne. The plain watered by the Loire river, which traverses Forez from south to north, is given to farming (largely around Feurs); in the west the massive Monts du Forez tower over the plain, cutting it off from the Dore valley (Auvergne); in the east there is access through the Monts du Beaujolais and Monts du Lyonnais to the Saône and Rhône valleys.

From the latter part of the 10th century the counts of Feurs were in dispute with the archbishops of Lyons for control over the whole *pagus Lugdunensis*, which had originally included both Lyons and Forez; they occasionally styled themselves counts of Lyons. Under a treaty of 1173, however, they had to renounce all but the western part of the territory, which then became the county of Forez. With strong castles at Montbrison, at Donzy and at Cervières, they were still powerful in the 13th century. Finally, in 1372, the county came into the hands of Louis II, duc de Bourbon, through his marriage with the heiress Anne Dauphine. Thenceforward it formed part of the Bourbon territories till they were confiscated by Francis I of France in 1527, after which Forez was merged in the new province of Lyonnais.

See J. E. Dufour, *Dictionnaire topographique du Forez* (1946); J. Denian, *Histoire de Lyon et du Lyonnais* (1951). (M. PAC.)

FORFAR, a royal and small burgh and the county town of Angus (Forfarshire), Scot. Pop. (1961) 10,252. It lies at the east end of Forfar loch in the valley of Strathmore, 13 mi. N.E. of Dundee by road. The municipal buildings contain portraits by Sir Henry Raeburn, George Romney, John Opie and others. Peter Reid, a merchant, gave the Reid hall and a public park to the town. The staple industries are linen and jute manufactures and minor industries include the manufacture of agricultural machinery, fruit and vegetable canning, an iron foundry and ladder making.

Forfar dates at least from the time of Malcolm III (Canmore) for the first parliament after his defeat of Macbeth (1057) met in the castle, which stood on a mound north of the town. The parliaments of William the Lion, Alexander II and Robert II also assembled within its walls. The town was created a royal burgh by David I and was burned about the middle of the 13th century. Edward I captured the castle and Robert the Bruce seized and destroyed it. Its site is now marked by a 17th-century octagonal tower, which together with a charter (1665) was presented by Charles II because of the loyalty shown by the town to his father during the Civil War. A witches' bridle, a gag to prevent witches from speaking while being led to execution, is still preserved in the town hall. One mile to the east lie the ruins of Restenneth priory, of 13th-century origin but believed to have been founded six centuries earlier by St. Boniface. (I. A. M.)

FORFARSHIRE: *see* ANGUS.

FORFEITURE, in law, the termination of a right or privilege in consequence of some default or act forbidden by law. Formerly the term referred to the transfer to the crown of the lands and goods of convicted traitors and felons; in modern times forfeiture is usually a penalty prescribed by statutes or contracts. *See* CONFISCATION AND EXPROPRIATION. (F. H. HE.)

FORGERY, a common-law crime (*i.e.*, one originally created by England's courts rather than by its parliament), has been defined in various ways; one definition is "a false making (which includes every alteration of or addition to a true instrument), a making *malo animo*, of any written instrument for the purpose of fraud and deceit" (2 East, *Pleas of the Crown*, 852 [1803 ed.]). At common law, forgery and its companion crime of uttering a forged instrument (*see* below) were misdemeanours; under modern statutes in the U.S. and England these crimes generally are felonies. Forgery and uttering are made criminal acts principally to safeguard confidence in the various papers relied upon in commercial activity.

Definition.—Unless the definition is varied by statute, forgery consists of three elements: the making of a false writing (including the material alteration of a genuine writing), of a type that either has legal significance or is commonly relied upon in business or commercial transactions, with intent to defraud.

Writing.—The writing which will do for forgery is not limited to handwriting; it includes printing, engraving and typewriting as well. Thus a railroad ticket, though entirely printed, can be forged. "Writing" excludes pictures, sculptures and antiques; signing the name "Rembrandt" at the foot of a painting done by someone else is not forgery. (In some cases, however, the scope of forgery has been expanded by statute to apply to these and other articles which are not considered "writings" in common law.) Generally speaking, the writing must have legal significance—that is, it must be of a kind that, if it were genuine, would impose or alter or extinguish a legal obligation. Thus checks, promissory notes, stock certificates, bonds and other negotiable instruments,

deeds, mortgages, leases, wills, receipts, contracts and the like may be forged. But forgery also encompasses some documents which, even if genuine, have no legal efficacy, such as a false letter of recommendation for employment, as it is a document commonly relied upon in the business world. On the other hand, a false letter of introduction will not suffice for forgery, even though it may request that courtesies be extended to the bearer of the letter.

Making a False Writing.—The forger may begin with an entirely blank piece of paper, with an incomplete genuine instrument with blanks to be filled or with a completed genuine instrument that may be altered. The usual manner of forging is to prepare a false writing and sign another's name to it, or to make a material alteration to a valid writing already signed by another. Forgery may be committed not only by the forger's signing of another's name, but by signing the name of a fictitious person whose purported signature is entitled to more credit than the forger's own signature; or by signing one's own name intending it to be accepted as the signature of another person of the same name; or by fraudulently securing the signature of another (as by showing the other an innocent writing and then fraudulently substituting a legal document for him to sign). It may be committed by an unauthorized filling-in of blanks in a genuine writing, as where the drawer of a blank check, after signing it, hands it to the forger with instructions to use it to pay the drawer's debt to his creditor, and the forger, in violation of his instructions, makes it payable to himself. It may be committed by a material alteration of a genuine writing, as by "raising" the figure "nine" to "ninety" on a valid check payable or endorsed to the forger. The alteration may be accomplished by means of the addition or substitution or erasure of words or letters or figures on a writing. The alteration must be material; it is not forgery to raise the figure 9 to 90 on a check if the written word "nine" is not raised to "ninety," since it is the written words, not the figures, which control in case of a variance.

A writing which contains false statements is not necessarily the "false writing" which forgery requires. Thus an employee who writes and signs a time sheet showing that he has worked 40 hours, when in fact he has worked but 30, is not guilty of forgery though he intends to defraud his employer. A check drawn on a bank wherein the drawer has no funds is not forgery, though the drawer implies that he has funds therein. These are examples of genuine writings containing lies. Thus it is sometimes said, "A forgery tells not merely a lie but a lie about itself."

Intent to Defraud.—A successful forgery may cause financial loss either to the person whose signature is upon the forged instrument or to the person to whom the instrument is negotiated and who relies on its genuine character. The forger need not intend to defraud any particular person; an intent to defraud in general will suffice. He need not intend to benefit himself; thus he may forge a check payable to his son. He is guilty of forgery though he intends to restore later what the injured party loses, or though he forges to collect a debt which he honestly believes the injured party owes him. Although in these situations he is not morally as much at fault as the forger who intends to obtain permanent financial rewards for himself, the goal of protecting commercial activity from spurious documents is furthered by the stricter rule. On the other hand, it is not forgery for one to sign another's name or fill in blanks or alter a genuine writing honestly, though mistakenly, believing that such conduct is authorized. For forgery it is not necessary that anyone be actually defrauded by the false document. Unlike crimes such as criminal homicide, battery and arson, which require a specified bad result (a human death or injury; the burning of a house), forgery is committed when the forger makes the false writing with fraudulent intent, without regard to any bad result of his conduct.

Uttering.—One who does not himself forge an instrument may be guilty of the related crime of uttering a forged instrument. This crime is committed by offering as genuine a writing which the offerer knows to be false, done with intent to defraud. It is not necessary that the person to whom it is offered be deceived, for "utter" means "offer" rather than "pass." Though the common-law crime of uttering a forged instrument is a crime separate from forgery proper, modern statutes sometimes consolidate the two, providing in effect that whoever either forges a writing or utters a forged writing is guilty of "forgery."

Related Crimes.—Forgery is different from, but related to, the crime of obtaining property by false pretenses. Making false statements in a genuine document—as in the case above of the employee who "padded" the figures in the time sheet in order to obtain more pay than he was entitled to—is not forgery; but if money or property is obtained as a result of the false statements, the crime of false pretenses is committed. "Bad check" statutes commonly make it a crime to draw a check on a bank in which the drawer has no funds, or insufficient funds, with intent to defraud, although such conduct does not amount to forgery.

A thorough study of bad checks in the state of Nebraska (*see* F. K. Beutel, *Some Potentialities of Experimental Jurisprudence as a New Branch of Social Science*, pp. 405–407, 1957) disclosed that one-half of 1% of all checks written in Nebraska were bad checks in the broad sense of forgeries, no-fund checks or insufficient-fund checks. Of these bad checks, 90% were insufficient-fund checks, 9% were no-fund checks and only 1% were forgeries. What is true in Nebraska is doubtless indicative of the situation elsewhere. So far as fraudulent checks are concerned, forgery does less harm to commercial activity than other forms of criminal conduct relating to checks.

See CRIMINAL LAW; LITERARY FORGERY; *see* also references under "Forgery" in the Index. (A. W. St.)

FORGET-ME-NOT, called also scorpion grass, the name popularly applied to the small annual and perennial herbs forming the genus *Myosotis,* of the family Boraginaceae (*q.v.*), from the Greek *mys* ("mouse") and *otos* ("ear")—the shape of the leaves. The genus is represented in Europe, north Asia, North America and Australia by over 40 species, and is characterized by oblong or linear stem leaves and small blue, pink or white flowers, with a five-cleft persistent calyx, borne in terminal one-sided clusters.

JOHN MARKHAM

COMMON FORGET-ME-NOT (MYOSOTIS SCORPIOIDES)

The common Eurasian forget-me-not, *M. scorpioides,* found in Great Britain and naturalized in North America, is perennial; it grows to a height of 6 to 18 in., with a creeping rootstock, softly hairy stem and light-green leaves. The flower buds are pink, becoming blue as they expand; the saucer-shaped corolla is bright blue with a yellow centre. About a dozen species are native in the United States, and *M. virginica* is found throughout the country.

The forget-me-not, a favourite with poets, and the symbol of constancy, is a frequent ornament of brooks, rivers and ditches and, according to an old German tradition, received its popular name from the last words of a knight who was drowned in the attempt to procure the flower for his lady. It attains its greatest perfection under cultivation and, as it flowers throughout the summer, is used with good effect for garden borders. Various species are widely cultivated, especially *M. scorpioides* and *M. sylvatica. M. azorica,* which has no yellow "eye," is best grown as an annual, and is not easy to cultivate.

In *M. versicolor* the flowers are yellow when first open and generally change to a dull blue. Many reputed species are widely cultivated for their generally prostrate habit and profuse bloom. Most of the popular sorts are horticultural forms of *M. sylvatica,* which is an annual, but best treated as a biennial, and often persists from self-sown seeds. Some species, especially the dwarf forms, make a beautiful ground cover when planted under spring-flowering bulbs.

The Chinese forget-me-not is *Cynoglossum amabile,* of the same family (*see* also HOUND'S-TONGUE). (N. Tr.)

FORGING. In the principal forging processes, articles of metal are shaped by hammering or pressing metal blanks between a pair of forging dies. In most processes an upper die is attached to the ram of a forging hammer, or press, so that it may be raised and dropped or forced under pressure against the rigidly supported, stationary lower die.

There are few theoretical limitations on the shape or size of a forging, other than the obvious need for a shape which can be removed from the die cavity. It has been estimated that more than 600,000 different closed die forgings are in regular production, including parts ranging from one-half-ounce automobile carburetor links up to aircraft landing gear weighing as much as four tons.

DROP FORGING

Drop forging employs a drop hammer, so designed that the falling weight of the ram and upper die forces the heated metal into cavities cut into the face of each die. Similar closed dies are used for forging in presses, upsetters, etc., described below.

Drop-forged articles are frequently confused with castings, but the manufacturing process is entirely different. Drop forging is essentially a shaping operation, the metal being worked in a forging hammer or press, commonly at a sufficient heat to bring it to a plastic state but never in the molten condition necessary for the production of castings.

Steel forgings ordinarily are produced from forging-quality steel. In producing forging-quality steel, improvement of the metal properties begins in the melting stage. The chemistry of the steel is carefully controlled. As the steel is processed from the ingot stage to bars, blooms, billets and slabs for forging, special care is exercised to eliminate foreign material and porosities which might be detrimental to metal quality. The forging operation constitutes a final step in improvement of metal quality to its maximum degree.

To understand the effect of the forging process on metal quality, it is necessary to consider the normal state of solid metal. Metals solidify from the molten state in minute crystal form. The process of rolling bars, billets, etc., from the ingot tends to elongate these crystals of metal and lock them together. This produces a "grain" in the metal (so called from the analogy to grain in wood) and the mechanical properties of the metal are usually found to be somewhat better in the direction of the grain. (This is not to be confused with "grain size," which refers to crystal size.)

In closed-die forging, the fibrelike flow lines of grain structure developed by rolling are worked into such positions as to impart maximum strength relative to the stresses expected in the forged article. For maximum strength the grain should not run transversely to the axis of the greatest bending stress. This is one of the great advantages of drop forgings over castings. In a casting, where the metal is melted and poured into a mold, there is no grain in this sense; but in closed-die forgings, always made from bars or billets which have the grain running longitudinally, very careful attention can be paid to the grain disposition so that maximum strength is achieved.

Forgings are made in many metals. In addition to the various alloys of steel and iron, other metals and alloys that may be forged include copper, brass, bronze, nickel, aluminum, magnesium, titanium and the various high temperature alloys. Considerable progress has been made in forging the newer light alloys.

Conventional forging is divided into four classes, dependent on the type of machine used: hammer forging, upsetting, open frame or smith forging, and helve hammer forging.

Hammer Forging.—In hammer forging, four types of hammers are employed: the board drop gravity hammer; the air lift gravity drop hammer; the steam drop hammer; and the steam-driven hammer. All have these features in common: a base, a hammer or ram which strikes the base and which travels vertically between side guides, and the overhead mechanism for lifting the hammer and releasing it. In the board drop gravity hammer a board, or set of boards, generally of maple, raises the ram. The lower end of the board is fastened to the upper portion of the ram and the upper end of the board travels between two driven rolls revolving in opposite directions. An automatic mechanism moves rolls toward one another, into contact with the board, and as they revolve they lift the board and attached ram. The rolls then spread apart, allowing the ram to fall. The steam drop hammer utilizes a steam cylinder for the lifting mechanism, a piston rod taking the place of the board and the ram being fastened to the lower end of the piston rod. The air lift gravity drop hammer is fundamentally the same as the steam drop hammer, but uses compressed air instead of steam. The steam-driven hammer operates in similar fashion except that the downward stroke of the ram is accelerated by both gravity and steam pressure.

Whether for closed die or flat die (smith) forging, metal to be drop forged is first heated in an adjacent furnace. In closed die forging, the heated metal is placed between the drop hammer dies and several blows are struck in quick succession, forcing the metal evenly into the die impressions. The number of blows must be gauged with close accuracy by the forging hammer operator. Too few blows will not obtain uniform strength in the forging, while too many will shorten the life of the dies. A small quantity of metal is forced outward, beyond the limits of the actual forging impressions when the two dies meet, and this surplus, called "flash," is removed after forging by means of trimming tools fixed in a press. One tool duplicates, in solid form, the outline shape of the forging; the other is made hollow to the outline of the part at the point of the flash. The forging is forced through the hollow tool by the solid one, cutting off the flash. The forging may subsequently be returned to the hammer for one more blow to correct any small distortion occurring during the trimming operation.

Drop forging hammers are rated according to the weight of the falling ram. Ratings range from 400 to 7,500 lb. capacity for board drop hammers; 500 to 5,000 lb. for air or steam lift gravity drop hammers; 1,000 to 50,000 lb. for steam-driven closed die drop hammers; and 200 to 100,000 lb. for steam-driven smith hammers.

Upsetting.—In the upsetter or forging machine, a bar or "multiple" is heated and placed in the opening between a pair of gripping dies; one of these may be fixed or both may be movable. A ram is then forced against the end of the held bar, forcing the metal to fill whatever impression the gripping dies contain. The ram is then withdrawn and the gripping dies open for removal of the piece. The size of forgings produced by the upset method ranges from less than a pound to as much as 500 lb. Upsetters are rated according to the size of the initial stock processed. Commonly, the size range of equipment is from one-half inch to about eight inches.

Open Frame or Smith Forging.—Open frame forgings are made by hammer forging the metal between a pair of flat dies, and some of the shape may be given to the piece by use of stock hand tooling. Thus, the shaping of the forging depends to a great extent upon the skill of the hammersmith. Smith forgings are made to approximate sizes and usually must be machined on surfaces requiring close dimensions. For this reason, the smith-forging method is usually employed when quantities are small and the finished shape can be completed by machine work, or when sizes are too large or irregular to be contained in closed dies. The size range of smith forgings is from less than a pound to more than 200 tons.

Helve Hammer Forging.—Helve hammers are used principally for high-speed work for which the heavy impact of drop hammers is not required. The striking force is delivered to the dies by a wooden helve (handle), operating with the motion of a hand sledge. The upper die may be fastened to a guided ram operated by the helve, or to the helve itself. Preparatory and finishing operations and light production work are usual applications of helve hammers.

Forging Presses.—The machines used for forging can be classified in two major categories, hydraulic and mechanical. Hydraulic forging presses are used both for smithing operations and for closed-die forging. The hydraulic medium may be either water or oil, but steam- and air-operated presses are also used. The hydraulic pressure may be applied through one or more rams to give single pressing action from above or below, or in combination with side-cylinder movements. For double-action purposes, one set of rams may furnish a holding action while another ram or

rams complete the forming action. The source of fluid pressure may be a storage accumulator of the water, air or nitrogen type. Alternatively, a direct pumping system commonly is used for efficiency and rapid response on self-contained presses.

Mechanical forging presses are the second structural type. A crank or eccentric drive furnishes power stored in a flywheel through a clutch to the slide and dies of the press. Mechanical forging presses are used particularly for mass-production closed-die work. More care must be taken with billet-size control and with thorough heating of billets to avoid damage to the positive actuating structure of the press. Single-crank machines are the most common, although wider double-crank types are desirable where a number of operations are required to complete the forging. Also in use are double-action mechanical presses in which one action closes the dies and the second action forces the metal to fill the dies.

The sizes of commonly used forging presses range from 50- to 300-ton capacities (this rating describes the pressure which can be exerted), while larger mechanical presses range up to 6,000 tons. The need for larger, stronger parts for jet and turbojet aircraft made necessary the development of giant hydraulic forging presses ranging from 25,000 to 50,000 tons capacity and larger. On these presses, complete wing and air-frame components formerly requiring hundreds of assembled parts can be forged in one piece, resulting in important savings in time and tooling costs as well as improvements in strength-to-weight ratio and performance.

In conjunction with the larger presses, heavy mobile manipulators or overhead cranes and lift trucks are essential for handling large forgings and for changing dies. Control systems for forging presses vary widely in design, depending upon the type of press and the work to be performed. Thus, for flat-die presses the ram is made to respond directly to manual hand or foot control so that the stroke may be long or short and pressure may be applied in a series of rapid strokes or intermittently, as required. For production types with closed dies, it is more usual to employ push-button or foot-pedal remote control, and the operator, aided by simple gauges, plus sight, sound and touch, can easily judge the proper action.

Control of the larger 25,000- to 50,000-ton forging presses requires the operator to depend on indicating instruments, servomechanisms and electronic aids for instantaneous, exact information on press reactions. Operators must also undergo special training. Several crewmen and observers are required, working under the chief operator who is stationed at a console-type control board.

OTHER FORGING PROCESSES

Roll Forging.—Another method of forging is by the use of matched rotating rolls or segments of rolls which have impressions sunk in their surfaces. The metal blank is rolled into these impressions as the rolls turn. Forging rolls are used chiefly for elongating and tapering stock for parts such as gear shift levers. Processing in forging rolls is frequently used in conjunction with other forging operations in hammers or upsetters.

Impact Forging.—The impacter is essentially a forging hammer in which both dies are moved from opposite directions, meeting at the point where the forging blow takes place. The movement of the dies is in the horizontal plane. The process has several advantages. Since the dies are of approximately the same weight, each tends to absorb inertial energy of the other at the point of impact, in contrast with the conventional hammer which transmits energy through the anvil and hammer base to its foundation. For this reason the impact type of equipment does not require the heavy foundations necessary for conventional hammer-type equipment. For the same reason, more energy is absorbed by the metal blank being forged, which is of advantage in processing material which is tough and resistant to forging, such as stainless steel, or which has a low modulus of elasticity and consequently absorbs much energy, such as aluminum. Other advantages include the facts that stock is worked equally from two opposing sides; that contact between stock and die occurs only during actual impact, resulting in lower die temperature and longer die life; and that stock is moved more rapidly and less forging energy is required. The capacity of impacters is rated according to the force of the blow delivered, measured in foot-pounds, and sizes range from 400 ft.-lb. to 15,000 ft.-lb.

Counterblow Forging.—Similar to the impacter, counterblow forging hammers were introduced in the United States after World War II. The counterblow hammer, as may be inferred from the name, uses two vertically operating, counteracting rams. The lower ram and die replace the anvil of the conventional forging hammer. The rams move together with nearly equal kinetic energy, imparting this energy to the metal being forged. Thus, kinetic energy is concentrated upon the forged piece from two opposite sides. This symmetrical blow of two rams on the forged piece, with accompanying energy concentration, makes possible the forging from resistant alloys of intricate shapes to close tolerances. It also provides for shock absorption within the forging itself, eliminating the need for deep hammer foundations and avoiding energy losses into the foundation. The impact velocity of the rams for counterblow hammers is reported to be about half that required for conventional drop hammers. The counterblow hammer fills a gap between the drop hammer and the hydraulic press, because it makes possible the economical forging of larger parts and complex shapes.

Cold Forging.—Much progress has been made in forging metals "cold," or at temperatures below the point at which grains begin to coarsen (a point above 1,700° F. for steels, varying according to alloy content). Advantages of dimensional accuracy, improvement of mechanical properties and other benefits are gained. Cold heading has of course been used for many years in the manufacture of bolts and similar products.

DIE BLOCKS AND DIE MAKING

For production of a closed-die forged article, impressions are cut in two die blocks to the exact shape and size of the part wanted, with compensation for normal die wear and shrinkage. Since metal is forged while hot and shrinks in cooling, contraction must be allowed for when making dies. All forging dies are made larger than the size of the cold piece by an amount equal to normal shrinkage. Careful attention is given to the cutting of die impressions, which are frequently very intricate. Expensive steel is employed for dies, and highly skilled craftsmen prepare the die impressions. In the design of dies for production of forgings, no hole or depression may be larger at the bottom than at the top, although it may be smaller. In actual practice, it is ordinarily slightly smaller by an amount equal to the "draft," as the angle at the side of every depression is called. No surface of a drop forging may be parallel to the path of travel of the dies, but must depart from parallelism by an amount not less than the draft angle and in the direction which will make all parts of the forging smaller at the bottom of the impression than at the top in each die. The usual draft angle is 7°.

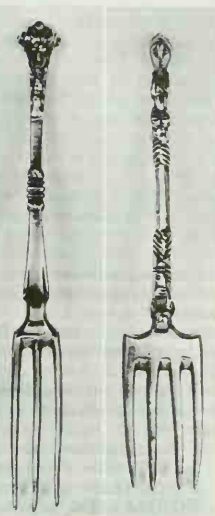
Die design is influenced by the quantity of parts to be made at one setting of the dies as well as by the quantity eventually wanted. Dies may be designed to make two or more forgings at once, the forgings later to be cut apart by trimming.

The cutting of die blocks involves several steps, and various impressions may be cut into the die faces to permit successive stages in forging the part to final shape. Basic preshaping forging impressions in sequence are fullering and edging, to alter the cross section of the material, and blocking, to rough-shape the metal prior to placing it in the finishing impression. After the finishing impression has been cut in the die blocks, accuracy of the work is tested by placing the pair of die blocks face to face and pouring melted lead into the impression and allowing it to harden. The resultant lead model of the finished forging is checked against specifications for the desired part.

The quantity of forgings which one pair of dies will produce varies from as few as 100 pieces under poor conditions to a maximum of 500,000 under the best conditions. Normal life lies between 10,000 and 40,000.

Much attention has been given to improvement of die-sinking

methods. One of the newer methods employs semiautomatic machinery which sinks die impressions by pantographic copying from a master or mock-up. Another method employs electrical disintegration. The "tools" used in this latter method are electrodes cast in the shape of the part to be forged. The cast electrode is placed in contact with the face of the new die block and high voltage electric current is passed through it. The die metal erodes at points of contact with the electrode, passing into a solution in which the die is immersed. As metal is eroded, the electrode sinks into the die face, forming the exact impression required. It is reported that this method eliminates bench work and produces new dies at approximately 50% saving. The same method can be used to resink worn dies. *See* also METALLURGY. (R. E. KR.)



BY COURTESY OF THE TRUSTEES, VICTORIA AND ALBERT MUSEUM

SILVER ITALIAN FORKS, 17TH CENTURY

FORK, an implement of much more recent development than the knife or spoon (*qq.v.*). In the middle ages forks were used only for serving; only one English 14th-century silver fork is known to survive. Tudor inventories refer to sets of knives completed by one fork. The more refined table manners of the Renaissance in Italy demanded the use of forks for eating but the practice was not generally accepted in England before the second half of the 17th century. Knives continued to be made in pairs, although one of a pair was often converted into a fork. Early forks have two prongs only, straight and ground to sharp points. Forks were sometimes mounted in handles of precious or semiprecious materials. Agate-handled ones were fashionable in the 18th century, but gave way about mid-century to silver, which has remained standard. For the manufacture of forks *see* FLATWARE. (J. F. H.)

FORKEL, JOHANN NIKOLAUS (1749–1818), German musicologist known for his biography of J. S. Bach, was born on Feb. 22, 1749, at Meeder, near Coburg, the son of a cobbler. In 1769 he studied at Göttingen university and the following year became organist of the university church. In 1779 he was made musical director of the university. He died in Göttingen on March 20, 1818.

Forkel's most important work is probably his *Allgemeine Literatur der Musik* (1792); his *Über J. S. Bachs Leben, Kunst und Kunstwerke* (1802), the first biography of that master, remains valuable (Eng. trans. by C. S. Terry, 1920). Though the claim that he was the founder of musicology ignores the existence of such men as J. C. Pepusch, J. Hawkins, C. Burney and G. B. Martini, Forkel was undoubtedly one of the first great musicologists. His library forms part of the Berlin State library.

See H. Edelhoff, *J. N. Forkel* (1935); Wolf Frank, "Musicology and Its Founder," in *Musical Quarterly* (Oct. 1949). (CS. CH.)

FORLÌ, capital of the province of the same name and an episcopal see in the region of Emilia-Romagna, northern Italy, is situated on the Montone river between Mt. Falterona and the Adriatic sea, 63.5 km. (39.4 mi.) S.E. of Bologna on the ancient Via Aemilia. Pop. (1957) 85,750 (commune). The town is elliptical in shape and the chief buildings of interest include the 12th-century abbey of S. Mercuriale, whose origins go back to the 4th and 5th centuries; the 13th-century church of S. Antonio Vecchio; the 15th-century fortress of Caterina Sforza; the church of Sta. Maria delle Grazie in Fornò (15th century); the church of Sta. Croce entirely rebuilt since 1844; and the church of Sta. Maria in Pieve Acquedotto (12th century). There are remains of the walls built by Pino III degli Ordelaffi in the 14th century. The chief works of Melozzo da Forlì (*q.v.*) are in Rome and Loreto. The art gallery contains works from the 15th, 16th and 18th centuries, including those of Marco Palmezzano (1456–1537), a native of Forlì, and the Collezioni Piancastelli is rich in incunabula and valuable books. There is also an ethnographic museum. Forlì is on the main railway and road from Milan to Bari and Brindisi; there is also an airport. Agriculture is the most important occupation and the surrounding land is very fertile. Industries include the making of felt, artificial silk, shoes, car bodies, stoves, household appliances and furniture.

Forlì, known to the Romans as Forum Livii, is said to have been founded by the consul Livius Salinator about 200 B.C. In the 12th century Forlì was in league with Ravenna and in the 13th it was the seat of the imperial count of the province of Romagna. In 1275 Forlì defeated Bologna with great loss, but in 1282 surrendered to Martin IV after repelling his besieging force. Forlì was under the Ordelaffi in the 14th and 15th centuries, and was taken by Cesare Borgia in 1500 and annexed to the papal states in 1504. In 1861 it became part of the kingdom of Italy.

The province of Forlì contains a rich variety of scenery; the Apennines and hills and the plain bounded on the east by the Adriatic present an unusual assembly of beautiful features. Other important centres are Cesena and the coastal resorts of Rimini and Riccione. (Ao. G.)

FORM, in ordinary language, is the shape or structure of a thing, as contrasted with the materials of which it is made, or with its contents. Two objects might then be said to differ from each other in respect of their contents while being similar in form (*e.g.*, two of Shakespeare's sonnets); or in respect of their form, while being similar in materials (*e.g.*, two different models built from the same constructional apparatus) or similar in content (*e.g.*, Shakespeare's play *Othello* and Verdi's opera based on the story); or in respect both of form and of materials or content. Differences and similarities of form are a matter of degree. Two musical compositions may both be in sonata form, while differing greatly in their formal detail. One play may resemble a second in being operatic, while differing from it and resembling a third nonoperatic play in being a tragedy. The greater the emphasis placed by an author, composer or artist on the structure of a composition, and the less on its content, the more formal the work is said to be, so that in the extreme case "formal" is applied as a term of critical disapproval to a work which is highly strict and rigid in its structure, while bloodless in its content.

Philosophy and Logic.—The notion of form has been constantly used in a variety of different ways throughout the history of philosophy. While Plato's word *eidos*, which is normally translated "form," perhaps should not be so translated (*see* IDEALISM; UNIVERSAL), Aristotle certainly made the distinction between matter (*hypokeimenon* or *hyle*) and form (*eidos* or *morphe*). The matter of a thing will consist of those elements of it which, when the thing has come into being, may be said to have become it; and the form is the arrangement or organization of those elements, as the result of which they have become the thing which they have. Thus bricks and mortar are the matter which, given one form, become a house, or, given another, become a wall. As matter they are potentially anything that they can become; it is the form which determines what they actually become. Here "matter" is a relative term, for a brick on the pile, while potentially part of a house, is already actually a brick; *i.e.*, it is itself a composite of form and matter, clay being matter to the brick as the brick is to the house or to the wall. Matter is that which is potentially a given object but which actually becomes that object only when it is given the right form.

Aristotle's notion of form combines with his teleological viewpoint to give the conclusion that formal development has a direction and may have a goal and that some things are more informed than others. Bricks are more informed than clay, and a house more than bricks. The four elements of which man is, as it was held, composed are the matter of man, but he, although at death he decomposes into them, is not the matter of them, for

in his creation they are given a form whereas in his dissolution he is not given a form.

In logic (*q.v.*) it has always been recognized that form is the central notion of the subject; that logic is the study of the rules of argument, independent of the particular subject matter involved in the argument; and that the validity of the argument depends upon the formal properties and relations of the statements. Because logic is in this sense formal, logicians have since the time of Aristotle tended to employ symbolic notations designed to exhibit the forms of statements and of arguments independent of their subject matter, in this way assimilating logic to mathematics; some have even gone so far as to claim that mathematics is reducible to logic. While the use of a special notation is helpful for displaying logical form, it has encouraged certain erroneous tendencies such as to suppose that a given statement has only one form, so that the question can sensibly be asked what is *the* form of that statement (whereas in fact it may have different forms in different respects); that the parts which a statement may play in arguments depend on its form (whereas in fact those parts *are* its form); or that the logical form of a statement is quite separate from its linguistic form (a mistake made possible only by a very superficial view of the nature of language). The logical forms of statements are wrongly conceived of as the skeletal structure of each: they should rather be thought of as the logical powers which they possess in varying kinds of arguments and inferences.

(A. D. W.)

Other Senses.—Some notion of form is indispensable to the practice and criticism of several disciplines other than philosophy and logic. In literature, form is the schema or structure that a writer chooses for the presentation of his matter; *e.g.*, novel, short story, maxim, epic, sonnet, pantun, etc. (*see* the individual articles on the various prose and verse forms). In criticism of the graphic and plastic arts, form means either the effect achieved by draftsmanship or mass as opposed to that achieved by colour or the total effect of the technical organization of the work as opposed to its representational significance (if any). In the study of the Gospels, form criticism is the attempt to analyze the narrative according to supposed sources and to classify each episode according to the form in which it is recorded, this form being regarded as distinctive of the special interests and motives of a particular body of preaching from which the evangelists derived the story of the episode. In sport, form is the standard of an athlete's or an animal's attainment as tentatively calculated from past performances.

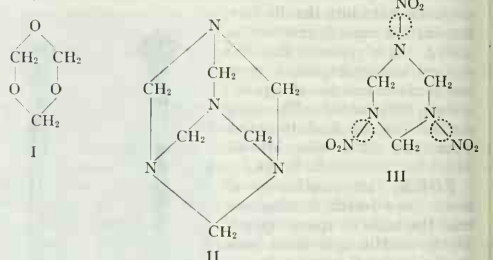
See also references under "Form" in the Index volume.

FORMALDEHYDE is the first member of the aldehyde group of chemical compounds. Pure monomeric formaldehyde is a rather unstable compound, but it has been obtained and is a gas (boiling point, −21° C.; melting point, −92° C.). It has the formula $H.CHO$. On keeping, the monomer is transformed into the polymer, trioxytrimethylene, $(CH_2O)_3$, which has the cyclic structure (I) below.

Practically all the formaldehyde now produced is made by a catalyzed vapour phase oxidation of methanol, $2CH_3OH + O_2 \rightarrow 2CH_2O + 2H_2O$. Of the many different catalysts which are effective, those which are used most frequently are silver either as a deposit on asbestos or as a fine wire mesh. Formaldehyde is available commercially as its aqueous solution, which is normally called formalin and which contains 36%–38% by weight of formaldehyde. On keeping formalin solutions, paraformaldehyde is precipitated as a white solid; it has the indefinite structure $(CH_2O)_n.H_2O$. Paraformaldehyde is of considerable technical importance because it is transformed into formaldehyde just by heating. Thus the solid paraformaldehyde is a convenient source of gaseous formaldehyde.

Chemical Properties.—Although formaldehyde contains the aldehydic $-CH=O$ function, it does in fact show many reactions which are not typical of the other aldehydes. Formaldehyde is oxidized to formic acid and is reduced to methanol. It reacts with practically all types of organic compounds including unsaturated hydrocarbons, aldehydes, ketones, esters, alcohols, carbohydrates, proteins, amines, amides and phenols, and it is this versatile chemical behaviour which makes formaldehyde such an important intermediate in technical processes.

Industrial Uses.—Formaldehyde and ammonia yield methenamine, or hexamethylenetetramine (II), which is used medicinally as a urinary antiseptic. Nitration of methenamine gives the explosive cyclonite, or RDX (III). Formaldehyde, acetaldehyde and calcium hydroxide give pentaerythritol, $C(CH_2OH)_4$, the intermediate in the manufacture of the explosive pentaerythritol tetranitrate, PETN.



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Large quantities of formaldehyde are used in the manufacture of urea-formaldehyde and phenol-formaldehyde plastics (*see* RESINS: *Synthetic Resins*). The reaction of proteins with formaldehyde forms the rationale for its use in the tanning industry and in the treatment of various vegetable proteins so that they become fibrous and can then be used in textile manufacture. The reactivity of proteins toward formaldehyde is also the reason for its use as a disinfectant, as an embalming agent and as a sterilizing agent for soil.

See also references under "Formaldehyde" in the Index volume.

See J. F. Walker, *Formaldehyde* (1944). (W. D. Os.)

FORMALIN: *see* FORMALDEHYDE.

FORMALISM, in philosophy generally, means undue attention to forms (of thought, or reasoning, etc.) at the expense of content and concrete circumstances. In ethics and religion it refers to the attachment of undue significance to the externals of convention, or to ritual, at the expense of the spirit and substance of morality and religion respectively.

FORMAN, ANDREW (*c.* 1465–1521), Scottish prelate and diplomat, was educated at St. Andrews university. James IV employed him as his emissary to Rome and to England, where he took part in negotiating James's marriage (1503) to Margaret Tudor. From 1511 he was engaged in furthering the king's plan for a general peace in Europe and for a great crusade against the Turks. To this end he acted as mediator between Louis XII of France and Pope Julius II, who were at war in northern Italy. Despite his record of peacemaking, Forman was blamed, perhaps unjustly, for the breach between Scotland and England leading to the death of James IV at the battle of Flodden (Sept. 1513).

Forman's career gave him opportunities of acquiring benefices in Scotland, England and France, including the bishopric of Moray (1501) and the archbishopric of Bourges (1513), but he failed to achieve elevation to the cardinalate. In 1514 Pope Leo X nominated him to the archbishopric of St. Andrews and appointed him papal legate in Scotland, although rival claimants kept him out of his see until 1516. As archbishop he issued constitutions for the discipline of clergy and laity. He died on March 11, 1521.

See J. Herkless and R. K. Hannay, *The Archbishops of St. Andrews*, vol. ii (1909); J. Robertson (ed.), *Concilia Scotiae* (1866).

(A. L. MU.)

FORMIA (formerly MOLA DI GAETA; ancient FORMIAE), a town in Latina province of Lazio (Latium), Italy, lies on the Gulf of Gaeta between the mouth of the Garigliano and the Gaeta peninsula, 141.7 km. (88 mi.) S.E. of Rome by road. Pop. (1957 est.) 20,087 (commune). Old buildings include the Villa Rubino (site of Cicero's villa), and the churches of S. Erasmo (15th century) and S. Giovanni. There are ruins of megalithic walls and Roman remains. Modern buildings include the Palazzo Municipale, the *grattacielo* ("skyscraper") and the National School of Athletics.

Formia is on the main Rome-Naples railway and has shipping services to the Ponza Islands. Industries include food processing. Wine and olives are produced; the ancient Caecuban and Falernian wines were made there. Vitruvius, the architect, was born there, and Cicero was murdered nearby in 43 B.C.; his mausoleum was restored at the bimillennium of his death. Formia was severely damaged in World War II but was rebuilt. (D. A. C.)

FORMIC ACID was first prepared from red ants (Lat. *formica*). It occurs naturally in animal secretions and in muscle. It is the first member of the series of aliphatic monobasic acids (*q.v.*), distinguished from the other members of the series by certain characteristic properties. For example, it shows an aldehydic character in reducing silver salts to metallic silver, it does not form an acid chloride or an acid anhydride, and, by the abstraction of the elements of water from the acid, carbon monoxide is produced, a reaction which finds no parallel in most higher members of the series. Finally, formic acid is, as is shown by the determination of its ionization constant, a much stronger acid than the other acids of the series. Its formula is H.COOH. It may be prepared synthetically by the oxidation of methyl alcohol and of formaldehyde; by the rapid heating of oxalic acid (J. Gay-Lussac, 1831); but best by heating oxalic acid with glycerine at a temperature of 100°–110° C. (M. Berthelot, 1856). In this reaction a glycerol ester is formed as an intermediate product, and undergoes decomposition by the water which is also produced at the same time.

On the industrial scale, formic acid is made from sodium formate (*see* below). It is employed in the dyeing and tanning industries and in organic synthesis.

Formates are produced by the action of moist carbon monoxide on soda lime at 190°–220° C. (V. Merz and J. Tibiriçá, A. Geuther, 1880). An interesting process for sodium formate, formulated by Bredig and Carter (1915), consists in reducing a solution of sodium bicarbonate with hydrogen at 70° C. under 60 atm. pressure in presence of a palladium catalyst. Sodium formate is manufactured by absorbing carbon monoxide by sodium hydroxide at 120°–130° C. under a pressure of 8 atm.

Concentrated formic acid is prepared by dissolving sodium formate in an equal weight of 90% formic acid, and then distilling the mixture with concentrated sulfuric acid in copper vacuum pans (M. Goldschmidt, 1894). Anhydrous formic acid results when the lead or copper salt is decomposed by dry hydrogen sulfide at 130° C. Solid formic acid melts at 8.6° C. At ordinary temperatures, formic acid is a colourless, sharp-smelling liquid that boils at 100.8° C. Its specific gravity is 1.2206 (20°/4°). It is miscible in all proportions with water, alcohol and ether. The sodium and potassium salts, when heated to 400° C., give oxalates and carbonates of the alkali metals, but the magnesium, calcium and barium salts yield carbonates only. The free acid, when slightly warmed with concentrated sulfuric acid, is decomposed into water and pure carbon monoxide; when heated with nitric acid, it is oxidized first to oxalic acid and finally to carbon dioxide. The salts of formic acid, the formates, are mostly soluble in water. The calcium salt, when heated with the calcium salts of higher homologues, gives aldehydes. The esters of the acid may be obtained by distilling a mixture of the sodium or potassium salts and the corresponding alcohol with hydrochloric or sulfuric acids.

Formamide, $H.CO.NH_2$, is obtained by heating ethyl formate with ammonia, by heating ammonium formate with urea to 140° C., or by heating ammonium formate in a sealed tube for some hours at 230° C. It is a liquid which boils at 122° C. under a pressure of 32 mm., but at 200° C. under ordinary atmospheric pressure, with partial decomposition into carbon monoxide, water, ammonia and hydrogen cyanide. (G. W. Wd.)

FORMICARIIDAE, a large family of tropical American perching birds (order Passeriformes) comprising the ant birds or ant thrushes. *See* Ant Thrush.

FORMIGNY, BATTLE OF, a victory won by the French over the English on April 15, 1450, at Formigny in Normandy, in the last phase of the Hundred Years' War (*q.v.*); it was notable also as the first occasion in that war when the French used field artillery. Sir Thomas Kyriel had landed at Cherbourg in mid-March 1450 with orders to go direct to Caen to reinforce Edmund Beaufort, duke of Somerset, whose control of Normandy was disintegrating. Instead Kyriel besieged Valognes, which held out till about April 10. By this time French forces under the comte de Clermont (the future Jean II, duc de Bourbon) and the constable de Richemont (later Arthur III of Brittany) were closing in to cut him off, and on April 15 he had to give battle at Formigny when Clermont came up. The two armies were evenly matched, for Clermont had about 3,000 men and Kyriel perhaps a few hundred more. Kyriel followed the traditional English preference for fighting from a defensive position. With his rear protected by a stream, he arrayed his line behind a hastily dug trench, the archers being grouped in the centre and on the wings. For about three hours the English had the better of the fighting, and when the archers advanced to capture two small cannon that had been troublesome, a section of the French turned in flight. Kyriel however gave the French time to recover, and they won their cannon back. The turning point in the battle came when Richemont arrived with reinforcements. The English retreated toward the stream and finally crumbled before a double attack. Some escaped, but their losses were severe, and the defeat probably hastened the loss of Normandy (Aug. 1450), though it is doubtful whether this could have been long deferred.

See C. W. C. Oman, *A History of the Art of War in the Middle Ages*, vol. ii (1924). (J. W. Se.)

FORMOSA (Taiwan) is an island separated from the southeast coast of China by the 100-mi.-wide Taiwan strait (T'ai-wan hai-hsia) and one of a great island system rimming the western Pacific ocean. Generally oval-shaped and with a north-northeast–south-southwest axis, it is 235 mi. long and 90 mi. wide at maximum; it lies between parallels 21° 54′ N. and 25° 20′ N. and meridians 120° 4′ E. and 121° 57′ E. Its area, exclusive of the neighbouring Pescadores but including several other small offshore islands, is 13,903 sq.mi. To the northeast are the Ryukyus; to the south the Bashi channel and the Philippines. The origin of the Chinese name T'ai-wan (conventionally Taiwan) is unclear; Formosa, commonly used by many, is from the Portuguese word meaning beautiful.

Physical Geography.—Formosa is a great fault block, tectonically unstable, trending north-northeast–south-southwest and tilted toward the west. Its eastern margin marks the edge of the continental shelf. The highest areas are in the Chung-yang Shan-mo (Central range), the crest of which lies east of the island axis. Numerous peaks rise above 10,000 ft., the highest being Yu Shan (12,959 ft.; called Niitaka Yama by the Japanese and Mt. Morrison by westerners). Old, resistant sedimentary and metamorphosed rocks are exposed by erosion in the east, and younger softer sedimentary formations in the west. East of the mountains is a long (100 mi.), narrow (5–9 mi.) valley of fault origin, covered with alluvium and open at its northern and southern ends to the sea. Farthest east are the eastern coastal ranges of volcanic origin, rising to 7,000 ft.

West of the central highlands is a coastal alluvial plain, still being extended into the shallow Taiwan strait, 25 mi. at its greatest width, and the heartland of the island. This plain is broken by hills north of 24° N. into a southwestern component and a lesser, fragmented northern portion, including the fertile T'ai-pei basin, to the north of which are volcanic highlands rising to 3,700 ft. Along the northeastern coast is an isolated alluvial lowland, the triangular I-lan plain.

Rivers in general are short and subject to extreme variations in flow especially on the southwestern plain. Soils of alluvial origin cover about a fourth of the island and are its chief wealth. Upland soils are leached, acid and of low fertility.

About 55% of the island is forested; another 12% is wasteland. Forests are graded altitudinally, from coniferous stands above 9,000 ft. through mixed stands to about 6,500 ft. of cedars, cypress, junipers, rhododendrons, maples and cryptomeria (Japanese cedar) to broad-leaved evergreen forests which include camphor trees. In the lowlands are mixed bamboo, evergreen and palm stands. Steppelike vegetation occurs in the drier southwest. The animal life is similar to that of southern mainland China.

Climate.—Lowland Formosa is frost free. The climate is ameliorated by the waters of the warm Japan or Black current. The mean temperature of the coldest month, January, in the north is about 58° F. (14.5° C.); summers are hot and humid, and in the south winters are warm to hot as well. Temperatures fall with altitude, however, and the central mountains are snow covered in winter. All areas receive 40 or more inches of rainfall, and the mountains receive up to five times that figure. The southwest, which lies in the winter lee of the central mountains, receives its rainfall almost entirely in the summer months. The northeast also receives orographic winter precipitation.

Population.—Population is predominantly Chinese. Most are the descendants of immigrants from Fukien (Fu-chien) province, chiefly from the Lung-ch'i (Chang-chou) and Ch'üan-chou areas; secondly from Kwangtung (Kuang-tung) province, chiefly Hakkas (*q.v.*) from the hinterland of Swatow (Shan-t'ou). Seven major Chinese dialects are spoken by these people. In addition, a sizable immigration of Chinese, many Mandarin-speaking, from other parts of China occurred after 1946. The aborigines, numbering about 200,000, are of Indonesian origin and reside in the foothills and highlands where many practise shifting cultivation. The Ami, Atayal, Paiwan, and Apayao (Izneg) are the major groups, all experiencing partial assimilation.

In 1905 the Japanese took the first census, and seven population censuses were taken thereafter at five-year intervals, followed by censuses in 1946 and 1956. The population of Taiwanese (exclusive of Japanese and other foreigners) increased from 2,970,000 in 1905 to 5,510,000 in 1940. By the mid-1930s the rate of natural increase had accelerated to 24 per 1,000. This rate increased in the late 1950s to about 36 per 1,000 because of falling death rates (8 per 1,000 in the late 1950s) and continued high birth rates (about 46 per 1,000). This meant a young population, and over 40% was under 16 years of age. The official population for 1956 was 9,367,661, not including military personnel from the mainland, their families or others not classified as permanent residents. Estimates of total population, however, reached 12,000,000 or 867 per square mile.

Most Taiwanese live in villages, as in the south, or in dispersed rural settlements, as in the north. Few are urban, although a pre-World War II drift to the cities was accelerated after 1949. The mainland Chinese are urban, and the rapid urban growth since 1946 partially reflects their arrival. In 1956 T'ai-pei (*q.v.*) with 737,029 population and Kao-hsiung (*q.v.*), the southern regional focus with 365,159, were the major cities. Three others had populations of over 200,000, including Chi-lung (*q.v.*; Keelung), the port of T'ai-pei. However, population figures were inflated by many rural people living within the official municipalities. Other large towns are Hsin-chu (Sin-chu) and P'ing-tung (*qq.v.*).

History.—Taiwan was known to the Chinese as early as the beginning of the 7th century A.D., but settlement did not take place until the first quarter of the 17th century after recurrent famines in Fukien province encouraged the emigration of Fukienese from the Chinese mainland. Before then, the island was a base of operations for Chinese and Japanese pirates. The Portuguese, who discovered the island in 1590 and named it Formosa, made several unsuccessful attempts at settlement. The Dutch and Spaniards established more lasting settlements, the Dutch at An-p'ing in southwestern Taiwan (1624), the Spaniards in 1626 at Chi-lung. Until 1646 when the Dutch seized the Spanish settlements, northern Taiwan was under Spanish domination, the south under Dutch control. The Dutch were expelled in 1662 by Koxinga (Cheng Ch'eng-kung), a man of mixed Chinese-Japanese parentage and supporter of the defeated Ming emperors, who used the island as a centre of opposition to the Ch'ing (Manchu) regime. In 1683, 20 years after Koxinga's death, the island fell to the Ch'ing and became part of Fukien province. Meanwhile, sizable migrations of refugees, Ming supporters, had increased the population to about 200,000. Settlement proceeded from south to north and from the western coast to the foothills of the central highlands, held by the aboriginal tribes.

Population increased rapidly as immigrants streamed in from the southeast China coast, and large areas in the north came under the plow. T'ai-nan (then known as T'ai-wan) acted as the capital. Settlement of the eastern coastal areas began in 1796. By 1842 the population had risen to an estimated 2,500,000, and both rice and sugar had become important exports to China proper. In 1858 the treaty of T'ien-ching (Tientsin) designated two Taiwan ports as treaty ports, T'ai-nan and Tan-shui, the latter a river port, long used as a port of call under the Spanish and Dutch, and downstream from the growing city of T'ai-pei. Tea became an important export crop, and the island's trade centre shifted to the north, particularly to Tan-shui where British and other trading companies established their headquarters. In 1875 T'ai-pei became the capital of northern Taiwan.

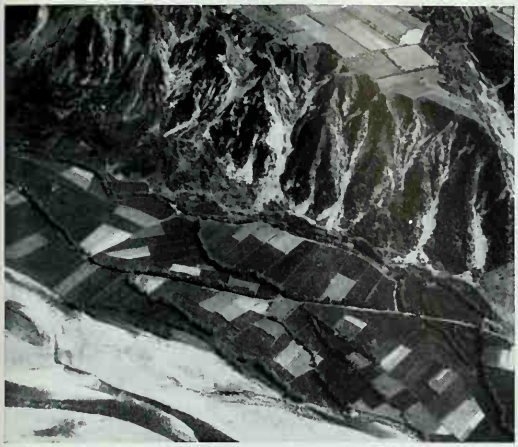
Japan's continued interest in the island was reflected in a Japanese punitive expedition of 1874 ostensibly to protect the lives of Ryukyu fishermen along the island's coasts. The French blockaded the island during the undeclared Chino-French war of 1884–85 and occupied Chi-lung for a short period. In 1886 Taiwan became a separate province of China with a legal capital at T'ai-chung and a temporary capital at T'ai-pei which became the legal capital in 1894. Considerable economic development took place in the next eight years under the initial leadership of Liu (Ming-chuan).

In 1895, as a result of the treaty of Shimonoseki after the Chinese-Japanese War (*q.v.*), China ceded Taiwan and the Pescadores Islands (*q.v.*) to Japan, and the Japanese occupied T'ai-pei in June of that year over the violent opposition of the Chinese population. For several months a Republic of Taiwan was in existence, but it was overcome by Japanese army and naval forces. The Japanese also faced the hostility of the aborigines, some of whom remained uncontrolled until the outbreak of the Pacific war. Under the Japanese, Taiwan was developed as a major supplier of rice and sugar for Japan. Irrigation projects, agricultural extension services and improvements in transportation and power supplies led to rapid increases in Taiwan's gross product. Japanese policy was oriented toward the japanization of the Taiwanese; Japanese was the language of instruction in a widespread basic educational system, and even after the end of World War II Japanese remained a lingua franca among the various Chinese dialect groups. In the 1930s Japanese economic policy shifted toward the development of industries based on relatively cheap hydroelectric power, such as aluminum refining and ferroalloy manufacturing. Nevertheless, rice and sugar remained the basis of Taiwan's prewar export trade, almost all of which was directed toward Japan. Imports consisted largely of diverse manufactures from Japan. During World War II, Taiwan was a major staging area for Japan's invasion of southeast Asia, and it was described as the largest "aircraft carrier" outside Japan. By 1940 its total population, including Japanese, had risen to 5,870,000.

As a result of the Cairo agreement of 1943, Taiwan was turned over to the Chinese Nationalist government on Oct. 25, 1945, after the defeat of Japan. Antagonism against the new regime was reflected in an uprising in 1947. In 1949–50, following the victories of the Chinese Communists on the mainland, a stream of Nationalist troops, government officials and other refugees estimated at 2,000,000 persons, poured onto the island, and Taiwan became the effective territory, apart from a number of islands off the China coast, of the Republic of China (Nationalist China).

Following the outbreak of the Korean War in 1950, the United States interposed its 7th fleet between the island and the mainland to protect it from further Communist attack. In 1955 Nationalist China and the United States entered into a mutual security agreement to defend the island and the Pescadores. U.S. assistance was given in two forms, economic and defense. An American military advisory group was established in 1951 to assist in training military forces and to advise on other military matters. The government of the People's Republic of China repeatedly declared its intention of eventually conquering the island; the Nationalists, also describing it as an integral part of China, held to their objective of using Taiwan as a stepping-off point for an eventual return to the mainland. (*See* also CHINA: *History;* CHIANG KAI-SHEK.)

Administration and Social Conditions.—Taiwan is regarded by both Communist and Nationalist Chinese as a province

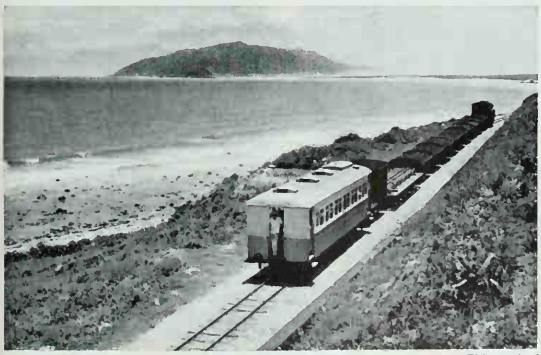


Aerial view of a river valley in the western coastal region of Formosa which is composed of alluvial plains interrupted by ranges of eroded hills

Formosan artist sketching in the Botanical gardens at T'ai-pei. Across the lagoon is the National Science hall

Mother and child before a shop in a village market place. Most Formosans live in rural settlements

Chi-lung (Keelung) harbour, the port for T'ai-pei, which has facilities for accommodating ships up to 20,000 gross tons



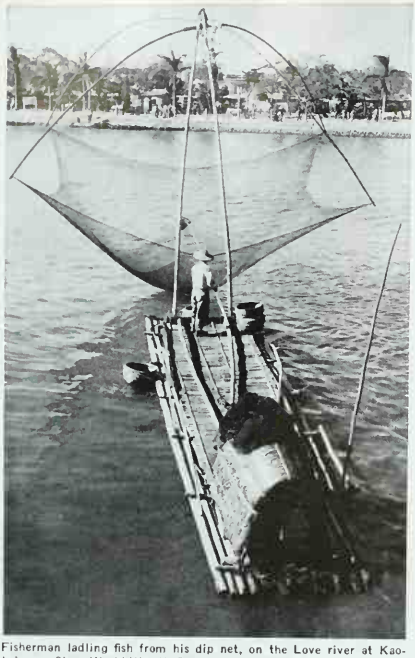
View along the east coast portion of the island's 590-mi. railway system. This part of the line is used to transport cane, sugar and timber between T'ai-ting and Hua-lien

South Chungking road in the business district of T'ai-pei, capital of Formosa and provisional capital of the Republic of China

VIEWS OF FORMOSA

PHOTOGRAPHS, (TOP LEFT) HORACE BRISTOL FROM PHOTO-REPRESENTATIVES, (TOP RIGHT) HEDDA MORRISON—CAMERA PRESS—PIX FROM PUBLIX, (CENTRE LEFT) BOB KLEIN FROM BLACK STAR, (CENTRE RIGHT) QUENTELL VIOLETT FROM BLACK STAR, (BOTTOM LEFT) BARRY SCHUTTLER FROM BLACK STAR, (BOTTOM RIGHT) PAUL BERG—POST DISPATCH PICTURES FROM BLACK STAR

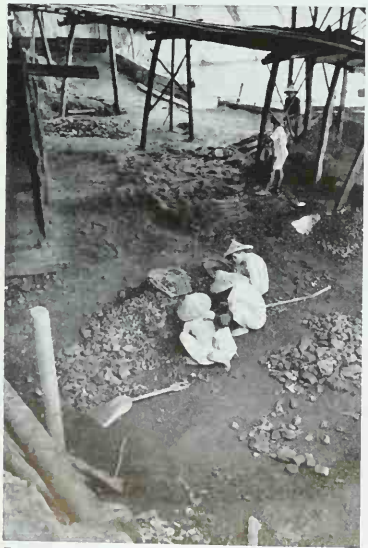
FORMOSA



Fisherman ladling fish from his dip net, on the Love river at Kao-hsiung. Since World War II, fishing has become an essential element in Formosan economy

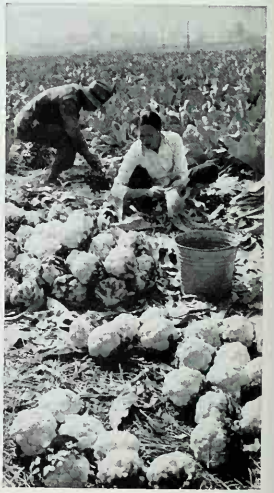
Farmer transplanting rice seedlings in his paddy field. More than 50% of the cultivated land in Formosa is devoted to growing rice, the island's major crop

Harvesting sugar cane near Hua-lien. Grown primarily in the southwest, sugar cane is the second most valuable crop in Formosa and its primary export product



Formosan women grading coal by hand at the Homei mine in northern Formosa. Of the few minerals found on the island, coal is economically the most important

Bagging dried peanuts at Tsoying, near Kao-hsiung. Stacks of rice straw, used as fodder for livestock, are in the background



Gathering cauliflower on a Formosan farm. The island's temperate climate is conducive to growing fruits and vegetables

AGRICULTURE AND INDUSTRY IN FORMOSA

PHOTOGRAPHS (TOP LEFT, CENTRE RIGHT) BARRY SCHWEID FROM BLACK STAR, (TOP RIGHT, BOTTOM LEFT) PAUL BERG—"POST DISPATCH" PICTURES FROM BLACK STAR, (BOTTOM CENTRE AND RIGHT) MONICA [illegible] FROM [illegible]

of China (T'ai-wan sheng). Controlled by the Nationalists, it is divided into 18 counties (*hsien*), including the Pescadores and Quemoy and Matsu islands, and 6 municipalities (*shih*)—T'ai-pei, Chi-lung, T'ai-chung, T'ai-nan, Kao-hsiung (Takao) and Yaung-ming-shan (centrally administered); the provincial government is headed by an appointed governor; a provisional provincial assembly is elected. Governments of the *hsien* and *shih* also are elected, as are officials of townships and villages. T'ai-pei is the temporary capital of the Republic of China. The provincial capital is located at Chung Hsing Hsin Ts'un, near T'ai-chung. Thus, two governments are operative on the island, one national, one provincial.

In the early 1960s a national military establishment numbering about 600,000 persons, chiefly mainland Chinese, was based on the island, equipped with weapons provided under the military aid program of the U.S.; American personnel acted as advisers.

Living standards in Taiwan were among the highest in Asia in the second half of the 20th century, but rapid population increases, underemployment and overcrowding, particularly in the cities, have created major problems. Although a third of the people were illiterate, education at the elementary level was available for about 95% of the younger population; instruction was in Mandarin, the Chinese national language. Only one-fifth of the lower school graduates attended secondary school, and less than 4% attended institutions of higher learning. The latter included the National Taiwan university (T'ai-pei), with over 6,000 students and a library of 500,000 volumes; the Taiwan Provincial Normal university (T'ai-pei), the National Political university (near T'ai-pei), the Cheng-kung university (engineering) at T'ai-nan, and after 1957 a new National Ch'ing-hua university at Hsin-chu. Several U.S. universities were co-operating with these and other institutions.

Public health facilities were widely distributed in the form of over 400 government-supported health stations and clinics, although environmental sanitation remained poorly developed, and only the major cities had pure water supplies.

Social change was accelerated during the 1950s and 1960s as an urban way of life began to permeate the island through improved communications. About 30 newspapers had a combined direct circulation of 350,000 and an effective circulation several times that number. There were about 475 periodicals and magazines and over 200,000 radio sets, each serving several people. The many traditional and government-sponsored local associations, organized for varied socioeconomic purposes, reflected both Chinese and Japanese influences, but the family was becoming less important as the key to social organization. Religion tended to be a polytheistic amalgam of Buddhist, Confucian, Taoist and animist ingredients, with Christianity a minor element.

Economy.—Formosa's industrial resources are limited and agriculture is the leading element in the framework of the economy. In the late 1950s and early 1960s, 60% of the gainfully employed were engaged in agriculture and fishing.

Agriculture.—The single most important crop was rice, which supplied one-half of the total agricultural product and occupied 61% (most of the irrigated portion) of the total cultivated area (2,200,000 ac., one-fourth of the island's area). Most paddy fields were double cropped. Half the rice produced was high-grade *pon-lai* rice, introduced originally by the Japanese. Both rice acreages and output were higher than in the pre-World War II period, output reaching 1,900,000 metric tons of brown rice, or one-third more than in 1938, although yields per acre remained about the same. Sugar cane, the next most valuable crop in the southwest, competed with rice for land and was raised on small holdings. Acreages varied, but averaged about 200,000. Annual sugar output was about 800,000 metric tons, considerably lower than the 1,400,000 tons produced in 1938–39. Sweet potatoes occupied the second largest acreage, 625,000, chiefly on slope lands unsuited to rice or cane. Production approximated 2,500,000 metric tons. Other important crops included tea, peanuts, bananas, pineapples, soybeans, wheat, citrus fruit and citronella grass. Increased consumption of wheat, both local and imported, reflected both dietary shifts and the presence of urban northern Chinese.

Production of rice and sugar cane depended on commercial fertilizers (500,000 tons consumed annually; 350,000 imported). Farm-originated fertilizers also were intensively applied, night soils and hog manures contributing to the formation of compost. The hog population exceeded 3,000,000; the water buffalo and cattle population 400,000. Agricultural improvement was encouraged by the Sino-American Joint Commission for Rural Reconstruction established in 1948. Farmers' associations and co-operatives helped provide credit, marketing facilities and technical assistance. The Land-to-the-Tillers act of 1953 resulted in a diminution of tenancy to 15% of the cultivated land from a previous 40%.

Fisheries.—Fisheries production rose to 200,000 metric tons annually, of which one-fourth was produced by fish farming.

Forestry.—Forestry production amounted to less than 500,000 cu.m. annually, chiefly from government-owned lands. Inaccessibility, low quality of many stands and high costs of production made substantial lumber imports necessary. Overcutting and delayed reforestation were associated with excessive erosion and destructive floods.

Mining.—Mineral resources are modest. Coal deposits, the most important, measured 115,000,000 metric tons of low-grade subbituminous reserves, and production varied around 2,500,000 tons annually. Some petroleum and natural gas were produced. Sulfur and sulfur pyrites were important mineral resources; copper and gold less so. Salt (300,000–400,000 tons annually) was produced by the evaporation of sea water, though at relatively high costs.

Industries.—Industrialization, begun by the Japanese, centred about the generation of electric energy. Total capacity by the late 1950s was 600,000 kw. of which 75% was hydroelectric. The island is covered by an integrated distribution grid centring on the great installation at Sun Moon lake (Jih-yüeh T'an). Nearly 80% of the electricity produced (3,000,000,000 kw.hr.) was consumed by industry. Government participation characterizes almost every major industry. Government-owned enterprises include fertilizer, aluminum, sugar (26 large mills), coal, cement, paper, mining and machinery manufacturing, power, fertilizer. A largely privately owned textile industry with nearly 300,000 spindles makes the island virtually self-sufficient in cotton goods, and woolen, rayon and silk mills also contribute to textile production. Glass, cement, leather goods, rubber goods and electrical equipment are important products, but the processing of agricultural products (rice milling, sugar refining) remains the chief industrial activity.

Communications.—The government-operated railway system, also developed originally by the Japanese, extends for 590 mi., chiefly on the western plain; most trackage is Cape-gauge (three feet, six inches), but the 109-mi. east-coast line between T'ai-tung and Hua-lien is two feet six inches gauge. Additional two feet six inch gauge tracks (nearly 1,860 mi.) primarily carry cane, sugar and timber. Highways are less well developed. Of the total of 9,750 mi. of roads and highways, about 10% is surfaced, all-weather roadway. A main north-south highway connects Chi-lung and Kao-hsiung, and there is a cross-island road. Port facilities are best developed at Kao-hsiung and Chi-lung, each of which can accommodate ships up to 20,000 tons gross.

Trade.—Merchandise trade balances in the 1950s, unlike those of pre-World War II years, were adverse. In 1958, for example, total trade was U.S. $397,000,000, of which U.S. $164,400,000 were exports. The deficit was balanced by United States economic assistance. As before 1941, the chief export items were sugar, rice and other agricultural products, but sugar exports were restricted by international agreement to 750,000 metric tons annually as compared with a pre-World War II average of nearly 1,000,000 tons. Rice exports amounted to only 15% of the prewar annual total of over 700,000 tons. Japan was the chief postwar customer, taking from 35% to 60% of Taiwan's exports; it also supplied up to 60% of the imports. Nevertheless, trade orientations were diversified as compared with the prewar period when Japan was virtually the sole trading partner. Imports were highly diversified, consisting chiefly of a variety of consumer goods plus raw materials (*e.g.*, bauxite, lumber, rubber, cotton and wool) for Taiwan's growing industries (*see* also CHINA: *History*).

See also references under "Formosa" in the Index volume.

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Current history and statistics are summarized annually in the *Britannica Book of the Year.* (N. S. G.)

FORMOSA, a northern province of Argentina bordering the republic of Paraguay, has an area of 27,825 sq.mi. Pop. (1960) 178,458, a large percentage of whom are Indian. The province lies within the Gran Chaco (*q.v.*), a vast alluvial plain covered with forests interspersed with grasslands and marshes. It has a subtropical climate, with a long rainy season (October to June) and an average temperature during those summer months of 80° F. The winter months are dry, with an average temperature of 63°. Agriculture (particularly tobacco and sugar) and cattle-grazing are the chief sources of wealth, but both activities are seriously handicapped by recurrent droughts and floods. Quebracho trees (from which tannin is extracted) grow wild in the more distant forests. The capital is Formosa (pop. 1956 est., 26,645) on the bank of the Paraguay river. (GE. P.)

FORMOSAN LANGUAGE: *see* MALAY LANGUAGE; POLYNESIAN LANGUAGE.

FORMOSUS (*c.* 816–896), pope from 891 to 896, was made cardinal bishop of Porto by Nicholas I, who sent him to Bulgaria to promote the conversion of that country. In 867 Formosus returned to Rome, where he enjoyed the favour of Adrian II. Pope John VIII, however, treated him as a personal enemy, and Formosus fled from Rome and was excommunicated and reduced to the lay state. Absolved under Marinus I and restored to his see of Porto by St. Adrian III, Formosus was elected pope on Oct. 6, 891. He died on April 4, 896. Under Stephen VII his political enemies had his body disinterred and subjected him to a posthumous trial. His election was declared invalid and his acts quashed. A mob cast his body into the Tiber. Later popes reversed the decisions of Stephen's synod.

Formosus' letters are printed in J. P. Migne (ed.), *Patrologia Latina*, vol. cxxix, 837–848. (J. V. HN.)

FORNER, JUAN PABLO (1756–1797), Spanish scholar and satirist, one of the most violent agitators in the literary polemics of his time, was born in Mérida, Spain, on Feb. 23, 1756, and died at Madrid on March 17, 1797. His brilliant wit was often admirably used against fads, affectations and muddleheadedness, but often cruelly and spitefully against personalities. Typical of his libelous satire is *El asno erudito* ("The Erudite Ass"; 1782) ridiculing the character and works of the erudite but irritatingly self-righteous Tomás de Iriarte. His scholarly *Exequias de la lengua castellana* ("Exequies of the Castilian language"; 1795) is a constructive defense of Spanish letters addressed to writers who ignorantly despised them. (I. L. Mc C.)

FORRES, a royal and small burgh of Moray, Scot., lies 12 mi. W.S.W. of Elgin by road in the centre of the Laigh of Moray. Pop. (1961) 4,780. Its first charter, probably granted by David I in 1150, was lost but James IV granted a charter of confirmation in 1496. The castle, the site of which is known, was a royal hunting seat frequented by Scottish kings from William the Lion onward and, traditionally, by Duncan and Macbeth. The town buildings in the square in the centre of Forres are known as the Tolbooth, the present building following the pattern of its three predecessors. The Market cross in the square is Decorated Gothic. Very near is the Falconer museum built of local sandstone in memory of Hugh Falconer, born in Forres in 1808, who was scientific adviser and chairman of the commission that introduced the tea plant into India and founded the tea-growing industry. Another famous son of the royal burgh was the first Lord Strathcona who, with his cousin, Lord Mount Stephen, built the Canadian Pacific railway. Forres is a thriving town with farming, forestry, distilleries and engineering works.

At the eastern entrance to the town is Grant park, named after the donor, Sir Alexander Grant, and above is the Nelson tower erected in 1806. A little beyond stands Sweno's stone, a sculptured sandstone monolith 23 ft. high with the figures of men on one side and on the other a cross with elaborate runic ornamentation, said to have been erected by Sweyn I in celebration of his victory over Macolm II in 1008. The cross was probably carved at a later date by a follower of St. Ninian or St. Columba. Nearby is the Witches stone, the scene of early witch burnings.

(A. H. MACD.)

FORREST, EDWIN (1806–1872), U.S. actor, centre of two major scandals of the mid-19th century, was born in Philadelphia on March 9, 1806. In 1820 he made his stage debut as Young Norval in Home's *Douglas* at the Walnut Street theatre in Philadelphia. After four years spent on the frontier, he arrived in New Orleans (1824), where the wild, colourful life made a lasting impression on him. In 1825 he played in support of Edmund Kean, and his maturity as an actor dates from this experience. During 1826 he played Othello in New York to great critical acclaim. On offering cash prizes for plays by U.S. authors, Forrest received several plays suited to his talents, including John Augustus Stone's *Metamora* and Robert Montgomery Bird's *The Gladiator*. In Metamora and Spartacus, Forrest found characters that served him to the end of his career.

Forrest was initially successful in his first engagement in England in 1836, but a misunderstanding led him to hiss publicly a performance of William Macready's, arousing great indignation in England. His disagreement with the English actor culminated in the infamous Astor Place riot in New York city of May 1849. While Macready was playing at the Astor Place Opera House, a mob of Forrest supporters stormed the theatre. The militia was called out, the rioters fought the militia, and the militia men fired on the mob. Twenty-two persons were killed and 36 wounded. Forrest's reputation never quite recovered from this catastrophe, and only two years later he caused another national sensation when he instituted a divorce suit against his wife, the former Catherine Sinclair. Although he lost the verdict, he appealed the decision for 18 years. After 1852 Forrest acted only sporadically, spending much time alone in his gloomy Philadelphia mansion, where he died on Dec. 12, 1872. He left most of his money for the establishment of a home for aged actors.

Opinions on Forrest as an actor varied. Although many critics considered him first-rate, he was described by William Winter as "a vast animal, bewildered by a grain of genius."

See M. J. Moses, *The Fabulous Forrest* (1929); B. Matthews and L. Hutton, *Actors and Actresses of Great Britain and the U.S.*, vol. iv (1886). (S. W. H.)

FORREST, JOHN FORREST, 1ST BARON (1847–1918), Australian statesman and explorer who increased the knowledge of the interior of Western Australia, was born at Bunbury, Western Australia, on Aug. 22, 1847. He joined the government survey department in Perth, and in 1869 led an expedition into the desert to search for traces of Friedrich Wilhelm Ludwig Leichhardt. In 1870 he traveled overland from Perth to Adelaide, and in 1874 explored the arid country from Champion bay eastward to the telegraph line between Darwin and Adelaide. Forrest was appointed surveyor general of Western Australia in 1883. He took part in Western Australia's struggle for self-government and, after it was granted in 1890, became the state's first premier. He attended the discussions which led to the federation of the Australian colonies in 1900, contested the first federal election, and until his death was a member of the commonwealth parliament and a minister in liberal governments.

He was raised to the peerage in 1918, the first native-born Australian to be so honoured, and died at sea en route for England on Sept. 3, 1918. (T. M. PY.)

FORREST, NATHAN BEDFORD (1821–1877), Confederate cavalry general in the American Civil War, was born near Chapel Hill, Tenn., on July 13, 1821. He received no formal education but taught himself with fair success and is said to have been an able mathematician. He was in turn a horse and cattle trader in Mississippi and a slave dealer and horse trader in Memphis, Tenn., until 1859, when he took up cotton planting in northwestern Mississippi and acquired considerable wealth. At the outbreak of

the Civil War in 1861 he volunteered as a private, raised a cavalry unit of which he was lieutenant colonel and in Feb. 1862 took part in the defense of Ft. Donelson. Refusing to capitulate with the rest of the Confederate forces, he made his way out before the surrender with all the mounted troops there. He was made a colonel and regimental commander and fought at Shiloh with distinction. He was promoted brigadier general in July 1862. At the head of a mounted brigade he took a brilliant part in Gen. Braxton Bragg's autumn campaign and in the winter of 1862–63 was continually active in raiding hostile lines of communication. One of his most remarkable actions was the capture, near Rome, Ga., after five days of marching and fighting, of an entire cavalry brigade under Col. A. D. Streight (April 1863).

He was present at Chickamauga in September, after which he clashed with General Bragg and was transferred to the Mississippi. He was made a major general in Dec. 1863. On April 12, 1864, he assaulted and captured Ft. Pillow, in Tennessee, on the Mississippi; U.S. Negro troops formed a large part of the garrison and according to survivors many were massacred after the fort had surrendered. The "massacre of Ft. Pillow" has been the subject of much controversy and there is conflicting testimony regarding it.

On June 10 he decisively defeated a superior Federal force at Brice's Cross Roads, Miss., and throughout the year, in spite of the efforts to crush him, he raided successfully in Mississippi, Tennessee and Alabama. He was once more with the main Confederate army of the west in the last disastrous campaign of Nashville and fought stubborn rear-guard actions to cover the retreat of the broken Confederates. In Feb. 1865 he was made a lieutenant general, but the struggle was almost at an end. Gen. James H. Wilson rapidly forced back the few Confederates, now under Forrest's command, and stormed Selma, Ala., on April 2. The surrender of General Forrest and his whole command followed on May 9.

Forrest is often described as a born military genius. His simple rule of action, "Get there first with the most men," became one of the most often-quoted statements of the Civil War.

After the war he lived in Memphis, and for several years was president of the Selma, Marion and Memphis railroad. He was for a time active in the Ku Klux Klan. He died at Memphis on Oct. 29, 1877.

See J. H. Mathes, *General Forrest* (1902); R. S. Henry, *"First With the Most" Forrest* (1944), *As They Saw Forrest* (1956).

FORRESTAL, JAMES VINCENT (1892–1949), U.S. cabinet member, the first to serve as secretary of defense, was born on Feb. 15, 1892, at Beacon, N.Y. He studied at Dartmouth college, Hanover, N.H., and at Princeton university, graduating in 1915. He served in naval aviation during World War I and in 1919 resumed his connection with a New York city investment banking firm, of which he was made president in 1938. In June 1940 he became an administrative assistant to Pres. F. D. Roosevelt and in August was named undersecretary of the navy to direct the huge expansion and procurement programs. He was appointed secretary of the navy in May 1944, following the death of Sec. Frank Knox.

Upon enactment of the National Security act of 1947, Forrestal was appointed to the new cabinet position of secretary of defense and initiated a reorganization and co-ordination of the armed services.

He resigned, effective March 28, 1949. Suffering from what navy doctors called "a severe depression of the type seen in operational fatigue during the war," Forrestal entered the U.S. naval hospital at Bethesda, Md., and on May 22, 1949, plunged through a window to his death.

See *Forrestal Diaries*, ed. by Walter Millis (1951).

FORSSMANN, WERNER (1904–), German surgeon who shared with A. Cournand and D. W. Richards (*qq.v.*) the 1956 Nobel prize for medicine, was born in Berlin on Aug. 29, 1904. Having qualified in medicine at Berlin university, he started practising at a private hospital at Eberswalde. His contribution to the development of cardiac catheterization (*q.v.*) started in 1929 when he opened a vein in his arm and inserted a catheter until it reached the right atrium of the heart. He then had an X-ray photograph made of his chest. By this daring experiment Forssmann showed the practicability of passing a radio-opaque catheter into the heart for investigating its structure and function. This method made slow progress, however, because of difficulties of research. During World War II Forssmann served first at the front and later as chief surgeon of a military hospital for the seriously wounded. In 1950 he was appointed chief surgeon of the urological department of a hospital at Bad Kreuznach. In 1951 he was honoured as a pioneer in heart research by the *Deutsche Gesellschaft für Kreislauforschung*, and three years later he was awarded the Leibniz medal of the German Academic societies. Finally, on Dec. 10, 1956, his services were internationally recognized. From 1957 Forssmann served as chief surgeon of the Evangelical hospital at Düsseldorf. (R. B. J.)

FORST, a town of Germany which, after partition of the nation following World War II, became a regional capital in the *Bezirk* (district) of Cottbus, German Democratic Republic, is situated on the left bank of the Görlitzer Neisse at the Polish frontier about 19 km. (12 mi.) E. of Cottbus city. Pop. (1961) 28,598. It is famous for its cloth industry and its rose garden is also well known. Forst was founded in the 13th century and was for long known as the cloth city. There has been a textile school there for several decades. It was heavily damaged by the fighting in the last days of World War II. The town of Zasieki across the river, formerly part of Forst, was transferred to Poland in 1945.

FORSTER, EDWARD MORGAN (1879–), English novelist and essayist, though less prolific than some of his contemporaries, won an eminent place among the writers of the first half of the 20th century. Of his five published novels, four, *Where Angels Fear to Tread* (1905), *The Longest Journey* (1907), *A Room with a View* (1908) and *Howard's End* (1910), appeared before he was 32, and the last, *A Passage to India*, was published in 1924. But his fictional interpretation of the world has been supplemented by critical and biographical writings. From the first he showed such an inability to take for granted many of the values of the period and society in which he found himself that his expressed dissatisfaction may be called revolutionary. Regarded as a whole, his work presents an original and remarkably consistent view of human nature. To religion his attitude became that of a declared agnostic and anticlerical; politically his views, though liberal and democratic, were always individualistic. In all that he wrote, personal emotion and impulse were elevated above social convention, which he showed as constantly tending toward narrowness, shallowness and rigidity and toward the prevention or destruction of the heart's more generous inclinations and of the exercise of imaginative sympathy. His wisdom and his social criticism, whether drastic or playful, were conveyed in a direct and unformal style.

Forster was born on Jan. 1, 1879, in London and was educated at Tonbridge school and King's college, Cambridge. The accepted opinion that the English public school system was an unquestionable national asset was one of the first which his own experience and independence of mind caused him to reject, but at Cambridge he came under congenial and lastingly formative influences: he was on friendly terms with the Bloomsbury group (*q.v.*) and in later years King's college, of which he was made an honorary fellow in 1946, became his home. His education was enlarged by travel. In 1901 he visited Greece and Italy, and the Mediterranean world stimulated his still youthful imagination as the oriental world stimulated its maturity. In 1912 he first visited India, and during World War I he spent three noncombatant years in Egypt. In other countries, as in his own, he showed a fresh and subtle insight into the social differences that keep different kinds of persons apart and into the common humanity that at times brings them together; this insight is in all his fiction. His two most important novels were *Howard's End* and *A Passage to India*. The theme of *Howard's End*, held by some to be Forster's masterpiece, is "Only connect the prose and the passion"; it is concerned with the obstacles to such a connection in the Edwardian middle class. *A Passage to India*, dominated by the theme of the barriers between individuals of the same or of different races in India under the British raj, is perhaps the most impressive novel by any European about Asia.

Aspects of the Novel (1927), first delivered as lectures at Cambridge, shows Forster's resilient, unpompous style at its best, and although some of his judgments are questionable, his critical exposition of the art of fiction has had a lasting influence. His miscellaneous essays, articles and broadcasts were collected in *Abinger Harvest* (1936) and *Two Cheers for Democracy* (1951). The latter includes the essay "What I Believe." Written in 1939, this is a key to the appreciation of its author; it offers a concise definition of his mature and characteristic convictions—his belief in the supremacy of personal relationships, his dislike of faith and dogma and hero worship, his view of democracy as "less hateful than other contemporary forms of government" and his confidence in an ever-renewed "aristocracy of the sensitive, the considerate, and the plucky."

Despite Forster's devotion to music and his belief that "music is the deepest of the arts," he has only touched lightly and occasionally upon music in his writings; yet musical analogies are discernible in the composition of his novels, and he collaborated with Eric Crozier on the libretto of Benjamin Britten's opera *Billy Budd* (1951). Among his other writings were short stories—a volume called *The Celestial Omnibus* was published in 1911—in which, employing fantasy and allegory, he adumbrated some themes of his novels; biographical books, in one of which, *Marianne Thornton* (1956), he evoked something of the atmosphere of robust piety, philanthropy and intellectual cultivation surrounding his forbears of the evangelical Clapham Sect (*q.v.*), from whom he may have inherited a tendency to moralize; and *Alexandria, a History and a Guide* (1922; new ed., 1961), which has been called a model of popularization without condescension.

See R. Macaulay, *The Writings of E. M. Forster* (1938); L. Trilling, *E. M. Forster* (1943). (W. PL.)

FORSTER, (JOHANN) GEORG (ADAM) (1754–1794), German explorer, writer, scientist and politician, was born at Nassenhuben, a small village near Danzig, on Nov. 26, 1754. With his father, Johann Reinhold Forster, a clergyman and brilliant amateur scientist, he emigrated to England in 1766. In 1772 the father and son were invited to accompany Capt. James Cook on his second voyage around the world. Georg Forster's account of the journey, entitled *A Voyage Round the World*, appeared in London in 1777, and the German version, *Reise um die Welt*, in Berlin in 1778–80. This book is a work of travel, science and literature all in one, and it established Forster's name as one of the most advanced German thinkers and accomplished stylists of the time. It had a wide influence on German scientific and literary writing, including that of Goethe, Johann Gottfried von Herder, Friedrich Schlegel, Samuel T. Sömmerring and Alexander von Humboldt. Since its publication the literary travel book has become a favoured genre in German literature, and Goethe's *Italienische Reise* and Heinrich Heine's *Harzreise* are its direct successors. Forster made also, in his articles and letters, major contributions to the scientific, especially botanical, knowledge of the South seas. From 1778 to 1784 he held a professorship at Kassel and from 1784 to 1787 at the University of Vilna. He subsequently became university librarian in Mainz. A keen sympathizer with the French Revolution, he became the leading spirit in the republican government of Mainz. In 1793 he went to Paris to carry out negotiations on behalf of that government. Meanwhile the Germans seized Mainz. Unable to return, publicly reviled in Germany as a traitor, especially by Friedrich Schiller, and disillusioned by what he had seen of the Revolution in France, Forster died in Paris on Jan. 12, 1794.

His collected works are *Sämmtliche Schriften* (1843) and *Werke* (1958–).

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FORSTER, JOHN (1812–1876), English writer and journalist, friend and biographer of Charles Dickens and a notable figure in mid-19th-century literary London. Born at Newcastle upon Tyne, April 2, 1812, he read law and history at University college, London, and began to write, undertaking biographies of statesmen of the Commonwealth period for a 10-vol. *Cyclopaedia* and contributing to periodicals. In 1832 he became a critic on the *True Sun* and there met Leigh Hunt, through him entering on the third aspect of his career—as adviser, agent and proofreader to most of the writers of the day. He joined the staff of the *Examiner* in 1834 and was editor from 1847 to 1856. He met Dickens in 1836 and, until Forster's marriage in 1856, was his closest personal and professional friend, following him as editor of the *Daily News* and receiving from him the innumerable letters "of unexampled candour and truthfulness" which formed the basis of his biography. After 1850, ill-health caused his withdrawal into the research which had formed the background to his busy life. He became secretary to the commissioners in lunacy in 1855 and a commissioner in 1861. He died in London, Feb. 2, 1876.

Forster was a discriminating editor, an indefatigable friend and a careful scholar. Pugnacious and possessive, yet inexhaustibly kind, he roused strong feelings. He was nicknamed "Fuz" by Carlyle, and "the Beadle of the Universe" by Thornton Hunt, caricatured as "Fuzbuz" in Rosina Bulwer's novel, *Cheveley*, loved and admired by "L. E. L." (Letitia Landon), to whom he was briefly engaged, Lady Blessington, Landor, Tennyson and Browning. His *Life of Dickens*, 3 vol. (1872–74), is an essential source book and a literary masterpiece, despite its personal bias and occasional suppressions and inaccuracies, especially for the period after 1856. His *Life of Oliver Goldsmith* (1848; expanded into *Life and Times*, 1854), his *Life of Landor* (1868) and the unfinished *Life of Swift* (1875) remain authoritative and readable, revealing, as do his now superseded historical works on the 17th century, his shrewdness, trenchancy of style and keen, yet selective, interest in detail.

See R. Renton, *John Forster and His Friendships* (1912); M. Elwin in *Victorian Wallflowers* (1934).

FÖRSTER, JOSEF BOHUSLAV (1859–1951), Czech composer belonging to the school of Dvorak and Smetana. Born at Prague, Dec. 30, 1859, he was the son of Josef Förster (1833–1907), the composer of organ music. After studying at the Prague conservatory, he was organist at several Prague churches and music critic of *Narodny Listy*. In 1888 he married the Wagnerian soprano, Berta Lauterer, and from 1893 to 1903 lived in Hamburg, where he became a friend of Gustav Mahler and taught at the conservatory. From 1903 to 1918 he was music critic of *Die Zeit* in Vienna. In 1919 he taught composition at the Prague conservatory and was later appointed director. He died at Novy Vestec, near Mlada Boleslava, May 29, 1951.

Förster's music was largely inspired by personal memories and associations. His second and fifth symphonies, his cantata, *Mortuis fratribus* and his Trio in A minor were tributes to his near relatives. He was a devout man and his fourth symphony ("Easter Eve"), and his operas, *Nepromozeni* (1918), *Srdce* (1923) and *Bloud* (1936), were inspired by religious subjects. He also wrote four Masses, two violin concertos, a cello concerto and chamber and vocal works. Though his romantic and religious outlook suggests Mahler, his simpler, lyrical works, notably the song-cycle, *Liebe*, show his allegiance to the heritage of Dvorak and Smetana.

See J. B. Förster, *Der Pilger. Erinnerungen eines Musikers*, trans. by P. Eisner (1955); *J. B. Foerster*, a symposium ed., with a bibliography, by J. Bartos *et al.* (1949).

FORSTER, THOMAS (*c.* 1675–1738), English Jacobite and a leader of the 1715 rising, was squire of Etherston, Northumberland. He was member of parliament for that county from 1708 to 1716, but his Jacobite proclivities became known, and in 1715 he was ordered under arrest by the house of commons. He fled before this could be done, however, and at Greenrig in Northumberland on Oct. 6 proclaimed the Old Pretender as James III. Forster assumed command of his small band of followers but proved a woeful general. After failing to take Newcastle he allowed the rebellion to degenerate into a series of purposeless marches. He was joined by the rebels from southern Scotland under Lord Kenmure and the combined force marched to Kelso in Roxburghshire where, on Oct. 22, it was further reinforced by a detachment of High-

landers under Brig. William Mackintosh of Borlum. Mackintosh had considerable military talents but was obliged to serve under the incompetent Kenmure in Scotland and the no less incompetent Forster once the rebels had crossed into England. Forster expected reinforcements from the Roman Catholic gentry of the northwestern shires of England, but these failed to appear. At Preston on Nov. 17 he capitulated, despite the protests of his officers. He escaped from prison to France where he died, at Boulogne, on Nov. 3, 1738.

See R. C. Jarvis (ed.), *The Jacobite Risings of 1715 and 1745* (1954); A. and H. Tayler, *1715—the Story of the Rising* (1936). (W. Fe.)

FORSTER, WILLIAM EDWARD (1818–1886), British statesman, famous both for his Education act of 1870 and for his term as chief secretary for Ireland, 1880–82, was born of Quaker parents at Bradpole in Dorset on July 11, 1818. Educated at the Friends' school at Tottenham, he became a woolen manufacturer in Yorkshire and was soon well known for his philanthropy. He and his father went to Ireland in 1846–47 to distribute the Friends' relief fund for the famine in Connemara, and the state of the country made a deep impression on him. In 1850 he married Jane Martha, eldest daughter of Thomas Arnold, headmaster of Rugby. Being childless, they adopted the four orphans of her brother William Arnold when he died in 1859.

Forster stood as Liberal candidate for Leeds in 1859 without success. In 1861 he was returned unopposed for Bradford, for which he sat till his death in spite of local religious and political opposition. He was made undersecretary for the colonies in Lord Russell's ministry in 1865 and became a prominent advocate of imperial federation. In 1866, supporting parliamentary reform, he demanded universal education as its essential complement. With other private members in opposition, he brought in education bills in 1867 and 1868, and when the Liberal party returned to office at the end of 1868 Forster was appointed vice-president of the council and charged with preparing a government measure for national education. The elementary education bill (*see* Education, History of) was introduced on Feb. 17, 1870, and finally passed on Aug. 9 after a prolonged and complicated wrangle in the commons about its religious clauses. Protestant dissenters found it hard to forgive Forster for what they thought excessive lenience toward Anglicanism, and the bill passed only because some Anglican Conservatives voted for it. Extremists on both sides abused Forster, but it is to his enduring credit that the bill of 1870, imperfect as it was, established something approaching a system of national education in England. In July, while it was still under debate, he was admitted to the cabinet.

Forster's next important task was the ballot bill, passed by the commons and rejected in the lords in 1871 and finally enacted in 1872. His standing in the Liberal party had so much grown that when W. E. Gladstone retired in 1875 Forster was strongly supported for the leadership of the party in the house of commons, but he yielded to the superior strength of Lord Hartington (afterward 8th duke of Devonshire). On Gladstone's return to office in 1880 Forster was made chief secretary for Ireland. As a radical, he approved extensive land reform, but as the man responsible for maintaining law and order during the Irish agricultural revolution, he found he had to press for measures of coercion instead. The Irish, in and out of parliament, did their best to counteract him. He was nicknamed "Buckshot Forster" by the nationalist press, which asserted he had ordered the police to use buckshot when firing on a crowd. His work kept him constantly on the move between Dublin and London, conducting his campaign against crime and anarchy in Ireland and defending it in the cabinet and in the house of commons. From the autumn of 1881 his life was in almost daily danger. Extreme pressure of work and anxiety told on his temper and his judgment, and when, on May 2, 1882, his colleagues agreed to release C. S. Parnell and other prisoners from Kilmainham jail, Forster seized the occasion to resign. Four days later his successor, Lord Frederick Cavendish, was murdered in Phoenix park, Dublin.

It was characteristic that Forster at once offered to go back to Dublin temporarily as chief secretary, but the offer was declined. It was also, unhappily, characteristic that he made several speeches in the next two years that could only serve to exacerbate the Irish question. He delivered his fiercest attack on Parnell in Feb. 1883, charging him not with directly planning or perpetrating outrages but with conniving at them. Forster died in London on April 5, 1886, on the eve of the introduction of the Home Rule bill, to which he was stoutly opposed. He had found himself more and more at variance with his party, differing from Gladstonian Liberalism on questions like the Transvaal and the Sudan and disagreeing with the claims of the caucus (*q.v.*) and with the Birmingham program.

See Sir T. Wemyss Reid, *Life of . . . Forster*, 2 vol. (1888). (M. R. D. F.)

FORSYTH, PETER TAYLOR (1848–1921), an outstanding Scottish Congregationalist theologian, was born at Aberdeen on May 12, 1848. The son of a postman, he was educated at Aberdeen grammar school and university, and spent a term at Göttingen, where he was deeply influenced by Albrecht Ritschl. After a brief period studying theology at New college, London, he was minister of several Congregational churches in England, including Emmanuel church, Cambridge. In 1901 he became principal of Hackney theological college, London, where he remained until his death in London on Nov. 11, 1921. He was a distinguished preacher, but exercised his influence chiefly through his numerous books and published lectures, which were written in a vigorous and highly characteristic, though over-epigrammatic, style.

Beginning as a theological liberal, Forsyth gradually moved to a position of great originality and power to which there was no precise equivalent in his own time, although it had some affinity with the "positive theology" of Germany. He had little in common with old-fashioned evangelical orthodoxy but was the shrewdest critic of the modernistic liberalism which was then at the height of its popularity in the free churches. He reasserted the classic faith of the Reformation in terms appropriate to his own time, bringing the word "grace" back into Protestant theology and showing afresh what was meant by the sovereignty of God revealed in holy love in Christ. He thus anticipated many of the characteristic insights of Karl Barth, and there are also similarities of spirit between the two men.

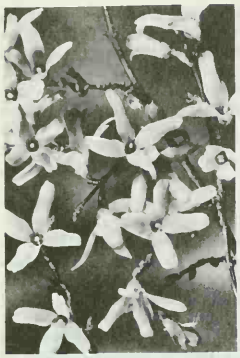
Forsyth's most famous book, *The Person and Place of Jesus Christ* (1909), was an attempt, in his own phrase, "to moralise dogma," to express in terms of modern personal experience the meaning of the doctrine of Christ's divinity. His *Positive Preaching and the Modern Mind* (1907) and *Lectures on The Church and the Sacraments* (1917) recalled Protestants to the richness of their own teaching about the church at a time when liberalism and evangelicalism together were in danger of making them forget it. He also wrote on the relation between Christian faith and the questions of his day. *The Justification of God* (1916) is one of the best essays of the 20th century in this subject. *Christ on Parnassus* (1911) was notable as one of the first efforts in the same century to relate theology and the arts, although it has worn less successfully than most of his writings.

In the range of his interest and the breadth of his sympathy Forsyth was the successor in the theological life of England of John F. D. Maurice (*q.v.*), whom he greatly admired. Like Maurice, he was widely misunderstood in his own time, although never without powerful support and devoted disciples. Since the theological revival led by Barth, however, his work has been much more readily understood and appreciated.

See G. O. Griffith, *The Theology of P. T. Forsyth* (1948); R. M. Brown, *P. T. Forsyth: Prophet for Today* (1952). (D. T. J.)

FORSYTHIA, an old world genus of the olive family with several very showy, hardy, spring-blooming species that are widely planted for their profuse, usually yellow flowers that bloom before or with the unfolding of the foliage, and are commonly called golden bell. They usually have arching or spreading branches bearing opposite leaves, 2½ to 6 in. long, that are carried late in the fall and often become olive or purplish in colour. The plants are not particular as to soil and do well in partial shade, although they prefer an open location. Cuttings of stems root easily.

Weeping golden bell (*F. suspensa*), an upright shrub to ten feet, with the tips of the long, arching, hollow branches often pendulous and, in age, rooting at the tip, has golden-yellow flowers



ROCHE

WEEPING GOLDEN BELL (FORSYTHIA SUSPENSA)

about an inch long. Some of its horticultural varieties show variations in plant form. Greenstem golden bell (*F. viridissima*), has erect, bright green branches, reaching ten feet, and greenish-yellow flowers about an inch long. Border golden-bell (*F. intermedia*), a hybrid between *F. suspensa* and *F. viridissima*, is deemed by many as the best of the forsythias, particularly the variety *spectabilis* with its bright yellow flowers about 1½ in. long.

Other varieties show flower colours from pale to deep yellow. Early golden bell (*F. ovata*), also called Korean forsythia, a shrub up to 5 ft., has solitary, amber-yellow flowers about 2½ in. long. It is the earliest to bloom. Forsythias are especially attractive massed against a background of evergreens. (J. M. Bl.)

FORTALEZA, a city and port of Brazil and the capital of the state of Ceará (*q.v.*), on a crescent-shaped indentation of the coast line, 7½ mi. from the mouth of the Ceará river. A progressive and growing city, it had become one of the country's more important municipalities in the second half of the 20th century. Pop. (1960) 354,942. The city stands on an open sandy plain overlooking the Atlantic, and is regularly laid out, with broad streets and numerous parklike squares.

Because of the arid climate the vegetation is less luxuriant than in most Brazilian cities. The usually high temperature is modified by the strong sea winds and the climate is considered healthful. A small branch of the Ceará river, called the Pajeú, traverses the city and divides it into two parts, that on its right bank being locally known as Outeiro. Fortaleza is the see of a bishopric, created in 1854.

Its public buildings include the government house, legislative chambers, bishop's palace, an episcopal seminary, a lyceum (high school) and hospital. The port is the principal outlet for the products of the state. Long an open roadstead harbour, it has been much improved by construction of a breakwater and port facilities at Mucuripe point 4 mi. E. The Baturité railway, built by the national government partly to give employment to starving refugees in times of long droughts, connects the city and its port with fertile regions to the southwest and extends southeast to Patos in Paraíba.

The exports include sugar, coffee, rubber, cotton, carnauba wax, oiticica oil, rum, rice, beans, fruits, hides and skins.

Fortaleza had its origin in a small village adjoining a fort established by the Portuguese at this point in early colonial times. In 1654 it took the name of Villa do Forte da Assumpção, but it was generally spoken of as Fortaleza.

In 1810 it became the capital of Ceará captaincy and in 1823 it was raised to the dignity of a city under the title of Fortaleza da Nova Bragança. It is sometimes referred to as Ceará.

(Js. J. P.)

FORT-DE-FRANCE, administrative capital and principal town of the island *département* of Martinique (*q.v.*) in the French Antilles, is situated on the west coast at the northern entrance to the large Bay of Fort-de-France, at the mouth of the Madame river. Pop. (1960 est.) 62,000. Its deepwater harbour is sheltered to the east by a small peninsula which provided a convenient site for a fort. The town, originally called Fort-Royal, occupies a narrow plain between hills and the sea but is accessible by road from all parts of the island, including the airport at Lamentin, 9 mi. E.

At Trois Islets on the south side of the bay the empress Josephine was born in 1763. St. Pierre was the island's chief town until destroyed by the eruption of Mt. Pelé in 1902. Fort-de-France remained small, without an adequate water supply, partly surrounded by swamps and notorious for yellow fever. In 1839 it was partially destroyed by earthquake and in 1890 by fire. After 1918 it grew rapidly. The swamps were drained and extensive suburbs have spread, particularly eastward across the Monsieur river toward Lamentin. Fort-de-France has become the largest town, chief port and busiest commercial centre in the French Antilles. (D. R. H.)

FORT DODGE, a city of Iowa, U.S., situated on the Des Moines river at its junction with the Lizard, 85 mi. N.W. of Des Moines; the seat of Webster county. It was established as an army post, Ft. Clarke, Aug. 23, 1850, and in 1851 was renamed in honour of Israel and Henry Dodge, father and son, senators from Wisconsin and Iowa. When the troops left in 1853 Maj. William Williams remained and bought the land and buildings. He laid out the town the following year and became its first mayor and postmaster. The town was chartered as a city in 1869. Many of the early settlers of the fertile lands around Fort Dodge who held title under federal patents were dispossessed in the 1860s by the Des Moines Navigation and Railroad company which had its grant from the state of Iowa for work done in a futile effort to make the river navigable.

Extensive gypsum deposits make Fort Dodge one of the centres of this industry. Clay is abundant and several plants make tile, brick and sewer pipe. Other industries include meat packing, farm implement plants and pharmaceutical production. (For comparative population figures *see* table in Iowa: *Population.*)

The "Cardiff giant," famous hoax of the 19th century was carved from the Fort Dodge gypsum deposits. In 1868 George Hall of Binghamton, N.Y., procured a block of gypsum from the deposits in Fort Dodge, hauled it overland to Chicago, had it carved in the shape of a human figure, and buried it near Cardiff, Onondaga county, N.Y., where it was discovered by men digging a well in 1869. The "Cardiff giant" was exhibited in various parts of the country as a petrified man or a statue dating from prehistoric times, and was the subject of much discussion among scientists and scholars, until the hoax was exposed by Othniel C. Marsh of Yale, and the perpetrator confessed his part in it. (E. J. Br.)

FORTESCUE, SIR JOHN (*c.* 1385–*c.* 1479), English judge, is famous for his legal treatise written for the instruction of Prince Edward, son of Henry VI. The second son of Sir John Fortescue, he was born at Norris, near South Brent, Somersetshire. He was admitted to Lincoln's Inn before 1420, and in 1421 was elected to parliament. In 1430 he became a serjeant and in 1441 king's serjeant. In 1442 he became chief justice of the king's bench, and was knighted the following year. He fled to Scotland with Henry VI in 1461, when he seems to have been appointed lord chancellor. In 1463 he went into exile with Queen Margaret, and returned to England with her in 1471. On the final defeat of the Lancastrians, he submitted to Edward IV. He retired to Gloucestershire and died some years later. He was most learned and upright, and from his decision in *Thorpe's Case* in 1452 stems the modern doctrine of parliamentary privilege. His treatise, *De Laudibus Legum Angliae,* was written while in exile and eulogizes the constitution and much of English law and legal education, with many comparisons with Roman and continental law, and proposals for law reform. Its outlook was ahead of its time, and it was not published until 1546.

His other works included *The Difference between an Absolute and a Limited Monarchy* (*see* C. Plummer, ed., *Sir John Fortescue: The Governance of England* [1885]). *See* S. B. Chrimes, ed. and trans., *Sir John Fortescue: De Laudibus Legum Angliae* (1942); Lord Campbell, *Lives of the Lord Chancellors* (1868). (R. E. My.)

FORTESCUE, SIR JOHN (*c.* 1531–1607), English statesman, chancellor of the exchequer under Queen Elizabeth I, was the eldest son of Sir Adrian Fortescue (executed in 1539), and of his second wife, Anne Reade or Rede. Through his father's mother, Alice, daughter of Sir Geoffrey Boleyn, he was connected with Queen Elizabeth I. He directed the princess Elizabeth's classical studies in Mary's reign, and, on his pupil's accession, was appointed keeper of the great wardrobe. He entered parliament in 1572. In 1589 he was appointed chancellor of the exchequer and a member of the privy council. He was knighted in 1592, and in addition to

his other offices, received the chancellorship of the duchy of Lancaster in Nov. 1601. Fortescue was a member of the court of the star chamber and an ecclesiastical commissioner, sat on various important commissions, and as chancellor of the exchequer explained the queen's financial needs and proposed subsidies in parliament. He was deprived by James of the chancellorship of the exchequer, but retained his two other offices. In 1604 Fortescue, who stood for Buckinghamshire, was defeated by Sir Francis Goodwin, whose election, however, was declared void by the lord chancellor on the ground of a sentence of outlawry under which he lay, and Fortescue was by a second election returned in his place. This incident gave rise to a violent controversy regarding the chancellor's jurisdiction in deciding disputed elections to parliament, which was repudiated by the commons but maintained by the king. The matter after much debate was ended by a compromise, which, while leaving the principle unsettled, set aside the elections of both candidates and issued a new writ. Fortescue was elected member for Middlesex in 1606, remaining so until his death on Dec. 23, 1607.

FORT GEORGE RIVER (Big River), Quebec province, Can., rises in Lake Nichicun at 1,737 ft. above sea level and flows northward for 60 mi. before turning west for the final 420 mi. to discharge into James bay. Except for its lower course it has no well-defined valley and consists of a series of irregular lakes connected by rapids. Hudson's Bay company posts are situated at its mouth (Fort George) and on Lake Nichicun, the latter being established prior to 1800. (J. D. I.)

FORTH, a river and firth in east Scotland, the Bodotria estuary of Ptolemy. The river takes a dominantly west-east course from headwaters on the eastern slopes of Ben Lomond to a gradual meeting with the firth near Kincardine, a direct distance of 38 mi. over which the river flows with many windings for about 65 mi. Within its last few miles, near Stirling, the Forth receives two important left-bank tributaries, the Allan which drains the strath between the western Ochil hills and the Highland Edge, and the Teith which drains the fine mountain country round the Trossachs (*q.v.*) and accounts for about half of the 645 sq.mi. of the entire Forth basin and a greater volume of flow than the main stream. The Forth proper has a short Highland course and a much longer Lowland section: it is generally taken as beginning at the confluence, west of Aberfoyle and near the Highland fault line, of two short streams of Highland character, the Duchray flowing about 10 mi. from Gleann Dubh, and the Avondhu which drains Lochs Chon and Ard. From the confluence to the sea, in contrast, the Forth is very much a Lowland river, falling only about 80 ft. in a meandering course of 55 mi. Most of this Lowland course is through a very flat plain of alluvium, boulder clay and notably the peats of Flanders Moss, largely reclaimed for agriculture during the early 19th century, especially in the east. Meanders, actually slightly incised into the clay, are especially well marked above and below Stirling and are well known as the Links of Forth. Forth, Teith and Allan are angled for salmon and trout.

The Firth is taken as beginning at Kincardine, which is the site of the older road bridge (completed 1936). The river is tidal to Stirling but there is now little serious navigation above Grangemouth. The Forth and Clyde canal (completed 1790) connects the latter with Bowling on the Clyde estuary 35 mi. distant. The firth stretches for 48 mi. from Kincardine to the Isle of May; first it broadens to 2½ mi. in a west-east stretch, then narrows to 1 mi. with the constriction of the dolerite sills of North and South Queensferry, the site of the high cantilever railway bridge completed in 1890 (*see* Bridges), with the road bridge completed in 1963 half a mile upstream. At these narrows the river attains its maximum depth of more than 200 ft. It then turns northeast and broadens to the main estuary. The chief ports on the north are Methil and Burntisland, near the Fife coal field, and the naval base of Rosyth; on the south are Leith, Granton (a small trawler port near Edinburgh), and Bo'ness and Grangemouth serving Falkirk and the industrial areas farther west. There are also numerous small fishing ports. The shores of the Forth include several holiday resorts and well-known goll links. (A. T. A. L.)

FORTIFICATION, the military art or science of strengthening positions against attacks. Permanent fortifications include lasting and elaborate forts and troop shelters; they are usually constructed of masonry, concrete or stone and are most often erected in times of peace. Field fortifications are those constructed when in contact with an enemy, or when contact is imminent. They consist of entrenched positions for personnel, weapon emplacements, cleared fields of fire for weapons, manufactured obstacles like mines and barbed-wire entanglements, and the strengthening of available natural obstacles by utilizing felled trees, rocks and other materials. Modern field fortifications require concealment and camouflage, and covering fire to hold the enemy at bay.

There are two chief reasons for fortifications: to obtain the greatest advantage from one's own strength and weapons; and to prevent the enemy from using his resources to advantage. The defender is shielded by the protecting fortification, and the attacker is delayed or his impetus minimized by obstacles.

The defense of cities and trade centres, usually by high walls, has been important for centuries as a protection for their wealth. Permanent fortifications have also been established at strategic points along routes of invasion. Seacoast fortifications have normally been for protection against naval attack, though from a military standpoint they sometimes included protection from the land side. Field fortifications have been used in varying degrees since the time of the Greeks and the Romans.

The citadel was the municipal fortress of the ancient world. It appeared in cities of Egypt, Greece and the Roman empire. Roman citadels were less important than those of Greece because they were less necessary as most Roman cities were less exposed to potential attackers.

Obstacles have been utilized throughout history to prevent an enemy from coming to close quarters. The Romans depended upon protective walls and dry ditches in the republican era but later utilized ditches filled with water and spiked tree trunks set in the ground. Obstacles were of little value unless they were tied into the defense system. For instance, the concrete dragon's teeth of the German west wall of World War II were an inconsequential obstacle when no troops or defense guns were nearby. Bulldozers merely pushed dirt over them to create an elevated road, or engineers dynamited a path through them.

In ancient days, fortifications held up the best attacking troops for months and even years. The medieval castle was almost impregnable until gunpowder gave artillery increased battering power. Even against artillery, the fortifications of World War I were able for a time to bear up successfully. In World War II new methods of combined attack made even the strongest permanent fortifications vulnerable. Field fortifications gave some help to the defense by channelizing enemy attacks, though at no time were they impregnable for any considerable period.

Historically, both permanent and field fortifications were strong against hand weapons and engines of war (*q.v.*), but required extensive modification after the arrival of gunpowder. In the age of the tank and airplane, permanent fortifications became inadequate, but field fortifications were able to compel some delay in enemy advances.

EARLY HISTORY OF FIELD FORTIFICATIONS

The Ancient World.—Field fortifications played an important role in warfare of the ancient world. The main purpose, particularly among the Greeks, was to secure an advantage by being above the enemy, so that the defenders could stand on a hillside while engaging in personal combat. A Roman legion was trained to dig a ditch and erect a palisade each night that it made camp. In preparation for the defense of the camp, each man had a set job to do, and each legionary carried a piece of the palisade that was erected inside the ditch. When Roman columns met with resistance while on the march, half of the force would engage the enemy while the remainder prepared a fort on a height or slope. The palisades were low because the men behind them fought with shields and needed space to use their lances. When campaigns extended over long periods, the main camp of the Romans was further protected by outlying redoubts, or small forts, which were occupied by a cohort of the legion.

Julius Caesar mentions the building of walls as much as 14 mi. long during his campaign in Gaul. On one occasion, Caesar reversed the usual procedure. He surrounded a town with a line of fortifications 11 mi. long, thus permitting his 60,000 Romans to bottle up 80,000 Gauls in Alesia. Then he turned in the other direction to fight 100,000 Gauls who were in turn besieging him. It appears that had it not been for Caesar's fortifications, all Gaul would have been lost. Caesar was a master at field fortification and the construction of obstacles; he employed nearly all the basic types known in modern times.

In later centuries, when the Roman empire had been extended through much of Europe, a system of permanent forts was built along the Rhine and Danube rivers to form the defense of the empire. The technique of entrenching for the protection of the legion was passed on to the Byzantine armies, which insisted that troops entrench their camps in the manner of the Roman legion. The Byzantines also erected a chain of fortresses to defend the line of the Danube river. These frontier posts were worked into a system of defense together with the walled towns and castles of the Balkan area. After the fall of Rome, field entrenchments were almost unknown for many centuries because the code of feudal warfare looked upon such devices as unchivalrous.

Middle Ages.—In the 13th century the Mongols revived the long-forgotten field entrenchment in Europe. Timur consistently followed a tactic of defending his centre in battle by entrenchment, employing the troops thus released for strengthening his flank operations on the wings of the defended position. The next notice of field fortification is in the late 16th century during the Huguenot uprisings against Henry IV. The duke of Parma, in support of the Catholic monarch of Spain, fought Henry several times from behind field fortifications which his veterans had erected overnight. In this same period the Spaniards, under Parma and his successors, encountered a master at maneuver and fortification in Maurice, comte de Saxe. Spanish generals tried again and again to bring Maurice to a pitched battle. When challenged he threw up field fortifications too strong to be taken.

17th, 18th and 19th Centuries.—Gustavus Adolphus, the father of modern tactics and organization of armies, also made a considerable contribution to field fortification. The Swedes were thoroughly impressed with the necessity of digging as well as shooting. Gustavus had adopted the Dutch engineering system of Maurice, comte de Saxe, but he was more than an imitator. Outlying posts were defended by redoubts, while his forts were protected by palisades and entanglements; in the field, his armies always built a ditch and a wall around their camp. Instead of the single line common to his day, he prepared two lines of mutually supporting fortifications, possibly the forerunner of the 20th-century system of detached fortresses. Gustavus' field fortifications staved off his defeat by Johann Tzerclaes, count of Tilly, on the banks of the Elbe. Tilly twice attacked the earthworks of the Swedes, but was repulsed by case shot fired at point-blank range from the Swedes' new regimental cannon.

The American Revolution dramatically demonstrated the value of field fortifications. At Bunker Hill, the Americans utilized entrenchments in a manner that seemed entirely natural to the frontier spirit. A low trench, a parapet chest high or a tree gave the frontiersman protection while he reloaded and aimed his musket. In all the battles of the Revolutionary War, the Americans utilized field fortifications, particularly earthworks. At the last battle of the war, Yorktown, the Americans and French conducted a successful siege against the excellent British defenses, utilizing Marshal Sébastien de Vauban's system of digging parallel trenches and moving forward gradually against the main system of entrenchments and redoubts. Within a generation, American troops under Andrew Jackson at the battle of New Orleans made effective use of cotton bales to defend their position against the advancing British troops.

In the Napoleonic period the one great historical example of field fortification was that known as the Tôrres Vedras line. The duke of Wellington, with 60,000 men, faced French armies of more than double his strength in the campaign in the Spanish peninsula. During the winter of 1810 he built a series of 87 connected redoubts about 25 mi. N. of Lisbon. There, from two low ranges of hills and with almost 300 guns in his redoubts, he defended the Lisbon peninsula from the Tagus river to the sea. Again and again the Frenchmen assaulted the slopes but were unable to take Wellington's position. Later, the lines were blockaded by the French, but in the spring both armies had to withdraw because they were near starvation.

From the start of the American Civil War, troops fought behind stone walls and trees, or dug entrenchments. In two notable sieges, that of Vicksburg, Miss., in the west and a later one at Petersburg, Va., in the east, trench warfare was the accepted method of siege. The Vicksburg siege lasted for six months. The Union forces supplemented their artillery and rifle fire by mining, much in the nature of siege warfare against permanent forts. The men tunneled under the fort and placed there a charge of powder to explode after they had withdrawn to safety. In the Cold Harbor, Va., campaign, when Gen. Ulysses S. Grant sent his troops against earthwork defenses of the Confederates he lost 14,000 men in 13 days. Early in the war Gen. Robert E. Lee adopted the frontier riflemen's breastwork comprising two logs on the parapet of the entrenchment. The logs afforded protection to the upper part of the soldier's body but enabled him to fire from the slit between the logs.

At no time during the Civil War were great efforts made to furnish material and supplies for such fortifications. The soldiers usually brought their own spades and axes, and with them built field fortifications far beyond anything known to that date. Changes in tactics wrought by the new rifles and by field entrenchments on defense did not reach European battlefields in time for the Franco-German War in 1870. Both armies were so steeped in the idea of attack that it was unthinkable to take advantage of the folds in the ground and of trenches for defense.

World War I.—The offensive tactics in which the German and French armies were educated bogged down within a few months after the outbreak of World War I. The firepower of the machine gun brought the war to a stalemate. War on the western front took on the nature of a gigantic siege operation.

For 600 mi. from the border of Switzerland to the channel, two systems of trenches faced each other. During the period from Dec. 1914 to March 1918 this zigzag gash of trenches shifted no more than ten miles at any one place with the single exception of one salient which the Germans voluntarily gave up in order to straighten their lines. For 29 months the expression "western front" became synonymous with a new way of life which was lived by several million uniformed men. "No man's land" was known around the world. At night it was often lighted up by coloured flares and brilliant star shells. At the glimpse of a patrol nervous fingers touched off hundreds of rifles, machine guns and artillery cannon. As the danger disappeared, the battlefield returned to its former quiescence, while a few men did sentry duty in the trenches and their fellow soldiers slept as best they could in the dugouts deep under the earth. In daytime the opposing lines were marked by balloons and occasionally by the dogfights of a few biplanes, which strangely enough enlivened by their combat the daily grind of the human moles in the trenches.

Throughout this entrenched line, the typical trench system was not unlike the parallel trenches which Vauban (*see* below, *Permanent Fortifications: Vauban's Siegecraft*) had prepared two and one-half centuries before as a means of attacking fortresses. Early in the war, the trenches were normally in four parallels about a mile in depth. Each trench was angled so that no enemy, standing at one end, could fire for more than a few feet down its length. In the zigzagging of the trenches lay protection for the defenders when a breakthrough occurred at one point. Each of the four lines of trenches was connected by a series of communication trenches, perpendicular to the front. These were the supply avenues for the bringing of food, ammunition and mail and through which relief and replacement of troops were affected. In general, the first line of trenches was known as the outpost line and was thinly held. The next two lines were commonly called the main line of resistance and the supporting line, while the fourth was the reserve line. Still farther to the rear of this rigid defense system,

the artillery was posted. The main purpose of this defense in depth was to prevent an enemy from getting through the third line.

After many months of stalemate, both sides adopted new ideas in both attack and defense. The Hindenburg line in the rear of the regular trench system was the German contribution to defense in depth, far beyond the one-mile-deep, rigid defenses previously used. The Hindenburg trench system was an extremely elaborate field fortification with a unique feature known as the pillbox. These concrete shelters for machine guns were spaced along the front where the protected machine guns were most effective against infantry attack. Behind the pillboxes were trenches and dugouts reinforced with concrete designed to withstand artillery bombardment. These defenses were scattered over a depth of three or four miles. The second position, spaced approximately two miles from the first, was out of range of artillery. The artillery, being about two miles behind its own front lines, was therefore four miles from the second, or main positions, of the Hindenburg line. This distance was further than the artillery could fire effectively. Another reason for this spacing was that, in the attack formations, the co-ordination between infantry and artillery had become so close that the troops followed a creeping barrage which moved forward on a regular time schedule without regard to the actual position of the troops.

FIELD FORTIFICATIONS OF WORLD WAR II AND THE KOREAN WAR

Defensive Systems.—Entrenchments in World War II followed somewhat the general pattern of those of World War I, with one great exception. They had to be prepared for all-around defense against tank attacks. The development of the land mine made it possible to work out field fortifications which restricted the movement of tanks but actually did no more than delay the enemy for a time. When the German army attacked France in 1940, the tank columns were organized into two groups; the first was primed to rupture the French defense, and the second, in the rear, to penetrate and then fan out in exploitation of the attack.

The French field fortifications were in many places well built. There were ditches sufficiently deep to stop tanks, and antitank guns sited to fire down the front of these ditches. First of all, the Germans bombarded the French positions with artillery and low-flying aircraft. The tanks then advanced under the cover of smoke against the zigzag antitank ditches. Knowing about where the antitank guns would be placed in the defensive system, one vehicle moved against the antitank gun position and, when it was knocked out, blocked the view of the gunner. In this way, some protection was given to other machines which moved upon the ditch, bridged it with special equipment and then moved forward. Against each of the successive defense lines, German tanks advanced under cover of smoke against the concrete emplacements and pillboxes, utilizing flame throwers to compel the defenders to close their loopholes. The German tanks then pulverized them with their heavy guns.

During World War II, field fortifications were thrown up in practically every kind of terrain. In north Africa, men dug individual protection trenches, called foxholes, in the desert, or used sandbags for the same purpose. The coral rock of some Pacific islands made it impossible to dig field fortifications. In such cases the only salvation was to stack sandbags, cut down vegetation and make use of other devices to create a form of field fortification. In the Pacific war there were many atolls where Allied forces had to mop up Japanese troops hidden in caves, log bunkers or trenches that had been covered and cleverly concealed. Japanese field fortifications had been built methodically during the long period of preparation for the expected U.S. offensive; they were probably the most difficult ones attacked by the Allies during the war. Jungle foliage quickly covered the earth which had been dug out, making entrances to emplacements and shelters almost impossible to discover except by close inspection, an extremely dangerous practice.

Attack of Field Fortifications.—The U.S. method of operating against the cave systems of field entrenchments was to employ machines, instead of manpower, in every possible way. The sequence sometimes included aerial bombing, followed by naval bombardment of the area for days, or even weeks, and then close-up attack by artillery and tanks. The final effort was an infantry mopping up after infiltrating through the jungle areas.

On the eastern European front, the Germans found little difficulty in moving through the field fortifications of the Stalin line, employing tactics of penetration and exploitation by teams of tanks and dive bombers which had been so successful in France. However, the Germans made the mistake of believing that once through the Stalin line they could move unopposed, as they had in France. Russians of all ages and sexes helped dig parallel trench systems outside such cities as Moscow and Leningrad. They were hasty, improvised trenches and antitank ditches, but they proved sufficient to stop the German attack, which had been blunted by continuous fighting.

Hasty Fortification in Towns.—A striking development in the realm of fortifications was the house-to-house fighting in western Europe. As combat troops moved into a new village they invariably selected certain homes, preferably those of stone on the outskirts of the village, as their field fortifications. The next problem was how to develop a co-ordinated field fortification system utilizing the inherent strength of the buildings augmented by fieldworks on commanding ground near the town.

Field Methods.—The location of field fortifications required knowledge of terrain and of the fire power of weapons and evaluation not only of the protection offered by the ground but also the terrain advantages to the attacker. The usual sequence after determining the general location of combat emplacements was the clearing of fields of fire, the provision of observation and signal communication, the laying of mine fields and barbed-wire entanglements, the preparation of individual shelters, the emplacement of weapons, the preparation of obstacles other than mine fields and the improvement of supply routes and paths for the movement of reserves. As a part of camouflage and concealment, most armies took advantage of ruses such as dummy positions and the use of deceptive devices, both of which might be interpreted as part of field fortification methods.

The tools the men used for field fortifications were necessarily what they were normally carrying with them and in the use of which they were skilled. The most important was the entrenching tool; an ax was helpful in hard turf and power tools were especially good for heavier construction. Bulldozers, tractors, pneumatic drills and other construction tools, as well as explosives, were helpful in preparing field fortifications. Individual shelters and hasty emplacements were usually built with the materials naturally available. Manufactured items were also necessary for barbed wire, concrete construction and mine fields.

Occasionally there were natural breastworks and parapets, such as in the hedges of the *bocage* country in Normandy. Stone walls in Germany and France on practically every farm and in every village also assured certain defensive assistance. In the hedge country, ports for firing machine guns and other weapons were cut through the dirt ridges, thus providing a well-camouflaged strong point. In the villages, stone and brick walls as well as rubble from demolished buildings made natural breastworks and parapets. German forces in Italy showed great skill and ingenuity in taking advantage of terrain features to develop a network of field fortifications that forced the Allies to pay dearly for every foot of ground, particularly at Cassino. (*See* WORLD WAR II: *The Italian Campaign, Sept. 1943–May 1945.*)

Foxholes.—Foxholes provided the best defensive position for the individual rifleman. They afforded good protection against enemy fire, both small arms and artillery, except for direct hits by shells. Furthermore, they gave protection against the crushing action of tanks. The first reaction of foot soldiers in their foxholes when confronted by a tank attack was one of flight. However, once it was realized that the tank guns were unable to fire at a depressed angle, the men's best protection was to crouch down in their foxholes when the tanks passed over them. The best foxhole was found to be about three and one-half feet long, two feet wide, or the width of a man's shoulders, and at least four feet deep to the firing step. Below the firing step, it was desirable to dig a

drainage pit which, in dry weather, gave some measure of comfort as a place for the feet when in a sitting position. Soldiers found that the earth taken out of foxholes needed to be removed since it gave away the location of the hole. Camouflage was achieved by covering the hole with sticks and vegetation. If the unit was in the line or in a defensive position for a day or more, foxholes were connected into V- or Y-shaped figures for better defense.

Emplacement of Weapons.—Dugouts for weapons were more involved, since not only the weapon but the men had to be concealed, and yet there had to be sufficient elbow space for efficient use of the weapon. The pit with parapet was the normal type of emplacement for weapons.

The digging in of heavy artillery and supply depots created great difficulty. Not only were large areas needed but mechanical equipment was required to dig these emplacements and shelters. In many cases, time and effort were saved by digging into the sides of hills or by merely constructing a camouflaged area in heavy woods. Another method was to push earth around the supplies and then cover the area with camouflage nets or natural materials.

Mines.—In field, as well as permanent, fortifications, the obstacles of World War II were much more complex than and varied greatly from those of World War I. The greater use of vehicles, amphibious operations and air-borne drops all evoked the development of obstacles. On the defensive, antipersonnel and antitank mines were located so as to offer additional security to the defending unit. For example, antipersonnel mines were used to break up or hinder enemy patrol action and to slow down infantry assaults. The antipersonnel mine was a charge of explosive, encased in steel, wood or plastic and equipped with a detonator activated when a fuse was stepped on, pulled or kicked. German box mines popped into the air when fired, often blowing off the foot of the individual who had fired it. This mine was also used for "booby traps," a method of killing or injuring souvenir-hunting soldiers particularly. Traps were placed on doors of evacuated buildings, on equipment which might be picked up, in abandoned vehicles and wherever else human ingenuity dictated. The trap was usually so hidden that an unsuspecting person set it off merely by lifting or moving an apparently harmless object.

Antitank mines were similar to antipersonnel mines in their action, but were heavier and had greater explosive charges in order to blow the tracks off tanks and to blow up vehicles. Obviously, mine fields were of permanent defensive use only when covered by weapon fire.

It was absolutely essential to leave paths through friendly mine fields, and it was required that all friendly mine fields be shown on maps. During the war, retreating troops often laid what were known as nuisance mine fields, scattering them along normal avenues of approach to slow the advance of their opponents. In laying mine fields the geometric patterns were varied so as not to be obvious. Yet mine fields had to be laid quickly and recorded so there would be no difficulty with them later. Mine clearance never quite caught up with mine laying, partly because it was slow work locating mines and then deactivating them to make them harmless. Toward the end of the war, mines were made with plastic and were impossible to locate with the normal electronic mine-clearance device which "pipped" when it was brought near a metal object (*See* MINE, LAND.)

Other Obstacles.—Many obstacles other than mine fields were used against troop movements. The Germans, for example, set up tree trunks in fields before the Normandy invasion as obstacles to parachute troops or gliders. They also felled trees or left vehicles abandoned in open pastures where landings might occur.

There were a number of types of barbed-wire entanglements, but the most effective were balls three feet in diameter with two on the ground and one placed on top. The wire was rolled in continuous piece in what is known as a concertina. In Europe, antitank ditches were common and in some places were dug on beaches. Other types of obstacles were roadblocks made of logs (the abatis), which included trees placed across an enemy path of approach so as to point at a 45° angle. Another obstacle was a forest of steel beams and the cement dragon's teeth of the Siegfried line, which traversed the whole frontier of Germany. At a distance, eight or ten rows of them looked like the tread of an automobile tire.

Typical Field Fortifications.—The sequence of field fortification in World War II included the location of a defensive position, preparation of emplacements and shelters and the creation of obstacles such as mine fields and barbed-wire entanglements. It was regularly put together in a defensive situation in land warfare. A schematic picture of a typical battlefield showed an antitank ditch running down the centre. The defenders behind it would have in sequence concealed entrenched riflemen and gunners spaced backward about 600 yd., so that their machine guns, mortars and bazookas were able to fire most effectively on an enemy held up momentarily by the obstacles in front of the antitank ditch. The defenders looked out beyond the antitank ditch to barbed wire and the main mine fields, then more barbed wire and, farther in the distance, antipersonnel mines and again barbed wire with mine fields among it. The total depth of this obstacle area in front of the defensive position was usually from 400 to 600 yd.

An example of the development of complete field fortifications in World War II was the Papuan campaign in New Guinea in early 1943, when U.S. troops attacked Japanese positions in the jungles. The defenses often consisted of groups of bunkers arranged about five yards apart in circular or oval patterns. Automatic weapons were sited to fire six or eight inches above the ground and long fire lanes so skilfully cleared that the jungle appeared undisturbed. A typical Japanese perimeter defense in the Sanananda area was about 120 yd. long and 70 yd. wide. The network of trenches gave protection to the riflemen and automatic weaponeers. The positions were linked by connecting trenches, and in the centre were bomb shelters to which all the men could repair. The outer perimeter included concrete pillboxes artfully worked into the jungle vegetation so that they were concealed completely. About ten yards from the perimeter and encircling it were trip wires, to which antipersonnel mines were attached.

From 1941 until the Allied invasion of Normandy in 1944, the Germans publicized the Atlantic Wall as their response to any attempts at invasion. Huge guns, pillboxes, entrenched troops, antitank ditches and barbed-wire entanglements were pictured. The Allies meanwhile were photographing the beaches from the air and gathering data about them. Underwater obstacles, though not publicized, were an essential part of this field fortification. Many were festooned with mines, and caused great concern to the Allies.

From the bluffs, attacking troops were under constant fire, both plunging and grazing, from all types of infantry weapons. In addition, lateral fire was received along the beaches from emplaced artillery in concrete pillboxes. Behind the close-up infantry entrenchments, antitank ditches were laid about 100 yd. from the beach and along the limited number of roads and paths running inland from the beach.

When the combination of defensive fire, obstacles and well-trained troops was considered, it looked at first as if any invasion would be thrown back into the channel. However, bombardment from the air, sea and land was effective in knocking out some of the field fortifications. Once a breakthrough was made, and the Allied invaders got inland in any area, they compelled the Germans who were nearby to withdraw from their long-held Atlantic Wall. (*See* WORLD WAR II: *Allied Reconquest of Western Europe.*)

Korean War.—After the first year of the Korean War, elaborate field fortifications assumed a prominent role in the fighting. The North Korean and Chinese troops were indefatigable in burrowing into the earth, particularly on the reverse slopes of hills, and concealing their positions. They were known at times to dig all the way through a hilltop to reach the crest facing the enemy. Extensive log-faced bunkers of the type built by the Japanese in World War II provided safe refuges and were remarkably resistant to artillery fire. Both sides followed the standard practice of establishing a thinly held line of outposts to sound the alarm if the enemy attacked. The lines of field fortifications were often five or ten miles deep and extended across the entire peninsula.

PERMANENT FORTIFICATIONS

Permanent fortifications have been important in the history of warfare since earliest times. These fortifications followed a pat-

tern which essentially included: the use of walls during the period of the Greeks and Romans; the feudal castle with its moat and drawbridge; the bastioned fortresses of the early modern period; and the ring fortresses or "concrete battleships" of the early 20th century.

Permanent fortifications were, of course, either emphasized or relatively forgotten as the cycle of war changed from the defense to the offense. When the defensive was predominant, fortifications were inevitably important; when the offensive was supreme, permanent fortifications were bypassed or blasted and their place taken by field fortifications.

Ancient Fortifications.—The civilized tribes of Africa utilized a bank of earth from which they were able to gain an advantage over an attacking force by defending from behind a parapet filled with alternate layers of stone, earth and logs. Some time later came the wall made of mud, sun-dried brick or masonry. The construction of towers at intervals along the wall was the next development. The towers served as sentry posts, barracks and rallying points for the defenders; they were spaced close enough to permit archers to cover the intervening distance with arrows.

In Egypt, labour was available to build walls as much as 120 ft. high and 30 ft. thick. Frequently a ditch was dug on the outside to keep attackers and their siegeworks at a distance. The attacking group usually tried to scale the wall or heap up materials, such as branches, to give them a footing and to permit them to hurdle the wall. As the walls became higher and too difficult to scale, men turned to attacking devices such as the battering ram and to mining. The use of devices for throwing heavy missiles came later, though they were mentioned at the defense of Jerusalem against the Philistines in the 8th century B.C. At the siege of Jerusalem two centuries later, there is the first mention of the ram and of movable towers designed to overlook the walls. (*See* ENGINES OF WAR.)

In Greece and Rome the feats of building fortresses and towers and constructing the mechanical devices for attack are the wonder of modern engineers accustomed to machinery and the use of steam, hydraulic and diesel engines. The Romans brought fortifications to a stage of development unequaled until Vauban. They perfected the siege towers, one of which Caesar mentions as being 150 ft. high. The lower stories housed the battering ram, which had a pointed head for breaching walls and a ram's head for battering walls. The upper stories were occupied by archers whose object was to drive the defenders from their platforms. Mention is made also of hinged bridges at the top of the tower which were dropped to assist the assaulting parties to get into the fortress.

The long history of the wall as a dominant feature of permanent fortifications must include mention of the famous Chinese wall, built about the 3rd century B.C. The great wall was about 1,500 mi. long with 25,000 towers; it was as much as 17 ft. thick with an average height of more than 20 ft., but even so did not prevent invasion by large armies. It did serve as an obstacle to small raiding parties who were unable to get their horses over it and lacked the tools for opening a gap in the wall.

Roman Empire Defense.—Great walls were built by the Roman emperor Hadrian in Britain and between the Rhine and Danube. The barbarians, though able to make raids against Roman outposts, were not capable of strong attacks against walled fortresses. Accordingly, the Roman plan for frontier defenses included masonry walls and fortified camps, and in places merely a line of detached forts. The number of defenders was normally small, though reserves had to be concentrated to meet the invaders when they broke through. As the barbarians grew in strength, the forts developed into fortified cities which served as refuges for the neighbouring people.

The defense of the empire was on the Rhine, or in Britain, but always a great distance from the city of Rome. As a result, the city was relatively unfortified and stood as testimony to the fact that fortification was not needed when a nation's strength was great enough to meet the enemy far from its borders. On the other hand, Constantinople, which stood for 1,000 years as the bulwark of the eastern Roman empire, fought off one besieger after another. During this period the genius of its military leaders managed at first to extend the empire's frontiers, but there were a number of times later when the empire was overrun except for its greatest city.

Medieval Castles.—The decline of the Roman empire and the barbarian invasions brought new problems to the defense of western Europe. The more powerful groups fortified their states against the marauding bands, and the weaker turned to the stronger for protection. Central governments dwindled away, to be replaced by local lords whose strongholds were their castles, located on difficult ground since they were used mainly for passive defense.

The forts constructed by William the Conqueror to consolidate his conquest of England were of wood. On the other hand, the Norman castles in western Europe were built of stone, to get maximum strength and utility with a minimum perimeter to defend. The Normans constructed a single large tower, named a keep or donjon, and surrounded it with a low wall a short distance from the tower. As time went on, this outer wall became the first line of defense and was gradually moved farther from the keep. Most of these castles were practically impregnable against the siege weapons then available. Blockade was the only way to reduce them, but long blockades were very difficult to maintain because the lords were unable to keep their serfs for more than 40 days' service each year (*see* CASTLE).

Influence of Gunpowder.—The introduction of cannon in the 14th century brought about new developments in fortifications. Protection thereafter lay only in the erection of much larger and better-built fortifications. In 1450 Charles VII of France had so powerful a siege train that he captured all the castles in Normandy from the English in one year. Charles VIII moved against Italy at the end of the same century and conquered so many castles and fortified towns that it became obvious a new defense system was needed. The leaders of the opposition came from Italy, and many of them were the greatest figures of the Renaissance. Leonardo da Vinci, Michelangelo and Niccolò Machiavelli all interested themselves in the problems of defense. About this time the famous painter Albrecht Dürer became the first to write of modern fortifications.

Bastioned Forts.—After 1500, when the private castle had lost its defensive capacity, interest centred again on the defense of cities and towns, as had been common in ancient ages. The citadel once again achieved a position of importance as the centre of municipal defense. Strategically significant were border towns like Metz and Verdun between France and Germany, and cities like Liège, Namur and Charleroi on the Franco-Belgian border. Nations sought to control the key approaches to their territory while giving themselves a base or springboard for invasion against enemy countries. From that day to the 20th century, military engineers laboured to make these fortress cities strong.

The terms used by military engineers which are of importance in studying forts and sieges include: the complete wall, known as the *enceinte;* the parapet or top of the wall; the escarp or face leading into the ditch; the counterscarp or opposing wall of the ditch; the covered way on top of it; and finally a mound or glacis leading away from the fort (*see* fig. 1). The glacis was sloped upward so that a projection of its incline was higher than the parapet wall. Artillery fire directed at the fort could not be raised, and thus projectiles were often lost in the soft earth of the glacis instead of reaching their target.

The general outline of the fortress was also changed, the old straight walls being altered by adding a bastion. These were projections shaped like an ace of spades, which assured that the defenders' weapons and artillery would ward off the assault forces when they approached the walls. Bastions were built into the forts at intervals and so arranged that their guns covered each other. The usual forts had five or six bastions, and were called star fortresses.

Military engineers developed many elaborate geometric patterns to increase the power of defense, their competition in design emphasizing that once again the defense had become dominant over attack.

After the development of the bastion, military engineers still sought the objective of obtaining the greatest amount of protec-

FIG. 1.—DIAGRAM OF A TYPICAL CROSS SECTION OF A FORT

tion, combined with the strongest defensive fire power. The simple star trace (*i.e.*, outline) with four or five bastions was replaced by the tenaille trace (fig. 2), in which the flanks were placed back-to-back between the faces. This had the disadvantage that there was still a certain amount of dead ground in the ditch which could not be reached by the guns on the parapets. Eventually military engineers found the solution in what became known as the bastioned trace, its flanks directly opposite each other and linked by curtains (fig. 3). In succeeding decades, fortifications became geometrical patterns with all sorts of details such as gates, sally ports and hornwork coverings. Each part of the fortification became a separate fort that could be divided off from the remainder and be self-sustaining with its own garrison, while still offering mutual support to the remainder of the units in the system.

FIG. 2.—TENAILLE TRACE

Vauban's Siegecraft.—Even the bastioned fortress had a short-lived day of predominance, for in the latter part of the 17th century Louis XIV's engineer officer, Marshal Sébastien de Vauban, developed a systematic method of attacking bastioned forts. His objective was to make a breach in the walls through which the attacking column could pass, but to do this he had to establish his artillery on the glacis directly opposite the wall. To make his own artillery safe, he had to knock out that of the enemy. Since the range of guns was from 600 to 700 yd., the first move after the investing forces had established themselves was to set up batteries at that distance to engage in a duel with the artillery in the fort. When the artillery defenses had been reduced, though not necessarily silenced, trenches had to be pushed to the front, so that the guns could be taken to the glacis and the assaulting troops prepared in safety for the launching of their attack. The Vauban system, which long served as a model for armies, was known as the approach by parallel lines (*see* fig. 4). Its first use was at the siege of Maastricht in 1673, where Vauban completed the capture in 13 days after commencing the digging of trenches.

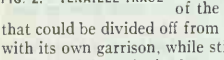


FIG. 3.—BASTIONED TRACE

Vauban placed his engineers just behind his heavy siege artillery, where they dug a trench parallel to the fort's walls. This served as a shelter for the infantry, from which they could protect the batteries when the defenders sallied forth to try to capture them. While the counterbattery duel was in progress, approach trenches perpendicular to the walls were dug from the parallel, but in zigzag form so that the batteries of the fort could not sweep down their length.

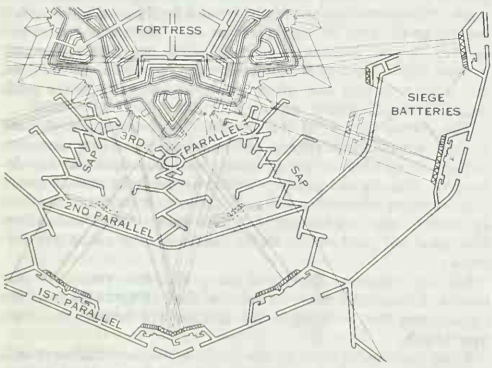


FIG. 4.—REGULAR ATTACK ON A FORTRESS (VAUBAN'S SYSTEM)

From the approaches, a second parallel trench was dug closer to the fort. These trenches were about 12 to 15 ft. wide and 3 ft. deep, with the earth from the excavation thrown forward to make a parapet. The second parallel, about halfway to the wall, was again used as a base for the infantry, and was protected in part by its own batteries which were brought up in closer support. Again the approaches were pushed out, and now they came within musket range of the fort's defenders. Specially trained men called sappers dug slowly ahead under a shelter called a gabion. This was a shield on wheels pushed ahead by the first sapper. The leading man was followed by others who increased the width of the trench and its depth under cover of additional shields. Because of the danger of the work at the head of the sap, Vauban paid them on the spot piecework rates which rose rapidly in proportion to the risk. He counted on a rate of progress of about 50 yd. a day for the usual sap.

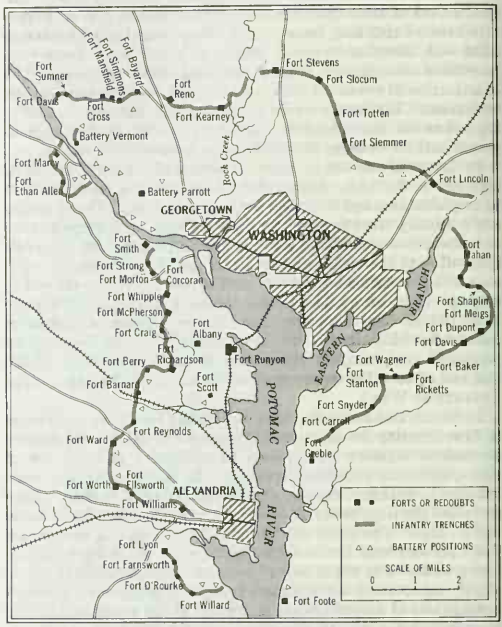


FIG. 5.—DEFENSES OF WASHINGTON, D.C., IN AMERICAN CIVIL WAR

Finally, the third parallel was dug near the glacis, from where the sappers dug their way up the slope to its top. The breaching batteries were then established in full view of the escarp, and when it was breached the fortress usually surrendered. Most of the sieges during the century and a half after Vauban's successes followed his method with some variation.

19th Century.—As a result of the open tactics of the Revolutionary army in America, the idea of linear battle formations and infiltration was taken up by Napoleon. Also, in the manner of Frederick the Great, he depended upon superior strategy and expert battlefield tactics to win victories. He did not believe in shutting up his armies in fortifications, and whenever possible he avoided attacks against permanent forts. When in exile he stated that in his campaigns against Austria, Prussia and Spain those nations might well have been saved from defeat had their capital cities been fortified. Under the mode of warfare of that day, as long as the government was preserved and had fighting forces for protection, the country was not defeated. Napoleon added, "Had

Paris been fortified in 1814, my own Empire would have been saved from overthrow."

At the outbreak of the American Civil War, the U.S. had no permanent fortifications except on the seacoast. Several fortresses were built later, however, such as those in Washington, D.C. The system included 68 separate forts, a number of blockhouses and 20 mi. of connecting rifle trenches. The works were so devised that they could support each other by fire. Though never put to test, these fortifications had an indirect influence on the campaigns in Virginia (*see* fig. 5).

Greater attention was paid to permanent fortifications in the Franco-German War. Developments in rifles and artillery made attacks against fortresses successful. The Germans were victorious in rapid order since they attacked with rifled guns against French fortifications armed with smoothbore artillery, and in many cases insufficiently protected by detached forts. The German siege howitzer was able to breach the walls of the fort at Strasbourg from more than a mile away, while the largest German gun hurled shells into Paris from a distance of four miles.

The great increase in artillery range compelled the spreading out of detached forts around the fortresses, from a minimum of a few hundred yards to a minimum of six miles by 1910. These detached works were moved out so far from fortress towns that they became almost independent of them. Consequently, fortifying of towns became too expensive, and declined rapidly. The towns began to seek some other means of defense, and unless a town dominated a strategic point its fortifications fell into disuse.

Artillery made its greatest advance in the race against the defensive capabilities of fortifications in the latter half of the 19th century. Once again the attack became ascendant, requiring land fortifications to be rebuilt. The idea of detached forts had, of course, increased the capability of defense, but now the construction of the forts themselves had to be changed. It was useless to have correct dispersion and mutually supporting fire unless the forts could stand up under artillery pounding. Revetments had to be strengthened immensely and concrete roofs from six to ten feet thick were built over them.

The leading fortification engineer in this period in Europe was Gen. Henri Brialmont, who was considered a Belgian Vauban. He placed his forts at an average distance of four miles from a city such as Liège, and at intervals of approximately two and one-half miles. At Antwerp, his defense system was even more dense. His idea was that forts could be joined by a ring of infantry trenches, but this was never effected by the Belgians. One of his greatest contributions was the use of armour to protect the guns. He devised disappearing cupolas, and turrets of steel, so that the guns popped out only when they were being fired. The remainder of his fortress (known as the ring fortress) was built of concrete.

Some of the forts were five-sided, while others were triangular. They appeared far smaller than they actually were, because most of their bulk was concealed underground. Brialmont's ideas were used by the French in developing their fortress systems along the German frontier. Antwerp, Liège and Namur were Brialmont's masterpieces.

World War I.—Though the Allies subscribed to the axiom of war that victory is the result of offensive action, they looked to their fortresses to give them time for mobilization. The fortresses in France and Belgium were designed not only to delay the enemy on important lines of advance but also to channel his attack. From an offensive standpoint, the fortresses were useful for maneuvering since they formed a pivot for the attacking formations.

By marching through Belgium in 1914, however, the Germans avoided the strong fortresses on the eastern border of France. The fortresses of Liège and Namur in Belgium, and their counterparts in northern France, which were in the path of the German right wing, were weak in comparison with those farther south on the eastern frontier of France. The Germans had assessed this problem and developed what was known as the Schlieffen plan. This called for a strong right wheeling movement in an area where there were good railway connections. As long as the Belgians held Liège, the German plan would be blocked. However, it was not a modern, strong fortress and its ring of 12 forts fell within 11 days. The town itself, with its vital bridges over the Meuse, was captured on the third day, after which the howitzers pounded the fortifications for a week more. Namur stood up for only four days under German bombardment, and four of the Antwerp forts were reduced in three days.

Further south, the forts on the eastern front of France gave a better account of themselves. There were no serious attacks against the Verdun and Belfort fortifications, though the Germans did reduce some of the lesser forts in from 2 to 11 days. Consequently the French high command, seeing how weak fortifications were against the new artillery, decided to abandon permanent forts like Verdun and put their faith in field fortifications. However, when it was later discovered that the steel turrets and concrete of the modern forts had suffered little damage, they were reoccupied and became the focal points for some of the greatest battles of the war.

Permanent fortifications were not only costly but they gave an illusion of security. Field fortifications had proved as effective as permanent ones since they were able to take advantage of concealment and had been built rapidly in many areas. During the war there had been few instances of the use of mines, or sapping, against permanent fortifications. On one occasion 20 mines, containing 1,000,000 lb. of explosives, were detonated under the German lines on the Messines ridge. Before that time, mining operations had been resorted to in the battle of the Somme, where great quantities of explosives were used against the Ludendorff line. One mine, for instance, took months to complete and when exploded its concussion was felt ten miles away. Gen. Erich Ludendorff reported that "the moral effect of these explosions was simply staggering." Just as the appearance of the tank made fortifications of a permanent type less useful, so, too, did tanks eliminate the need of these tremendous mining operations.

The experience of World War I appeared to have dictated the passing of the great fortified areas, but the French continued to rely upon an elaborate chain of defenses which they built in the interim between World Wars I and II.

Developments Between 1918 and 1939.—The fact that certain modern fortresses had held out against German artillery during World War I, as well as the admitted saving in military manpower, induced France to build the celebrated Maginot line as a permanent defense against German attack. This ultramodern defensive fortification showed traces of the old circular system of fortifications but its dominant feature was linear. The Maginot line was, from the standpoint of the troops, a tremendous advance over previous fortifications. Its concrete was thicker than anything heretofore known and its guns heavier. In addition, there were air-conditioned areas for the troops, and the line was usually referred to as being more comfortable than a modern city. There were recreation areas, living quarters, supply storehouses and underground rail lines connecting various portions of the line. Strong points had been established in depth, capable of being supported by troops moved underground by rail.

Germany, too, fortified the Rhineland in 1936 with a series of obstacles and pillboxes known as the Siegfried line. It had steel and concrete defensive positions, behind great masses of concrete and steel obstacles running along the entire frontier of Germany. The frontier fortifications of the Soviet Union against Poland, known as the Stalin line, were built on the model of the Maginot line.

World War II.—The Germans marched through Belgium in May 1940 on a modified Schlieffen plan. As in 1914, they struck at the crossings of the Meuse and at the Albert canal near Liège. Once more the Allies expected the Liège fortifications to hold the enemy for a time along the Meuse. However, the system's key fort of Eben-Emael fell within 24 hours. The whole world was startled by this rapid fall of a modern fortification. The Belgians had manned the fort with good troops and incorporated the newest ideas in its erection.

The alarm of the western world was expressed in the phrase "secret weapon." The Germans never disabused the world of this thought. For a long time there was a belief that the Germans actually had some new weapon which could bring about the down-

fall of a modern fort in a day's time. In reality, the Germans had merely planned the operation completely and rehearsed their attack with models. The assault was perfection in co-ordination. Early in the morning German gliders landed troops directly on top of the fortification. Trained engineers acted swiftly in placing charges to blow up the cupolas, used explosives against the ammunition hoists, and even dropped grenades into the muzzles of the guns. By the time the air raid sirens had given their warning, dive-bombing planes were bombarding the other forts. The airborne troops were strengthened by infantry which crossed the river in rubber boats, and together they mopped up the entire Liège fortification system in an unbelievably short period. Besides attributing the fall of the forts to new weapons, the "fifth column" was also blamed. The real reason was skill, plus the action of the air-borne troops, and the co-ordination of all German arms, both ground and air, in the attack.

The Germans continued their march through Belgium and crossed the Somme, where they struck at Sedan at the northern end of the Maginot line. Having made a breakthrough with their tanks and planes, they continued around to the rear of the line, making it useless. Later, on the eastern front, the Germans used similar tactics in cutting through the Stalin line. Again and again they broke through at one point, employing a combination of tanks, planes, infantry and engineer troops to exploit their success as they had done in France. In some places the Russian zone of permanent fortifications was 100 mi. deep but it was insufficient to halt the German blitzkrieg.

The Soviet Union, however, had never placed the same dependence upon the Stalin line that the French had on the Maginot, but considered it rather as a method to compel the Germans to attack through certain areas. One writer maintained that upon the German breakthrough of the Stalin line they were the victims of a Maginot-line complex in reverse, for they believed the offensive had been successful once the fortified line was pierced. The delay which the Germans encountered in getting through the line gave the Russians two months to determine the direction of the German attack and to bring up their reserves. Also, the line had blunted the cutting edge of the German offensive.

A short time later, the great coast defense of Singapore fell to the Japanese, an event which the western nations hardly believed possible. For Singapore was "the mighty bastion of the far east" and a symbol of Allied resistance. The Japanese landed far to the north of Singapore and after fighting their way southward, attacked it from the land side. The fort was under constant attack from the air and was heavily bombed by artillery. It had neither fighter planes nor antiaircraft guns for defense, and its huge 16-in. guns could fire only seaward.

During the middle period of the war, little was heard about permanent fortifications playing a part in any of the battles. There were none in north Africa except the crumbling Mareth line in southern Tunisia, and none at all in the Pacific war after the fall of Corregidor in the Philippines. The great battles of 1942 and 1943 were fought behind and against field fortifications, though during this period there were the great defense and siege operations at Leningrad. This city, despite the support of a number of naval forts on the Baltic and a lake to its rear, was not completely fortified. However, the combination of permanent forts, water barriers, field fortifications and ruined buildings made of the city a fortress which held out for 515 days until relieved by Soviet forces.

By 1944 there was more and more emphasis on concrete and steel fortifications in the defense of Germany's "fortress of Europe." Newsreels from Germany filtered out through neutral nations to show the world the strength of the channel defenses. Tremendous areas of concrete served by rail and road and mounting railway guns in disappearing turrets brought fear to the onlooker. The forts were built into the sides of cliffs and gave an appearance of impregnability, beyond anything known in previous fortifications. However, when the Allied troops went ashore in the invasion of Normandy they caught certain of the garrison troops napping and also utilized both air and naval bombardment to drive the garrisons underground. It was found upon entering the continent that the permanent fortifications at the seacoast had insufficient support of infantry troops and that there was not a continuous fort along the entire seacoast as had been intimated by German propaganda.

At the close of World War II it was generally concluded that permanent fortifications were not worth the economic cost and the material effort, because, in most cases, delay of an enemy could be accomplished by other means. That is not to say that permanent fortifications were forever outmoded, since in an atomic attack troops might well return to earth or concrete dugouts. Also, permanent fortifications when fitted into a defense pattern continued to have a definite use along river lines and near mountain passes. Third-dimensional warfare, however, had very nearly ended their usefulness as harbour defenses or beach defenses. *See* Coast Defense; Tactics; *see* also references under "Fortification" in the Index volume.

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(W. H. Bau.)

FORTIS, ALESSANDRO (1842–1909), Italian statesman, a prominent republican of the Risorgimento who eventually became prime minister under the monarchy, was born at Forlì. He was brought up as a republican under the influence of Giuseppe Mazzini in the most revolutionary of Italian regions, the Romagna. He fought with Garibaldi in 1866 against the Austrians in Trento and again in 1867 against the papal troops when Garibaldi tried to capture Rome. Most of the Italian republicans had defected since the success of the monarchy in 1860. But Fortis still remained faithful for some time longer. In 1874 the government arrested him with other republicans as they were working out their party program at Villa Ruffi, but a jury acquitted them. In 1876 the party congress at last agreed to drop their former intransigence and to accept the permission held out to them by the new government of the left to take part in parliamentary politics. Fortis himself became a deputy in 1880, attaching himself to Francesco Crispi's group, which sat well over on the left of the chamber. In parliament he proved to be an assiduous but not brilliant politician. He was minister of agriculture in Luigi Pelloux's government in 1898–99. Giolitti chose him as a safe man to take over the premiership for a few months in 1905–06. Fortis' most important achievement in this post was to carry through the nationalization of the railway system. He died in Rome on Dec. 4, 1909. (*See* also Italy: *History.*) (D. M. Sh.)

FORT KNOX, a U.S. army reservation, is approximately 35 mi. S. of Louisville in Kentucky. Comprising 110,000 ac., the reservation contains the United States Army Armored centre and the principal U.S. bullion depository.

The fort was established in 1918 as Camp Knox and used as the army's Field Artillery Officer Training school. In 1932 the name was changed, and the following year the 1st cavalry regiment was moved from Marfa, Tex., to Ft. Knox where it was mechanized. The fort was made headquarters of the armoured force in 1940 and became the armoured centre in 1944.

Located at the centre are several units, including the U.S. Army Armor school, 6th armoured cavalry, Army Armored Training centre, Army Medical Research laboratory, army armour board and the army maintenance board.

For maximum security, the bullion depository was built at Ft. Knox in 1936. By the second half of the 20th century the gold stocks there were valued at more than $10,000,000,000. The fabulous treasure is housed in a solid square bombproof building, constructed of granite, steel and concrete, enclosing a two-level torch-proof steel and concrete vault. Added security is provided by guards, sentries and an encircling steel fence, as well as by mechanical protective devices, such as the photoelectric eye. The

nearby army post gives further protection.

During World War II the gold vault was used as a repository for the original copy of the U.S. constitution and the Declaration of Independence, the Magna Carta, a copy of the Gutenberg Bible and the original draft of Lincoln's Gettysburg address.

(G. H. T.)

FORT-LAMY, capital of the Republic of Chad in west-central Africa, lies on the right (east) bank of the Shari river at its confluence with the Logone, in an alluvial plain which is flooded during the rainy season (July–Sept.). The population, which fluctuates seasonally, was 58,179 in 1961 (commune). The French-built district containing administrative, military and residential quarters lies between the Shari and the St. Martin *marigot*, or branch channel. The African-built town along the river bank contains 16 districts named after tribes or regions. The population is of mixed origins but consists principally of Arabs, "Chad Arabs" and Fulani (Peuls). The different peoples are frequently intermingled but the Muslims and fetishists tend to be separately grouped. Arabic is generally spoken and French understood. Fort-Lamy is linked by road with Nigeria, the Sudanese Republic and the Central African Republic, and is a major airline junction. It is an important market, especially for livestock, and has numerous handicraft industries (leatherwork, jewelry), as well as slaughterhouses and meat freezing works. Across the river on the left bank lies Fort-Foureau, Cameroon Republic. Fort-Lamy is named after the French soldier and explorer F. J. A. Lamy (1858–1900). (J. D.)

FORT LAUDERDALE, a residential and resort city of southeastern Florida, U.S., at the mouth of New river on the Atlantic ocean, 26 mi. N. of Miami; the seat of Broward county. The city is noted for its water areas and water fronts; of the incorporated area 10% is water, and there are 260 mi. of ocean, bay, river and canal frontage, 135 mi. of which are navigable. The Atlantic Intracoastal waterway, a yacht highway in winter, brings 1,000 boats a year to city-owned Bahia Mar yacht basin. Port Everglades on the south limits of the city, built jointly with Dania and Hollywood, is the deepest harbour on the Atlantic coast south of Norfolk, Va., and ranks third in Florida after Jacksonville and Tampa in cargo volume, much of it tanker-borne fuel.

A fort named for Maj. William Lauderdale in 1838 was a base for expeditions into and across the nearby Everglades in search of Seminole Indians for removal to the west. Washington Jenkins came to the region in 1876 as keeper of a house of refuge on the uninhabited and lonely coast. Frank Stranahan, the first permanent white settler, came from Ohio to operate a ferry and a trading post where he befriended and traded with Seminole Indians. There were 52 inhabitants in 1900, and 175 persons incorporated the city in 1911. In 1930 there were fewer than 9,000 inhabitants. By 1960 the population of the city was 83,648; that of Fort Lauderdale-Hollywood standard metropolitan statistical area (Broward county), 333,946. (For comparative population figures *see* table in FLORIDA: *Population.*) The city adopted a council-manager form of government in 1925. (C. W. TE.)

FORT LEE, a borough of Bergen county, in northeastern New Jersey, U.S., across the Hudson river to the west of New York city and connected to the borough of Manhattan via the George Washington bridge. It is a residential community, lying mainly along the top of the Palisades. It was the site of Ft. Constitution (later renamed Ft. Lee) which along with Ft. Washington defended the southern approach to West Point during the American Revolution. The location has been continuously inhabited since about 1700, but the borough was not incorporated until 1904. From 1907 till 1919 Fort Lee was the motion-picture capital of the world. The last picture was made there in 1923, but the borough remains a major film processing centre, turning out large quantities of film daily for the motion-picture industry. For comparative population figures *see* table in NEW JERSEY: *Population.*

(D. N. A.; M. P. M.)

FORT MADISON, a city in the southeastern corner of Iowa, U.S., on the Mississippi river; the seat of Lee county.

Fort Madison has large railroad shops and various manufacturing industries. It is the seat of a state penitentiary. A 525-ft. movable swing span railroad bridge across the Mississippi was completed in 1927. A fort was built there in 1808, and was named after James Madison, who was elected president that year. It was constantly harassed by the Sauk and Fox Indians, who considered that its erection was a violation of the treaty made with them by Gen. William Henry Harrison in 1804.

In Sept. 1813, the little garrison of 100 men abandoned the post, burning the fort behind them and escaping to the river through a tunnel. Permanent settlement began in 1833. The town was incorporated in 1838 and chartered as a city in 1839. The courthouse, built in 1841, is the oldest in the state constantly in use. For comparative population figures *see* table in Iowa: *Population.*

FORT MYERS, a city of southwestern Florida, U.S., on the Caloosahatchee river, 13 mi. from the Gulf of Mexico, 145 mi. N.W. of Miami; the seat of Lee county. The city is at the western end of the cross-state waterway through the St. Lucie canal, Lake Okeechobee and the Caloosahatchee canal. There is a municipal boat basin with a capacity for 100 yachts and smaller boats. The city is the centre of a trading area including five nearby counties. A state farmers' market and local packing houses process the citrus fruits, truck crops, cut flowers and commercial fishing products of the area. The city's boulevards are lined with royal palms, and more than 100 varieties of palm are found in the city and along the banks of the river, which is stocked with tarpon. Fort Myers, named for Lt. Col. Abraham C. Myers, was established on Feb. 20, 1850, on the site of the old Ft. Harvie, a temporary post during the Second Seminole War (1835–42). The city was incorporated in 1905. For comparative population figures *see* table in FLORIDA: *Population.* (J. E. D.)

FORTROSE, a royal and small burgh and seaport of Ross and Cromarty, Scot., lies on the southeastern coast of the Black Isle peninsula, by Inverness firth, 28 mi. N.N.E. of Inverness by road. Pop. (1961) 902.

The burgh of Fortrose consists of the two towns of Fortrose and Rosemarkie, about 1 mi. apart, which were united into a free burgh by James II of Scotland in 1455, though total union was achieved only by an act of the Scots parliament of 1661.

In 1124 David I instituted the bishopric of Ross with its seat at Rosemarkie, and a century later the seat was transferred to Fortrose, thereafter known familiarly as the Chanonry of Ross, a name which survived the Reformation and is still used locally. Little remains of the red-sandstone cathedral founded by a countess of Ross in the 14th century; many of its stones are said to have been used by Cromwell to build the fort at Inverness. Still standing are the Decorated south aisle to the nave, the chancel, and the separate chapter house. The canopied tomb of the countess is on the north wall. Other remains are in the Perpendicular style of Melrose abbey, one of whose monks, Abbot Fraser, completed the church in 1485. The curfew is sounded nightly from the clock tower on a bell of 1460.

St. Peter's parish church at Rosemarkie, founded by St. Boniface in 716, has a carved Celtic cross in its churchyard. The cliffs to the northeast are inhabited by fulmar and are well known to geologists through the writings of the geologist Hugh Miller (1802–56). Fortrose and Rosemarkie are residential and resort towns.

FORT SMITH, a city on the western border of Arkansas, U.S., midway between the Ozark or Boston mountains to the north and the Ouachita mountains to the south, on the south bank of the Arkansas river at the mouth of the Poteau river; the seat of Sebastian county. The site was known as Belle Pointe to the early French explorers. An army post was established there in 1817 and named for Gen. Thomas A. Smith. The town was laid out in 1821, incorporated in 1842 and chartered as a city in 1845. Troops were finally withdrawn in Sept. 1871, and the military reservation was transferred to the department of the interior.

The U.S. district court for the western district of Arkansas was located in Fort Smith for many years and had jurisdiction over the Indian Territory, now the state of Oklahoma. Isaac C. Parker, judge of the court from 1875 to 1896, had the difficult task of enforcing federal law in the Indian Territory, refuge for great numbers of outlaws and the home of the Five Civilized Tribes. He used 200 deputy United States marshals in the task. In 1957 the Fort Smith Historical Restoration corporation restored Judge Parker's

courtroom in its original building and built an exact replica of the gallows used by this court in hanging convicted capital offenders.

Local industries include the manufactures of wood, metal, paper, glass, fabric and electronic products. The city is in the heart of a natural gas region and the Arkansas-Oklahoma coal field. Truck and food crops are grown in abundance in the rich Arkansas river valley. Livestock production, dairying, poultry and meat packing are important sources of income. One of the greatest horse and mule markets in the nation is located in West Fort Smith.

Two city-owned mountain lakes and several man-made lakes within easy driving distance provide excellent Ozark mountain water and recreational facilities in addition to the many parks and playgrounds and the Arkansas-Oklahoma Livestock Exposition grounds within the city limits.

Van Buren, Ark., to the north, and West Fort Smith, Okla., are adjacent cities. Ft. Chaffee army base is 8 mi. E.

Pop. (1960) city, 52,991; standard metropolitan statistical area (Sebastian county), 66,685. (For comparative population figures *see* table in ARKANSAS: *Population.*) (E. P. HI.)

FORTUNA (FORTUNE), an Italian goddess who later became identified with the Greek Tyche, a divinity of chance or lot. The original Italian deity, however, was not an abstraction of chance or luck, but rather the bearer (her name is derived from the root *fer-*) of, it is hoped, prosperity and increase. As such she approaches a fertility deity and hence her association with the bounty of the soil and the fruitfulness of women. Frequently she is an oracular goddess, consulted in various ways regarding the future. She is worshiped under numerous cult-titles (*e.g., muliebris, virilis*).

Fortuna was worshiped extensively in Italy from the earliest times. Her introduction at Rome was comparatively late, traditionally under the auspices of Servius Tullius, who built a temple of Fors Fortuna outside the city on the right bank of the Tiber. She had numerous other shrines in Rome, many of which traced their founding back to the regal period. The most celebrated shrines of Fortuna outside the city were those at Praeneste and Antium. At Praeneste, where she was worshiped particularly by women as Primigenia, "first born" (apparently of the daughters of Jupiter), her shrine was an oracular seat of some celebrity. The procedure was for a child to draw at random from an ancient collection of wooden tiles bearing various messages, which would then be related to the problems of the consultant. The cult of Fortuna Primigenia on the Capitoline was according to tradition established by Servius Tullius. The shrine at Antium, well known from Horace's *Odes* i, 35, had two Fortunae who gave responses by the mysterious movement of their cult statues.

ALINARI

STATUE OF THE GODDESS FORTUNA HOLDING CORNUCOPIA AND RUDDER, THE SYMBOLS WITH WHICH SHE IS USUALLY ASSOCIATED. FOUND AT OSTIA, THE STATUE IS NOW IN THE VATICAN CITY, ROME

Fortuna is represented in literature and art as bearing a cornucopia as the giver of abundance, a rudder as controller of destinies, or standing on a ball to indicate the uncertainty of fortune.

See also G. Wissowa, *Religion und Kultus*, pp. 256–268 (1912); W. W. Fowler, *Roman Essays and Interpretations*, pp. 64–70 (1920); W. Roscher, *Ausführliches Lexikon der griechischen und römischen Mythologie.* (R. B. LD.)

FORTUNATE ISLANDS: *see* ISLES OF THE BLEST.

FORTUNATUS, VENANTIUS HONORIUS CLEMENTIANUS (*c.* 540–*c.* 600), poet and bishop of Poitiers, was born near Treviso in Italy and studied at Ravenna. Thence, probably in fulfillment of a vow to St. Martin of Tours, he crossed the Alps (*c.* 565) and visited (among other cities) Metz and Paris, the capitals of Sigebert and Charibert: in this period he formed friendships with prominent churchmen and officials. In 567, after visiting Tours, he reached Poitiers, where Radegunda, formerly Clotaire I's queen, had founded a monastery. Radegunda and Agnes, the abbess of this monastery, impressed Fortunatus by their holiness, and a firm friendship developed; Fortunatus became a priest and subsequently bishop of Poitiers, where he died. He is venerated as a saint on Dec. 14 in parts of Italy and France.

Fortunatus' extant works are the *Vita S. Martini* (in four books of hexameters, prompted by his friend Gregory of Tours); his prose saints' lives (including the *Vita Radegundis*); and 11 books of poems (with an appendix of 34 poems). His earlier poems are courtly; they include addresses to bishops and officials, panegyrics of Childebert, Charibert and Chilperic, an epithalamium (vi, 1) on the marriage of Sigebert and Brunhilda, epigrams and occasional poems (*e.g.*, vi, 6, on the garden of Ultrogotho, widow of Childebert; x, 9, on a journey on the Moselle). While these poems show a pleasing facility, and some (*e.g.*, x, 9) an appreciation of nature, their dominant characteristic is a strongly rhetorical flavour (good examples are iii, 12, on the castle of Nicetius, and vi, 1, with its wealth of mythological reference). The influence of rhetoric persists in the religious poetry written at Poitiers (side by side with epigrams and epistles in his earlier vein), and it is especially effective in the poem that celebrates the installation of Agnes as abbess (viii, 3). Fortunatus' six poems on the Cross admirably reflect the influences which acted on him at this time. Two of these (ii, 4 and 5) are artificial and uninspired acrostic poems embodying a cruciform pattern, while two are splendid hymns in which the religious note finds its noblest expression: these poems, the *Pange lingua* (ii, 2, written in trochaic tetrameters) and the *Vexilla regis* (ii, 6, in iambic rhyming couplets), have been translated into English by J. M. Neale as "Sing my tongue the glorious battle" and "The royal banners forward go."

Fortunatus had extensive familiarity with earlier Latin poetry, both pagan and Christian, and echoes of Virgil, Horace, Ovid, Claudian and Sedulius are frequent. A large part of his poetry is in the traditional manner, but a medieval tone is also present. Because of this combination Fortunatus ranks as an important transitional figure: his poems enjoyed considerable popularity and were often imitated in the Carolingian and Ottonian periods.

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FORTUNATUS, the hero of a popular European chapbook. He was a native, says the story, of Famagusta in Cyprus, and meeting the goddess of Fortune received a purse which was replenished as often as he drew from it. He wandered through many lands, and at Cairo was the guest of the sultan. Among the treasures which the sultan showed him was a hat which had the power of transporting its wearer to any place he desired. Of this he feloniously possessed himself, and returned to Cyprus, where he led a luxurious life. On his death he left the purse and the hat to his sons Ampedo and Andelosia; but they, by their recklessness and folly, fell on evil days. The moral of the story is obvious: men should desire reason and wisdom before all the treasures of the world. In its full form the history of Fortunatus occupies more than 158 pages in vol. iii of Karl Simrock's *Die deutschen Volksbücher* (1839–67). The style and allusions indicate a comparatively modern date for the authorship; but the nucleus of the legend can be traced back to a much earlier period. The earliest known edition of the German text of Fortunatus appeared at Augsburg in 1509. Innumerable versions occur in French, Italian, Dutch and English.

The story was dramatized by Hans Sachs in 1553, and by Thomas Dekker in 1600. J. L. Tieck used the legend in his *Phantasus*, and Adelbert von Chamisso in *Peter Schlemihl*. Ludwig Uhland left an unfinished narrative poem entitled "Fortunatus and His Sons."

See the edition of *Fortunatus* by H. Günther (1914).

FORTUNETELLING is the forecasting of future events (or the delineation of character) by traditional, intuitive or arbitrary methods not ordinarily considered rational.

There is evidence that some forms of fortunetelling, such as numerology, palmistry and astrology, were practised in ancient China and Egypt, Babylonia and Chaldea from at least 4,000 B.C. Fortunetelling usually has been an integral part of both religion and medicine and often a priestly prerogative. The Bible relates many prophetic dreams, such as those of Jacob, Joseph and Pharaoh in the Old Testament and of the Magi and Pilate's wife in the New Testament. The Greek and other ancient peoples had their sacred places to which they could come with important questions. These were answered, they believed, by a god, generally through a priest, sometimes directly in dreams (*see* DIVINATION). At the famous oracle at Delphi, the Pythia, prophetess and priestess of Apollo, would fall into a frenzy. Attendant priests noted down her utterances, which were accepted as divinely inspired and such oracular advice was sought on all great national occasions (*see* ORACLE).

The Greek philosopher Pythagoras (*c.* 6th century B.C.) is known to have visited Egypt and parts of Asia, where he studied Chaldean and Magian lore. The discovery of the so-called Pythagorean form of numerology, or its introduction into Greece, is ascribed to him but he left no writings about it.

Plato and other Greek philosophers are credited with belief in fortunetelling because of some ambiguous passages on the subject. However, Aristotle (384–322 B.C.) wrote a treatise on physiognomy and in his time many professors of this art flourished. Michael Scot (*q.v.;* A.D. 1175–1234), scholar and astrologer, translated Aristotle's treatise and Johann Lavater (*q.v.;* 1741–1801), a Swiss Protestant pastor, published a work on physiognomy.

During the middle ages and even later, important people sometimes had their personal soothsayers, who often combined fortunetelling with alchemy or medicine. Michael Scot was tutor and adviser to the emperor Frederick II, and the famous French astrologer Nostradamus (*q.v.*) is said to have predicted for Catherine de Medicis. From girlhood Queen Elizabeth I of England had faith in John Dee (*q.v.;* 1527–1608), mathematician, alchemist, astrologer, crystal-gazer and necromancer (spiritualist), whom she consulted concerning a lucky day for her coronation.

Cartomancy is prediction with playing cards or, occasionally, with a special pack. Cards, first shuffled by the inquirer, are laid out in prescribed ways and interpreted according to each card's fixed meaning. Predictive methods using playing cards, tea leaves and "bumps" are relatively modern in Europe. The first substantiated use of the pack of 52 cards for playing games occurred about 1377; the date of the earliest use in fortunetelling is uncertain (*see* CARDS, PLAYING: *The Origin of Playing Cards*). Gypsies have practised cartomancy for centuries and it had a fashionable vogue in Revolutionary and Napoleonic Paris. Teacup reading in Britain started several years after 1658, when tea was introduced into England. Phrenology was evolved by a German, F. J. Gall, at the end of the 18th century but there are few parts of the body (including the entrails of animals), natural phenomena or everyday objects that have not been employed as predictive media somewhere at one time or another.

Amulets or charms (*see* AMULET) are objects worn or carried to protect against evil or to attract good luck. They are often trinkets embodying the gem attributed to the owner's birth month but may take many other forms. In crystal gazing the practitioner describes and explains any images seen by gazing steadfastly into a crystal ball. Graphology delineates character from handwriting. Numerology attaches a digit with certain meanings to each alphabetical letter; thus readings are made from the inquirer's names and from the figures forming the birth date. In oneiromancy the future is forecast through dreams, which may be explained literally by contraries or by arbitrary meanings (*see* DREAM AND DREAMING: *Psychological Investigation*). Physiognomy (*q.v.*) is the assessment of character from physical traits, particularly those of the face. In phrenology similar deductions are made by feeling the contours ("bumps") of the cranium. (*See* also ASTROLOGY; PALMISTRY.)

Other fortunetelling methods, though they may persist among primitive peoples, are rarer or extinct in the civilized world. They include: sortilege, tossing a coin or dice or otherwise casting lots; picking dominoes blank side up and then interpreting their numbers; haruspication, enlightenment by examining the entrails of animals, or osteomancy, the same method with bones; pyromancy, nephelomancy and austromancy, divination from the behaviour of fire, clouds and winds respectively; hydromancy, various methods with water; halomancy, shapes formed when salt is scattered on a flat dry surface; ceromancy, shapes assumed by melting wax; chi-chi, a Chinese system of drawing numbered sticks out of a box; and many other devices. (*See* also AUGUR.)

The Vagrancy act, passed in England in 1824 and extended to Scotland and Ireland in 1871, provides that anyone pretending to tell fortunes by palmistry or otherwise, with intent to deceive and impose upon any person, is liable to imprisonment as a rogue and vagabond. The Fraudulent Mediums act of 1951 covers fraudulent activities of spiritualists, telepathists and clairvoyants.

In actual fact the fortuneteller may be psychologically useful. Unwelcome truths are often more readily accepted when wrapped in a mysterious jargon. Rudyard Kipling's short story "Marklake Witches" (in *Rewards and Fairies,* 1910) tells how a bygone "wise man," asked for a charm to cure a tuberculous girl, cleverly intertwines deep breathing and open windows with his magic. Again, fortunetellers may provide merciful outlets for overburdened minds: an inquirer with a worry that cannot be confided to family or friends might willingly pay a modest fee to a stranger who listens sympathetically; reassurance rather than divination is sought. Telepathy, generally unconscious, so often enters into prediction that close rapport between practitioner and client is likely and helpful. It is significant that fortunetelling flourishes most in times, whether personal or national, of emotional insecurity or enforced inaction.

See also PARAPSYCHOLOGY.

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(A. M. MI.)

FORTUNY Y CARBÓ, MARIANO JOSÉ MARÍA BERNARDO (1838–1874), an influential Spanish historical painter, was born at Reus on June 11, 1838. He entered the Academy of Barcelona, where he worked for four years under Claudio Lorenzale, and in March 1858 he gained a scholarship which enabled him to complete his studies in Rome. On the outbreak of the war between Spain and the emperor of Morocco in 1859 Fortuny was sent by the authorities of Barcelona to paint the most striking incidents of the campaign. He returned to Spain in 1860. He visited Paris in 1868 and shortly afterward married the daughter of Federico Madrazo, the director of the royal museum at Madrid. Another visit to Paris in 1870 was followed by a two years' stay at Granada, but then he returned to Rome where he died on Nov. 21, 1874.

The work which Fortuny accomplished during his short life is distinguished by facility of execution and cleverness in the arrangement of brilliant hues.

FORT WAYNE, a city of northeastern Indiana, U.S., and the seat of Allen county. Kekionga (Miami Town or Great Miami village), chief town of the Miami Indians, was located within the limits of the present city, where the St. Marys and St. Joseph rivers join to form the Maumee. Because of the natural advantage of the site for both travel and defense, French traders and soldiers built Fort Miami there. In 1760 the fort was occupied by the English, but in 1763 it was captured by the Indian chief, Pontiac. In 1790 Pres. George Washington sent Gen. Josiah Harmar to establish a post there. He was quickly defeated by Little Turtle, as was Gen. Arthur St. Clair a year later. In 1794 Gen. "Mad Anthony" Wayne defeated the Indians and built a stockade which came to be known as Fort Wayne.

From a crude military and commercial outpost Fort Wayne

turned into a fur-trading centre. It was incorporated as a town in 1829 and became a city in 1840. Although its industrial growth was stimulated by the building of the Wabash and Erie canal, true industrial and commercial development resulted in the 1850s with the coming of the railroads. Easy access to raw materials and to markets permitted diversification in industrial development. Manufactured products include wire, electrical machinery, pumps and tanks, radio and television equipment, motor trucks, pistons, dredges, mining machinery, oil burners, biscuits and beer. Pop. (1960) city 161,776; Fort Wayne standard metropolitan statistical area (Allen county) 232,196. (For comparative population figures for the city *see* table in INDIANA: *Population.*) A part of the growth between 1950 and 1960 is accounted for by annexations which doubled its area.

Among the city's buildings is the tower of the Lincoln National bank, and the home office building of the Lincoln National Life Insurance company, which houses a remarkable collection of Lincolniana. Centres of Purdue and Indiana universities are located in Fort Wayne as is the Fort Wayne state school for the mentally retarded. (I. G. G.)

FORT WILLIAM, a city of the Thunder Bay district of Ontario, is on the northwestern shore of Lake Superior at the mouth of the Kaministikwia river alongside its twin city Port Arthur (*q.v.*); the two cities comprise the area called the lakehead.

Fort William is a major transportation centre; on both the Canadian Pacific and Canadian National railways, it is also served regularly by air and by several Great Lakes steamship lines. There are more than 25 mi. of river front, with water-rail docks, coal docks, freight sheds and grain elevators. The grain storage facilities are among the largest in the world. Other industries include newsprint-paper mills, marine and general engineering shops, foundry, sawmills and woodworking factories, bus and aircraft factories, brewery and brick and clay works. Plants on the Nipigon river and at Kakabeka falls provide hydroelectric power. Fort William is the centre of a rich mining area of gold, copper, silver and iron and of an extensive fur-farming industry.

The site was probably first occupied as a French fur-trading post in 1678. The North West Fur company built Fort William there (1801–05), and during the early 1800s company employees and partners met annually at Fort William. Pop. (1961) 45,214. (F. A. CK.)

FORT WILLIAM, a small burgh of Inverness-shire, Scot., at the northeastern end of Loch Linnhe, an arm of the sea, about 62 mi. S.S.W. of Inverness and 115 mi. N.N.W. of Glasgow by road. Pop. (1961) 2,715. The original fort, called Inverlochy, was built by Gen. George Monk in 1654 to keep the peace in the Highlands. It fell into ruins during the Restoration and in 1690 was rebuilt by Gen. Hugh Mackay, who named it Fort William after William III, calling the little village at its foot Maryburgh after his queen. The Jacobites unsuccessfully besieged it in 1715 and 1746. The fort was dismantled in the mid-19th century and demolished to provide room for the railway and freight yard, but the town had by then taken its name. Fort William is a touring centre for the west Highlands, and a starting point for the ascent of Ben Nevis, invisible from the town although lying 4½ mi. E.S.E. Corpach, about 2 mi. N., stands at the head of the Caledonian canal. To the northeast are the modern Inverlochy castle, with extensive cattle rearing in the vicinity, and the ruins of old Inverlochy castle, near which was fought the battle of Inverlochy, when the marquess of Montrose defeated the earl of Argyll on Feb. 2, 1645. Fort William was the first town in the British Isles to light its streets by electricity entirely generated by water power. Water from Loch Treig, conveyed by a 15-mi. tunnel beneath Ben Nevis, provides power for the large aluminum works, which absorbs much local labour. The employees are housed in Inverlochy village. Other industries are cattle farming and distilling. The west Highland museum exhibits local crafts and historical relics, including the "secret portrait" of Prince Charles Edward.

FORT WORTH, the seat of Tarrant county, Tex., U.S., is located at the confluence of the Clear and West forks of the Trinity river, 30 mi. W. of Dallas. Pop. (1960) city, 356,268; standard metropolitan statistical area (which includes Tarrant and Johnson counties), 573,215.

History.—Fort Worth was founded May 8, 1849, by Maj. Ripley Arnold and the second dragoons on a site suggested by ranger officer Middleton Tait Johnson of Johnson's Station (present Arlington) as a frontier outpost against Comanche depredations, and was named for Maj. Gen. William J. Worth, commander of federal troops in Texas at that time.

A fort in name only and abandoned as a garrison in 1853, Fort Worth hovered on the ragged edge of disappearance until 1856, when by election it was chosen to succeed Birdville as seat of Tarrant county, named for Gen. Edward H. Tarrant, Indian fighter and legislator. According to some disgruntled citizens of Birdville, the outcome was determined by the generous use of whisky and by voting "every man as far West as the Rio Grande." A second election validated the choice, however, and Fort Worth was on its way from a crude frontier settlement to a cattle and rail centre. In the 20th century it was a sophisticated, cosmopolitan focus of transportation facilities, industry, commerce and the arts.

Early growth was accentuated by the cattle drives of the 1870s. Fort Worth was the last major population centre between the Brazos and the Kaw rivers, and it appealed to cowmen as a place where the cowboy "got a square deal from the merchants, and could have a high old time"; hence its names, "Cowtown" and "Where the West Begins." Boom, short-lived but exciting, came with the Texas and Pacific railroad, July 19, 1876. Anticipating its arrival, the city rejected scornfully a challenge from Dallas to a baseball game, replying that its young men were too busy to engage in such foolishness, an ironic twist since the Fort Worth Panthers subsequently were to establish an all-time record for successive Texas league pennants.

Another milestone was the opening of great meat-packing plants in 1902. A silver spade dug into wet soil April 18, 1949, marked the beginning of a new chapter in the story of Fort Worth—the genesis of aviation manufacturing. Thereafter, the growth of population—and its concomitants—was phenomenal; for comparative figures *see* table in TEXAS: *Population.*

In the latter half of the 20th century Negroes made up somewhat over 10% of the population, Latins less than 5%; the rest was largely native-born white. Western gear goes unnoticed on the streets, yet 25,000 people build jet bombers and other thousands are white-collar workers. Hospitality and friendliness of the old west accompany air-conditioned comfort and interest in the arts.

Government.—Incorporated in 1873, Fort Worth employed several forms of city government until the adoption in 1925 of the council-manager plan. The city has experimented with the recall, ousting six councilmen by the method in 1938.

Commerce, Industry and Transportation.—Within a 30-mi. radius a number of aircraft firms are in operation, and there is an automotive plant at nearby Arlington. Carswell air force base and the Fort Worth General depot are important. Carter field, international airport near Arlington, and Meacham field aid in making the city a centre of southwest aviation.

Packing houses and stockyards constitute the second major industry. Fort Worth is one of the most active oil areas in the U.S. It is a large grain-milling and storage centre and is important in the production of air-conditioning equipment, work garments and quality candy. Other items processed in Fort Worth range from saddles to expensive jewelry and from serums to fertilizers.

Fort Worth is served by trunk line railroads, buses, intercontinental highways, a toll road, and an expanding series of expressways. The Trinity Industrial authority works with river cities to extend ocean barge transportation to Dallas and Fort Worth.

Education and Cultural Activities.—Fort Worth is the home of Texas Christian university, founded in 1873 and supervised by the Disciples of Christ; and Texas Wesleyan, a Methodist college founded in 1891. Arlington State college is 6 mi. E., in Arlington. Cultural assets include the Children's museum; the

Noble planetarium; the Fort Worth Art centre; the Woman's club; the Fort Worth Public library; the Opera association; the Civic Music association; and the Fort Worth Symphony orchestra. Reactivated Casa Manana presents local and national theatre. Area colleges boast active fine arts groups. Publications include the *Star-Telegram* and the *Press*, and the famous *Cattleman's Magazine*.

Parks and Recreation.—Recreational facilities include over 60 parks; the famed Botanic gardens; an aquarium; a zoo; six inland lakes; North Fort Worth's western restoration, "Cowtown, U.S.A."; the Will Rogers Memorial coliseum and auditorium; and the annual Southwest Exposition and Fat Stock show with its world championship rodeo. Among the many area towns are Weatherford, 27 mi. W., a birthplace of the Populist party and home of Douglas Chandor, the artist, and Mary Martin, the actress; and Thurber, a ghost coal town. (E. C. Be.)

FORTY-SEVEN RŌNIN, the 47 loyal retainers of the lord of Akō, whose vendetta ranks as one of the most dramatic episodes of Japanese history. The incident began in April 1701, when imperial envoys from Kyōto arrived in Edo, the capital of the shogun. Three provincial *daimyō* (*q.v.*) were appointed to receive them, including Asano Naganori (1667–1701) from Akō. Because these men were ignorant of court etiquette they were directed to consult Kira Yoshinaka (1641–1703), an expert in such matters. The other two *daimyō* gave Kira lavish presents to ensure his co-operation, but Asano offered only a token gift. Kira was apparently annoyed and expressed his displeasure by constantly taunting the inexperienced Asano. The latter finally gave way to his pent-up wrath, and on April 21, 1701, in the audience hall of the shogun's palace, he flew at Kira with his dirk. Kira escaped with minor wounds, but Asano's gross breach of etiquette enraged the shogun, who ordered Asano to commit suicide the same day.

Word of the unhappy event reached Akō five days later. Asano's retainers, headed by Ōishi Yoshio (1659–1703), at once met to determine their future actions. Some favoured resisting if the castle had to be yielded; others swore an oath to disembowel themselves before the castle gate; but Ōishi counseled caution, and his view prevailed. The castle was surrendered on May 26.

For over a year Ōishi and other retainers lived in apparent retirement. Ōishi passed much time in the gay quarters of Kyōto, leading so dissolute a life that Kira's spies were convinced that he entertained no thought of revenge. In the autumn of 1702 Ōishi decided to strike. He and the 46 other *rōnin*, including his son, gathered in Edo. On the night of Jan. 30, 1703, they attacked Kira's mansion, forced their way in and killed their hated adversary. That night they offered up his head at Asano's grave. When the shogun learned of the vendetta he was sympathetically disposed to Ōishi, but finally decided that the 47 *rōnin* could not be allowed to take the law into their own hands. They were accordingly ordered to disembowel themselves on March 20, 1703.

The incident created an immense stir in Japan. The samurai virtues, seemingly forgotten during long years of peace, asserted themselves again. Innumerable poems and essays described the vendetta, and by 1844 no fewer than 47 plays had been written about the *rōnin*. Of these the greatest was *Chūshingura* (1748), in 11 acts, by Takeda Izumo (1691–1756) and others, a work whose popularity has never flagged.

See Sakae Shioya, *Chūshingura: an Exposition* (1940); Jukichi Inouye, *Chushingura*, rev. ed. (1937). (Dd. K.)

FORUM, an open place in Roman cities used, like the Greek agora (*q.v.*), for the transaction of mercantile, judicial or political business. It was level, usually rectangular in form, surrounded by colonnades, basilicas, temples, law courts and other public buildings. In the laws of the Twelve Tables the word is used of the vestibule of a tomb; in a Roman camp the forum was an open place immediately beside the *praetorium*, and the term was no doubt originally applied generally to the space in front of any public building or gateway.

In Rome itself *forum* denoted the flat and formerly marshy space between the Palatine and Capitoline hills (also called *forum Romanum*), which even during the regal period accommodated such

CULVER SERVICE

RESTORATION OF THE FORUM ROMANUM

public meetings as could not be held within the *area Capitolina*. In early times the *forum Romanum* was used for gladiatorial games and over the colonnades were galleries for spectators; there were also shops of various kinds. But with the growth of the city more than one forum became necessary, and under the empire a considerable number of forums, the *fora civilia* (judicial) and *venalia* (mercantile), came into existence. In addition to the *forum Romanum*, the forums of Caesar and Augustus belonged to the former class, the *forum boarium* (cattle), *holitorium* (vegetable), etc., to the latter. The *forum Nervae* (also called *transitorium* or *pervium*, because a road led through it to the *forum Romanum*) and those of Trajan and Vespasian (the latter also called *forum Pacis*), although partly intended to facilitate the course of public business, were chiefly erected to embellish the city. (*See* Rome: *The Ancient City.*) In Pompeii (*q.v.*), at the northeast end of the forum, there was a *macellum* (market) and shops for provisions, and on the east side a clothworkers' exchange; at Timgad (*q.v.*) in north Africa the whole of the north side of the forum was occupied by shops. The forum was generally paved and although on festal occasions chariots were driven through it was not a thoroughfare and was enclosed by gates at the entrances, of which traces have been found at Pompeii. (*See* also Roman Architecture; Governmental Architecture.)

The word *forum* frequently appears in the names of Roman market towns as, for example, in Forum Appii (Faiti, on the Appian way), Forum Julii (Fréjus), Forum Livii (Forlì), Forum Sempronii (Fossombrone). These were distinguished from mere *vici* by the possession of a municipal organization, which, however, was originally less complete than that of a municipium (*q.v.*). In Roman legal phraseology the word is practically equivalent to "court" or "jurisdiction."

FOSCARI, FRANCESCO (1373–1457), doge of Venice from 1423, had already had political experience as head of the Quarantia or Council of Forty during Venice's two wars against the Da Carrara and the Della Scala and again during the conquest of the territories of the patriarchate of Aquileia before he was elected to succeed Tommaso Mocenigo as doge. Mocenigo in a famous speech of farewell had advised the Venetians to consolidate the successes they had won in a long period of territorial expansion and economic development rather than to endanger their prosperity by attempting further conquests. Foscari, however, was to disregard this advice. The expansion of Florence on the one hand and that of Milan on the other was indeed presenting Venice with a problem that he could not ignore. While Florence was sometimes friendly and sometimes hostile, Foscari committed Venice to a series of wars against Milan that was to last 30 years. Allied with Florence against Filippo Maria Visconti in 1425, the Venetians won Brescia, their first territory in Lombardy west of the Mincio river, in 1426. A second war won Bergamo also for them at the first peace of Ferrara (1428). Then war started again in 1431. Great *condottieri* exerted themselves on one side or on the other but the second peace of Ferrara (1433) failed to de-

termine the balance of power. When war broke out yet again between Venice and Milan, a greater number of Italian states took sides, so that the Venetians found themselves in a harsher conflict, with the role of champions of "Italian liberty" against Visconti tyranny. The conflict opened the door to foreign intervention in Italy, and France, in particular, proved far more dangerous than the Holy Roman emperors had been in the past. The peace of Cavriana (1441) failed to dissipate the atmosphere of imminent aggression, to which Foscari's government contributed no less than did the enemies of Venice. Even when Filippo Maria was dead and the Ambrosian republic had been proclaimed in Milan (1447), Venice became involved in war with Milan again and hostilities went on likewise after Francesco Sforza had become duke of Milan (1450). Finally, however, the peace of Lodi (1454) was followed by the formation of an Italian league including Venice, Florence and Milan.

Foscari had been Venice's leader in the wars against Milan but meanwhile had done almost nothing to save Venice's eastern possessions, which had been the cradle of the city's prosperity, from Turkish encroachments. When Constantinople fell to the Turks (1453), he had to submit to a burdensome treaty with the sultan in order to keep the route to the orient open. Opposition to him in Venice came to a head as peace prevailed. The successive convictions of his son Iacopo for a series of offenses were used to discredit the doge, whose prestige was now vanishing, and on Oct. 23, 1457, he resigned his office on the formal demand of the Council of Ten. He died on Nov. 1, 1457. (R. Ce.)

FOSCOLO, UGO (originally Niccolò) (1778–1827), Italian poet and novelist who expressed the aspirations of his compatriots during the French Revolutionary and Napoleonic Wars and under the Restoration in some of the most perfect works of the national literature, was born of a Venetian father and a Greek mother on the Ionian island of Zante (Zakynthos) on Feb. 6 (Jan. 26 in the Greek calendar), 1778. He went to Venice about 1793, frequented the literary circles of the countess Isabella Teotochi-Albrizzi, Ippolito Pindemonte and Melchiorre Cesarotti and became famous in 1797 with his tragedy *Tieste*. His early enthusiasm for Napoleon, proclaimed in his ode *A Bonaparte liberatore* on the overthrow of the Venetian oligarchy in 1797, was followed by bitter resentment when the French ceded Venice to Austria under the treaty of Campoformio, and his novel *Le ultime lettere di Jacopo Ortis* (1798) contains a courageous denunciation of the transaction. However, when the Austrians and the Russians invaded Italy in 1799, Foscolo, with other Italian patriots, fought bravely on the French side; and after the battle of Marengo he became a captain in an Italian division of the French army.

After several commissions in Milan, Bologna and Florence and a brilliant, rather dissipated life which involved him in many love affairs (his love for Isabella Roncioni is expressed in a revised edition of *Ortis*), Foscolo in 1804 was sent to France. In the long vigil on the channel coast with the French army expecting to invade England, he found time to translate Laurence Sterne's *Sentimental Journey*. The news of the battle of Trafalgar moved him to include open praise of Nelson in his poetical masterpiece *I sepolcri*, which was published in 1807. Returning to Italy in 1807, Foscolo became professor of Italian rhetoric at Pavia in 1808, but the chair was abolished before the end of that year and he went to Milan. Satirical references to Napoleon in his tragedy *Ajace* (1811; first printed 1828) brought suspicion on him there, and in 1812 he moved to Florence. There he composed another tragedy, *Ricciarda* (1813; printed 1820), and most of his great unfinished poem, *Le Grazie*, fragments of which he had already published in 1803. He returned to Milan in Nov. 1813.

After the fall of Napoleon, Foscolo refused to serve the Austrians and went into exile, going first to Switzerland and then, in 1816, to England. As an Italian patriot he was greeted with sympathy by the liberal circles in London and was for some time a frequent guest of Lord Holland; but Foscolo's difficult character and extravagant life gradually estranged most of his English friends. He tried to support himself by giving lessons and contributing to periodicals, including the *Edinburgh Review* and the *Quarterly Review*, in which he published some valuable essays on Italian literature; but his last years were spent in great poverty. He died at Turnham Green on Sept. 10, 1827. His remains were transferred to Florence in 1871 and buried in the Santa Croce church, close to the tombs of the great men whom he had sung.

If one does not count the numerous juvenile poems which he later repudiated, Foscolo's poetical output was not large: 12 sonnets, 2 odes and 2 longer poems. These 16 poems, however, are among the masterpieces of Italian literature. The sonnets are the best in Italy since Tasso's and convey admirably the tumultuous feelings of the young lover, the soldier who despairs of his country, the exile longing for his distant home. The odes, "A Luigia Pallavicini" (1802) and "All' amica risanata" (1803) are colder in style, with a beauty of a neoclassic kind; both develop the idea that beauty is the only comfort granted by the gods to unhappy mortals, and both (the later one more felicitously than the earlier) exalt a woman with the attributions of a pagan goddess.

Foscolo's masterpiece, *I sepolcri*, begins with the supposition that Napoleon had forbidden inscriptions on tombs and so had violated one of the dearest illusions of mankind. The tombs of great men are an inspiration to the living; Florence is blessed because it keeps in Santa Croce the remains of Michelangelo, Machiavelli and Galileo; the dead heroes of Marathon revisit the battlefield; and from the tombs of the Trojan kings Homer derived power to sing their glory. With such themes the poet summons contemporary Italians to be worthy of their national heritage, and the poem is clearly patriotic. It helped to inspire the Risorgimento and is still very popular in Italy. Its sources include not only the Greek tradition (especially Homer and Pindar) but also the work of the English poets Edward Young, James Hervey and Thomas Gray.

Foscolo's second long poem, *Le Grazie* (fragments 1803 and 1818; 1822), partly mythological, partly biographical, has passages of surpassing beauty and is unparalleled in its formal perfection but has never attained the popularity of *I sepolcri*. His tragedies have little merit.

On the other hand *Le ultime lettere di Jacopo Ortis* has pleased generations of Italian readers. In this youthful novel the Venetian Ortis, who in some respects resembles Goethe's Werther, finally kills himself after recounting to a friend, in a series of letters, the story of his decline from hope to despair as his country is sold by a tyrant and his beloved married to another man.

For a portrait of Foscolo *see* Italian Literature.

Bibliography.—For the complete works of Foscolo *see* the edition by F. S. Orlandini and E. Mayer, 11 vol. (1850–62), with 1 vol. appendix (1890), and the "national edition" (1933–). The best English translation of *I sepolcri* is *The Sepulchres* by S. C. (?Sinclair Cullen; *c.* 1820). For biography *see* G. Chiarini, *La vita di Ugo Foscolo* (1927); D. Bulferetti, *Foscolo* (1952); also E. R. P. Vincent, *Ugo Foscolo* (1953). *See* also A. Ottolini, *Bibliografia foscoliana* (1921); G. Citanna, *La poesia di Ugo Foscolo* (1920); M. Fubini, *Ugo Foscolo, saggio critico* (1931). (F. Di.)

FOSSANOVA, an abbey located in Latium, Italy, near Priverno, at the foot of Monti Lepini. Its origins are uncertain—traditionally it was founded by St. Benedict himself in the 6th century, but in the 12th century it passed into the hands of the Cistercians, who built the abbey in 1173. It is the finest example of a Cistercian abbey, and of the Burgundian Early Gothic style, in Italy. The church (1187–1208) is similar to that of Casamari. The other conventual buildings also are noteworthy. St. Thomas Aquinas died at Fossanova in 1274.

FOSSE (or Foss) **WAY,** the Roman road that linked the southwestern area of the civil province of Roman Britain with the northeast. The name is English, the original name being unknown. From a starting point probably on or near the mouth of the river Axe in Devon it went by way of Axminster and Ilchester (Lindinae) to Bath (Aquae Sulis) and Cirencester (Corinium Dobunnorum), after which began a remarkably straight alignment, more than 60 mi. in length, which took it to its intersection with Watling street (*q.v.*) at High Cross (Venonae), and so to Leicester (Ratae Coritanorum), East Bridgford (Margidunum) and (after crossing the river Trent at Ad Pontem near Newark) to Brough (Crococalana). The Fosse way joined Ermine street (*q.v.*) at the Bracebridge crossing of the river Witham just south

of Lincoln (Lindum Colonia), on which it ended. Some parts of this course continue as a modern highway. There is evidence to support the suggestion that the Fosse way was laid down as a military road, part of the temporary frontier from which the conquest of the country to the west was begun by Ostorius Scapula in A.D. 47. But the road may have been the work of his predecessor, Aulus Plautius. *See* also BRITAIN: *Roman Roads*.

(WI. F. G.)

FOSSIL. The term fossil comes from the Latin word *fodere*, literally "to dig." In its early usage the word fossil referred to any curious object that was dug out of the earth, whether organic or not. Since about the middle of the 16th century it has been applied, for the most part, specifically to objects of the past geologic ages that provide evidence of organisms. Actual remains of organisms, remains replaced by minerals, casts, molds, impressions, such as those of leaves, skin and feathers, and tracks and trails, fall under the category of objects classed as fossils. Coal, petroleum, some limestones and some deposits of graphite have organic origin and thus give evidence of ancient life. Technically, they might be called fossils, but generally such deposits are excluded from the definition.

This article deals with the nature of fossils, including a brief history of concepts of fossils; the preservation of the fossil record, including how remains are preserved; what fossils tell about evolution, how they serve as a basis of stratigraphy and their economic importance; and major collections and exhibitions of fossils and the role of amateur collectors. Additional information on the subject will be found in the separate articles on the major orders and families of plants and animals, as EQUIDAE; on extinct plants and animals, as DINOSAUR; and on the geologic systems and eras, as CAMBRIAN SYSTEM. *See* also EVOLUTION, ORGANIC; GEOLOGY; MAN, EVOLUTION OF; PALEOBOTANY; PALEONTOLOGY.

THE NATURE OF FOSSILS

Fossils appear to have attracted the attention of man even prior to the beginning of written history. Throughout the known history of man they have been the subject of innumerable speculations and have been given various shades of supernatural interpretation. Even in the pre-Christian era, however, their essential nature was recognized by some of the Greek scholars. In early writings there are hints of the present-day concept that fossils represent a record of an orderly evolution of life through the past ages. The modern version of this concept began to take form prior to the publication of the *Origin of Species* by Darwin in 1859, in the work of such men as Lamark, Linnaeus and Cuvier among biologists and William Smith among geologists. With the advent of the theory of organic evolution, fossils came to assume an increasingly important place in the interpretation of earth history and the changes that life has undergone during geologic ages. In the second half of the 19th century, fossils played two dominant roles as man strove to extend his knowledge for both theoretical and practical ends. They served as a historical guide in the interpretation of the course and meaning of life, and as an essential basis for determination of age equivalencies and the nature of deposition of many of the sedimentary rocks accumulated in ages long past.

The Fossil Record.—The record of life on earth extends back over 1,000,000,000 years. The early part of the record is vague and difficult to decipher, but for the last 500,000,000 years it is written with amazing clarity by abundant, varied and well-preserved organic remains. Both plants and animals contribute to the record. Only an extremely small part of the total of all life has been preserved, but it seems remarkable that even this infinitesimal fraction has come down to the present in view of the vicissitudes of time to which it has been subjected.

Persistence of organic remains occurs only when the organism, some part of it or some impression that it has made, has maintained sufficient equilibrium with the environment of the encompassing rock to ensure that its identity is not totally obliterated. This condition is met most commonly in sedimentary rocks (*q.v.*). The diagenetic changes, or alterations of sediments after they have been deposited, involved in the development of metamorphic rocks and the heat and chemical activities of igneous rocks usually destroy organic remains that may have been within them.

(RIGHT) BY COURTESY OF WASHINGTON UNIVERSITY, PHOTOGRAPH BY JOHN H. GERARD; (LEFT) E. M. SHAUB

TWO EXAMPLES OF FOSSIL MINERALIZATION: (LEFT) PYRITIZED AMMONITE FROM THE LOWER LIAS (LOWER JURASSIC), DORSET, ENG.; (RIGHT) ALETHOPTERIS, FERN OF THE CARBONIFEROUS PERIOD COMMON TO CENTRAL UNITED STATES. ROCK HAS BEEN SPLIT TO SHOW BOTH THE FOSSIL AND ITS IMPRESSION

Buried impressions, such as footprints, skin and leaf impressions, as well as impressions of hard structures, tend to persist unless the sediments in which they are buried are drastically altered. Preservation of the organisms themselves, however, is a somewhat different matter. With notable exceptions, only hard parts, skeletal parts in a very broad sense, tend to be preserved. Hard parts may persist in their original state, but in rocks of appreciable age some degree of mineralization is the rule. Thus fossil remains are often said to be petrified.

Mineralization may merely involve filling of the interstices of skeletal elements by minerals carried by water. There may, however, be partial or total replacement of the original skeletal material by other mineral matter. Sometimes this is a crude process that preserves only the general outline of the structure, but in many cases the introduced minerals reproduce the details of both external and internal structure with remarkable fidelity, even to the extent that cell structure may be determined. One of the best-known examples of this type of preservation is found in the silicified trees in petrified forests, such as the one in Arizona in the United States. A wide variety of mineral compounds act as agents of replacement, but by far the most common are calcium carbonate, calcium phosphate and silica.

Although hard parts generally are essential to preservation, there are notable and highly instructive exceptions in the record. These have given special insight into the structure and age ranges of some groups of organisms which otherwise would have been very poorly known. From the very recent past have come frozen carcasses of mammoths in Siberia and hair and dung of ground sloths from a cave in New Mexico. The fossil ambers of the Baltic region have preserved mid-Tertiary insects, perfect in every detail. Much more ancient are records of such soft-bodied animals as worms in the Cambrian Burgess shales of British Columbia. Such finds are spectacular, but extremely rare.

BY COURTESY OF THE BUFFALO MUSEUM OF SCIENCE

CRANE FLY PRESERVED IN AMBER, IN THE COLLECTIONS OF THE GEOLOGY DEPARTMENT, BUFFALO MUSEUM OF SCIENCE

The degree to which different organisms are subject to preservation is highly varied. This introduces a strong bias into studies designed to probe into the past history of life on our earth. A second important bias is produced by the obvious fact that rocks which provide the medium of preservation must persist to the present time and be accessible for study. This bias is partially time-dependent, since increasing remoteness in time affords increasing chances of removal of rock by erosion and obliteration of fossils by diagenetic activities. In gen-

eral, deposits formed along sea margins, either on land or in relatively shallow marine waters of continental shelves and broad epicontinental seas, are the most likely to be preserved and later made available for study. Erosive forces tend to be at a minimum in such regions and many have displayed structural stability over the ages so that these deposits have been neither seriously altered nor destroyed. However, even where belts of deposition have been folded into mountain ranges, remnants of the sediments may remain and include excellent records of life.

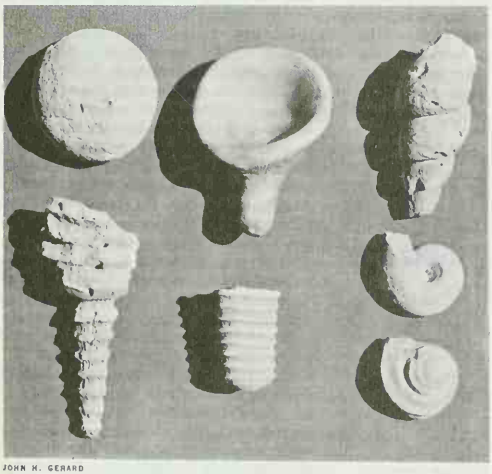
The great majority of accessible deposits of fossils of the Paleozoic era and the early and middle Mesozoic era were formed on deltas, in vast, shallow coal swamps, in shallow epicontinental seas and in linear, subsiding basins known as geosynclines. The last in particular have been subject to strong structural deformation to provide many of the great mountain ranges of present and past time. The record of marine life now many thousands of feet above sea level is commonplace in the sediments of such ranges.

Because of this localization of the types of deposits likely to persist, records of organisms that lived under other circumstances, in higher continental interiors or in open seas, are rare. Only since the late part of the Mesozoic era have upland continental deposits been well preserved, and the percentage of preservation increases sharply from the late Mesozoic to the present. Through this time, the Cenozoic era, animals and plants that lived in these circumstances provide an increasingly important part of the fossil record. Thus, the nature of organisms, their geographic and ecological distribution, types of rocks, sites of deposition and geological time all play important roles in determination of the completeness and validity of the fossil record of ancient life. While much can be known, some facets of ancient life must always be denied for direct study through fossil remains.

FOSSIL STUDY

The study of fossils is called paleontology, but under this general term are grouped various subdisciplines such as paleozoology, paleoecology, paleobotany and micropaleontology. Fields of interest of the majority of paleontologists fall into two general categories, one in which concern is primarily with geological problems, and the other in which the biological aspects of fossils are uppermost.

Geological Research.—The uses of fossils in the area of geological research include the ordering of strata in time series, temporal correlation of formations in different parts of the world and studies of the conditions of sedimentation during deposition of the rocks that contain fossils. Late in the 18th century William ("Strata") Smith observed, in the course of his work in sedimentary strata in England, that each bed of rock contained a characteristic suite of fossils and that beds in vertical succession showed sequences of characteristic fossils from the base to the top. From these observations stemmed the concepts of temporal correlation of rock formation by use of the fossils that they contained. For the first time authoritative geological maps became a possibility.



JOHN H. GERARD

FOSSIL REMAINS OF PREHISTORIC INVERTEBRATE SEA ANIMALS FOUND IN ILLINOIS SHOWING THE FORMER EXISTENCE OF SALT WATER IN THAT REGION

(Top left) *Receptaculites* sponge; (bottom left) Cephalopod siphuncle; (top centre) *Zittelella* sponge; (bottom centre) *Spyrocera* cephalopod; (top right) *Hormotoma* gastropod; (centre right) *Maclurites* gastropod; (bottom right) *Trochonema* gastropod

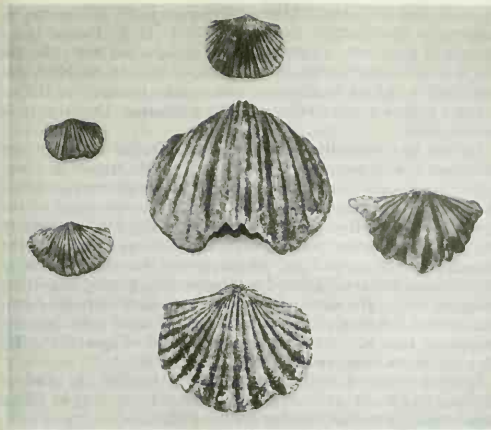
Index Fossils.—Extension of the basic idea led to the concept of the index fossil, a particular species or genus which has a wide geographic range and limited temporal range, and thus is diagnostic over a short span of geological time. Over half a century elapsed before the concept of diagnostic faunas could be cast into the framework of the theory of evolution. Even without this integrating theory, by which successions find logical explanation, stratigraphic studies dependent upon fossils and geological maps made great strides.

Commercial Importance.—As industrialization increased, petroleum and other mineral resources that occur in sedimentary rocks, for example, coal, limestone, lead and zinc, became of great economic importance. The study of stratigraphy assumed a major role in the search for these mineral deposits and the use of fossils provided an essential tool for solution of problems in the industrial nations. Remains of marine invertebrates have played the dominant role in these studies. Particularly important are the fossil remains of very small organisms such as Foraminifera and Ostracoda (*qq.v.*). The subfield of micropaleontology, which deals with these small animals, has taken on a major significance.

Evolution.—Vertebrate animals and plants have been less important in the development of practical stratigraphy, since they are less characteristic of the important marine strata. Both have been used in the solutions of particular problems and in nonmarine stratigraphy. For the most part, however, students of fossil plants and vertebrates have directed their efforts to studies more specifically biological in nature. In their biological role fossils have provided a factual record of the past life of the earth. Irrespective of the interpretation that may be put upon them, they serve to answer many questions about the characteristics of life in times long past. The earliest fossils date back over 1,000,000,000 years. They represent very primitive plants and animals such as algae and sponges. Then, in grand succession, appear the various more complex phyla of invertebrate animals, the vertebrates, fish, amphibians, reptiles, mammals and birds, and the arrays of plants that show the early invasion of land, development of great forests, such as those of the Carboniferous coal measures, and the development of ancestors of the present forests and grasslands.

Beyond a mere recording of facts fossils have stimulated the development of many theories and hypotheses relating to the course of life. Foremost among these is the theory of organic evolution. Fossils provide the critical opportunity to view the changes of life over long periods of time. In effect, they provide the fourth dimension in the study of organic evolution. Neither the organisms that live today nor the record of the past, known from fossils, alone can give an adequate understanding of evolution. Together, however, they provide the basis for one of the most significant concepts yet revealed by the studies of man: the concept of the continuity of life on our earth, and of the patterns and causes of changes that have produced the myriads of divers plants and animals that lived through past geologic ages and are seen alive in our own fleeting glimpse of the passage of time.

Collections.—Fossils occur under such a wide variety of circumstances throughout the world that sites for collection are available to the great majority of its peoples. Major collections have been brought together and displayed to portray historical aspects of the theory of evolution by large and small museums of natural history and by colleges and universities in many parts of the world. The most striking displays are those of large vertebrates, such as dinosaurs, but equally significant are exhibits



BY COURTESY OF WASHINGTON UNIVERSITY, PHOTOGRAPH BY JOHN H. GERARD

FOSSIL BRACHIOPODS OF THE ORDOVICIAN PERIOD SHOWING THE VARIATIONS IN RADIAL RIDGES OR COSTAE OF SIX SPECIES OF PLATYSTROPHIA BY WHICH THE FOSSIL FORMS ARE IDENTIFIED

(Centre) *P. ponderosa*, Mt. Auburn, O.; (clockwise) *P. colbiensis multata*, Winchester, Ky.; *P. unicostata*, Madison, Ind.; *P. moritura*, Richmond, Ind.; *P. profundosulcata*, var. *hopensis*, Cincinnati, O.; *P. foerstei*, Valmeyer, Ill.

of small vertebrates, plants and invertebrate animals. Outstanding large exhibits are to be found in New York, Chicago, Washington, D.C., and Pittsburgh in the United States, and in London, Paris and Moscow in Europe. Smaller but excellent exhibits are to be found in the museums of such universities as Harvard, Yale and the University of California, at Berkeley, in municipal and state museums in the United States, as well as equivalent museums throughout much of the world.

The study of fossils is an important profession, but, unlike many areas of scientific endeavour, it provides a rewarding avocation for amateur paleontologists. Opportunities for collection of fossils, for study of semitechnical and popular literature and for use of outstanding collections in museums are available to a vast segment of the populations of North America and Europe and to significant parts of the populations of other continents. Amateurs who have taken advantage of these opportunities have made many truly significant contributions to the total knowledge of life as gleaned from the fossil record.

See also references under "Fossil" in the Index volume.

(E. C. O.)

FOSSIL PLANTS: *see* PALEOBOTANY.

FOSSOMBRONI, VITTORIO, CONTE (1754–1844), Tuscan statesman, the real master of the grand duchy of Tuscany for 30 years, was born at Arezzo on Nov. 15, 1754. He was appointed minister of foreign affairs by the Habsburg grand duke Ferdinand III (*q.v.*) in 1796, but on the French occupation of Tuscany in 1799 he fled to Sicily. On the erection of the grand duchy into the ephemeral kingdom of Etruria in 1801 he was appointed president of the commission of finance. In 1809 he went to Paris as one of the senators for the Tuscan *département* of the French empire to pay homage to Napoleon. He was president of the legislative commission on the restoration of the grand duke Ferdinand III in 1814, and served as prime minister until his death. The bases of his regime were equality of all subjects before the law, honest administration of justice and toleration of opinion. He died in Florence on April 13, 1844.

FOSTER, SIR GEORGE EULAS (1847–1931), Canadian statesman, was born in Carleton county, N.B., on Sept. 3, 1847. He was educated at the University of New Brunswick, Fredericton, and from 1873 to 1879 was professor of classics there. In 1882 he was elected a Conservative member of the Canadian house of commons; in 1885 he became minister of marine and fisheries in the J. A. Macdonald government, and in 1888 minister of finance, a portfolio he retained until the defeat of the Conservatives in 1896. In 1911 he became minister of trade and commerce, retaining this portfolio in the Union government of 1917 and its successor. Foster played an important part in Canadian government during World War I, and he was one of the Canadian delegates to the peace conference. In 1920–21 he was chairman of the Canadian delegation to the first assembly of the League of Nations at Geneva, Switz. He was created a knight commander of St. Michael and St. George in 1914 and a knight grand cross of St. Michael and St. George in 1918; in 1916 he was appointed an imperial privy councilor. He died at Ottawa on Dec. 30, 1931.

See W. S. Wallace, *The Memoirs of Sir George Foster* (1933).

(W. S. WA.)

FOSTER, SIR MICHAEL (1836–1907), English physiologist, who had a very large share in the organization and development of the Cambridge biological school, was born at Huntingdon on March 8, 1836, the son of a surgeon. After a brilliant career at University college, London, he studied in Paris, and then taught physiology for two years at University college. In 1870 he was appointed by Trinity college, Cambridge, to its praelectorship in physiology, and 13 years later he became the first occupant of the newly created chair of physiology in the university, holding it until 1903. From 1881 to 1903 Foster was biological secretary of the Royal society. In 1899 he was created knight commander of the Bath and in 1900 was returned to parliament as a Unionist for London university. In 1906 he stood as a Liberal, and was defeated. His chief writings were a *Textbook of Physiology* (1876), which became a standard work, and *Lectures on the History of Physiology in the 16th, 17th and 18th Centuries* (1901), lectures delivered at the Cooper Medical college, San Francisco, in 1900. He died in London on Jan. 29, 1907.

FOSTER, STEPHEN COLLINS (1826–1864), U.S. composer of popular sentimental ballads and songs in the style of Negro minstrels. Born at Lawrenceville, Pa., later a part of Pittsburgh, on July 4, 1826, he was largely untutored in music but had a natural predilection for it and began to write songs as a young boy. In 1846 he went to Cincinnati as a bookkeeper but returned in 1850 to Pittsburgh, where he married Jane McDowell, daughter of a Pittsburgh physician. His song "Oh! Susanna" was published in 1848 and became popular in the California gold rush of 1849. As a result, Foster was commissioned to write songs in the manner of the southern Negroes for E. P. Christy's minstrel show. The most famous of these songs was "Old Folks at Home" (1851), also known as "Swanee River," originally published as by Christy. Foster's authorship was, however, never questioned and his name appeared on publications of the song from 1879 onward. He stated that his ambition was to become "the best Ethiopian (*i.e.*, Negro minstrel) song writer." Although many of his songs were inspired by southern life, he visited the south only once—in 1852. He was separated from his wife in 1861 and spent the remainder of his life in debt, though he received large royalties.

Foster left about 190 songs, for most of which he wrote the words as well as the music. His best-known songs, published between 1848 and 1862, are: "Oh! Susanna," "Old Uncle Ned," "Nelly Was a Lady," "Camptown Races," "Nelly Bly," "Old Folks at Home," "My Old Kentucky Home," "Massa's in de Cold, Cold Ground," "Old Dog Tray," "Jeanie With the Light Brown Hair," "Old Black Joe" and "Beautiful Dreamer."

He died penniless in New York city on Jan. 13, 1864.

See H. V. Milligan, *Stephen Collins Foster* (1920); J. T. Howard, *Stephen Foster, America's Troubadour* (1954). (N. SY.)

FOSTER, WILLIAM Z. (1881–1961), U.S. Communist leader and presidential candidate in 1924, 1928 and 1932, was born at Taunton, Mass., on Feb. 25, 1881. He came to national attention as the American Federation of Labor leader in the 1919 steel strike. In 1921 the Russian Communists designated Foster's Trade Union Educational league, which he founded in 1920, as the U.S. branch of their Profintern (Red International of Labour Unions), thereby moving Foster into the U.S. Communist organization as a top leader. In 1932 he suffered a serious heart attack, and party leadership passed to Earl Browder. Foster disapproved of Browder's policies, especially during World War II, but did not

assert his more extreme position until international Communist leadership indicated its dissatisfaction with Browder in 1945. Foster then became party chairman. In 1948 he was among the Communist leaders indicted under the Smith act, but because of his precarious health he was not brought to trial.

Foster's extreme position and control of the party were endangered in a conflict among Communists precipitated in 1956 by Soviet repudiation of Stalin and by Russian suppression of the Hungarian revolution. Foster, who steadfastly defended the Russian leadership, was made chairman emeritus, however, at the party's national convention in New York city in Feb. 1957. The Dec. 1959 convention retained him in that position. He died on Sept. 1, 1961, at Moscow.

See T. Draper, *The Roots of American Communism* (1957); D. A. Shannon, *The Decline of American Communism* (1959). (D. A. Sn.)

FOTHERGILL, JOHN (1712–1780), English physician, was born on March 8, 1712, in Wensleydale, Yorkshire, of a Quaker family. He studied medicine at Edinburgh and later acquired a large practice in London. His "Account of the Sore Throat Attended With Ulcers" (1748), which contains his observations on a severe epidemic, probably of scarlatina, brought him into wide prominence. He was interested in botany and maintained a large botanical collection. He popularized the use of coffee and was the first to describe sclerosis in the coronary arteries. He died in London on Dec. 26, 1780.

FOTHERINGHAY, a parish in the Peterborough parliamentary division of Northamptonshire, Eng., picturesquely situated on the left bank of the river Nene, 4 mi. N.N.E. of Oundle. Pop. (1961) 172. The castle, of which nothing but the earthworks and foundations remain, is famous as the scene of the imprisonment and execution of Mary, queen of Scots on Feb. 8, 1587 (*see* MARY [Mary Stuart]). The earthworks, commanding a ford of the river, probably bore a castle from Norman times. It became an important stronghold of the Plantagenets from the time of Edward III, and was the birthplace of Richard III in 1452. The church of St. Mary and All Saints, originally collegiate, is Perpendicular; the nave with aisles, and the tower surmounted by an octagon, are in the best style of the period. Of the Plantagenets, Edward, 2nd duke of York, who was killed at the battle of Agincourt in 1415, Richard, the 3rd duke, and his duchess, Cicely (d. 1495), as well as his son the earl of Rutland, who with Richard himself fell at the battle of Wakefield in 1460, are buried in the church. Their monuments were erected by Elizabeth I, who found the choir and tombs in ruins. The oak pulpit was given by Edward IV.

FOUCAULD, CHARLES EUGÈNE, VICOMTE DE (1858–1916), French soldier, explorer and ascetic, was born at Strasbourg on Sept. 15, 1858. After military training he led a dissolute life as an officer in Algeria until in 1882 he left the army and explored Morocco, then forbidden to Christians, disguised as a Jewish rabbi. His *Reconnaissance au Maroc* (1888) describes his discoveries there. In 1886 he was converted, and decided to devote his life to God. After visiting Palestine he became a Trappist monk in 1890 at Notre Dame des Neiges in the Cevennes and then in Syria. He left the order in 1897 to become a hermit, living first in Palestine as a convent servant, then, after ordination in France to the priesthood (1901), returning to Algeria. He spent several years at Beni Abbès before settling at Tamanrasset, in the Hoggar mountains. There he learned the Tuareg language, for which he wrote a grammar and a dictionary, and endeared himself to the people. It was largely because of him that the Tuareg remained loyal to the French when the Senusi (*q.v.*) in Tripoli were inciting them to rebel. He was a valuable source of intelligence to the French authorities until he was assassinated by the Senusi on Dec. 1, 1916. The process for his beatification was initiated in 1927.

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FOUCAULT, (JEAN BERNARD) LÉON (1819–1868), French physicist, best known for his experimental work in light and motion. He was the son of a publisher at Paris, where he was born on Sept. 18, 1819. After studying medicine he became interested in experimental physics. With A. H. L. Fizeau (*q.v.*) he carried on a series of investigations in light and heat. By the use of a revolving mirror, he was able in 1850 to establish that the velocity of light in different media varies inversely as the refractive indices of the media, and later to measure the velocity of light in air.

In 1851 he verified the earth's rotation by hanging a heavy iron ball from a wire more than 200 ft. long. This apparatus (later called the "Foucault pendulum") swings through all compass points in one day. For this demonstration and for his invention of the gyroscope, he received the Copley medal of the Royal society in 1855, and in the same year he was made physical assistant in the imperial observatory at Paris. He discovered the existence of eddy or "Foucault currents" induced in a copper disk moving in a strong magnetic field. He invented the polarizer which bears his name, and devised a method of giving to the speculum of reflecting telescopes the form of a spheroid or a paraboloid of revolution. He also introduced improvements in the electric arc.

Foucault received many honours during his life; he died of paralysis on Feb. 11, 1868, at Paris. From the year 1845 he edited the scientific portion of the *Journal des Débats*.

FOUCHÉ, JOSEPH, DUC D'OTRANTE (1759–1820), French statesman and organizer of the police, whose efficiency and opportunism enabled him to serve every government from 1792 to 1815, was born at Pellerin, near Nantes, on May 21, 1759. He was educated by the Oratorians at Nantes and Paris, but was not ordained priest, and became a teacher in the Oratorian colleges. Later, while teaching at Arras, he met Robespierre.

In 1791 the Oratorian order was dissolved and Fouché became principal of their college at Nantes, joining the local Jacobin club and becoming its president. On Sept. 16, 1792, just after his election as deputy to the Convention by Loire-Inférieure, he married Bonne Jeanne Coiquaud, the daughter of the head of the district administration.

In the Convention Fouché sided first with the Gironde. He joined many committees and was particularly diligent in the committee of public instruction. At Louis XVI's trial he voted for the king's death; thereafter he grew closer to the Montagne.

After war was declared on England (Feb. 1793) Fouché was sent on several missions to ensure the loyalty of the provinces. At Nantes he introduced taxation of the rich and encouraged "dechristianization" in the *départements* of Nièvre and Allier. In October he was sent to join Jean Collot d'Herbois in Lyons to punish that city for rebelling against the Convention. The rebels were executed by the guillotine or by mass shootings (the *mitraillades*) and beautiful buildings were destroyed. The importance of Fouché's role cannot be denied, but nonetheless, when the majority of the committee of public safety, under pressure from Robespierre, began to criticize the massacres and "dechristianization," Fouché too supported moderation. After the execution of the Hébertists, he was recalled to the Convention (April 1794). He began to fear Robespierre and therefore intrigued against him. In June he became president of the Jacobin society but abandoned it after Robespierre's attacks and amassed a hostile coalition that contributed to Robespierre's fall in July. Nevertheless, Fouché did not ally himself to the Thermidorians now in power and remained a *montagnard*. He was implicated in the riots of the Parisian sans-culottes in April and May 1795, his arrest being decreed in August, but he escaped and reappeared in the Convention after the abortive royalist rising of Oct. 4, 1795.

Under the Directory (1795–99) Fouché was a Jacobin. After the *coup d'état* of Sept. 4, 1797, had excluded the royalists from legislative councils, he was made minister plenipotentiary to Milan, but he was surprisingly feeble in supporting the Italian Jacobins against the French commissaries, G. Faypoult and N. Amelot. He was recalled, and the new Directory sent him as ambassador to The Hague, but he was even cooler toward the Batavian Jacobins. On July 20, 1799, he became minister of police and closed the Jacobin club of the Manège in Paris, which was a chief obstacle to military dictatorship. He warmly supported Napoleon Bonaparte's *coup d'état* of 18 Brumaire (Nov. 9, 1799). Still minister

of police, Fouché organized the secret police and restrained Bonaparte's harshness toward Jacobins and royalists until Aug. 1802, when the ministry was suppressed because of his efforts to prevent the senate from making Bonaparte consul for life.

Fouché's departure from office disorganized the police, which had difficulty in dealing with the Cadoudal-Pichegru conspiracy of the spring of 1804. The ministry was re-established for him after his support of the senate's proclamation of the empire. He was made *comte de l'empire* (1808), and duc d'Otrante (1809). In June 1809 he became minister of the interior as well as of the police.

The prolonged wars and especially the Spanish rebellion made Fouché doubt the solidity of the empire, and from 1807 he began to intrigue, mainly with the royalists and with England. From Jan. 1809, Napoleon became suspicious, but Fouché was cleared. In July, during the English expedition to Walcheren, Fouché, on his own authority, ordered a levy of the national guard throughout France. This annoyed Napoleon, especially as the Parisian guard chose his enemies as leaders, and when Fouché was denounced Napoleon dismissed him in October. He was, however, made governor of the Roman states, but before leaving France his negotiations with England were discovered and he was disgraced. He lived at Aix-en-Provence for three years. It is not known whether he joined the conspiracy of Gen. Charles de Malet at the end of 1812. In order to get him out of France, Napoleon made him governor of the Illyrian provinces, and after the occupation of these provinces by the Austrians, he was sent on a mission to Naples in which he seems to have played a double game with Napoleon and Joachim Murat, king of Naples.

After Napoleon's fall, Fouché returned to Paris in April 1814, but was ignored by Louis XVIII, against whom he therefore intrigued. When he was finally offered the ministry of police he refused, although he accepted it from Napoleon on his return from Elba. During the Hundred Days, Fouché recommended liberalism to Napoleon and kept on good terms with Louis XVIII and Austria. After Waterloo he made Napoleon agree to a second abdication and was elected president of a provisional government. Louis XVIII made him minister of police, but the ultra-royalists soon forced his resignation and he became minister plenipotentiary to Dresden. He was proscribed as a regicide on Jan. 5, 1816. He then lived in Prague, Linz and Trieste, where he died on Dec. 26, 1820.

Among Fouché's works are *Réflexion sur le jugement de Louis Capet* (1793); *Rapport et projet de loi relatif aux collèges* (1793); *Rapport sur la situation de Commune-Affranchie* (1794). His letters were published by D. Caillé in *Joseph Fouché, duc d'Otrante d'après une correspondance privée inédite* (1893); his police bulletins by E. d'Hauterive in *La police secrète du premier Empire . . . 1804–1809*, four volumes (1908, 1913, 1922, 1963). The authenticity of his *Mémoires* (2 vol., 1824) has been doubted, but apart from some passages they are undoubtedly by him.

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FOUGÈRES, a town of northwestern France in the *département* of Ille-et-Vilaine, lies on the Nançon 47 km. (29 mi.) N.E. of Rennes by road. Pop. (1962) 25,171. Strikingly situated on a ridge which is bisected by the cleft containing the Nançon, Fougères was severely damaged in World War II, but many medieval features remain. Of the castle (12th-15th century), once an important fortress, 13 towers still stand and local history through the medium of the *Son et Lumière* spectacle is presented within the castle walls on summer evenings. In the lower town the door of Notre Dame, the 15th-century St. Sulpice church and many old houses are of interest, while the upper town contains the 16th-century town hall, St. Leonard's church (12th–16th centuries) in front of which is the Place aux Arbres (a public park) with extensive views, and a 14th-century bell tower. The town contains a large public library, a school of music and an archaeological society. Two miles to the north is an extensive forest with megalithic ruins, a 12th-century cellar and a pool. The town's ancient trades were tanning, dyeing, cloth and paper manufacture (from the 16th to the 19th centuries), the making of tin, wooden shoes, earthenware, tiles, glass and the salt trade. Its modern industries include the manufacture of shoes and raincoats; and granite is quarried. Agriculture is important, especially the production of cattle, butter and eggs. There are fairs and agricultural shows. Fougères frequently figured in Breton history from the 11th to the 15th century, Raoul II (12th century) being the most famous lord. The town was captured by the English in 1166 and 1449, and by Charles VIII of France in 1488. François René Chateaubriand, Honoré de Balzac and Victor Hugo were frequent visitors and it has been described by Alfred de Musset, Gustave Flaubert and Prosper Merimée who all lived there for a time. In World War II Fougères was captured by the Germans in June 1940. After bombing on June 6 and 8, 1944, it was liberated on Aug. 4, 1944.

(A. H. Le P.; G. Rt.)

FOULARD, a light silk fabric having a distinctive soft finish and of a plain or simple twill weave. It is said to come originally from the far east. In French, the word "foulard" signifies a silk handkerchief. The fabric, which is figured with a pattern printed in various colours, is used for dress material, handkerchiefs, scarves and neckties. Fine textures of good-quality cotton yarn or man-made fibres are also sold as "foulard." The nonsilk foulard, which is usually of the plain calico or simple twill weave, is mercerized and printed with patterns in styles and colourings similar to those of silk foulard and is employed for the same purposes as silk foulard.

FOULD, ACHILLE (1800–1867), principal financial adviser to Napoleon III and a minister who exercised great influence during that reign, was born in Paris on Nov. 17, 1800, of a Jewish (later Protestant) family of bankers. After a youth divided between study of the arts, travel in Italy and in the east and work in his father's firm, he was elected to the chamber of deputies in 1842. There he soon made his mark as a financial expert. In 1848 he espoused the cause of Louis Napoléon, whom moreover he is said to have assisted financially; he was minister of finance (four times, 1849–51), of state (1852–60) and of finance again (1861–67). To pay for the Crimean War he inaugurated the new method of government borrowing direct from the public; and in 1861 he was responsible for a reorganization of budgetary methods, giving the legislature increased control over expenditure. It was under his direction too that the Opéra was reorganized, the new Louvre completed and the great exhibition of 1855 staged. He was described by a contemporary as being "the first confidant of the emperor's initiative" and also "his most important auxiliary"; conservative by instinct, he was yet favourable to the liberal development of the constitution. As his private papers were destroyed by fire, his full role in the second empire will probably never be thoroughly known. He died at his château near Tarbes (Hautes-Pyrénées) on Oct. 5, 1867.

His *Journaux et discours* were published in 1867. (T. Ze.)

FOULIS, ANDREW (1712–1775) and **ROBERT** (1707–1776), Scottish scholar-printers, were the sons of a Glasgow brewer. Robert, born April 20, 1707, qualified as a master barber and worked as such till 1738. But he had a restless enthusiasm for learning and attended the lectures of the philosopher Francis Hutcheson, who then befriended him. Andrew, born Nov. 23, 1712, probably completed a normal university course. In 1738 and 1739 the brothers visited France, returning each time with books, which they sold at a profit. Glasgow's growing university needed its own bookseller, and Robert was allowed to open a shop within the college precincts. In 1743 he became university printer, supplying as evidence of his skill the first Greek book printed in Glasgow, the pseudo-Demetrius Phalereus' *De elocutione*. Five years later he went into partnership with Andrew, and by 1775 they had produced over 500 separate editions, the finest being their Homer (4 vol., folio, 1756–58), Callimachus (small quarto, 1755) and Thomas Gray's *Poems* (quarto, 1768). They also printed Herodotus, Thucydides and Xenophon with Latin translations "to render the reading of the Greek historians more convenient for gentlemen in active life" and one of the first Scottish editions of Shakespeare. An excellent layout, legibility and accuracy were the principal merits of their finest work, which exercised a considerable

influence. Some of the credit for their achievements must go to the type founder Alexander Wilson, but other printers used Wilson's types with undistinguished results, and his much-praised abandonment, in the folio Homer, of confusing ligatures and contractions was undertaken on Robert Foulis' insistence.

Robert considered a training in the fine arts essential to a liberal education. On a visit abroad (1751–53) he purchased 350 pictures and engaged teachers of drawing, engraving and modeling. The university provided a gallery and studio, and the Glasgow Academy of Arts was opened in 1754. This imaginative but premature venture drained the brothers' resources, and after Andrew's death in Glasgow on Sept. 18, 1775, the academy had to be closed. Robert, grief-stricken, died on June 2, 1776, in Edinburgh. The printing business passed to his son Andrew (1758–1829), principally remembered for his "surreptitious folio." Engaged to print an octavo Aeschylus which Richard Porson (*q.v.*) was editing, and having received some corrections, Andrew embodied these in a folio (1795) of Thomas Stanley's text, without mentioning Porson. The octavo, with further emendations by Porson, appeared in 1806.

See P. Gaskell, "The Early Work of the Foulis Press and the Wilson Foundry," *The Library* (Transactions of the Bibliographical Society), 5th series, vol. viii, no. 2 and 3 (1952); D. Murray, *Robert and Andrew Foulis and the Glasgow Press* (1913). (R. R. Bo.)

FOUNDATIONS, PHILANTHROPIC. The philanthropic foundation, broadly defined, is a legal and social instrument for applying private wealth to public purposes. Although charitable endowments existed in antiquity, the modern foundation is predominantly a 20th-century American phenomenon. It is a large, autonomous organization formed to support research or public service in such fields as education, science, medicine, public health and social welfare. It may be an operating foundation with a service and research staff but it is usually a grant-making organization. Its legal form may be that of a charitable trust or a nonprofit corporation. It may be either a perpetuity with only its income distributed, a discretionary perpetuity with capital also expendable, or a liquidating fund with mandatory distribution of capital. An individual may endow a foundation by bequest or by a gift made during his lifetime; a business corporation or a family may create and support a foundation through continued giving.

In ancient Greece, Egypt and Rome a foundation was usually a single-purpose perpetuity supporting an academy, library or local charity. The typical medieval foundation was an ecclesiastical perpetuity operating a monastery, almshouse, orphanage or school. Many early hospitals, colleges and universities in western Europe and in the United States were supported by foundations, usually under religious control. During the Elizabethan period and afterward, thriving English merchants created numerous special foundations for educational and local charitable purposes, notably for poor relief. These small perpetuities, both in Great Britain and on the continent, drew increased criticism after 1750 for their mismanagement, narrowness or obsolescence of purpose, and their palliative character. Adam Smith in England and Turgot in France were among their early critics.

Although foundations or charitable trusts with narrow, local purposes have survived, they are overshadowed by large foundations possessing broad purposes and flexibility of action. Among the first of these in the United States was the Smithsonian institution (*q.v.*), created in 1846 "for the increase and diffusion of knowledge among men." In 1867 the Peabody Education fund was founded in the U.S. to promote education in the south. As business fortunes and organized philanthropy developed, other general foundations were created, notably by Andrew Carnegie (*q.v.*) and John D. Rockefeller (*see* ROCKEFELLER) after 1900. As a result of the publicity and success attending these foundations, many others appeared in the United States; a number also appeared in Canada and Great Britain and a few on the continent. After 1914 the United States also witnessed a substantial growth of community foundations and after 1940 a wave of personal, family and company-sponsored foundations.

Modern foundations are usually tax-exempt and have independent, self-perpetuating boards of trustees with considerable freedom of action. They stress studies and experiments to determine the fundamental causes and solutions of the problems of mankind. They often act as pioneers in social betterment by investigating basic problems that lie beyond the reach of local philanthropy or government and by using philanthropic "venture capital" to start programs that are later taken up by other private or public agencies.

UNITED STATES

Foundation directories show that there were at least 27 philanthropic foundations in the United States in 1915, 179 in 1926, 243 in 1939, 505 in 1946, 4,162 in 1955, and approximately 12,000 in 1960. New ones were being created at a rate exceeding 1,000 a year by 1960. Over 90% of them had assets of less than $1,000,000 each in 1960; fewer than 1,000 had assets exceeding $1,000,000.

Types of Foundations.—Despite their diversity, four general types of foundations may be identified: general research, family or personal, company-sponsored and community foundations.

Research foundations are the large, well-endowed organizations that are noted for their research programs in education, health, social welfare and the sciences. They are usually grant-making organizations but a few are partly or wholly operating foundations. In 1960 there were 178 such foundations, 129 of which had assets of $10,000,000 or more. They possessed more than half of all foundation assets and played a pioneering role in social betterment through research and experimentation.

Family or personal foundations are created by bequest or, more commonly, by living donors to facilitate their charitable giving. A few, such as the Ford foundation, have become huge through continued gifts and bequests. The larger family or personal foundations have broad philanthropic programs resembling major research foundations; the smaller ones have local, specialized programs resembling ordinary family giving. They have multiplied in number because they carry prestige, provide a convenient means for systematic philanthropy and offer income tax exemption for sponsors' gifts.

Corporation foundations, or those sponsored by individual companies, multiplied rapidly after World War II. They were created by many large concerns to systematize corporate giving and several have assets exceeding $10,000,000 each. Company-sponsored foundations are tax-exempt, independent legal entities whose trustees are almost exclusively officers of the sponsoring firm. Since their sponsors' profits and gifts may fluctuate, they use a reserve fund to regularize this "in-and-out" giving. Although small foundations stress local charity, most large corporation foundations support education, especially scholarships and fellowships, and also health, scientific research and social welfare. Several have distinctive programs keyed to the interests of their industry. The Bulova Watch Company foundation, for example, trains disabled veterans to be watch repairmen. The Nutrition foundation, supported mainly by food manufacturers, promotes basic research and education in nutrition. The Statler foundation finances research on hotel construction, operation and personnel training.

Community foundations or community trusts are charitable organizations that operate in individual cities or areas. They receive gifts and bequests from many persons and apply these funds as the donors stipulate or as a distribution committee of representative community leaders decides. They stress local philanthropic activities, especially education and social welfare. The community trust movement began in Cleveland in 1914 with the creation of the Cleveland foundation. New ones have appeared regularly, especially in large eastern cities. By mid-century there were about 100 and their aggregate assets approached $150,000,000. At least eight had assets exceeding $10,000,000 each.

The government foundation is another type worth noting. The National Science foundation was established in 1950 to advance fundamental scientific research. Although tax-supported, it has an independent governing board and makes grants for research projects, fellowships and related programs.

Peabody and Slater Funds.—The Peabody Education fund

mentioned above is often called the first modern American foundation. George Peabody, an American who became a wealthy banker in England, endowed it in 1867 with $2,000,000 primarily to advance public education in the south. It was an optional perpetuity and was liquidated in 1914. The John F. Slater fund was established in 1882 and promoted southern education until it was terminated in 1937. Influenced by the Peabody and Slater funds, by growing concern over educational, medical and social problems, by the philanthropic possibilities of great family fortunes, and by Carnegie's "gospel of wealth," millionaire philanthropists created foundations at an increasing rate after 1900.

Carnegie Trusts.—With his concept of the stewardship of wealth, Andrew Carnegie deemed it a disgrace to die wealthy. The philanthropic foundation was his favourite means of employing personal riches for long-run social good. His gifts and bequests, exceeding $330,000,000, went mainly to endow several perpetuities whose income was applicable to broad purposes as interpreted by the trustees.

The Carnegie Institute of Pittsburgh was created in 1896 with original grants of $11,700,000. It serves the Pittsburgh, Pa., area as a general educational agency, including libraries, museums of fine arts and natural history, a music hall and the Carnegie Institute of Technology.

The Carnegie Institution of Washington was established in 1902 with a $10,000,000 grant "to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind." It conducts fundamental research in various scientific fields.

The Carnegie Hero Fund commission was endowed in 1904 with $5,000,000 to recognize heroic deeds in civil life through awards and grants to heroes or their survivors.

The Carnegie Foundation for the Advancement of Teaching was created in 1905 with an original gift of $10,000,000, primarily to provide retirement pensions for professors at nonsectarian colleges and universities. It pioneered in the pension field, raised educational standards, and helped free many institutions from strict denominational control. Its noncontributory pension scheme taxed its resources and in 1918 it established the Teachers Insurance and Annuity Association of America to handle these pension commitments and develop contributory retirement plans. These activities influenced the retirement plans developed by insurance companies, private industry and the federal government. Among this foundation's important educational studies was the famous Flexner report of 1910 on *Medical Education in the United States and Canada*, which produced a revolution in medical education.

The Carnegie Endowment for International Peace was founded in 1910 with a $10,000,000 fund to promote world peace. It attempts to increase international understanding by conducting research on international law, history, economics and other aspects of foreign relations.

The Carnegie Corporation of New York, established in 1911 with gifts of $135,000,000, is a grant-making organization promoting "the advancement and diffusion of knowledge and understanding among the people of the United States and of the British dominions and colonies." It has made large gifts to the other Carnegie trusts and to many colleges, universities and research organizations for educational and research programs. It created the Church Peace union and materially supported the National Research council. It has made substantial grants for adult education, the fine arts, modern languages, engineering education, international affairs, and fellowship programs.

Carnegie created several philanthropic trusts in Europe, including ten hero funds, the Carnegie Trust for the Universities of Scotland (1901) with a $10,000,000 endowment, a $3,750,000 trust (1903) for the benefit of Dunfermline, Scot., his birthplace, and the Carnegie United Kingdom trust (1913) with a $10,000,000 grant.

Rockefeller Benefactions.—Three generations of Rockefellers have given well over $1,000,000,000 to philanthropy. The elder John D. Rockefeller gave more than $530,000,000, primarily to four large foundations. He helped build The University of Chicago and gave to several colleges. He believed in general endowment gifts on a matching basis, to encourage further philanthropy. Prior to 1928 the foundations he created made extensive endowment gifts on this basis. They were independent charitable corporations with broad powers and self-perpetuating trustees. Rockefeller disliked perpetuities and empowered his trustees to expend both capital and income.

The Rockefeller Institute for Medical Research (1901), the only operating foundation created by Rockefeller, received gifts totaling $60,000,000 to advance and disseminate knowledge about the nature, causes, treatment and prevention of diseases. Located in New York city, it has become a well-equipped medical research centre. In 1908 its charter was amended to allow educational activities. A further amendment in 1954 permitted it to be incorporated into the University of the State of New York as a degree-granting institution for graduate training and research in the medical and biological sciences.

The General Education board was founded by Rockefeller in 1902 as a discretionary perpetuity of nearly $130,000,000. In 1903 it was chartered by congress for "the promotion of education within the United States of America, without distinction of race, sex or creed." By 1952, it had distributed nearly $316,000,000 to strengthen educational institutions. It promoted agricultural education in the south by instituting a farm demonstration program in collaboration with the U.S. department of agriculture. It worked with southern educational officials to establish and improve rural schools and public high schools. It helped establish normal schools for Negro teachers and public schools for Negro children, spending nearly $30,000,000 on Negro education in its first three decades. Prior to 1928 it made matching endowment gifts of $60,000,000 to nearly 300 colleges and universities and $90,000,000 to various medical schools.

The Rockefeller foundation was created in 1913 "to promote the well-being of mankind throughout the world." Directly and indirectly it received nearly $242,000,000 from the founder. By 1960 it had distributed well over $500,000,000, one-third of it abroad. Until 1928 it emphasized public health and medical education. In 1909 Rockefeller personally financed the Rockefeller Sanitary commission to help health departments curb hookworm in 11 southern states. The foundation assumed this work in 1913 and created the International Health board. The two organizations co-operated in the south to combat hookworm, yellow fever, malaria, pellagra, smallpox, tuberculosis, etc., and to strengthen county and state public health departments. They extended this program to many other countries and the Rockefeller foundation spent $94,000,000 on public health abroad in its first 40 years. It co-operated with the General Education board to improve American medical schools and made grants to several American and foreign universities to create schools of public health. Directly and through the China Medical Board of New York which it created, it provided nearly $45,000,000 to develop the Peking Union Medical college.

When the Rockefeller philanthropies were reorganized in 1928, the Rockefeller foundation was broadened in scope and thereafter liberally financed pure research. It created divisions of public health, medical sciences, natural sciences, social sciences and humanities, each of which supported fellowship programs, special research projects and independent research agencies. The medical sciences division also supported psychiatry and mental hygiene. The natural sciences division financed costly research tools such as marine biology laboratories, telescopes and cyclotrons. The social sciences division continued the work of the Laura Spelman Rockefeller memorial, on which the two spent about $100,000,000 in a 25-year period. It helped support university and independent research agencies, including the National Bureau of Economic Research, Brookings institution, and Social Science Research council. It also helped finance publication of the *Encyclopaedia of the Social Sciences*. The humanities division made special grants to individual universities, museums, and libraries, to the American Council of Learned Societies, and for publication of the *Dictionary of American Biography*. In its first 35 years the Rockefeller foundation spent $28,000,000 for 10,000 fellowships in 75 countries and $10,000,000 on research grants-in-aid.

Laura Spelman Rockefeller memorial was endowed with nearly $74,000,000 by Rockefeller in 1918. Before being merged into the Rockefeller foundation in 1929, it made grants exceeding $55,000,000, of which $41,000,000 was for social science research.

In addition to its international public health work, the Rockefeller foundation developed technical, educational and research programs to aid agriculture in several Latin-American countries and, since 1957, in India and other eastern countries. The Rockefeller Brothers fund also supports foreign aid programs, especially in Latin America. In 1946 it created the American International Association for Economic and Social Development and the two have since founded the Association for Credit and Rural Assistance (providing supervised credit and technical assistance to farmers), International Basic Economy corporation (investing in developmental enterprises in Latin America), and IBEC Research institute (studying agricultural problems). These agencies have been operating in Brazil, Venezuela and other Latin-American countries; in the late 1950s they entered India and Africa.

John D. Rockefeller, Jr., helped administer these foundations and made additional charitable gifts of $473,000,000. In 1923 he endowed the International Education board with $20,000,000. It supported research in the natural sciences, agriculture and humanities, and spent more than $18,000,000 before merging with the Rockefeller foundation in 1928. He also endowed the Bureau of Social Hygiene, Institute of Social and Religious Research, and Sealantic Fund, Inc. He died in 1960, leaving half of an estate valued at $150,000,000 to the Rockefeller Brothers fund, created in 1940, to which he had previously given $58,000,000.

Ford Foundation.—In 1960 the Ford foundation held about one-fourth of all U.S. foundation assets. It was created with an initial $25,000 gift in 1936 to facilitate the Ford family's charitable giving. Later gifts and bequests from Edsel and Henry Ford II made it very wealthy and by 1960 it had distributed nearly $1,200,000,000. It made grants to existing organizations and to 11 autonomous funds of its own creation, including the Fund for the Advancement of Education (1951), Fund for Adult Education (1951), Fund for the Republic (1952) and National Merit Scholarship Corp. (1955). In 1954 it established the Center for Advanced Study in the Behavioral Sciences at Stanford, Calif. In 1956–57 it distributed $500,000,000 from capital funds among 615 private colleges and universities, 3,500 nonprofit hospitals and 42 privately supported medical schools. In 1959 its annual expenditures reached $110,000,000.

The Ford foundation's chief concern is education and it is the leading foundation contributor to social science research. It makes grants to groups engaged in international affairs and to universities and research institutes for intensive study of foreign areas. Its technical assistance programs are designed to improve farming, local industry, public administration and education in underdeveloped countries. It spent $78,000,000 on overseas development between 1951 and 1958; $28,000,000 was for India and smaller amounts for other countries of south and southeast Asia, the middle east, Africa and Latin America.

Other Foundations.—Charitable foundations created by other wealthy philanthropists help to illustrate their diversity.

The Russell Sage foundation is a perpetuity chartered in 1907 with a $10,000,000 endowment to promote better social and living conditions in the United States. It is primarily an operating foundation, conducting research, demonstrations, publication and other educational endeavours. Its work has greatly advanced the professions of social work and city planning.

The Julius Rosenwald fund was created in 1917 as a liquidating fund to be terminated within 25 years after Rosenwald's death, reflecting his dislike of perpetual endowments. He died in 1932 and it was liquidated in 1948. Its charter purpose was to serve "the well-being of mankind," and it aided southern rural education, race relations and the health and education of Negroes.

The Twentieth Century fund is a discretionary perpetuity chartered by Edward A. Filene in 1919 to improve economic, industrial, civic and educational conditions through research and publication. It pioneered in studying economic and social problems and became strictly an operating foundation.

The John Simon Guggenheim Memorial foundation was created in 1925. It awards fellowships each year to further the development of scholars and artists.

The Duke endowment is a charitable trust created by James B. Duke in 1924 to establish Duke university and serve other educational, health and religious needs in North and South Carolina. Duke required that 20% of the annual income be reinvested to double his original gift of $40,000,000, thus making it an accumulating fund. The trust indenture allocated the available income among Duke university, nonprofit hospitals, orphanages, three other colleges and universities, and support of certain retired ministers and rural churches. Duke bequeathed additional funds to this trust.

The largest foundations in the United States include:

Name	Date founded	Assets (approximate; 1959)
Ford foundation	1936	$3,316,000,000
Rockefeller foundation	1913	648,000,000
Duke endowment	1924	414,000,000
John A. Hartford foundation	1942	414,000,000
Carnegie Corporation of New York	1911	261,000,000
W. K. Kellogg foundation	1930	215,000,000
Alfred P. Sloan foundation	1934	176,000,000
Lilly endowment	1937	157,000,000
Commonwealth fund	1918	120,000,000
Danforth foundation	1927	110,000,000

Other foundations which reportedly had assets approaching the $100,000,000 class in 1960 included the Vincent Astor foundation (1948), Charles F. Kettering foundation (1927), Moody foundation (1942) and Sid W. Richardson foundation (1947).

The 12,000 foundations in existence in the U.S. by 1960 had combined assets of about $11,500,000,000 and total annual expenditures of approximately $625,000,000. This slightly exceeded all direct corporate giving but was less than 10% of total private charitable giving. The foundations' support of new ideas, research and social experimentation in neglected or controversial areas has had great significance despite the fact that their expenditures are dwarfed by federal spending.

Tax and Regulatory Aspects.—The most significant and direct influence of government on foundations is through tax legislation. Foundations are exempt from federal and state income taxes on their investment-type income. They are also usually exempt from local property taxes. Gifts of property to foundations are not subject to gift taxes and bequests are exempt from estate and inheritance taxes. Charitable contributions to them are deductible within limits in determining taxable income for a person or corporation. A person's charitable contributions (including gifts to a foundation) are tax exempt to an amount equal to 20% (30% under special conditions) of his adjusted gross income. High surtax rates encourage tax-exempt giving; an individual with income subject to the 91% tax rate may give to charity at a net cost in spendable income of nine cents on the dollar. An individual or firm may give appreciated assets such as securities and make a charitable deduction at their market value without incurring capital-gains taxes. Since 1935 a corporation's contributions (including gifts to a foundation) have been tax exempt up to 5% of its taxable income. During World War II and the Korean War a corporation with income subject to the excess-profits tax then prevailing could supply charitable dollars costing as little as 18 cents (or even less if also subject to state income tax).

As noted above, these tax provisions have encouraged some companies and individuals to create foundations and make tax-exempt gifts to them. However, several large foundations were created before the federal income tax was enacted in 1913 and many more before tax rates became high. Factors other than the income tax exemption have been important in the growth of foundations; these include the pure philanthropic motive, desire to perpetuate a family name or improve a "corporate image," prestige value of foundations, their advantages in making family or corporate giving more regular and effective, and their use to maintain control of a family-owned corporation upon the death of a principal owner by avoiding forced sale of the firm or its assets or stocks to pay estate and inheritance taxes.

The privilege of tax exemption as an encouragement to charitable giving has been preserved and protected from abuse through a long series of tax laws, court decisions and internal revenue service (IRS) regulations. Federal tax law, particularly the exemption privilege, has actually become the chief instrument of public control over foundations. A foundation must apply for tax exemption, giving prescribed information as to its purposes, intended activities, finances and sponsorship. This application is open to public inspection. The IRS will approve it only if the foundation's purposes are genuinely charitable and if its intended activities conform to its declared purposes. Every foundation must file with the IRS an annual report of its assets, liabilities, net worth, accumulation, gross income, total gifts received and total disbursements for tax-exempt purposes. Most of this annual report is open to public inspection. The IRS annually audits these reports to see that foundations conform to their declared purposes. A foundation may forfeit its tax-exempt status if it engages in propaganda or lobbying, makes an unreasonable accumulation of income, invests capital recklessly, uses a substantial part of its income for nonexempt purposes, or engages in certain "prohibited transactions" benefiting its donors or directors. The IRS also scrutinizes a foundation's sources of income. Its income (in excess of $1,000) from business activities not substantially related to its exempt purposes is taxable, as is a "feeder" corporation's income which is devoted entirely to a sponsored foundation.

Officials of large foundations believe that they have an obligation to make voluntary public reports of their operations. While most large foundations published periodic reports in the late 1950s, less than 5% of those with assets of less than $10,000,000 did so. In 1956 the Foundation Library centre was established in New York city to encourage foundation reporting and to collect and disseminate information about foundations.

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(F. G. H.)

GREAT BRITAIN

In Great Britain, unlike the United States, no special meaning attaches to the word "foundation." It is simply a name given to certain charitable trusts, and the words "trust" and "foundation" are used interchangeably. Foundations vary in size and scope from the Barlboro (Old Infant school) foundation for the educational benefit of children in a particular parish, to the Nuffield foundation which distributes funds to a wide variety of causes in a large number of countries.

In Britain a foundation as a charitable trust was defined originally by the Statute of Charitable Uses (1601). This statute was repealed in 1888 by the Mortmain and Charitable Uses act which, however, retained the preamble to the Elizabethan statute in which were listed the charitable uses which the law recognized. Chief among these were relief of aged, impotent and poor people; the maintenance of sick and maimed soldiers and mariners, schools of learning, free schools, scholars in universities; the repair of bridges, ports, havens, causeways, churches, sea banks and highways. The English judge Edward Macnaghten further added to this list of charitable uses the legal definition of a charity: "Charity in its legal sense comprises four principal divisions—trusts for the relief of poverty; trusts for the advancement of education; trusts for the advancement of religion; and trusts for other purposes beneficial to the community, not falling under any one of the preceding heads." Certain statutes also contain special definitions of charity; *e.g.*, the War Damage act of 1943. The fourth heading of the Macnaghten classification is indefinite, leaving ample room for ambiguities in defining a charity and resolvable only by litigation. A large fund of case law therefore exists which is relevant in determining whether or not the object of a foundation is charitable. The *Report* of the committee on charitable trusts, published in 1952, recommended that a definition should be enacted based upon the Macnaghten classification, which should itself be ended, but preserving the case law as it stands. The only law to be passed as a result of the committee's recommendations, however, was the partial adoption of their views on the retrospective validation of certain imperfect trust provisions in the Charitable Trusts (Validation) act, 1954. The legal basis of a foundation thus remained unaltered at the beginning of the 1960s.

Legal Position.—The legal recognition of a foundation as a charity carries several important privileges. In the first place, gifts to charity have always enjoyed a privileged position in the law of testamentary dispositions. A charity is treated as an artificial legatee with the right to hold property in perpetuity and with the additional important advantage that the courts are willing to provide new purposes as near as possible to the original objects of a charity if these become incapable of fulfillment. This latter doctrine, known in law as cy pres, has, however, been widely criticized in that it does not allow changes in the purposes of charitable trusts and foundations sufficient to enable them to keep in step with a rapidly changing social environment. Thus, for example, the doctrine would be difficult to apply to a foundation which had originally had as its object the abolition of slavery. After the 1860s, parliament was willing to relax the doctrine of cy pres for some particular kinds of charity, notably in the case of educational endowments under the various Endowed Schools acts passed between 1869 and 1948 and in the case of parochial endowments in the city of London. The economic changes and especially the wide extension of the social services in the 20th century made urgent the need for its more general relaxation and the 1952 *Report* on charitable trusts recommended that the doctrine be relaxed for all trusts and foundations.

As against the special position which charitable trusts and foundations enjoy in law, various attempts were made to check the possible abuses and maladministration which might arise as a result of their perpetual legal existence. The Statute of Charitable Uses (1601) authorized the appointment of *ad hoc* commissioners to inquire into malpractices, but these appointments became infrequent during the 18th century and finally died out in 1803. The Charities Procedure act and the Charitable Donations Registration act, both passed in 1812, were further attempts (largely ineffective) to correct abuses and in 1818 a parliamentary commission was created to record and investigate the charitable trusts of England and Wales. The 1835 select committee on public charities recommended the creation of an independent authority with powers to investigate any trust. It was not until 1853, however, that the Charitable Trusts act was passed "for securing the due administration of charitable trusts and for the more beneficial application of charitable funds in certain cases" and it led to the naming of the Charity commissioners. The act of 1853 was of additional importance in that it created the official trustee of charity lands and the official trustee of charitable funds, thus providing a way in which lands and securities could be held by charitable foundations having perpetual succession, without cost to their trustees and without interfering in their administration of their trust. Trust funds were further relieved of the constant expense of transferring their property on the death or retirement of a trustee and the appointment of a new one. The *Report* of the committee of charitable trusts of 1952 made several recommendations intended to reinforce the powers conferred by the Charitable Trusts acts; *e.g.*, it was recommended that the statutory provisions for recording trusts should be re-established.

Foundations are also subject to restrictions on the assets they hold in the form of land and investments in securities. By the Charitable Trusts Amendment act of 1855, trustees are forbidden to sell, mortgage or charge charitable property, or to grant a lease in reversion after more than three years or for a term of more than

21 years, unless expressly authorized by the commissioners. Restrictions upon the acquisition of land are imposed by the Mortmain and Charitable Uses act of 1888 and the amending acts of 1891 and 1892. Investments in securities can be made by foundations only if they are permitted by the terms of the trust instrument, by the provisions of the Trustees act of 1925, or by a high court order. The trustees are personally liable for loss from unauthorized investment and the range of securities in which investment is authorized is limited by the Trustees act. The financial position of trust funds thus suffers from a rigidity of income particularly onerous in a world prone to inflation.

Trusts and foundations enjoy a privileged position in the levying of rates and income tax. During the late 18th and early 19th centuries, properties provided and used for charitable purposes were frequently omitted from the poor rate, while the Scientific Societies act of 1843 specifically exempted such bodies from rate paying. In 1865, however, as the result of the decision in the case of *The Mersey Docks and Harbour Board Trustees* v. *Cameron*, public charities were held not to be exempt from the payment of taxes. Although the law quickly placed some charitable foundations in a more favourable position, as in the Sunday and Ragged Schools (Exemption from Rating) act, 1869, and subsequently extended rate relief to others, most charitable foundations between 1865 and 1955 were dependent upon sympathetic treatment by local rating authorities for which there was no statutory sanction. In 1955, however, charities were granted statutory relief from rates by the Rating and Valuation (Miscellaneous Provisions) act, though the relevant provisions were regarded as only temporary.

A foundation which is legally recognized as a charity is also, under the 1952 Income Tax act, able to claim tax exemption upon its income from land, interest, dividends or other annual payments and from the profits of a trade carried on by it.

Existing Foundations.—The precise number of foundations and trusts in Great Britain is unknown. It was estimated in 1952 to be at least 110,000, as compared with about 29,000 known to the Brougham commissioners in 1837, and new foundations were being created at the rate of about ten a week. Of the 110,000, about 30,000 were educational and about 40,000 catered for the needs of the poor, sick and needy. It was further estimated that more than one-third of the total number of trusts had an annual income of £25 or less. Excluding their considerable holdings of land, the assets of the 110,000 trusts existing in 1952 were estimated at £200,000,000, or about 5% of the estimated value of the national productive capital.

As opposed to the great mass of small foundations, there was an increasing tendency in the 20th century to emulate the U.S. practice of creating great charitable foundations with wide objectives, exercising their benevolence within and even beyond the country as a whole. Some of these giant foundations are, indeed, of U.S. origin as, for example, the Carnegie United Kingdom trust or the Pilgrim trust. The latter was founded in 1930 by E. S. Harkness and during the 1930s equally supported schemes to alleviate unemployment and to preserve the national heritage. Others are foundations with headquarters abroad such as the Commonwealth fund, founded in 1918, or the Gulbenkian foundation, founded in 1955 to support artistic, scientific, educational and charitable projects. In addition to these there are the great British foundations such as King George's Jubilee trust, founded in 1935; the King Edward's Hospital fund, London; and the series of Lord Nuffield's foundations, culminating in the creation of the Nuffield foundation in 1943 with an initial capital of £10,000,000.

Foundations make a valuable contribution to contemporary society, not only in their charitable disbursements but in the scope which they provide for voluntary service. Even with the greatly increased scale of provision by the state of education and of help for individuals faced with poverty, sickness, old age and unemployment, foundations supplement state activity. Thanks to the greater flexibility which they enjoy the foundations carry the fruits of philanthropy into areas in which the state does not function. The state tends to support existing activities and there is, therefore, room for the foundations in pioneering new ventures and in supporting new ideas which would otherwise remain untried for lack of funds. *See* also CHARITY; PHILANTHROPY; TRUST.

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FOUNDATIONS, STRUCTURAL. The foundation of a structure generally serves to transfer the loads from the structure to underlying materials (such as soil or rock) which are known as the foundation material. In the case of a dam (*q.v.*) the foundation material itself often is referred to as the foundation.

Before foundation design and construction, the foundation material usually is investigated by means of samples from exploratory borings or test pits. These samples may be tested for pertinent physical characteristics in a laboratory or at the construction site. The exploratory program is intended to establish the nature and arrangement of the foundation material, including its strength and compressibility. The position of the water table (*see* GROUND WATER) is also determined. Elaborate preliminary studies of this sort are sometimes required by complex projects.

Foundation Types.—Foundations for structures are classified as footings, mats, piles or piers, depending on their form and the method of their construction.

Footings (fig. 1) are enlargements of the lower portions of columns or walls. They distribute the load to the foundation material at a pressure sufficiently small to assure that settling will be tolerable and that the footing will be in no danger of breaking into the ground. From antiquity stone masonry piers have been used as footings, but for heavy loads on weak soils, masonry footings require much valuable space, and they add appreciably to the load. Grillages of steel rails and I-beams were introduced in the 1890s to overcome these disadvantages and were used extensively in early skyscraper construction (*see* STEEL CONSTRUCTION). These types were largely supplanted by reinforced-concrete footings shortly after 1900.

The proper area of a footing is determined by dividing the load by the allowable soil pressure, a value often specified in local building regulations. This value is determined by the character of the foundation material and the principles of soil mechanics (*q.v.*). The centre of gravity of the footing usually is required to

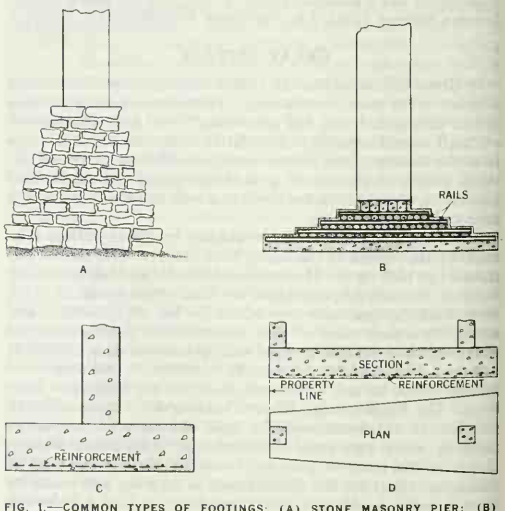

FIG. 1.—COMMON TYPES OF FOOTINGS: (A) STONE MASONRY PIER; (B) STEEL RAIL GRILLAGE; (C) REINFORCED-CONCRETE FOOTING; (D) COMBINED FOOTING FOR USE AT PROPERTY LINE

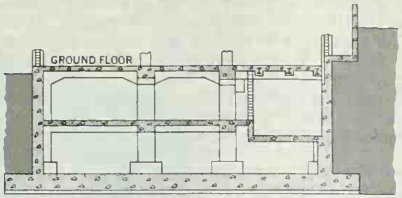

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FIG. 2.—SECTION THROUGH COMPENSATED-RAFT FOUNDATION

fall in line with the point of application of the load. This requirement (especially when columns fall along a property line) can be satisfied with combined footings as shown in fig. 1(D).

Mats.—If loads are high compared with the allowable soil pressure, the total area of multiple footings can constitute a large fraction of the base area of the structure. All the footings then may be combined into a single foundation known as a mat or raft. If foundation material is unusually compressible, excessive settling may result unless part or all of the weight of the structure is compensated for by excavating an appropriate weight of the material and providing one or more basements. The substructure, consisting of floors, cross walls and columns, can serve as the raft. A typical foundation of this type is shown in fig. 2.

Piles.—If foundation materials at normal footing or raft level are too weak or compressible, but become more suitable with increasing depth, the structure may be supported on piles. Prehistoric peoples built pile foundations with stakes driven into the ground. Ancient Romans drove timber piles of considerable length with drop hammers of essentially the same design as some modern types. The pile foundation for Caesar's bridge across the Rhine is a familiar example (*see* BRIDGES).

Timber piles, usually tree trunks, are most commonly used. They may decay above ground-water level, and are often treated with preservatives. When higher loads justify the increased cost, piles of more durable material are frequently installed where untreated timber piles would decay. Fig. 3 illustrates some of the many widely used varieties of piles, which are chosen on the basis of such factors as load per pile, foundation material and cost.

Piles are driven with drop hammers or more rapidly acting hammers powered by steam, compressed air or diesel engines. Penetration may be aided by water-jetting or predrilling a hole, but final positioning should always be by impact. The load capacity of a pile may be estimated on the basis of past experience in the construction area, by test-loading, or less accurately with formulas based on the penetration of the pile under the last few hammer blows. An outstanding example of pile-supported structures, the Pentagon in Washington, D.C., was founded on more than 41,000 cast-in-place concrete piles, each about 27 ft. long. Piles are also used to support bridge piers where the bed of a stream may be substantially lowered by scour. The piles penetrate to a depth sufficient to provide adequate support even when materials on the bed surface are temporarily removed.

Piers.—Piers serve generally the same purposes as piles but are not installed by hammer. If the supporting stratum is especially stable, the safe load on a pier may greatly exceed that for a pile.

Piers are usually cylindrical shafts of concrete cast in holes excavated by hand or machine, or cast in the form of caissons which are sunk into position. The lower portion of a pier may be widened to distribute pressure.

Formerly, hand-dug shafts were widely used where ground water was no serious problem. Most of the tall structures in Chicago are founded on concrete piers cast in such shafts. Some of these piers have diameters up to 12 ft., extend to depths of about 100 ft. and support loads of 6,000,000 lb. or more.

Hand excavation has been largely replaced by rotary or percussion machine drilling. Under favourable subsoil conditions, drilled piers may be more economical than footings. Small piers with shafts up to about 24 in. wide can be excavated with drilling buckets or augers to a firm stratum, and a bell or enlargement can be formed with extensible cutting arms (fig. 4). If water is encountered, it may sometimes be cut off by inserting a metal liner or casing in the shaft and reducing the diameter of the hole below the casing. If the ground caves badly, however, other types of construction may be indicated. Excavations for pier shafts have been drilled with diameters up to 6.5 ft. and depths of 115 ft.

In materials too hard or too full of boulders to permit machine drilling, a heavy steel casing is driven or rotated into the ground and the material within is broken up with chopping tools. The casing is often drilled several feet into bedrock to form a seal so that water may be removed and the bottom of the casing can be inspected before the concrete is placed.

Large piers, especially those for bridges, are often installed by the caisson method. The caisson is a hollow boxlike structure that is sunk to the bearing stratum by excavating from the interior, and ultimately becomes a permanent part of the completed pier.

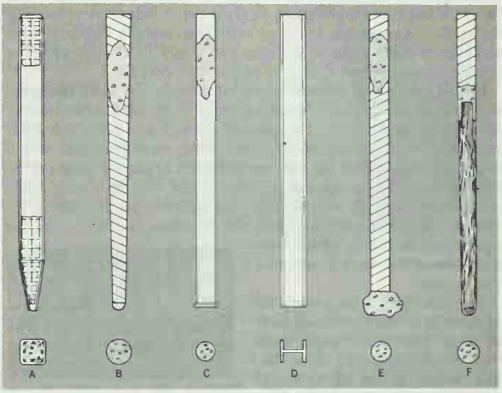
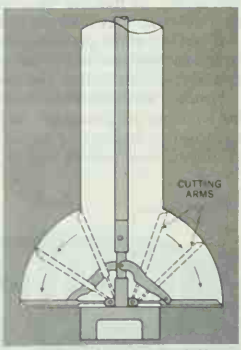


FIG. 3.—COMMON TYPES OF PILES: (A) PRECAST CONCRETE; (B) CONCRETE CAST IN THIN METAL SHELL; (C) CONCRETE-FILLED STEEL PIPE; (D) STEEL H-SECTION; (E) PEDESTAL TYPE WITH CAST-IN-PLACE CONCRETE, ENLARGED BOTTOM; (F) COMPOSITE TYPE CONSISTING OF DRIVEN TIMBER BELOW WATER TABLE, CAST-IN-PLACE CONCRETE ABOVE

The lower edges of the caisson walls are provided with cutting shoes to facilitate penetration. As material is excavated and the caisson sinks, the side walls are built up to increase weight and facilitate sinking. As the excavation deepens, pressure outside the caisson increases and surrounding material may blow into the caisson. Such accidents may cause considerable settling around the working area, and also can tilt the caisson. This difficulty often may be avoided by maintaining pressure within the caisson with water through which the material is removed by open dredging. Large caissons are subdivided into several vertical cells, and tilting can be controlled by dredging to greater depth in some cells than in others.

The centre anchorage pier of the San Francisco-Oakland Bay bridge is of exceptional size and depth (about 92 by 197 ft. in cross section, and 242 ft. deep). It was constructed as a 28-cell caisson, each cell being provided with a dome-shaped, removable steel roof. When the caisson tended to tilt, compressed air was admitted to some of the cells near the low side while dredging continued in other cells from which the domes had been removed.



BY COURTESY OF WABASH DRILLING CO.

FIG. 4.—EXTENSIBLE CUTTING ARMS FOR FORMING BELL AT BOTTOM OF DRILLED PIER SHAFT

When hand labour is necessary

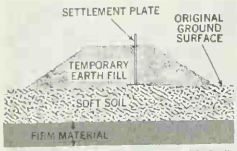


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FIG. 5.—USE OF TEMPORARY FILL TO STABILIZE FOUNDATION MATERIAL. SETTLEMENT PLATE SHOWS AMOUNT OF COMPRESSION

to remove obstacles beneath the cutting edge or to prepare the rock surface for concreting, a chamber for the workers may be provided in the lower part of the caisson. Air is introduced into the chamber at a pressure slightly greater than that required to balance the outside pressure, and the chamber is kept relatively dry. Air locks must be provided for passage of men and materials. Men cannot work efficiently under pressures exceeding 65 lb. per square inch, and compressed-air caissons are limited to depths of about 120 ft.

Compressed-air caissons once were the only practicable devices for installing some foundations at great depth below water-bearing materials. At present, they are often successfully replaced with such heavy steel casings as those previously described, avoiding the need for compressed air. (*See* also EXCAVATION.)

Stabilization of Foundation Material.—In some instances the need for an expensive foundation may be avoided by improving the foundation material. For example, many single-story industrial buildings with heavily loaded floors have superstructures which merely protect against the weather and exert negligible loads on the foundations. If the subsoil is compressible, the floor may settle excessively unless a very costly conventional foundation is installed. However, preloading the site to induce settling before the structure is built may permit construction of the floor directly on the ground.

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FIG. 6.—LOAD-SETTLEMENT CURVES FOR DETERMINING SOIL CONDITIONS. SETTLEMENT CURVE RISES SLIGHTLY TO STABLE LEVEL (RIGHT) WHEN TEMPORARY EARTH-FILL LOAD IS REMOVED

In preloading, a temporary fill of earth is ordinarily placed over an area somewhat larger than that of the proposed structure. The weight of the fill is determined through an analysis of the subsoil and the predicted degree of settling (*see* SOIL MECHANICS). The procedure fails if the subsoil is too weak to support the temporary fill, and becomes impractical if settling would be so slow that the fill would have to remain in place for an unreasonably long time. However, preloading has permitted many structures to be founded above loose sandy or silty soils and in marshy areas. Installation of settlement plates (fig. 5) on the surface before the fill is placed permits observation of the rate and magnitude of settling. Time-settlement curves (fig. 6) indicate when most of the settling has occurred; then the temporary load can be removed.

If settling under preloading will be too slow, it sometimes may be accelerated with sand drains which promote the escape of water. A sand drain installation is shown in fig. 7.

Shoring and Underpinning.—If the foundations of an existing structure are inadequate, or if they are likely to be excessively disturbed or endangered by adjacent construction or excavation, shoring or underpinning may be required.

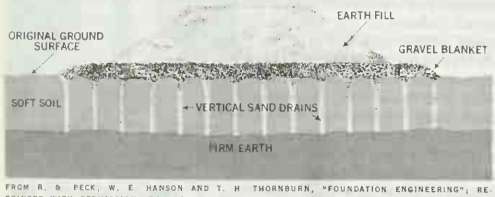

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FIG. 7.—USE OF BORED SAND DRAINS TO SPEED SETTLEMENT OF UNSTABLE SOIL

Shoring provides temporary support of a wall or column while adjacent construction or underpinning is in progress. If the foundation for a wall is to be retained after settling, part of the wall may be removed, leaving short horizontal slots in which screw jacks may be inserted (fig. 8). The slots are then extended in short sections and additional jacks are inserted until the entire upper part of the wall is supported by jacks. The jacks are extended as necessary to keep the wall in position until the foundation is stabilized, at which time they are removed a few at a time and the wall is restored in sections. If the footing beneath the wall is to be replaced, the wall is supported on needle beams, as shown in fig. 9, which are inserted as successive holes are made. The needle beams are supported by screw jacks and grillages resting on the ground. Needle beams also are commonly used to shore columns and are usually bolted or welded to the columns.

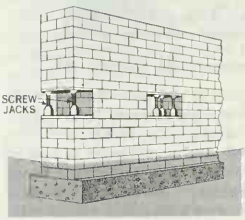

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FIG. 8.—SHORING WITH JACKS TO PROVIDE TEMPORARY SUPPORT FOR WALL

Underpinning may be used to replace old foundations (usually below the earlier level) and is often required if adjacent excavation for a new structure will extend below the old foundation level.

Pit underpinning is feasible if adequate support can be found close below the existing footing beneath a wall. Small pits are excavated at intervals alongside the wall to a depth sufficient to permit access to the underside of the footing. The earth is then removed to new foundation depth beneath part of the footing and is replaced by concrete. The operation is repeated in intervening sections until the entire wall has been provided with a new footing. If the wall is too weak to bridge the gaps it may be shored with needle beams before underpinning. Commonly, individual columns are also shored before being underpinned.

If suitable support depth is excessive, and water is not likely to interfere, band-excavated piers may be installed beneath the old foundations. More often, small working areas are opened beneath the foundation and piles are driven with jacks operating against the weight of the structure above. Successive short lengths of steel or concrete pile or of steel H-sections are driven and welded or interlocked to form continuous piles. Pipe piles are often jacked down with their lower ends open; the soil within is removed with small grabbing buckets and replaced with concrete.

When the load is transferred to the new foundation, it inevitably causes settling. To avoid this, jacks usually are left in place while the new concrete sets and shrinks. Shrinkage is compensated with wedges and expanding mortar, and the jacks are recovered.

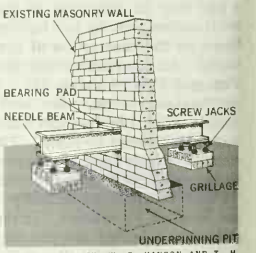

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FIG. 9.—SHORING WITH NEEDLE BEAMS TO PERMIT REPLACEMENT OF FOUNDATION

Water Control.—Foundations often extend below groundwater level. In clayey soils seepage may be negligible; but, with such pervious foundation material as sand or gravel, it may not be possible to excavate below water level without an inflow of material. This may produce instability in excavation slopes and detrimental settling of adjacent structures. Moreover, quick conditions may be induced in the foundation material with a loss of bearing capacity (*see* QUICKSAND). Drainage ditches and sump pumps may prove satisfactory, but it is often desirable before excavation to dewater the site with well points. These are vertical riser pipes with screened sections at the bottom (fig. 10), usually jetted into position to form a filter of sand around the riser, and

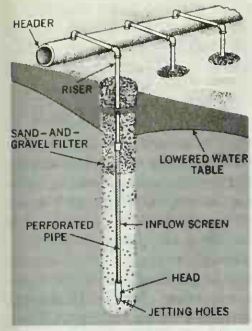

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FIG. 10.—WELL-POINT ASSEMBLY FOR DEWATERING FOUNDATION MATERIAL

connected through a header pipe or manifold to a pump. Such points spaced 3 to 8 ft. apart (depending on the permeability of the deposit) can usually lower the water table 15 to 20 ft. The materials above the lowered water table can then be excavated efficiently. Additional well points may be installed as excavation deepens, or wells of larger diameter may be used, each with a submersible deep-well pump (*q.v.*).

Intermediate in grain size and permeability between sand and clay, silts cannot be drained in a reasonable time by such simple procedures, but require special treatment.

Foundations for Dams.—In addition to satisfying strength and stability requirements, foundations for dams must not permit excessive seepage of water, which may lead to dangerous underground erosion and "piping." Many catastrophic failures of dams have been attributed to these phenomena. The evaluation of subsurface conditions at a damsite, and the determination of suitable procedures for design and construction, are particularly difficult aspects of foundation engineering. *See* also ARCHITECTURAL ENGINEERING.

See Ralph B. Peck, W. E. Hanson and T. H. Thornburn, *Foundation Engineering* (1953). (R. B. P.)

FOUNDING, the process of melting metal and pouring it into a cavity that has been molded on a pattern of the desired shape. When the metal solidifies the result is a casting—a metal object conforming to the shape of the cavity. This process is practised by foundries all over the world as a basic method for the production of metal shapes, utilizing in one form or another almost all of the metals known to man.

This article deals with the materials and processes used in foundries: for a discussion of metallurgical aspects of these processes *see* METALLURGY: *Cast and Wrought Metal.*

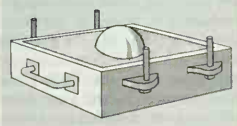

FIG. 1.—MOLD BOX AND PATTERN

The Mold.—A variety of materials is used in making molds, the most common being a mixture of sand and clay moistened with water. This mixture is firmly packed over the face of the pattern forming the cavity in which the casting is to be made. The whole is enclosed by a receptacle called a box or flask. (*See* fig. 1.)

The mold must be strong enough to resist the pressure of the metal and at the same time sufficiently permeable to permit the escape of air and gas from the mold cavity. Otherwise, these would remain as holes in the casting. The mold material must resist fusion by the heat of the metal and the surface next to the pattern be so closely knit as to avoid a rough casting surface.

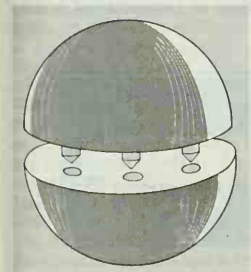

FIG. 2.—DIVISION OF PATTERN

The mold is made in two halves, each formed as described above and each contained in its own box. The upper half is known as the cope, the lower as the drag. The pattern must be so designed that the half mold can be lifted from its surface without breaking or tearing the mold material. (*See* fig. 2.) This requirement can be modified by the use of loose pattern pieces, withdrawn after the mold has been lifted.

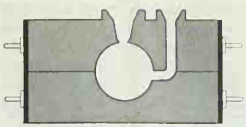

FIG. 3.—SECTION, COMPLETE MOLD

After removal from the patterns the cope and drag halves are joined, as shown in fig. 3, to make a complete mold.

The two halves are aligned so that the pattern cavities match exactly. This is accomplished by pins and bushings that are close fitting and located with precision. In forming the mold, provision is made for channels or gates through which the metal flows to the casting. Since the metal shrinks appreciably in volume as it solidifies, it is sometimes necessary to provide an additional reservoir of metal, called a riser, which stays fluid long enough to feed metal to the casting during this critical period.

Patterns of unusual or more complicated contour require the use of multiple boxes (fig. 4). In molding boxes of more than 14 in. square, crossbars serve to carry the sand; fig. 5 shows a drawing of the sections of this type box.

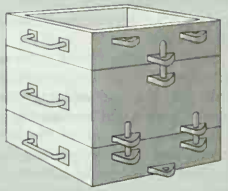

FIG. 4.—MULTIPLE MOLDING BOX

Mold Materials.—Suitable molding sands are found in natural deposits from which they can be mined and used without much alteration. The size and shape of sand grain is important and requirements vary for different metals. Comparatively coarse sands are used for casting steel and iron; finer sands are needed for copper and aluminum alloys. Molding sand deposits have enough clay to serve as a bond.

As natural deposits of good molding sand have become exhausted or less accessible, there has resulted a practice of using what are called synthetic sands. In this process, sands containing little or no clay are blended with clay or a claylike material such as bentonite (*q.v.*). Sand is prepared for use by mixing with the desired amount of water in a muller which coats each grain of sand with moistened clay by a kneading action. At this point certain other materials may also be added, such as flour to give the molded sand a certain amount of elasticity. Finally the mixture is aerated in a machine that breaks up lumps and gives the sand a fluffy texture. These operations are sometimes performed by hand with a shovel, but even in small foundries the use of machines is more common. For best results the physical character of the sand must be closely controlled; this is accomplished by testing equipment designed to measure strength, moisture content and porosity or permeability. These properties need to be held within narrow limits, whether the sand in use is natural or synthetic.

While clay and water are most often used to bond the sand, other bonds are sometimes employed. Molds can be made from sand mixed with a petroleum product or with man-made materials such as the synthetic resins or plastics. These are used only when their greater cost is offset by special advantages or unusual molding requirements. Several less generally used molding methods, described below, are based on a variety of differing materials.

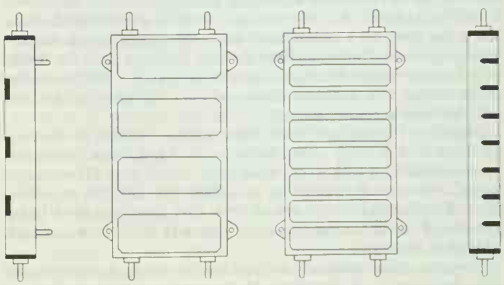

FIG. 5.—MOLDING BOX WITH CROSSBARS

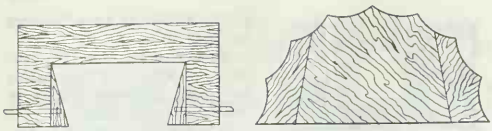

FIG. 6.—PATTERNS
(Left) with loose pieces, (right) for fluted column

Patterns.—If an accurate casting is to be obtained it is evident that an accurate pattern must be used in forming the mold. The making of such a pattern is a craft requiring great skill. When a considerable number of castings is needed it is usual to make a master pattern of wood from which working patterns can be cast in metal. Otherwise, the original pattern of wood or metal may be used in the foundry.

Since the metal in the casting will shrink as it solidifies, the pattern must be larger than the desired casting. Different metals have different shrinkage characteristics and allowance for this is made in making the pattern. Also the shrinkage is not always uniform in different directions, a variation which is sometimes unpredictable.

Sample castings have to be made before the pattern is actually put in service. When several pattern pieces are mounted on one plate for machine molding, their position on the plate must be perfectly matched so that the cope and drag halves of the mold will have an exact fit at the parting line. All pattern pieces must taper away from the parting line so that the pattern can be withdrawn from the mold without disturbing the mold material. Because of this taper some patterns must be formed of several loose pieces temporarily held in position by pegs, as shown in fig. 6 (left), or without pegs as in fig. 6 (right). Removal of the pattern may be facilitated by sprinkling it with a fine parting sand or compound to prevent adhesions.

When a metal pattern is employed, the need for a parting compound may be avoided by heating the pattern while in use, commonly by means of electrical heating elements.

Cores.—While many castings are solid, it more often happens that a hollow space is desired within the casting. Obviously this cannot be accomplished by the pattern, which must be removed without breaking the mold. To form the hollow, it is necessary to set a core in the drag. The core is so placed that there is an open space for the flow of metal between it and the face of the mold. In the finished casting the core is surrounded by metal except at openings through the casting wall, which form orifices from the hollow centre to the outside. The core material is removed through these openings and consequently must be so constituted that it loses strength when exposed to the heat of the metal and can easily be broken up.

Like molds, cores are made from a variety of materials, but most cores consist of clean sand mixed with an organic binder, often linseed oil or a blend of linseed oil with rosin, fish oil, vegetable oils or petroleum oils. Other substances such as cereal flours or bentonite are sometimes used. The core is very fragile when first made but is hardened by baking in an oven at 400° F. or more. Cores of the linseed oil type require slow baking in the presence of air since the hardening process is one of oxidation. A synthetic plastic resin is sometimes used as a binder and, when this is the case, the core can be baked very rapidly by an electrothermic process. In this method the core is heated from the inside out, the oven itself remaining comparatively cool. The hardening of the binder is a chemical change which takes place within the resin itself as a result of heat.

Simple core boxes built in sections to allow removal of the core are illustrated in fig. 7. Sometimes, as in fig. 8, loose pieces are employed that are withdrawn separately. Cores may take various curved forms as shown in fig. 9, a half-core box for an elbow pipe. Freshly made cores are so weak that they may have to be transferred to supporting frames or driers to hold them in shape until after baking.

Cores are made manually by packing the sand mixture into an open core box or, if the shape of the core and the quantity required permit, they are made in machines. In the latter case, the core box is clamped in place underneath a reservoir of the sand mixture which is then blown into the box by compressed air at a pressure of about 100 lb. per square inch. Often the box contains several core cavities that are thus filled at the same time. Since filling is almost instantaneous, provision must be made for rapid escape of air; otherwise the cavity will not fill completely. This is accomplished by means of orifices with screens so fine as to prevent the passage of sand.

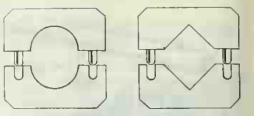

FIG. 7.—SIMPLE CORE BOXES

Patterns have core prints and the cores are placed in the imprints so that alignment is assured (*see* fig. 10).

Mold Making.—Molds may be made by hand and, in the case of very large molds, this is a common practice. Molds of medium or large size are often packed by a machine called a slinger. This has a head which can be moved to apply sand, by blowing or throwing, with equal force on all parts of the pattern. When the molds are not baked or dried they are known as green sand molds.

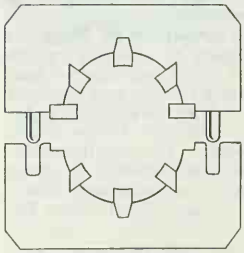

FIG. 8.—CORE BOX WITH LOOSE PIECES

Unless the number required is small or unusual molding skill is needed, small molds are made in machines that compact the sand by squeezing with air pressure, by mechanically jolting the sand into place, or by a combination of these methods. When a machine is used the molder is a machine operator rather than a craftsman; a minimum of skill is required and rapid production is possible.

Methods of Molding.—In large-scale production, where a great many identical small castings are to be made, the whole operation of sand conditioning and molding is sometimes almost completely automatic. The sand is carried by conveyers to conditioning units where water, clay, new sand and other additions are mechanically made in predetermined amounts. At the molding machines measured quantities of sand pour into the flasks; the flasks themselves and completed half molds are handled mechanically. Both cope and drag are conveyed to a closing position, where they are accurately joined. The finished green sand molds, on a moving conveyer, proceed to the pouring area and then to the shakeout, also mechanized, where the castings are removed from the molds. Broken moldings, reduced to sand, leave the shakeout on one conveyer, castings on another.

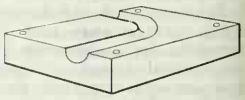

FIG. 9.—ELBOW CORE BOX

Cope flasks automatically go back to the cope machine and drag flasks to the drag machine. An outfit of this kind results in spectacular labour saving, but the investment is so great that it can be justified in only the largest operations. Smaller foundries make such use as they can afford of conveyers and labour-saving machinery.

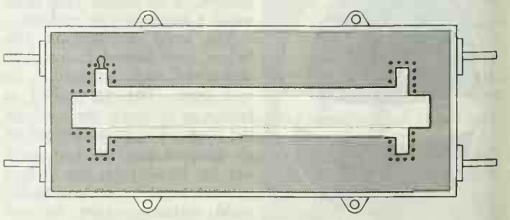

FIG. 10.—HALF-MOLD FLANGED PIPE READY FOR CORE
Core placed on two prints will leave space as shown

Although most molding is done by the green sand method, a number of other methods are in use. Green sand molds are sometimes strengthened by baking in an oven or the working surface is hardened by going over it with a torch. Molds may be assembled with shapes made from a core mixture and baked, a method particularly applicable for castings of odd shape that cannot be made in a conventional mold. Sand may be bonded with a synthetic resin, in place of clay and water, and used in the shell molding process. For this purpose a dry mixture of sand and powdered resin is spread over a heated pattern. The heat of the pattern melts the resin and then hardens it, forming a thin shell in the shape of the pattern.

The shell, after curing at a somewhat higher temperature, has considerable strength and can be stored indefinitely. The finished mold is formed by clamping or cementing together the cope and drag shells. In this manner more accurate dimensions and an improved surface can be obtained in casting some metals, notably the stainless steels. Cores, hollow instead of solid, are also made by the shell process.

For certain special applications, cements are used in place of clay. Iron and steel castings weighing many tons are sometimes made in sand bonded with portland cement. Time must be allowed for the cement to set before metal can be poured into the mold. Small castings of intricate shape, where a smooth finish and a minimum of machining are important, are often made in plaster of paris molds. The properties of the mold are augmented by mixing the plaster of paris with talc, asbestos and sometimes sand. The molds must be baked and should be poured while still warm from the oven.

Castings with very delicate parts, or so shaped that they cannot be made by conventional methods, can be produced by what was once known as the lost-wax process, more often called precision or investment casting. (*See* also SCULPTURE TECHNIQUES: *Modeling and Casting.*) The desired shape is formed from wax or a synthetic plastic and is coated with a refractory cement. After drying, this is placed in a box and enveloped in a porous cement which makes up the main body of the mold. When the cement has set and is sufficiently dry the mold is heated to a temperature sufficient to melt the wax which drains out, leaving cavities to be filled with metal for the finished casting. Alloys with low melting points or even frozen mercury are sometimes substituted for the wax

If sand is mixed with sodium silicate (water glass) and formed into a mold which is then treated with carbon dioxide gas, a reaction takes place between the gas and the silicate forming a colloidal or jellylike silica gel that acts as a firm binder for the sand. While this method is in use for molding, it is especially applicable for the making of cores that are so strong when first made that they do not require baking.

Metal molds that can be used over and over again are widely employed for casting alloys of aluminum and magnesium when a large number of identical castings are to be produced. Some cast iron is also made in this manner, and to a limited extent brass and bronze. The molds are coated with a refractory wash to protect them from the action of the molten metal. These molds are poured by gravity just as when expendable molds are used. Such low-melting alloys as those composed principally of zinc or aluminum lend themselves well to what is called pressure die casting. In this process a metal mold is mounted in a machine equipped with automatic controls. The liquid metal is forced into the die under high pressure and solidifies immediately.

This method is particularly applicable when many small intricate castings are to be made or for rather large castings, such as automobile door frames and grillwork, where there is an extended area of thin cross section. The dies are costly and at high temperatures are too short lived for use with such metals as iron and steel. To a limited extent the process is used with the copper alloys.

In the manufacture of small castings "stack molding" is sometimes employed. Half molds are stacked one on top of another to form a multiple mold that is poured at one operation from a common feed. Large cast-iron pipe, or cylinders of other metals, are cast by a centrifugal method in which a metal or baked sand mold is rotated rapidly enough to overcome the action of gravity. The liquid metal is forced against the face of the mold to form a spun casting of high density. Some progress has been made in the application of this process to smaller castings, not necessarily cylindrical, arranged around a central feed.

Furnaces.—Various steel composition, alloys of nickel and some of the complex alloys required for high-temperature service are melted and superheated to temperatures in the range of 2,500° to 3,000° F. or even higher. While certain types of fuel-fired furnaces, such as the open hearth, can be employed at these temperatures, foundries commonly use electric furnaces.

In the direct arc furnace intense heat is generated by bringing a carbon or graphite electrode directly into contact with the metal to be melted. Passage of electric current forms an arc at the point of contact. In the induction furnace the metal to be melted is separated by a refractory wall from a coil carrying electric current. The arrangement is such that passage of current through the coil induces a flow of current in the metal itself. The temperature attainable is limited only by the electrical resistance of the metal as it melts. For relatively small melts of stainless steel and the like this is a favourite method.

Cast iron is most commonly melted in a cupola, a sort of chimney in which the iron is mixed with burning coke. The mixture of iron and coke is charged at the top of the cupola. The iron melts as it progresses downward and is eventually drained through a tap hole at the bottom.

The copper alloys, such as brass and bronze, melt at lower temperatures and contain volatile constituents that cannot tolerate the high temperature of the direct arc or, in most cases, direct contact with fuel. A variety of furnaces is employed. One is the indirect arc, in which the source of heat is an electric arc between two graphite electrodes above the surface of the metal. Electric induction furnaces are also widely used.

In some fuel-fired furnaces burning gas or vaporized oil strikes directly against the surface of the metal. In others the metal is enclosed in a crucible or melting pot surrounded by burning fuel. For aluminum and magnesium alloys cast-iron melting pots are commonly employed. Many of the metals will not produce satisfactory castings unless the temperature at which they are poured is closely controlled. This is accomplished by temperature measuring instruments known as pyrometers.

For descriptions of various furnaces and their operation *see* FURNACE, METALLURGICAL.

See also CAST IRON; CRUCIBLE STEEL; CUPOLA FURNACE; DIE CASTING; and articles on various metals and alloys as ALUMINUM; COPPER; etc.

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FOUNDLING HOSPITAL. Institutions for foundlings—infants, usually illegitimate, who had been abandoned or exposed and left for public care—were established during the 7th and 8th centuries in Trier, Milan and Montpellier, the 14th century in Venice, the 15th century in Florence and the 17th century in Paris and Lyons. The celebrated Foundling hospital of London was established by Thomas Coram (*q.v.*) in 1739; a basket was hung outside the entrance and unwanted infants deposited there were admitted without question. The policy of unrestricted admission inaugurated by a parliamentary grant in 1756 was discontinued in 1760, though the grant continued until 1771. In the 20th century a program of boarding out or foster home care was evolved and the hospital became the Thomas Coram Foundation for Children.

The first institution in the United States designated for foundlings seems to have been St. Vincent's Infant asylum, established by the Sisters of Charity (St. Vincent de Paul) in Baltimore, Md., in 1856. Between 1860 and 1873 six others were founded; two in Washington, D.C., and one each in San Francisco, Calif., New York city, Chicago, Ill., and Cleveland, O. In the United States, as in Great Britain, foster care has largely replaced institutional care for infants and children. Many of the infants formerly referred to as

"foundlings" or "deserted" are cared for by legal adoption. *See* CHILD WELFARE.

FOUNTAIN, a term applied to simple arrangements for letting water gush into a basin, and to more elaborate ones in which water is forced mechanically in high jets. The term is applied equally to the ornamental receptacle and to the jet of water itself.

An early example is preserved in the carved Babylonian basin (*c.* 3000 B.C.) found at Tello, the ancient Lagash in Mesopotamia. An Assyrian fountain discovered in the gorge of the Gomel river consists of basins cut in solid rock and descending in steps to the stream. Small conduits led the water from one basin to the other, the lowest of which was ornamented by two rampant lions in relief.

Greek.—During the Aegean civilization, as in later Hellenic Greece, springs were frequently considered sacred and shrines were built around them, the water often emerging into artificial basins.

In historic Greece, more highly developed fountains existed; both literary references and excavated remains abound. Sometimes a planted grove or architectural setting provided for nearby shrines. Some were surrounded by columns, as at Lerna. The city of Corinth was noted for its fountains, particularly the spring dedicated to the nymph Pirene. Greek fountains were utilitarian as well, being provided with ample draw basins and reservoir supply and often shaded by a portico.

Roman.—In Roman civilization, water was distributed from each terminal reservoir, or *castellum,* to baths and large houses as well as to many public fountains which supplied the bulk of the population. Examples uncovered at Pompeii illustrate both types, the more decorative courtyard fountain of the aristocratic house and the utilitarian public street fountain. The latter consisted of a simple rectangular stone basin with a small pedestal above it carved with a human or animal head from whose mouth water flowed. The lip of the basin was notched for overflow.

In addition to the above types, the Romans developed the nymphaeum (*q.v.*), a purely decorative type of fountain originating in Hellenistic times. Roman nymphaea became monumental pleasure houses, often in the shape of an exedra covered by a half dome. The details of the fountain proper varied from multiple basin arrangements to the jet of water issuing from a sculptured figure. The architectural decoration was rich, often in mosaic. In addition to actual remains, wall paintings of the period illustrate Roman fountains and testify to their popularity as garden decorations.

In early Christian times, fountains were placed in the atrium court of the Christian basilica as symbols of purification; *e.g.,* old St. Peter's, Rome. Similar courtyard fountains continued to be used in the monasteries of western Europe and the Byzantine empire (*e.g.,* Cluny; Vatopedi on Mt. Athos).

Medieval.—In the earlier middle ages, ornamental and architectural treatment of fountains passed out of use; wells furnished the greater part of the necessary water. From the 12th century, however, public fountains began to reappear and the spring fountains received architectural treatment. The usual form of the latter consisted of a large basin reached by a descending stairway and covered over with a vault, sometimes enclosed and sometimes supported only on piers. At Poitiers, the Fontaine Joubert (14th century, restored 1597) was originally of this type. Other crude examples are common in Brittany. The public fountains of the medieval towns usually had a polygonal or circular basin, occasionally lobed, in the centre of which rose a column or pier carrying a series of spouts. The architectural details are of infinite variety. From the simple hexagonal vase and column of the 12th-century fountain at Provins to the elaborate richness of the 15th-century fountains of southern Germany, every kind of Gothic detail is found. Fountains were a peculiar feature of the communal building activities of the late middle ages, often commissioned by guilds. Few of these survive. A noteworthy example is the Schöne Brunnen at Nürnberg (1398), distinguished by its high, rich Gothic spirelet with many statues and ironwork railing.

The late middle ages developed decorative table fountains as extravagant toys. Also, contemporary Byzantine court versions of table fountains running with spiced wines are recorded. Unfortunately no examples of this type have survived.

Islamic.—The fountains of Muslim countries are of great importance, especially the public drinking fountains, called sebeels. They are an institution in the east. A common type is the simple spout and basin enclosed within a graceful niche. The more ambitious designs take the form of a richly decorated pavilion.

Renaissance and Baroque.—The Renaissance in Italy began a new phase of fountain design in which sculpture became prominent. A common type was a sequence of circular or polygonal basins on a vertical support topped by a fountain figure from which water spouted. Leonardo da Vinci did designs for fountains. During the following period of the Italian baroque, fountains became complex compositions of basins, sculpture and water display. Rome is noted for its many fountains of baroque design, notably the Fountain of the Rivers (1647) in the Piazza di Navona by Giovanni Bernini and the Trevi fountain (completed 1762) by Niccolo Salvi. Such fountains dramatized the rebuilding of the city, its piazzas and its churches, done under papal direction.

In addition to these public fountains, the Italian development included an enormous number of original villa garden fountains of spectacular and sometimes amusing designs. Trick effects were made possible by elaborate mechanical devices. For example, the water organ at the Villa d'Este, Tivoli (1549), played only when certain pavement stones were stepped on. The hillside location of most villas was utilized, upper fountains supplying the lower ones in turn as at the Villa d'Este and the cascade at Villa Aldobrandini, Frascati.

Italian precedent set the design for monumental civic fountains and for ornamental garden fountains in northern and western Europe.

An early example of an ornamental fountain in France is the Fountain of the Innocents (1550) in Paris by Jean Goujon, an original work which does not follow Italian models. The Medici fountain in the Luxembourg gardens in Paris by Salomon de Brosse is a fine example of the niche type. The most spectacular and ambitious fountains in France are those at Versailles, part of the vast garden complex designed by André Lenôtre (1661). Large reflecting pools were part of the axial scheme and fireworks often accompanied the fountain display. Hardly secondary to the artistic achievement was the engineering feat of supplying water in volume and pressure to run the numerous fountains at Versailles. Purely ornamental fountains continued to be popular in the 18th century as focal points for civic design in large cities and as decoration for royal palaces and country seats.

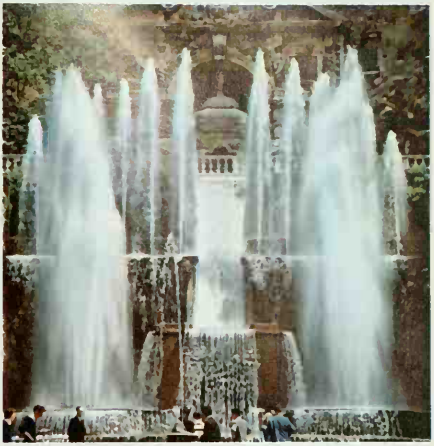
Modern.—Chatsworth in England was noted for its fountains designed by Sir Joseph Paxton in the 19th century, especially the single jet of water 260 ft. high issuing from a formal reflecting pool. Elsewhere at Chatsworth, a false willow tree of copper rained water on the unsuspecting beneath its branches.

In the 19th and 20th centuries fountains did not lose their popularity although quality and imagination is less evident. Expositions have provided occasion for ambitious fountain displays. Among the many examples are the Crystal palace at Sydenham, London; the World's Columbian exposition at Chicago, Ill. (1893), and the New York World's fair (1939). At the Festival of Britain, London (1951), a mobile water sculpture composed of pivoted receptacles was set in motion by changing points of gravity. When each receptacle was filled, it would overturn only to right itself and be filled again with water from above. Of permanent fountains, a fine modern example, although derivative in design, is the Buckingham Memorial fountain in Chicago (1927) by Jacques Lambert. (T. F. H.; H. F. K.)

FOUNTAIN PEN: *see* PEN.

FOUQUÉ, FRIEDRICH HEINRICH KARL DE LA MOTTE, BARON (1777–1843), one of the early German romantic writers, was born of French Huguenot stock in Brandenburg, Feb. 12, 1777. A godson of Frederick the Great, and loyal to the Hohenzollern house, he composed most of his works with the patriotic intention of awakening in his contemporaries during the Napoleonic era an awareness of German tradition and national character. He also tried to re-establish confidence in aristocratic

Gefion fountain, Copenhagen, Den., designed by Anders Bundgaard in 1907

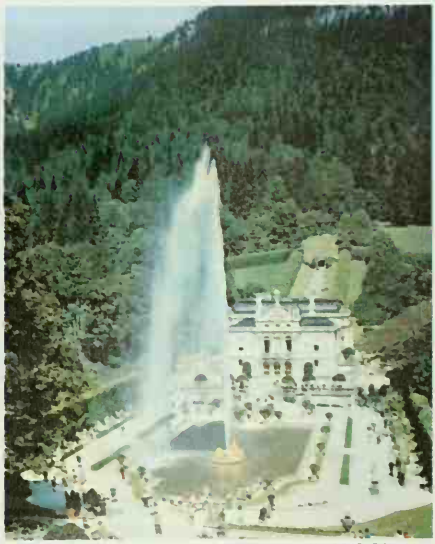


The water organ and waterfalls of the Villa d'Este, at Tivoli, Italy

FAMOUS FOUNTAINS

Fountains in the gardens at Versailles, France, designed during the period of Louis XIV

The Sun fountain at Peterhof, palace of Peter the Great, Leningrad. Peterhof was designed by the French architect Jean Baptiste Leblond (1679–1719)



Fountain of the Linderhof Palace, built by Louis II (1845–86), king of Bavaria. Near Garmisch-Partenkirchen, Ger.

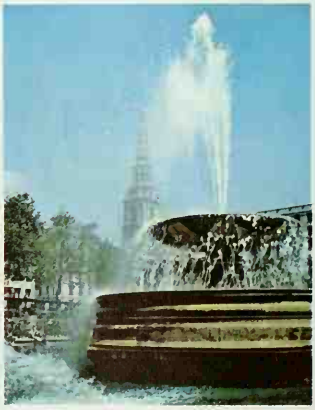
PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) DANA BROWN FROM FPG, (TOP RIGHT) SILBERSTEIN FROM CAMERA PRESS, (CENTRE LEFT) NADELMANN FROM SHOSTAL, (BOTTOM RIGHT) DUNCAN EDWARDS FROM FPG

FOUNTAIN

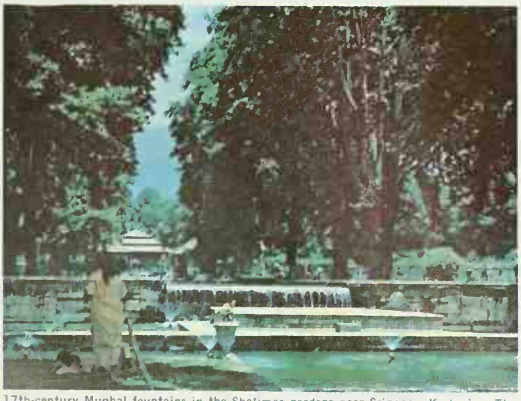
The Trevi fountain of Rome, designed and begun by Niccolò Salvi (1697–1751) and completed by Giuseppe Pannini in 1762

Fountain of the Place de la Concorde, Paris; designed by J. I. Hittorff in 1854

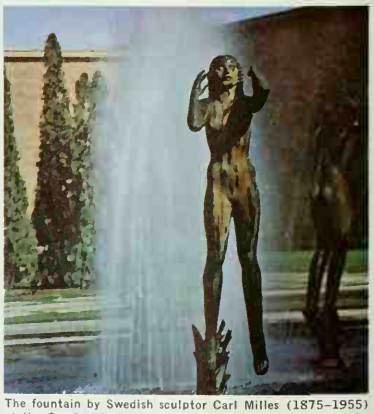
FAMOUS FOUNTAINS



One of the fountains of Trafalgar Square, London, by Sir Charles Barry (1795–1860)



17th-century Mughal fountains in the Shalimar gardens near Srinagar, Kashmir. The elaborate system of placid pools, graceful pavilions, and miniature waterfalls is typical of Islamic design



The fountain by Swedish sculptor Carl Milles (1875–1955) at the Cranbrook Academy of Arts, Bloomfield Hills, Mich., where Milles taught for many years

PHOTOGRAPHS: [illegible] HUGH CAREY, KEYSTONE, (TOP RIGHT) DANESE—RAPHO, (CENTRE RIGHT) WILLIAM G. FROELICH, (BOTTOM LEFT) F. C. WARD, (BOTTOM RIGHT) BALTHAZAR KORAB

government. His ideas were based on the view of linguistic development developed by J. G. Fichte, and he stressed the influence of the mother tongue in shaping the mind. At first his romantic allegories and popular versions of Germanic myth were enthusiastically received, but after 1820 his ideas were increasingly rejected as outmoded, his approach as unrealistic. Of his prolific writings only the fairy tale *Undine* (1811; modern edition by W. W. Chambers, 1956; Eng. trans., with other stories, by E. Gosse, 1932) is still widely known. For the literary historian, *Der Held des Nordens* (1810), the first modern dramatic treatment of the *Nibelungen* story, and *Der Zauberring* (1813; Eng. trans., 1846), a popular allegorical novel describing the racial complex of Europe, are, however, of interest. The conventional rating of Fouqué dismisses him as an unpractical dreamer, underestimating his thorough scholarship in the matters of Germanic folklore and even more his effective writing between 1810 and 1820. During that decade he was highly esteemed by A. W. Schlegel, among many others, and was chosen as their literary sponsor by Adelbert von Chamisso and Joseph Eichendorff. He died in Berlin (Jan. 23, 1843) in poverty, after belated recognition by Frederick William IV.

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FOUQUET, JEAN (*c.* 1415–1485), French painter remembered especially for his miniatures, was born at Tours. He visited Italy before 1447, since he executed the portrait of Pope Eugenius IV, who died in that year at Rome. There he absorbed the progress that such Italian painters as Tommaso Masaccio, Fra Angelico and Piero della Francesca had made in the handling of central perspective and foreshortening and in the rendering of plasticity and volume.

Upon his return to Tours Fouquet created a new, realistic art similar to that of Jan van Eyck in Flanders, with the same exquisite precision of characterization and detail. He was soon favoured in court circles by the king and high nobility. Like other great painters of the 15th century, he worked both as a panel and a miniature painter. He even worked in enamel, as his remarkable medallion with the self-portrait in the Louvre proves. For the royal secretary and lord treasurer, Étienne Chevalier, he executed between 1450 and 1460 his most famous works: a large "Book of Hours" with about 60 full-page miniatures, of which 40, now dismembered, are among the great treasures of the castle of Chantilly; the diptych from Notre Dame at Melun with Chevalier's portrait (Kaiser Friedrich museum); and a Madonna with the features of Agnes Sorel, the king's mistress (Antwerp museum). In these works he revealed his unsurpassed mastery of the new monumental representation which permeated European art in this century. In the same decade he also painted the portrait of King Charles VII (Louvre, Paris) and his queen (now lost), and that of the royal chancellor, Guillaume Jouvenel des Ursins (Louvre). Also to this last decade of the reign of Charles VII belong the two richly illuminated manuscripts, Boccaccio's *Cas des Nobles Hommes et Femmes* (1458, Munich library), and a copy of the *Grandes Chroniques des Rois de France* (Bibliothèque Nationale, Paris); and finally, the large altarpiece of the "Pietà," which was discovered in the church at Nouans. The latter represents his only monumental painting, since his "Ascension of the Virgin," painted for the archbishop of Tours in 1763, was destroyed by the iconoclasts.

In 1469 King Louis XI founded the Order of Saint Michael, and Fouquet was charged to illuminate the statutes of the order (Bibliothèque Nationale, Paris). In 1474 he worked with the sculptor Michel Colombe on the design of the king's tomb, and in the same year received the official title of royal painter. About the same time he completed the illustration of two volumes of Josephus' *Antiquités judaïques* (Bibliothèque Nationale, Paris). *See* also ILLUMINATED MANUSCRIPTS: *15th- and 16th-Century*.

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FOUQUET (FOUCQUET), **NICOLAS** (1615–1680), French finance minister in the early years of Louis XIV's reign, the last *surintendant* (as opposed to *contrôleur général*), whose career ended with his trial for embezzlement, was born in Paris in 1615. Belonging to a powerful family of the *noblesse de robe*, or judiciary nobility, Fouquet was received as *avocat* in the *parlement* of Paris at the age of 16 and became master of requests in 1636. In 1640 he married Marie Fourché (d. 1642), daughter of a counselor in the *parlement* of Rennes, by whom he had one daughter, Marie. Between 1642 and 1648 he was intendant first with the army on the northern frontier, then in Dauphiné, then in Catalonia and finally in Paris. A supporter of Cardinal Mazarin and of the royal government during all the troubles of the Fronde, he bought the important post of *procureur général* to the *parlement* of Paris in 1650. In Feb. 1651 he was married to Marie Madeleine de Castille, of a rich family of the *noblesse de robe*. By this marriage, which greatly increased his wealth, he had three sons and one daughter.

In reward for his faithful services to Mazarin, Fouquet on Feb. 8, 1653, was appointed *surintendant des finances*, jointly with Abel Servien (who died in 1659). Thenceforward he put his own personal credit, which was considerable, at the service of Mazarin, who until his death conducted the government for Louis XIV. To help Mazarin, who in return upheld him, Fouquet lent considerable sums to the treasury during the war against Spain, thus making himself, as it were, banker to the king. At the same time his numerous financial operations, which he conducted in a very irregular way but even so in accordance with the usage of the times, made him extremely rich. Thus, between 1656 and 1660 he was able to build the magnificent château at Vaux-le-Vicomte, near Melun, which was designed by Louis Levau, and decorated by Charles Le Brun, with gardens laid out by André Le Nôtre. He was an important patron of writers, supporting Molière, Jean de La Fontaine, Paul Scarron, Paul Pellisson and Pierre and Thomas Corneille. His private life was dissolute. Moreover, recognizing the possibility of a reversal in his fortunes, he acquired, under his own name or through intermediaries, powerful positions in Brittany or off the Breton coast, notably at Belle-Isle, which he fortified so as to provide himself with a retreat in case of prosecution.

AUTHENTICATED NEWS

"VIRGIN AND CHILD WITH ANGELS" BY JEAN FOUQUET: C. 1450. IN THE KONINKLIJK MUSEUM, ANTWERP, BELG.

Fouquet had long been friendly with Jean Baptiste Colbert, Mazarin's personal intendant and closest confidant. Eventually, however, conflicting interests and ambitions made the two men rivals. After Mazarin's death (March 1661), Fouquet hoped to take his place as prime minister, but Louis XIV instead decided to govern personally, with no prime minister. Colbert then destroyed Fouquet's reputation with the king, revealing irregularities in his accounts and denouncing the financial operations which had enriched him; and a cabal was organized to alienate the sympathies of the queen mother, Anne of Austria, from Fouquet. On Aug. 17, 1661, Fouquet received the king at Vaux and arranged a sumptuous *fête* for him. As early as May, Louis had decided to arrest Fouquet, and the magnificence of the entertainment at Vaux, displaying how much Fouquet must have amassed, sealed his fate. During a visit of the court to Nantes, Fouquet was arrested, in the morning of Sept. 5, 1661. Criminal proceedings against him lasted three years and excited great public interest. He was tried by an extraordinary chamber sitting at the Arsenal in Paris and packed with people hostile to him. Colbert, without any rightful standing in the case, interfered in the trial and made it his personal affair, because he wanted to succeed Fouquet as finance minister. Whatever the faults and abuses committed by the accused, the trial was a parody of justice. Fouquet was long denied the help of lawyers; while the inventory of Fouquet's papers was being made, Colbert suppressed many that would have proved Mazarin's personal responsibility for many of the operations in question; and pressure was brought to bear on those of the judges who showed themselves favourable to the accused or simply anxious for justice. Fouquet, thoroughly accustomed to legal procedure, defended himself cleverly and published or caused to be published numerous *memoranda* in his defense. Public opinion, at first hostile to him, turned in his favour when the maneuvers of his enemies came to light. Many pamphlets and satires were written for and against both Colbert and Fouquet.

On Dec. 20, 1664, Fouquet was condemned to banishment by 13 votes to 9, but Louis XIV "commuted" the sentence to life imprisonment. Fouquet was taken to the fortress of Pignerol (Pinerolo), where he died on March 23, 1680, on the eve of a measure of clemency in his favour and shortly after being allowed to see his family again.

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FOUQUIER-TINVILLE, ANTOINE QUENTIN (1746–1795), French Revolutionary lawyer responsible for making the Revolutionary tribunal a chief instrument of the Reign of Terror, was born at Hérouel, Picardy, of a family of wealthy landowners, on June 10, 1746. He studied law, became attorney at the Châtelet in Paris in 1774 and married his cousin Geneviève Saugnier. Several months after her death in 1782 he married Henriette Gérard. In 1783 he sold his office and worked hard to support his seven children. On Aug. 25, 1792, he was appointed director of the jury of prosecution of the tribunal dealing with crimes committed at the suspension of the monarchy. Early in 1793 he became assistant public prosecutor of the criminal tribunal of the *département* of Paris, and on March 15 public prosecutor of the Revolutionary tribunal re-established on March 10. He drew up the indictments of Marie Antoinette, the Girondins, Mme du Barry, the Hébertists and the Dantonists. Hardworking, eloquent and ruthless, he claimed to have judged more than 2,400 counterrevolutionaries.

After Robespierre's fall, Fouquier-Tinville demanded his outlawry, but was in turn attacked by the Thermidorians. In his defense he claimed to have upheld justice and to have merely obeyed the orders of the Revolutionary government's committees. Notwithstanding, he was condemned to death and executed on May 7, 1795.

See the documents relating to his trial enumerated by M. Tourneux in *Bibliographie de l'histoire de Paris pendant la Révolution française*, vol. i, no. 4445–54 (1890); also P. Labracherie, *Fouquier-Tinville, accusateur public* (1960). (MA. Bo.)

FOUR FREEDOMS, a formulation of social and political objectives for the people of the U.S. and, ultimately, the world, as defined by Pres. Franklin D. Roosevelt in his "state of the union" message to congress Jan. 6, 1941. Roosevelt stated these freedoms to be: the freedom of speech and expression, the freedom of every person to worship God in his own way, the freedom from want and the freedom from fear.

An integral part of freedom from fear was Roosevelt's plea for "a world-wide reduction of armaments to such a point and in such a thorough fashion that no nation will be in a position to commit an act of physical aggression against any neighbor—anywhere in the world."

FOUR-H CLUBS represent a program of "learning by doing" for children and young adults. The clubs originated among rural youth in the United States in the early years of the 20th century, the name 4-H club being generally accepted by 1924. By the 1960s the clubs' combined membership totaled around 2,500,000 in the U.S. and an approximately equal number in 70 other countries, including nearly 70,000 in Canada. Around 310,000 adult and 110,000 junior leaders supervise more than 90,000 clubs in the U.S. and Puerto Rico, and about 13,500 leaders supervise the 5,000 Canadian clubs. The local adult leadership in the United States is recruited and trained by the extension services of the land-grant colleges and universities, the U.S. department of agriculture and county governments co-operating, under provisions of the founding Smith-Lever act of 1914 and subsequent acts of congress and the state legislatures.

Four-H clubs are no longer limited to rural youth; enrollment is approximately 50% farm, 30% rural nonfarm and 20% urban. Each local club—they vary in size but average 24 members, between ages 10 and 21—elects its own officers and plans and carries on its program with the guidance and instruction of one or more adult leaders, assisted by junior leaders. More than 50 different projects may be undertaken by 4-H members. For example, among agricultural activities that may be carried on in accordance with recognized approved practices are growing a field crop; raising a garden or a flock of poultry; purchasing, breeding and caring for a sow and her litter of pigs; raising a dairy calf to maturity and building a dairy herd; feeding and fattening for market one or more beef steers; or running and maintaining tractors and other farm machinery. Typical projects developed for urban as well as rural youngsters are: automotive care and safety; dog care and training; electricity, including electronics; indoor gardening; power lawn equipment and safety. Projects in home economics for girls include such basic activites as food preparation, clothing and home furnishing.

While the program of the 4-H clubs is flexible, their ideals remain unchanged. Much emphasis is placed on the development of citizenship, leadership and intelligent ability to co-operate; on the improvement and protection of health, and on services that may be rendered in the home and local community.

The 4-H club emblem is the four-leaf clover with the letter H on each leaf; the club colours are green and white. At regular meetings, achievement days and other 4-H events, the 4-H pledge is given: "I pledge my head to clearer thinking, my heart to greater loyalty, my hands to larger service, and my health to better living, for my club, my community and my country." The club motto is "to make the best better."

The U.S. department of agriculture sponsors and directs annually the National 4-H conference in Washington, D.C., during which member delegates become acquainted with the functions of the federal government and especially those of the department of agriculture. Another major annual event is the National 4-H Club congress, held in Chicago, Ill., to which members are named delegates as rewards for outstanding records of achievement in 4-H club work. The congress is conducted jointly by the co-operative extension service and the National 4-H Service committee. The latter is a privately supported voluntary group of citizens, incorporated not for profit; it publishes a monthly magazine, *National 4-H News*, and provides incentives and recognitions for meritorious 4-H work. The National 4-H foundation sponsors the International Farm Youth Exchange, by which U.S. boys and girls ex-

change residence for a few months with rural youth from many countries. This program, plus visits of foreign youth leaders to the National 4-H congress and conference, has been largely responsible for the introduction of 4-H outside the United States.
(G. L. Ne.)

FOURIER, (FRANÇOIS MARIE) CHARLES (1772–1837), French social reformer who advocated a utopian society based on the voluntary association of producers in units known as phalanxes. Born at Besançon, April 7, 1772, of a business family, Fourier spent an outwardly uneventful lifetime primarily as a commercial salesman with mediocre earnings. Though his material circumstances were meagre, Fourier's mind showed a high degree of creativity. He foresaw certain 20th-century socioeconomic practices and directions of thought, such as social insurance, job classification, investigation of industrial fatigue and problems of mental health. Free association for co-operative production was to Fourier the true basis for organizing an economy to achieve stable expansion of output and an equitable distribution of wealth and income as well. Fourier contrasted his projected "societary economy" to the "actual economy" which in his time he described as commercialism—competitive production for private gain.

Fourier is best known for his idea of the "phalanx," a co-operative community of approximately 400 families (of four members each) living in a *phalanstère* or common building. Phalanxes were to derive their incomes primarily from agricultural pursuits conducted on a large but intensive scale; manufacturing was to play only a supplementary role. The separate phalanxes throughout the world were to be related through direct barter and were thus to realize the benefits of division of labour and specialization. Interphalanx barter was to be conducted by a public-service clearinghouse system that would operate without middlemen's speculative profits. Local phalanxes were to organize their work in a variety of labour grades and detailed job classifications called groups and series. Every individual was to perform a variety of tasks. Fourier insisted that people must change tasks frequently, even during the single working day, because he believed that continued specialization on narrow tasks undermined physical and mental health.

The individual member of a phalanx was to be rewarded on the basis of the total productivity of the phalanx, not according to market supply and demand. Every individual beginning at the age of five was to receive at the societary bank a credit for a social minimum of expenditures, whether he worked, attended school or was infirm. Above this social minimum there was to be profit-sharing—five-twelfths to labour, four-twelfths to capital, three-twelfths to talent. Individuals were to save out of the annual profit income they received and by investing their savings become co-owners of the capital stock of the phalanx. The phalanx was to be physically arranged to provide a community centre, public school, library, large residential hotel, "shoppers' mall," public health service, trade clearinghouse, bank and a social insurance office.

Fourier's writings inspired numerous workingmen in the United States, including William H. Sylvis (1828–69), the first organizer of American trade unionism on a national scale. But Samuel Gompers (1850–1924), founder of the American Federation of Labor, dismissed Fourier's phalanxism as "escapism" and preferred realistic day-by-day collective bargaining in the framework of capitalistic private enterprise. Fourier strongly influenced Horace Greeley, Albert Brisbane, William Ellery Channing and others. His theories inspired the short-lived but memorable North American phalanx at Red Bank, N.J., Brook Farm near Boston, Mass., the Wisconsin phalanx and many others. Fourier died at Paris on Oct. 10, 1837. His lasting practical impact was to contribute a measure of reasoned support to the emergence of that mixture of capitalism, co-operativism and social control which at mid-20th century had become a commonplace of economic organizations in many nations. *See* also Socialism; Utopian Communities.

See *Oeuvres Complètes de Charles Fourier*, 6 vol. (1846–48); Hubert Bourgin, *Fourier, Contribution a l'étude de socialisme français* (1905).
(G. W. Z.)

FOURIER, JEAN BAPTISTE JOSEPH, Baron (1768–1830), French mathematician and physicist famous for his pioneer work on the representation of functions by trigonometric series, was born at Auxerre, France, on March 21, 1768, the son of a tailor. Left an orphan at eight years, he was admitted, through the influence of the bishop, to the military school at Auxerre, where he revealed his mathematical talent. Unable to enter the artillery because of his low birth, he became a teacher in mathematics at the military school in 1784 and later took a prominent part locally in promoting the Revolution, although he objected to the Terror. He taught at the École Normale at Paris from its institution in 1795, where his success soon led to the offer of the chair of analysis at the École Polytechnique. He was one of the savants who accompanied Bonaparte to Egypt in 1798 and was made governor of lower Egypt. Returning to France in 1801 he became prefect of Isère, with headquarters at Grenoble. While there he carried on elaborate investigations into the conduction of heat. In 1815 he rejoined Napoleon during the Hundred Days. Following the second restoration he settled in Paris in 1816. He was made a member of the Academy of Sciences in 1817 and he became joint secretary with G. Cuvier in 1822. Believing that desert heat was ideal for health, he lived swathed like a mummy in overheated rooms. Fourier died in Paris on May 16, 1830.

Fourier's masterpiece was his mathematical theory of heat conduction stated in *Théorie Analytique de la Chaleur* (1822; trans. by A. Freeman, 1872), one of the most important books published in the 19th century. It marked an epoch both in the history of pure and of applied mathematics, for in it Fourier developed the theory of the series known by his name and applied it to the solution of boundary-value problems in partial differential equations (*see* Fourier Series). This work brought to a close a long controversy, and henceforth it was generally agreed that almost any function of a real variable can be represented by a series involving the sines and cosines of integral multiples of the variable. The first announcement of this discovery was made by Fourier in 1807. By his method the coefficients in any series of this type can be expressed in a form suitable for computation. The process is the same mathematically as the analysis of a musical sound into its fundamental and successive harmonics. Fourier's work was not received without criticism, the weak point in his analysis being his failure to provide a general proof that the Fourier series actually converges to the value of the function concerned. This difficulty was not satisfactorily resolved until the development of the Lebesgue integral nearly a century later.
(G. J. Ww.)

FOURIER SERIES, in mathematics, represents a class of series employed to fit sets of data and to approximate functions. Emerging from efforts to analyze empirical data in physics, Fourier series have had profound effects on the development of such fields of mathematics as integral and differential equations, and analytic functions.

Consider first an infinite series (*q.v.*).

$$(1)\quad \tfrac{1}{2}a_0 + (a_1 \cos x + b_1 \sin x) + (a_2 \cos 2x + b_2 \sin 2x) + \ldots$$

The quantities a_0, a_1, b_1, a_2, b_2, . . . are constants, and x varies between $-\infty$ and $+\infty$. Such series are called trigonometric. Suppose now that series (1) converges for all values of x, and let $f(x)$ denote the sum of the series. The function $f(x)$ is periodic, of period 2π, since replacing x by $x + 2\pi$ does not change the series. If both sides of the equation $f(x) = \frac{1}{2}a_0 + (a_1 \cos x + b_1 \sin x) + \ldots$ are multiplied by $\cos nx$ or $\sin nx$ and the result is integrated over the interval $(0, 2\pi)$, then

$$(2)\quad a_n = \frac{1}{\pi}\int_0^{2\pi} f(x) \cos nx dx,\ b_n = \frac{1}{\pi}\int_0^{2\pi} f(x) \sin nx dx$$

for all n. Though this argument is purely formal (it is justified, if series (1) converges uniformly, or even in some more general cases), it suggests an important problem. Suppose for any function $f(x)$ of period 2π the numbers a_n, b_n are computed by means of formulas (2) to form the series (1). Does the series so defined represent the function $f(x)$? The numbers (2) are called the Fourier coefficients of the function $f(x)$, and the series (1) just obtained is the Fourier series of $f(x)$. The fact that, under suit-

able conditions concerning $f(x)$, the problem just stated admits of an affirmative answer, is one of the main achievements of the theory of Fourier series. The latter take their name from Jean Baptiste Joseph Fourier, who based on them his mathematical theory of conduction of heat. Fourier's *Théorie analytique de la chaleur* was published in 1822, but the discovery of Fourier series dates back to the first half of the 18th century, in connection with the problem of vibrating cords (Daniel Bernoulli, Leonhard Euler). Thus Fourier series originated in problems of mathematical physics, and they continue to be a very valuable tool there.

Not less important are Fourier series in mathematical analysis. Very often they appear there in a more general form, as orthogonal series (*see* below), and provide a unifying link in such mathematical theories as differential and integral equations and analytic functions. Especially important are trigonometric (and, in particular, Fourier) series for the theory of analytic functions, since for $z = e^{i\varphi}$ the real part of the power series

$$\frac{1}{2}a_0 + (a_1 - ib_1)z + (a_2 - ib_2)z^2 + \dots \tag{3}$$

is the series (1). Thus trigonometric series are real parts of power series, and so form a bridge between real and complex functions. Aside from the value of trigonometric series as a method of investigation, they have played a great role in the historic development and clarification of various mathematical concepts, some of them quite abstract. A few examples may suffice.

Already in the days of its inception in the 18th century the theory of Fourier series stirred controversies in connection with the notion of mathematical function (*see* FUNCTION). The general attitude at that time was to call $f(x)$ a function if $f(x)$ could be represented by a single analytic expression like a polynomial, a power series or a trigonometric series. If the graph of $f(x)$ were "arbitrary," *e.g.* a polygonal line, $f(x)$ would not have been accepted as a function. So it came as a shock to many when the discovery of Fourier series showed that many such "arbitrary" graphs could be represented by trigonometric series, and so should be treated as functions. It took a long time before the matter was clarified, and it was not merely a coincidence that the now universally adopted definition was first formulated in a memoir of P. G. L. Dirichlet (1837) devoted to the theory of Fourier series. (Incidentally, this memoir contains the first rigorous proofs of the representation of functions by their Fourier series. The work of Fourier himself and of his predecessors was rather formal.) Another instance of application of trigonometric series to the theory of functions is due to Karl Weierstrass, who gave the first example (1861) of a continuous function without a derivative at any point. Weierstrass' function was given in the form of a trigonometric series, and it exemplified the general fact that trigonometric series are particularly useful in the construction of functions with various peculiarities. Another much more important example of the influence of Fourier series may be found in the history of the notion of integral. On account of formulas (2), this notion is a prerequisite to that of Fourier series. It is therefore interesting that the classical definition of integral due to G. F. B. Riemann (usually given in textbooks of calculus) was for the first time expounded in his fundamental paper *Ueber die Darstellbarkeit einer Funktion durch eine Trigonometrische Reihe* (1854). The ideas contained in that paper influenced the work of Georg Cantor concerning the uniqueness of the representation of a function by a trigonometric series. Cantor had to consider various sets of points that would not interfere with the uniqueness of representation. Starting from simplest cases he tried to master the structure of such sets—"sets of uniqueness" (*see* below). He was not completely successful, and the problem was still open in the 1960s, but his investigations led him to the general theory of sets, and in particular of point sets, one of the greatest mathematical discoveries of the 19th century. His results have permeated and changed the aspect of many mathematical theories. The theories of measure and of integral developed later by Emile Borel and H. L. Lebesgue, so fundamental in mathematical analysis, find their roots in Cantor's work on the theory of sets.

Particularly important is the work of Lebesgue, who put Fourier series on a new basis through his theory of integral. Though more general definitions of integral are possible, and though some of them are of interest for Fourier series, Lebesgue's definition is the most appropriate and is almost universally adopted in research. In this connection Arnaud Denjoy showed with a definition of integral more general than that of Lebesgue that an everywhere-convergent trigonometric series is always the Fourier series of its sum. Important for Lebesgue's theory is the notion of set of measure zero. A point set S situated, for example, on a straight line is said to be of measure zero if S can be covered by a finite or infinite system of intervals of total length arbitrarily small. In Lebesgue's theory sets of measure zero are considered as negligible, and if a certain property holds for all points except those forming a set of measure zero, that property is said to hold almost everywhere.

Convergence and Divergence of Fourier Series.—Let $s_n(x)$ denote the sum of the first $n+1$ terms of series (1). Using (2) gives

$$s_n(x) = \frac{1}{\pi}\int_0^{2\pi} f(x+t)\,\frac{\sin\,(n+\frac{1}{2})t}{2\sin\frac{1}{2}t}\,dt \tag{4}$$

a formula basic for Fourier series. It may be proved that as n increases indefinitely $s_n(x)$ tends to $f(x)$, provided the function $f(x)$ satisfies certain conditions. For example, if the graph of the function $f(x)$ in the interval $0 \leqq x \leqq 2\pi$ has only a finite number of maxima and minima (Dirichlet's condition), the Fourier series of $f(x)$ converges to $f(x)$ at every point of continuity of the function. At points x where such a function is discontinuous, the Fourier series also converges, its sum being $\frac{1}{2}[f(x+0) + f(x-0)]$ where $f(x+0)$ represents the limit of the function at the point x from the right, and $f(x-0)$ a similar limit from the left. Another condition ensuring the convergence of the Fourier series to sum $f(x)$ is the convergence of the integral

$$\int_0^{\pi} \frac{|\,f(x+t) + f(x-t) - 2f(x)\,|}{t}\,dt$$

(the Dini condition). It certainly is satisfied at every point where the function $f(x)$ is differentiable. These and all other known conditions for convergence are sufficient conditions only. Conditions that would be both necessary and sufficient (and would not be trivial tautologies) are not known. That mere continuity of the function is not sufficient to ensure the convergence of the Fourier series was shown by Paul du Bois-Reymond (1872). He constructed a continuous function for which the Fourier series diverges at some points. Whether there is a continuous function whose Fourier series diverges at every point was still (1960s) the most outstanding unsolved problem of the theory. That there exist integrable (in the Lebesgue sense) functions for which the Fourier series diverge everywhere, was shown by A. N. Kolmogorov (1926).

Summability of Fourier Series.—The fact that Fourier series of continuous functions need not converge everywhere endangered the whole theory of the representation of functions by their Fourier series. The situation was salvaged by Leopold Fejér (1900), who showed that the Fourier series of a continuous function $f(x)$ is summable to $f(x)$ by the method of the arithmetic mean (*see* SERIES: *Divergent Series*). More precisely, if $s_n(x)$ has the same meaning as above, the expression

$$\sigma_n(x) = \frac{s_0(x) + s_1(x) + \dots + s_n(x)}{n+1}$$

tends to $f(x)$ at every point of continuity of the function. Following this, H. L. Lebesgue proved that for every integrable function $f(x)$ the expression $\sigma_n(x)$ tends to $f(x)$ almost everywhere. This again put the theory on a firm basis, and at the same time showed that summability rather than convergence is important for Fourier series. Using (4) leads to

$$\sigma_n(x) = \frac{1}{\pi(n+1)}\int_0^{2\pi} f(x+t)\,\frac{\sin^2\frac{1}{2}(n+1)t}{2\sin^2\frac{1}{2}t}\,dt \tag{5}$$

It is not unlike (4), but there is one essential difference. The

factor $\sin^2\frac{1}{2}(n+1)t/2(n+1)\sin^2\frac{1}{2}t$ in (5), called Fejér's kernel, is non-negative, whereas the factor $\sin(n+\frac{1}{2})t/2\sin\frac{1}{2}t$ in (4), Dirichlet's kernel, is of variable sign. This positive character of Fejér's kernel is responsible for many interesting properties of the expressions $\sigma_n(x)$, and in particular for the fact that they represent $f(x)$ so much better than the $s_n(x)$ do.

Besides the method of the arithmetic mean, many other methods of summability have been applied to Fourier series. The most important of them is the method of Niels Henrik Abel that defines the sum of series (1) as the limit of the expression

$$\tfrac{1}{2}a_0 + (a_1\cos x + b_1\sin x)r + (a_2\cos 2x + b_2\sin 2x)r^2 + \dots$$

where r tends to 1 through values less than 1. If (1) is the Fourier series of $f(x)$, the last expression may be written

$$\frac{1}{2\pi}\int_0^{2\pi} f(x+t)\,\frac{1-r^2}{1-2r\cos t+r^2}\,dt$$

and is called the Poisson integral of $f(x)$. As r approaches 1, it tends to $f(x)$ at every point of continuity of the function (or almost everywhere, if $f(x)$ is merely integrable).

Conjugate Series and Functions.—For $z = e^{ix}$ the real part of the power series (3) is the trigonometric series (1). The imaginary part of (3) is the trigonometric series

$$(a_1\sin x - b_1\cos x) + (a_2\sin 2x - b_2\cos 2x) + \dots$$

called the conjugate of the series (1). Suppose that (1) is the Fourier series of a function $f(x)$; the conjugate series is then almost everywhere summable by the method of the arithmetic mean, or by the method of Abel, the generalized sum being equal to the integral

$$(6)\qquad -\frac{1}{\pi}\int_0^{\pi}\frac{f(x+t)-f(x-t)}{2\tan\frac{1}{2}t}\,dt, \text{ defined as } \lim_{\epsilon\to 0}\left\{-\frac{1}{\pi}\int_\epsilon^{\pi}\right\}$$

This integral is called the function conjugate to $f(x)$ and will be denoted by $\bar{f}(x)$. The fact that for every integrable function $f(x)$ the integral (6) exists almost everywhere is a very remarkable property that is far from obvious even in the case when $f(x)$ is continuous. Even in the special case that $f(x)$ is continuous, the integral (6) need not exist everywhere; it is a curious fact that continuous functions may have certain metric properties almost everywhere, without having them everywhere. Conjugate series are a link between trigonometric series and power series. They are also of importance for the theory of Fourier series since there seems to be a close relation between the behaviour of the partial sums of Fourier series and the behaviour of certain conjugate functions. The function conjugate to an integrable function $f(x)$ need not be integrable. Thus the series conjugate to the Fourier series of $f(x)$ need not be a Fourier series.

Parseval's Formula.—Suppose that (1) is the Fourier series of $f(x)$. If in the formula $f(x) = \frac{1}{2}a_0 + (a_1\cos x + b_1\sin x) + \dots$ both sides are squared and the result is integrated over the interval $0 \leqq x \leqq 2\pi$, the result is

$$\frac{1}{\pi}\int_0^{2\pi} f^2(x)\,dx = \tfrac{1}{2}a_0^2 + (a_1^2+b_1^2) + (a_2^2+b_2^2) + \dots$$

called Parseval's formula. The above argument was formal, but rigorous proofs are available to show that the formula is valid for any function $f(x)$ such that $f^2(x)$ is integrable. Thus the Fourier coefficients $a_0, a_1, b_1, \dots$ of any such function have the property that $\sum (a^2_n + b^2_n)$ is finite. That the converse is true was proved by F. Riesz and E. Fischer (1907). The Riesz-Fischer theorem, one of the great achievements of the Lebesgue theory of integration, asserts that, given any sequence of numbers $a_0, a_1, b_1, a_2, b_2, \dots$ such that the series $\sum (a_n^2 + b_n^2)$ converges, there is always a function $f(x)$ having the numbers $a_0, a_1, b_1, \dots$ as Fourier coefficients and such that $f^2(x)$ is integrable. This function is unique. Thus the theorems of Parseval and of Riesz-Fischer give a very simple characterization of function with integrable square in terms of their Fourier coefficients. No other class of function has a characterization of comparable simplicity and completeness.

Uniqueness of Representation by Trigonometric Series.—Can a function be represented by two different and everywhere-convergent trigonometric series? By taking the difference of two such series the problem may be restated as follows. Can a trigonometric series not identically zero (*i.e.*, a series whose coefficients a_n, b_n are not all zero) converge everywhere to zero? That this is impossible was proved by Cantor. His result is the simplest theorem on the uniqueness of the representation of a function by a trigonometric series. A point set S situated in the interval $0 \leqq x \leqq 2\pi$ is called a set of uniqueness (set U, for brevity) if every trigonometric series convergent to zero outside S is identically zero. Otherwise, the set S will be called a set of multiplicity (set M), and there will be trigonometric series convergent to zero outside S, but not identically zero. Generalizing the result just stated, Cantor proved that every set S consisting of a finite number of points, and even certain infinite sets, are sets U. It may be shown that every set U must be of measure zero, but it is remarkable that among sets of measure zero are found sets U as well as sets M. The problem of characterizing sets U and M in structural terms was still unsolved in the 1960s. One of its implications is that from the point of view of trigonometric series the notion of set of measure zero is too general, and that special classes of such sets may be of particular importance.

Trigonometric Interpolation.—A finite sum $T(x) = \frac{1}{2}a_0 + \sum_{k=1}^{n}(a_k\cos kx + b_k\sin kx)$ is called a trigonometric polynomial of order n (or less, if both a_n and b_n are zero). A trigonometric polynomial of order n has $2n+1$ coefficients $a_0, a_1, b_1, \dots, a_n, b_n$, and it can be shown that if $2n+1$ distinct points

$$(7)\qquad x_0, x_1, x_2, \dots, x_{2n}$$

are fixed in the interval $0 \leqq x < 2\pi$ there is always a trigonometric polynomial of order n or less that takes prescribed values at these points; moreover, this polynomial is unique. Consider now a function $f(x)$ defined as the interval $(0, 2\pi)$ and take the trigonometric polynomial $T(x)$ of order n that coincides with $f(x)$ at the points (7). Such a polynomial is called an interpolating polynomial for $f(x)$. Suppose now that n increases indefinitely; does the polynomial $T(x)$ approach the function $f(x)$ at all points? This must depend on the geometric configuration of the points (7), and the answer is not known in full generality. If, however, the points (7) are assumed distributed equally to form an arithmetic progression with difference $2\pi/(2n+1)$, and if the function $f(x)$ satisfies some smoothness conditions (*e.g.*, is differentiable) then the answer is affirmative, and the whole problem has points in common with the theory of Fourier series.

Orthogonal Series.—Fourier series as defined above are a special class of more general series. Suppose that in an interval $a \leqq x \leqq b$ there is a fixed set of functions $\varphi_1(x), \varphi_2(x), \dots$ with the following properties

$$(8)\qquad \int_a^b \varphi_m\varphi_n dx = 0, \text{ if } m \neq n; \qquad \int_a^b \varphi_n^2 dx = \lambda_n \neq 0$$

for all m and n. Such sets of functions are called orthogonal. If a function $f(x)$ has a representation $f(x) = c_1\varphi_1(x) + c_2\varphi_2(x) + \dots$, then, multiplying both sides by $\varphi_n(x)$, integrating over x the interval (a, b), and using (8), formally leads to the equations

$$c_n = \frac{1}{\lambda_n}\int_a^b f(x)\,\varphi_n(x)\,dx, \text{ for all } n.$$

Conversely, given any function $f(x)$, the latter formulas may be used to construct the series $c_1\varphi_1(x) + c_2\varphi_2(x) + \dots$, and it may be asked whether this series actually represents $f(x)$. This last series is called the Fourier series of $f(x)$ with respect to the orthogonal system $\varphi_1, \varphi_2, \dots$. Trigonometric Fourier series are obtained if for $\varphi_1, \varphi_2, \dots$ we take the system 1, cos x, sin x, cos 2 x, sin 2 x, ... and for (a, b) the interval $(0, 2\pi)$. Many other orthogonal systems are of considerable importance for mathematics.

Fourier Integrals.—Fourier series are used for the representation of periodic functions. For the study of a nonperiodic function $f(x)$ the Fourier integral of $f(x)$ is used. It has the form

$$(9) \qquad \int_0^\infty \{a(u) \cos ux + b(u) \sin ux\} du$$

where $a(u)$ and $b(u)$ are defined by the formulas

$$a(u) = \frac{1}{\pi}\int_{-\infty}^{+\infty} f(t) \cos ut \, dt, \; b(u) = \frac{1}{\pi}\int_{-\infty}^{+\infty} f(t) \sin ut \, dt$$

The integral (9) is analogous to the series (1), the only difference being that instead of summation there is integration. The functions $a(u)$ and $b(u)$ are analogues of Fourier coefficients and are called the Fourier transforms of $f(x)$. Under very general conditions, the integral (9) actually represents $f(x)$, the proofs being similar to the corresponding proofs in the case of Fourier series.

In the definition (8) of orthogonality it was tacitly assumed that the functions were real-valued. If the functions $\phi_1, \phi_2 \ldots$ are complex-valued the definition must be slightly modified, and instead of (8) it is required that

$$\int_a^b \phi_m \overline{\phi}_n dx = 0, \text{ if } m \neq n, \quad \int_a^b |\phi_n|^2 dx$$

where $\overline{\phi}_n$ is the conjugate (in the sense of complex numbers) to ϕ_n. The Fourier series is, as before, $c_1\phi_1(x) + c_2\phi_2(x) + \ldots$, but now the Fourier coefficients are

$$c_n = \frac{1}{\lambda_n}\int_a^b f(x)|\overline{\phi_n}|(x)dx$$

The most important special case is that of the system e^{inx} ($n = 0, \pm 1, \pm 2, \ldots$) that is readily seen to be orthogonal over $(0, 2\pi)$, with all $\lambda_n = 2\pi$. This system is called the complex trigonometric system. The Fourier series of a function $f(x)$ defined in the interval $(0, 2\pi)$ is then

$$\sum_{n=-\infty}^{+\infty} c_n e^{inx}, \text{ where } c_n = \frac{1}{2\pi}\int_0^{2\pi} f(x)e^{-inx}dx$$

The latter series is called the complex Fourier series of $f(x)$ and is meant as

$$c_0 + \sum_{n=1}^{\infty}(c_n e^{inx} + c_{-n}e^{-inx})$$

It can be shown that this series is nothing else but the series (1) with coefficients given by (2). Hence, except for notation, complex Fourier series are the same as ordinary trigonometric Fourier series, but the complex form sometimes simplifies proofs and leads to more elegant formulations.

Multiple Fourier Series.—If $\phi_1(x), \phi_2(x), \ldots$ is an orthogonal system over an interval $a \leq x \leq b$, and $\psi_1(y), \psi_2(y), \ldots$ is another orthogonal system over an interval $c \leq y \leq d$, then it may be shown that the double system $\phi_m(x)\psi_n(y)$ (where $m, n = 1, 2, \ldots$) is orthogonal over the rectangle $a \leq x \leq b$, $c \leq y \leq d$ of the plane, and a function $f(x,y)$ defined in this rectangle can be developed into a double Fourier series

$$\sum_{m=1}^{\infty}\sum_{n=1}^{\infty} c_{m,n}\phi_m(x)\psi_n(y)$$

The most interesting case occurs when both systems ϕ_m and ψ_n are complex trigonometric systems. The Fourier series is then

$$\sum_{m=-\infty}^{+\infty}\sum_{n=-\infty}^{+\infty} c_{m,n}e^{i(mx+ny)}$$

Similarly, triple Fourier series can be considered, and so on. The problems concerning the behaviour of multiple Fourier series are usually much more difficult than those of ordinary Fourier series.

The integral (9) can also be written in the form

$$\int_{-\infty}^{+\infty} c(u)e^{ixu}du, \text{ where } c(u) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} f(t)e^{-iut}dt$$

that is an analogue of a complex Fourier series. Multiple Fourier integrals are also considered (analogues of multiple Fourier series). *See* also references under "Fourier Series" in the Index volume.

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FOURNIER, PIERRE SIMON (1712–1768), French engraver and type founder, was born at Paris on Sept. 15, 1712. He designed many new characters, and his foundry became celebrated not only in France, but in foreign countries. His *Table des proportions qu'il faut observer entre les caractères* (1737) was followed by several other technical treatises. His principal work, however, was the *Manuel typographique* (2 vol., 1764), the first volume treating of engraving and type founding, the second of printing, with examples of different alphabets. He died in Paris on Oct. 8, 1768.

See also PRINTING TYPE: *Type Design.*

FOURTEEN POINTS. On Jan. 8, 1918, Pres. Woodrow Wilson, in his address to the joint session of the United States congress, formulated under 14 separate heads his ideas of the essential nature of a post-World War I settlement. Before the delivery of his address he had received from a committee of inquiry, set up by Col. Edward House in Sept. 1917, a report upon the territorial settlement that should follow the conclusion of the war. It has been stated that no fewer than six, and these the territorial points, of Wilson's Fourteen Points were "directly framed" upon the recommendations contained in the report. It has also been stated by Ray S. Baker in his *Woodrow Wilson* that the report was drawn up by S. Mezes, D. H. Miller and Walter Lippmann.

The text of the Fourteen Points was as follows:

1. Open covenants of peace, openly arrived at, after which there shall be no private international understandings of any kind but diplomacy shall proceed always frankly and in the public view.

2. Absolute freedom of navigation upon the seas, outside territorial waters, alike in peace and in war, except as the seas may be closed in whole or in part by international action for the enforcement of international covenants.

3. The removal, so far as possible, of all economic barriers and the establishment of an equality of trade conditions among all the nations consenting to the peace and associating themselves for its maintenance.

4. Adequate guarantees given and taken that national armaments will be reduced to the lowest point consistent with domestic safety.

5. A free, open-minded, and absolutely impartial adjustment of all colonial claims, based upon a strict observance of the principle that in determining all such questions of sovereignty the interests of the populations concerned must have equal weight with the equitable claims of the government whose title is to be determined.

6. The evacuation of all Russian territory and such a settlement of all questions affecting Russia as will secure the best and freest coöperation of the other nations of the world in obtaining for her an unhampered and unembarrassed opportunity for the independent determination of her own political development and national policy and assure her of a sincere welcome into the society of free nations under institutions of her own choosing; and, more than a welcome, assistance also of every kind that she may need and may herself desire. The treatment accorded Russia by her sister nations in the months to come will be the acid test of their good will, of their comprehension of her needs as distinguished from their own interests, and of their intelligent and unselfish sympathy.

7. Belgium, the whole world will agree, must be evacuated and restored, without any attempt to limit the sovereignty which she enjoys in common with all other free nations. No other single act will serve as this will serve to restore confidence among the nations in the laws which they have themselves set and determined for the government of their relations with one another. Without this healing act the whole structure and validity of international law is forever impaired.

8. All French territory should be freed and the invaded portions restored, and the wrong done to France by Prussia in 1871 in the matter

of Alsace-Lorraine, which has unsettled the peace of the world for nearly fifty years, should be righted, in order that peace may once more be made secure in the interest of all.

9. A readjustment of the frontiers of Italy should be effected along clearly recognizable lines of nationality.

10. The peoples of Austria-Hungary, whose place among the nations we wish to see safeguarded and assured, should be accorded the freest opportunity of autonomous development.

11. Rumania, Serbia, and Montenegro should be evacuated; occupied territories restored; Serbia accorded free and secure access to the sea; and the relations of the several Balkan states to one another determined by friendly counsel along historically established lines of allegiance and nationality; and international guarantees of the political and economic independence and territorial integrity of the several Balkan states should be entered into.

12. The Turkish portions of the present Ottoman Empire should be assured a secure sovereignty, but the other nationalities which are now under Turkish rule should be assured an undoubted security of life and an absolutely unmolested opportunity of autonomous development, and the Dardanelles should be permanently opened as a free passage to the ships and commerce of all nations under international guarantees.

13. An independent Polish state should be erected which should include the territories inhabited by indisputably Polish populations, which should be assured a free and secure access to the sea, and whose political and economic independence and territorial integrity should be guaranteed by international covenant.

14. A general association of nations must be formed under specific covenants for the purpose of affording mutual guarantees of political independence and territorial integrity to great and small states alike.

President Wilson developed these theories during 1918 in a series of speeches, to which reference was subsequently made during the Armistice negotiations. These are generally known as the "Four Principles," "Four Ends" and "Five Particulars."

The Four Principles.—In the "Four Principles" speech in congress, Feb. 11, 1918, he declared:

1. That each part of the final settlement must be based upon the essential justice of that particular case and upon such adjustments as are most likely to bring a peace that will be permanent;

2. That peoples and provinces are not to be bartered about from sovereignty to sovereignty as if they were mere chattels and pawns in a game, even the great game, now forever discredited, of the Balance of Power; but that

3. Every territorial settlement involved in this war must be made in the interest and for the benefit of the populations concerned, and not as a part of any mere adjustment or compromise of claims amongst rival states; and

4. That all well-defined national aspirations shall be accorded the utmost satisfaction that can be accorded them without introducing new or perpetuating old elements of discord and antagonism that would be likely in time to break the peace of Europe and consequently of the world.

The Four Ends.—In the "Four Ends" speech of July 4, 1918, occurs the following passage:

These are the ends for which the associated peoples of the world are fighting and which must be conceded them before there can be peace:

1. The destruction of every arbitrary power anywhere that can separately, secretly, and of its single choice disturb the peace of the world; or, if it cannot be presently destroyed, at the least its reduction to virtual impotence.

2. The settlement of every question, whether of territory, of sovereignty, of economic arrangement, or of political relationship, upon the basis of the free acceptance of that settlement by the people immediately concerned, and not upon the basis of the material interest or advantage of any other nation or people which may desire a different settlement for the sake of its own exterior influence or mastery.

3. The consent of all nations to be governed in their conduct towards each other by the same principles of honor and of respect for the common law of civilized society that govern the individual citizens of all modern states in their relations with one another; to the end that all promises and covenants may be sacredly observed, no private plots or conspiracies hatched, no selfish injuries wrought with impunity, and a mutual trust established upon the handsome foundation of a mutual respect for right.

4. The establishment of an organization of peace which shall make it certain that the combined power of free nations will check every invasion of right and serve to make peace and justice the more secure by affording a definite tribunal of opinion to which all must submit and by which every international readjustment that cannot be amicably agreed upon by the peoples directly concerned shall be sanctioned.

These great objects can be put into a single sentence. *What we seek is the reign of law, based upon the consent of the governed and sustained by the organized opinion of mankind.*

The Five Particulars.—The "Five Particulars" (speech of Sept. 27, 1918) were as follows:

1. The impartial justice meted out must involve no discrimination between those to whom we wish to be just and those to whom we do not wish to be just. It must be a justice that plays no favorites and knows no standard but the equal rights of the several peoples concerned;

2. No special or separate interest of any single nation or any group of nations can be made the basis of any part of the settlement which is not consistent with the common interest of all;

3. There can be no leagues or alliances or special covenants and understandings within the general and common family of the League of Nations.

4. And more specifically, there can be no special, selfish economic combinations within the League and no employment of any form of economic boycott or exclusion except as the power of economic penalty by exclusion from the markets of the world may be vested in the League of Nations itself as a means of discipline and control.

5. All international agreements and treaties of every kind must be made known in their entirety to the rest of the world.

Special alliances and economic rivalries and hostilities have been the prolific source in the modern world of the plans and passions that produce war. It would be an insincere as well as an insecure peace that did not exclude them in definite and binding terms.

Armistice and Peace Settlement.—On Oct. 4, 1918, Prince Maximilian of Baden, the German imperial chancellor, informed President Wilson:

The German government accepts the program set forth by the President of the United States in his message to Congress of Jan. 8, 1918, and in his later pronouncements, especially his speech of Sept. 27, as a basis for peace negotiations.

The Fourteen Points were thus designated by the German (and separately by the Austrian) government as an acceptable basis for peace. *See* VERSAILLES, TREATY OF.

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FOUSSA (*Cryptoprocta ferox*), the largest carnivorous mammal peculiar to Madagascar, which combines characteristics of the civet and the cat families. It is about twice the size of a house cat (five feet from nose to end of tail), with short dense fur of pale brown. Most active at night, the foussa usually dwells in trees during the day. Although it has been known to prey upon poultry, sheep and cattle, it more commonly feeds on birds and lemurs. The specific name refers to its ferocity, which the foussa shows when wounded.

See also CARNIVORE. (J. E. HL.; X.)

FOWEY, a seaport and municipal borough in the Bodmin parliamentary division of Cornwall, Eng., 12 mi. S. of Bodmin and 28 mi. W. of Plymouth by road and ferries. Pop. (1961) 2,237. It lies on the west bank of the river Fowey where it widens into a deepwater estuary which vessels drawing 30 ft. can enter. The riverbanks are high and wooded; the town, with its steep narrow streets, is a residential one, attracting many artists and writers. It is also a vacation centre, and the headquarters of the Royal Fowey Yacht club. Deep-sea fishing is carried on, and china clay is exported. There are a car ferry to Bodinnick and a passenger ferry to Polruan opposite Fowey. The 14th-century church, dedicated to St. Fimbarrus or Fin Barr of Cork, stands on the hillside. Place house, adjacent, is a Tudor building, and there are 16th- and 17th-century houses in the town, which is portrayed as Troy Town in various writings of Sir Arthur Quiller-Couch. There is a ruined fort of the time of Henry VIII; the grammar school was established in 1692.

Fowey held a leading position among Cornish ports from the time of Edward I to the days of the Tudors. The numerous references to the privateering exploits of its ships in the Patent and Close rolls testify to its importance. Tin was exported in medieval times. Incorporated by James II, Fowey retained its charter until 1882. A new charter came into force in 1912. In 1316 the prior of Tywardreath, as lord of the manor, obtained the right to hold a Monday market and two fairs, which in 1690 were altered to a Saturday market and three fairs that continue to be held.

FOWL. Originally used to mean any bird, this term has now become (except in combination, as seafowl, wild fowl) almost restricted to the wild red jungle fowl, *Gallus gallus,* its domestic form, the chicken, and its wild allies. (For domestic fowls, *see*

POULTRY AND POULTRY FARMING.) *Gallus gallus* inhabits northern India, Burma, southern Vietnam, the Malay archipelago and neighbouring islands. It resembles in plumage the domestic black-breasted game breed. It inhabits forests, thickets and bamboo jungles, dwelling in small flocks. The crow of the cock is like that of a bantam. The cream-white eggs, 8 to 12 in number, are laid on the ground.

Three other species occupy much the same habitat. The gray jungle fowl, *G. sonnerati*, is found in western, central and southern India; the cock has the shaft of the neck hackles dilated, and his crow is more like a cackle. The Sinhalese species, *G. lafayetti*, is peculiar to Ceylon; the cock has a yellow comb with a red edge and is red beneath. *G. varius* inhabits the Malay islands from Java to Flores; it does not possess hackles, and the cock has a large unserrated comb. All the species will interbreed with domestic poultry and with the wild *G. gallus*, but the hybrids are sterile.

See also GAME BIRDS.

FOWLER, CHARLES (1792–1867), English architect best known for his buildings in Covent Garden and Hungerford markets, was born at Cullompton, Devon, on May 17, 1792, and died at Great Marlow on Sept. 26, 1867. After an apprenticeship of five years at Exeter, he worked in the office of David Laing in London from 1814 until he began to practise alone. His first important work was the court of bankruptcy in Basinghall street (1821). In 1822 he gained first premium for a design for London bridge, which, however, was not used. Among Fowler's designs for bridges was one erected across the Dart at Totnes. He also designed the markets of Gravesend and Exeter (lower market), several churches, the Devon lunatic asylum (1845), the London fever hospital (1849) and the hall of the Wax Chandlers' company, Gresham street (1853). He was honorary secretary and a vice-president of the Institute of British Architects.

FOWLER, SIR JOHN (1817–1898), English civil engineer, best known as the designer of the London Metropolitan railway and as joint designer of the Forth bridge in Scotland, was born on July 15, 1817, at Wadsley Hall, near Sheffield. He engaged in railway construction at an early age and set up his own business in 1844, laying out many small railway systems, which were later amalgamated into the Manchester, Sheffield and Lincolnshire railway. Fowler was engineer of the London Metropolitan railway, the forerunner of the underground railways, which was noteworthy in that it was mostly made not by tunneling but by excavating from the surface and then covering in the permanent way. He designed and constructed a special type of locomotive for this railway, afterward known as "Fowler's Ghost." He lived to be one of the engineers officially connected with the deep-tunneling "tube" system extensively adopted for electric railways in London. Fowler was engineer for the construction of Victoria station. He was also engaged in the making of railways in Ireland, and in 1867 he served on a commission to consider a state purchase of the Irish railway system. He carried out considerable works in relation to the Nene valley drainage and the reclamation of land in the Norfolk estuary.

In 1865 Fowler was elected president of the Institution of Civil Engineers, the youngest president who had ever sat in the chair. He was strongly opposed to the project of a channel tunnel to France, and in 1872 he endeavoured, in vain, to obtain the consent of parliament to a channel ferry scheme. For eight years from 1871 he acted as general engineering adviser in Egypt to the khedive Ismail. The railway he planned to the Sudan was not developed for financial reasons, but the maps and surveys were given to the war office and proved most useful to Lord Wolseley in his Nile expedition of 1882. For his service Fowler was knighted in 1885. He was created a baronet in 1890 on the completion of the great Forth bridge, of which he was joint engineer with his partner, Sir Benjamin Baker. He died at Bournemouth on Nov. 20, 1898.

See T. Mackay, *The Life of Sir John Fowler* (1900). (T. M. S.)

FOWLER, JOHN (1826–1864), English engineer, inventor of the steam-hauled plow, was born at Melksham, Wiltshire, on July 11, 1826. He was at first engaged in the grain trade but later trained as an engineer. In 1850 he joined Albert Fry in Bristol to found a works for the production of steam-hauled implements, and in the same year he laid porous pipe drains 2 ft. 6 in. deep by horse-powered windlass. He applied the steam engine to draining in 1853 and to cultivation in 1856. In 1857 he was awarded a £200 prize by the Highland Agricultural society for cultivation by a single stationary engine, using the first steel wire rope. The following year he won the Royal Agricultural society's £500 prize, using a single self-moving engine hauling the implement by a rope around a disk anchor on the headland opposite. He patented his famous clip drum and coiling gear in 1859. In 1861 he founded at Leeds the firm of John Fowler and Co. to make this machinery, and at one time other firms did so under licence. Fowler died at Ackworth, Yorkshire, on Dec. 4, 1864. (R. H. C.)

FOX, CHARLES JAMES (1749–1806), British statesman, champion of liberty, was born in Conduit street, Westminster, on Jan. 24, 1749, the third son of Henry Fox, afterward (1763) 1st Baron Holland, by his wife, Lady Caroline Lennox, daughter of Charles Lennox, 2nd duke of Richmond. Through his mother he was descended from Charles II of England and Henry IV of France. He was educated at a school at Wandsworth, at Eton and at Hertford college, Oxford, where he acquired an extensive knowledge of the classics, to which he remained devoted for the rest of his life. His father brought him up without the least regard for morality, and encouraged him, while still a schoolboy, to acquire extravagant and dissolute habits. He lost vast sums at gambling, and in 1774 his father, just before his death, paid his gambling debts to the amount of £140,000. Almost 20 years later, political friends not only freed him from debt but settled on him a comfortable income. He then showed his gratitude by abandoning forever both racing and gambling.

Parliament, Office and Opposition.—Fox was brought into parliament for Midhurst by his father, in 1768, before he was of age, as a supporter of the duke of Grafton's ministry, and in the famous conflict over the Middlesex election he took the unpopular side, opposing the return of John Wilkes (*q.v.*). Two years later he was appointed a lord of the admiralty, but disapproving of needless restrictions on marriage, he gave up his office in Feb. 1772 in order that he might be free to oppose the Royal Marriage act. He re-entered the government the following December as a lord of the treasury, but the king, who already disliked him for his recent opposition, accused him of insubordination and dismissed him in Feb. 1774. He at once began the long and brilliant vendetta against George III that filled the rest of his life. In his view the excessive power of the crown was the great source of all the country's ills, and the destruction of that power became the dedicated object of his life. Thus Fox spent almost the whole of his remaining years in opposition.

Already a friend of Edmund Burke, he naturally gravitated into the Whig group, and before long was their accepted leader in the commons. Not even the worst of upbringings had spoiled his great natural gifts. He had a genius for friendship, and the secret of his political influence was the uncalculating generosity of his mind. As a statesman he had great and manifest failings. He was often governed by prejudice and he was not a profound political thinker like Burke. Above all, he hated anything that savoured of oppression. As a party leader he resembled Gladstone in that, when he took up a cause, he took it up with his whole heart, never pausing to inquire what would be thought of him or how his advocacy of that cause would affect his own or his party's prospects. He went into opposition just when the controversy with the American colonies was becoming acute. Believing that Lord North's colonial policy was unjust and oppressive, he flagellated it with unrestrained violence, but he later admitted that the American war was popular and that it would have been waged even by a parliament purged of placemen. The series of disasters sustained by the British troops in America, culminating in Cornwallis' capitulation at Yorktown (Oct. 1781), eventually brought down North's government (March 1782), and the king had to call in the Rockingham and Shelburne Whigs. Rockingham became prime minister and Shelburne colonial secretary; Fox became the first foreign secretary in English history.

The differences between the Whigs and the Chathamites on the questions of parliamentary reform and the peace negotiations were

fatal to the stability of the ministry because they were reinforced by personal rivalries and animosities. Fox considered Shelburne as much the king's tool as Lord North had been, and declared him "ridiculously jealous of my encroaching on his department and very anxious to encroach on mine." Fox believed, erroneously, that the American negotiations came within the province of the foreign secretary, and he wished to recognize the independence of the former American colonies immediately and unconditionally. Shelburne wanted to withhold this recognition until all the peace treaties were ready for signature, thereby hoping to secure some advantage from the favour; and he maintained that, since the independence of America had not yet been formally recognized, he as colonial secretary had the right to conduct the negotiations. Fox, therefore, notified his intention to resign (June 30), but before he could implement it Rockingham died (July 1).

When the king offered the premiership to Shelburne, Fox and his friends demanded it for the duke of Portland, who was distinguished only by a great title. They maintained that Rockingham had been prime minister because he had been their leader, not because he was the nominee of the sovereign; and that it was for them, not for the king, to choose his successor. This was unconstitutional; the king had the undoubted right to choose the minister. Fox and some of his friends at once resigned, but others remained to support Shelburne. Sir George Trevelyan described Fox's refusal to serve under Shelburne as the fatal and irreparable mistake of his life. Though his suspicions of Shelburne were far from groundless, they were exaggerated; moreover, Shelburne was in some respects the most enlightened statesman of his time. Fox sought to justify his resignation on the ground that he was trying to prevent the re-establishment of the king's power, but his judgment was partly warped by personal feeling.

The Fox-North Coalition (1783).—Although Fox had accepted Burke's views on the value of party connection, he always had a liking for coalitions; on Feb. 14, 1783, he joined with his old enemy North to eject the new government, and this object was accomplished ten days later. Defending an action that was undoubtedly unpopular and damaging to his reputation, Fox maintained that it was wise and candid to end the hostility between North and himself now that its sole cause, the American war, was over. The new allies agreed that nothing more was to be done in the way of "economical reform," North saying that the influence of the crown had already been too much reduced. Parliamentary reform was to be an "open" question, since North was opposed to it. Fox said that though he himself was pledged to its support, most of his friends and the most weighty and consequential among them were decidedly against it, and he specifically mentioned Portland. Fox also pressed the necessity of "governing independent of the king." North observed:

> If you mean by that, that there should not be a government of departments, I agree with you. I think it a very bad thing. In this country some one man or some body of men like a cabinet should govern the whole and direct every measure . . . I am clearly of opinion that the king should be treated with all sort of respect and attention, but the appearance of power is all that a king of this country can have.

After trying desperately for five weeks to withstand "the most unprincipled coalition the annals of this or any other nation can equal," the king had to submit (April 2). Portland became the nominal prime minister, Fox and North the two secretaries of state. Although the king withheld from the ministers the customary marks of confidence such as the creation of peers, they had no difficulty in retaining their majority in the commons. The habit of supporting the king's ministers, whoever they were, was evidently so ingrained in the independent country gentlemen that the majority of them continued to vote with the administration, and Fox wrote: "I cannot help thinking the fear of our being overturned in parliament is quite chimerical."

The new ministers made their position at court no better by proposing to give the prince of Wales an income of £100,000 a year. By remaining the intimate friend of this dissolute young man, who was detested by his father and who ostentatiously supported them, Fox further outraged the king's feelings. But George III did not dismiss the coalition on this issue, and Fox will still sanguine about his prospects when the new session opened on Nov. 11.

The coalition fell over its India bill. Fox and North had no wish to evade their responsibility for ending a system of misgovernment in India that had alarmed and disquieted English statesmen of all parties. Their bill proposed to change the whole constitution of the East India company (*q.v.*) by abolishing the courts of directors and proprietors, and transferring Indian patronage and control of the company's territories, revenues and commerce to seven commissioners to be nominated by ministers and removable only upon an address from either house of parliament. Vested interests took alarm, and the ministers were assailed with torrents of exaggerated criticism and pointed invective. The bill passed the commons by 208 votes to 102, but the peers rejected it on Dec. 17 by 95 to 76, after the king had made it known that he would consider as an enemy anyone who voted for it. The coalition was dismissed next day, and William Pitt accepted an invitation to form a government.

Fox increased his unpopularity by attacking the sovereign's right to choose his ministers and to appeal to the electorate to confirm his choice. Fox's opponents could now plausibly maintain that he would not even submit his case to the judgment of the nation. Many of the coalition's supporters changed sides, and the dissolution (March 1784) completed the discomfiture of the opposition, which found itself in the new house of commons with only about 145 members. Fox himself, however, was re-elected for the great popular constituency of Westminster, defeating the ministerial candidate, Sir Cecil Wray.

Opposition to Pitt and Addington.—It can hardly be maintained that Fox's coalition with North, however ill judged, necessarily doomed him to nearly 25 years of opposition. Had he been even a little accommodating, he could have joined William Pitt's government on honourable terms in 1784, to the great advantage of the cause of reform. It was unfortunate for his reputation that in 1785 he attacked Pitt's proposed commercial concessions to Ireland, and that in 1787, criticizing the commercial treaty with France, he countenanced the antiquated doctrine that England and France were natural enemies. In opposing the re-establishment of friendly relations between the two countries, Fox ignored the obvious fact that the monarchy of Louis XVI was no longer formidable, persecuting or bigoted. He was equally wrongheaded in opposing any modification of the Navigation acts. He also criticized the corn law of 1791 on the ground that the farmers were to be given too little protection against foreigners, and he put forward the doubtful proposition that protection for agriculture would never injure the poor, who on the contrary would always benefit by measures designed to encourage tillage. He blundered again in 1788–89, when the king was temporarily insane, by supporting the claim of the prince of Wales to the regency as a right—a doctrine that provoked Pitt (who maintained that parliament alone had the right and competence to appoint a regent) into declaring that he would "unwhig the gentleman for the rest of his life." Party interests were deeply involved in the constitutional dispute; the prince's first act of power would have been to dismiss Pitt and bring in the Whigs.

Fox welcomed the French Revolution. On hearing of the fall of the Bastille he wrote: "How much the greatest event it is that ever happened in the world: and how much the best!" Privately he showed himself far from insensible to the horrors that were soon perpetrated by the French republicans, but he gave no adequate public expression to his feeling of detestation. Approval of the Revolution led on to disapproval of the war with France as a crusade against freedom in the interest of despotism. On these issues Fox's friendship with Burke was shattered. A large part of the Whig party, headed by Portland, went over to the government in 1794, and the minority (50–60) adhering to Fox became one of the weakest oppositions ever known in England. By 1797 Fox was reduced to a condition of despair on finding that his hopes of peace and the restoration of the liberty of the subject (the Habeas Corpus act had been suspended in 1794) were as remote as ever, and the opposition seceded from parliament, some of them returning in 1800 to oppose the act uniting the Irish parliament with the English. Fox acquiesced in this mistaken move from indolence rather than from judgment. He was dismissed from the privy

council in 1798 for reaffirming in a public speech the doctrine of the sovereignty of the people; eight years later the king had to reinstate him without exacting any retraction of principle.

Fox approved of the peace negotiations that resulted in the treaty signed at Amiens (1802), but spoke of the "shameful surrender of all our conquests." He wrote to Charles, afterward Earl Grey: "I am gone something further in hate to the English government than perhaps you and the rest of my friends are, and certainly further than can with prudence be avowed. The triumph of the French government over the English does in fact afford me a degree of pleasure which it is very difficult to disguise." He was critical of the ministry (1801–04) of Henry Addington (afterward Viscount Sidmouth) for its failure to preserve the peace and to put the country into an adequate state of defense to meet the invasion threat. Though his motion, virtually one of censure (April 23, 1804), was defeated by 256 votes to 204, the government resigned a few days later.

Pitt now wished to form a nonparty government on a broad base, but failed to persuade George III to waive his objections to Fox as a minister (he would have been foreign secretary), though the king would have been ready to give him a foreign mission. Fox with his usual generosity acquiesced in this proscription, said that he was too old (at 55) to care about office, and advised his friends to join, but both they and the followers of Lord Grenville, with whom they had recently acted, rejected the suggestion and went into opposition. In the summer of 1805 Fox was informed, apparently on good authority, that the royal prejudice against him was weakening, but Pitt again failed to break it down. But adverse prejudice in other quarters was waning. The strength of Fox's party in the commons was beginning to revive; the Whigs and the Grenvilles now numbered about 150, though their increase may perhaps be attributed to some extent to the precariousness of the king's health, which then as always tended to increase the influence of the prince of Wales.

The Ministry of All the Talents.—When Grenville became prime minister after Pitt's death on Jan. 23, 1806, the king's veto on Fox's appointment to office as foreign secretary disappeared without protest. During the earlier phase of the war Fox had believed that the European despots were fighting to destroy the newly won liberties of the French, and he had underestimated the bellicose spirit of France and the danger to England of French conquests. But by 1806 he had come to realize that France, under Napoleon, far from being the innocent victim of reactionary attacks, was itself an aggressor threatening the independence not only of Great Britain but of the whole continent. He accepted the view that England was bound to continue the war, but in March 1806 the cabinet authorized him to open peace negotiations in the hope that reasonable terms might be obtained. After several months of diplomatic effort, however, Fox satisfied himself that the French would make peace only after military defeat.

By this time Fox's health was breaking down. Suggestions were made that he should take some less laborious office or even that he should remain in the cabinet without portfolio, and that he should take a peerage to save him from the yet more exacting task of leading the house of commons. The crowning achievement of his career came on June 10, when he carried, by 114 votes to 15, a motion pledging the house speedily to abolish the slave trade. The introduction of the abolition bill was delayed by press of business until the beginning of the next session, and by that time Fox was dead. His only other great reform had been the Libel act of 1792, which restored to juries their right to decide, upon an indictment for libel, whether the defendant was guilty or not guilty and whether what he had written could be adjudged libel; previously, mere proof of publication had been the only matter within the jury's competence. Fox made his last speech in parliament on June 19, and he died on Sept. 13, 1806, in the duke of Devonshire's house at Chiswick. He was buried in Westminster abbey, by the side of Pitt.

Character and Achievements.—The charm Fox exerted in personal intercourse overcame the hostility of the most inveterate of his foes. Sidmouth, who had been one of his bitterest enemies, wrote on July 30, 1806: "The want of poor Mr. Fox's assistance both in counsel and debate in parliament, is a calamity of enormous magnitude on every public and on every private account."

In 1795 Fox secretly married Mrs. Elizabeth Armistead, with whom he had been living for many years and to whom he always remained devoted; the marriage was revealed only in 1802. In their country house, St. Anne's Hill, near Chertsey, he indulged his tastes for classical literature and a bucolic existence, and found there ample compensation for all the disappointments and stresses of public life. Mrs. Fox, who bore him no children, died on July 8, 1842.

On the face of it, his career was an almost unrelieved failure. He held high office for only a few months. He failed to persuade the English people that his view of the French Revolution and of the ensuing wars was the correct one, and he failed to persuade the French to make peace on acceptable terms. His career as leader of the parliamentary opposition was marked by incredible blunders. He achieved only two important reforms. He shared with Pitt the optimism characteristic of the age: shortly before Europe was plunged into a quarter of a century of almost unceasing war on a scale hitherto unknown, he declared that the world was rapidly improving not only in science and knowledge but in virtue; philosophy was spreading its light around every part of the globe, and enlightened principles of freedom were rapidly becoming more and more universal.

Fox was no democrat. He despised public opinion if he considered it prejudiced and intolerant. He detested the great part of the doctrine embodied in Thomas Paine's *Rights of Man*. He never believed in universal suffrage, and was not wholehearted in his support of parliamentary reform. He wrote in 1792: "I am more bound by former declarations and consistency than by any strong opinion I entertain in its favour. I am far from sanguine that any new scheme would produce better parliaments than the present mode of election has furnished." He was critical of Grey and the other Whigs who founded the Friends of the People society in that year to further the cause of parliamentary reform, knowing that the effect would be to break up the party. He would never have countenanced the notion that property, the security of which was one of the prime preoccupations of both Whigs and Tories, would be safe in a democratic society in which the propertyless voters would obviously be in a majority. An aristocratic party, in his view, was essential to the preservation of both property and liberty. He belonged to the 18th century, too, in believing that a "mixed" constitution, in which the elements of monarchy, aristocracy and democracy were mutually blended and united, was the ideal form of government. He himself did not spring from an ancient family, and he had no predilection for an aristocracy resting merely on birth. In his view property was the true foundation of aristocracy, and a country best prospered whose government was in such hands. He was proud of his political connection with some of the first families in the country, "renowned for their ancestry, their importance and their possessions." His jealousy of the power of the crown marks him out as a true Revolution Whig of the old-fashioned type. To that extent he lived in the past—as he did in relying, in his struggle against the king, on the support of the prince of Wales.

Yet he looked forward as well as back. He anticipated 19th-century liberalism in maintaining, in his great struggle with Pitt in 1784, that the crown must choose the prime minister from the party that commanded a majority in the house of commons, irrespective of the sovereign's personal inclinations; but there was no historical justification for his contention that this view of the constitution had prevailed ever since the Revolution of 1688. In opposition to the view not only of Pitt, the reformer, but also of many of the great Whig aristocrats who believed in the sanctity of property, Fox denied that the possession of the parliamentary franchise was a form of property of which no elector should be deprived without compensation; rather was it a trust. In championing the cause of religious liberty he did not construe such liberty as meaning merely freedom from persecution. In his view there could be no real liberty without equality; to refuse to any man civil rights and an equal participation of civil advantage because of his religious opinions was in itself a form of persecution.

Supporting (March 28, 1787) a motion for the repeal of the Test and Corporation acts, he said that religion was not a proper test for a political institution; no government had the right to inquire into private opinions.

His share in the impeachment of Warren Hastings (*q.v.*) shows that he was inspired by a passionate determination that the independent peoples of the empire were no longer to be exploited and oppressed. His love of liberty was seen again in his view of the Canadian situation in 1791. He opposed Pitt's Canada act because it did not propose to establish a constitution consistent with the principles of freedom. He had none of the "cut the painter" attitude of the later radicals and he insisted that Canada must be preserved to the empire by the free choice of its inhabitants, enjoying all the benefits of the English constitution. All the British colonies must be given liberty, "to render them happy, flourishing, and as little dependent as possible." The American colonies had revolted because they were not sufficiently free; that error must not be repeated.

In the sphere of foreign relations he repudiated 18th-century conceptions grounded on the evil traditions of Machiavellian statecraft and substituted the modern idea that a small state is as fully entitled to its independence as a great power; that nations are naturally equal, possessing the same rights and incurring equivalent obligations. He repudiated the view of the Portland Whigs that a state has the right to interfere in the internal affairs of a neighbour in order to force upon it a constitution, a dynasty, a religion or a civilization it does not want. "War," he said, "should never be undertaken when peace can be maintained without breach of public faith, injury to national honour or hazard of future security."

Fox had a strong European sense and a deep feeling for the responsibilities of his own country as a member of a large society with mutual obligations. It was because he held these large and generous views that his influence endured after his death, inspiring not merely such domestic measures as the Reform act of 1832 but the liberal policy pursued by Lord Grey and Lord Palmerston toward Belgium in 1830–32, and the whole series of concessions by which 19th-century liberals, especially Gladstone, sought to govern Ireland in accordance with the wishes of the Irish people. *See* also references under "Fox, Charles James" in the Index volume.

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(A. AL.)

FOX, GEORGE (1624–1691), founder of the Society of Friends (Quakers), was born in July 1624 at Fenny Drayton, Leicestershire. His formal education was slight. As a child he was of an unusually tender and serious disposition. At the age of 19, in deep distress at men's vanity and immorality he left home and work and, thirsting for God, wandered the countryside. Later he valued this time of testing as equipment for helping others in like case. At last he found himself brought "by the power of Christ" through this "ocean of darkness and death" into the revelation of God's love. "And this I knew experimentally": henceforth his religion went beyond the Bible, which he treasured, to a direct experience. In its strength he believed himself to be sent to bring people "off" from false religion and worldly ways to a new and living experience of Christ. In 1649 he interrupted a preacher and was imprisoned, and in 1650 he was again imprisoned, for six months, for alleged blasphemy; but his force of character and speech never failed to win men, and many were eagerly seeking the message with which he was aflame. During 1651 by itinerant preaching he began to make converts, including James Nayler (*q.v.*). In June 1652 he convinced some hundreds at meetings in Westmorland, and the Society of Friends was born.

For the rest of his life Fox traveled continually throughout England, and to Wales, Scotland, Ireland, the Netherlands and Germany, and even to the West Indies and North America. He appealed to "that of God in every man," the light of Christ which both exposes sin and overcomes it and then endows men with simplicity and integrity. He was frequently in conflict with authority. Between 1653 and 1675 he suffered six further imprisonments, one lasting two and a half years. But in his desire to touch men's hearts he sought to exercise forbearance toward those who persecuted him, and he gladly used his times in jail as opportunities to release those who were also imprisoned spiritually. Through his combination of tenderness and gentleness with honesty and courage Fox attracted a large body of men and women, including some from a class above his own (among them William Penn and Robert Barclay), who not only shared his principles, sense of call and way of life but were devoted to him personally. He also possessed considerable organizing powers, and by establishing in 1667–68 the system of monthly business meetings which is still in use prevented Quakerism from falling apart or simply fading away. In 1669 he married one of his earliest converts, the widow of a judge of assize, Margaret Fell, of Swarthmore Hall, Ulverston, Lancashire, who for many years had given powerful leadership to Friends in the north of England. He died in London on Jan. 13, 1691, and was buried in the Friends' burial ground near Bunhill Fields.

In what remains the best short account of Fox, Penn describes him as "an original, being no man's copy"; "very temperate, eating little, and sleeping less, though a bulky person"; "no busybody, nor self-seeker, neither touchy nor critical"; "as ready to forgive as unapt to take or give an offence"; "he excelled in prayer"; "a discerner of others' spirits, and very much a master of his own"; "I never saw him out of his place."

Though no scholar, Fox issued about 200 tracts and other writings, many with a social or political rather than a doctrinal or homiletic character. His *Journal*, though not a day-to-day account composed at the time but dictated in 1675 as he surveyed his life, conveys the force of his remarkable personality. *See* also FRIENDS, SOCIETY OF.

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(G. F. N.)

FOX, SIR WILLIAM (1812–1893), New Zealand statesman and historian, who worked for responsible government and was prime minister for brief terms after its achievement, was born in England, at Durham, on June 9, 1812. He was educated at Wadham college, Oxford, and was called to the bar in 1842, but he emigrated immediately to New Zealand, where he became the New Zealand company's agent at Nelson in 1843 and principal agent at Wellington in 1849. He vehemently supported the colonists' demands for self-government and in 1851, when the company expired, went to England to work for this in the constitution then being drafted. Returning, he bought land at Westoe, Rangitikei, entered the Wellington provincial council in 1854, and the first general assembly after the adoption of responsible government in 1856. Fox proved more effective in opposition than in office. Pugnacious and incisive in attack, he had not enough political insight for a steady course, and on Maori troubles, for instance, his policy changed repeatedly. In 1856 he formed a cabinet that lasted 13 days. In 1861, after the first Taranaki war, he took office again, trying with the governor, Sir George Grey, to work for peace while preparing against war. He was defeated in 1862 when aiming to lessen Grey's control over native affairs. As colonial secretary and native minister in 1863–64 he urged vigorous war and confiscations of Maori land. He was premier in 1869–72, but Julius Vogel (*q.v.*), the treasurer, held the real power. Fox held office for a few weeks in 1873 while Vogel was abroad. He left parliament and was knighted in 1879. He died at his home in Auckland on June 23, 1893.

Fox published *The Six Colonies of New Zealand* (1851); *The War in New Zealand* (1860; rev. ed., 1866); and several pamphlets. He furthered exploration in the early days, was a watercolourist, and ardently advocated temperance. (N. M. TA.)

FOX, WILLIAM (1879–1952), U.S. motion-picture producer and distributor, was born in Tulchva, Hung., on Jan. 1, 1879. Brought to the U.S. as an infant, he was reared in New York city and worked there in the garment industry. He entered the motion-picture business in 1904 when he bought a nickelodeon in Brooklyn for $1,600. He soon formed an exhibition company, a chain of motion-picture theatres and later a production company in Staten Island, N.Y. In 1915 he founded the Fox Film Corp. to produce, distribute and exhibit films. His holdings were expanded until by 1929 his interests in the Fox corporation, Loew's, Inc., and Gaumont-British were valued at $300,000,000. After the 1929 stock market crash the Fox empire swiftly crumbled, and in 1936, plagued by lawsuits, he went into bankruptcy.

Fox died in New York, May 8, 1952. (M. S. By.)

FOX, a common name used generally for several species of the carnivorous mammalian genera *Vulpes, Fennecus, Urocyon, Alopex* and *Otocyon*, all of the dog family (Canidae) (*see* CARNIVORE). Foxes resemble medium-sized to small bushy-tailed dogs with long fur. In a more restricted sense the term designates the *Vulpes* (or true) foxes, especially the common red foxes, *Vulpes vulpes* of the old world and *V. fulva* of the new.

The red foxes differ from other true foxes in having a white-tipped tail and the outside of the ears heavily suffused with black. The coat is full, consisting of long guard hairs and soft, fine underfur, and is usually of a rich reddish colour, although in North America other colour phases are known: pure black, silver and cross (brownish yellow with a dark band over the shoulders crossing a dark band down the back). A peculiar inherited mutant strain—the samson fox—which has appeared in northwestern Europe, lacks guard hairs, and the underfur is tightly curled. Red foxes average 3 to 3½ ft. in length (of which about 14 in. is tail), stand 16 in. high at the shoulders and weigh 5 to 10 lb. Both species have a wide geographic distribution, *V. vulpes* occurring over virtually all of Europe, temperate Asia and Africa north of the Sahara and *V. fulva* ranging over most of North America north of Mexico. They have become differentiated into a number of geographic races, yet wherever they are found they exhibit remarkably little variation in behaviour. The preferred habitat is mixed farmlands and woodlots and especially weedy, brushy fence rows bordering fields. Occasionally the red fox is found also in dense forests, along the edges of marshes and even in urban areas. Small mammals—mice and rabbits chiefly—are staple elements of the fox's diet, and birds, including domestic fowl, and eggs and fruits are accepted avidly. The red fox seldom kills animals larger than a rabbit, although occasionally a fawn will be brought down. Remains of larger animals around a den site indicate usually that the fox fed on carrion.

The red fox relies on its keen ears, eyes and nose to detect its prey. It stalks even the smaller animals with great skill and patience and ends the stalk with a lightening-quick pounce. The usual gait is a slow, mincing trot, with the tail carried low. When pursued, as by hunting hounds, the fox runs with a fluid, bounding motion, but has relatively little endurance. Although the red fox does not mate for life, a mated pair remains together while their young are being reared. Breeding takes place in winter, and the one to ten blind, helpless young are born 49 to 55 days later. They first emerge from the den in about five weeks, at which time they are alert and lively. The male brings food to the young until midsummer when both parents begin to teach the young to hunt. The den is usually a burrow abandoned by another animal (*e.g.*, a woodchuck), and which the foxes enlarge. It is located in or at the edge of a clearing that affords good visibility and a sunny exposure.

Although the red fox is an inquisitive animal that behaves in wilderness areas like a shy but friendly dog, it enjoys the reputation of being a wily and sagacious animal, skilled in deceiving pursuing hounds and in avoiding traps. A fox that lives in an area that is much hunted does become adept at avoiding detection and capture; its cleverness in this regard is probably as much due to its keen senses as to its intelligence. Few creatures, except man, prey on the fox.

At times when long-haired furs are fashionable, fox pelts, especially of silver foxes, are much in demand and are often produced on commercial fox farms (*see* FUR: *Fur Farming*). Although the red fox sometimes becomes a pest because of its depredations on poultry, in the broader sense it is valuable in controlling noxious rodents.

JOHN H. GERARD

AMERICAN GRAY FOX (UROCYON CINEREOARGENTEUS)

All other species of foxes are of much more restricted occurrence. The small corsac (*Vulpes corsac*) ranges over the steppes of eastern Eurasia. The two-foot-long, gray hoary fox (*V. cana*) occurs from Iran to Baluchistan. The Tibetan sand fox (*V. ferrilata*), with a yellowish colour, short ears and tail and a narrow skull, is found in Tibet and Nepal. The small, gray Bengal fox (*V. bengalensis*) occurs in India and Nepal. Rüppell's fox (*V. rüppelli*), 29 in. long, is a big-eared gray desert fox that occurs from Algeria to Afghanistan. The African sand fox (*V. pallida*), yellow in colour, is also a desert species, and occurs from west Africa to Egypt. The small, gray, long-eared African "silver fox," chama fox or caama (*V. chama*), occurs in south Africa. The fennec (*Fennecus zerda*) is a small, buff-coloured desert fox with enormous, erect ears; it ranges over north Africa south to the Sudan. The small, gray to yellow kit (*Vulpes macrotis*) and swift (*V. velox*) foxes of western North America are smaller-eared counterparts of the fennec; both are uncommon now and are probably extinct over most of their former ranges.

The American gray fox (*Urocyon cinereoargenteus*) is a grizzled gray animal of shier, more retiring disposition than the red fox. It prefers the safety of the swamps, dense thickets and underbrush. It lacks the craftiness of the red fox and usually attempts to avoid detection and capture by hiding. Also unlike the red fox, it seldom stores food and is the only fox that climbs trees. Otherwise its diet, social behaviour and general habits resemble those of the red fox. The gray fox is common over most of the United States, except for the western plains, and extends southward into South America. A closely related but distinctly smaller species, the island gray fox (*U. littoralis*), occurs on the islands off the southern California coast.

The arctic fox (*Alopex lagopus*) is a small fox, gray in summer and white in winter. It has small ears, a comparatively blunt face and dense fur; it is circumpolar arctic in distribution. A colour phase of this species is the "blue fox" of the fur trade.

The African big-eared fox, or motlosi (*Otocyon megalotis*), with a gray body and black legs, is about the size of a red fox but has ears almost as large as those of the fennec. Curiously, certain of the shearing cheek teeth characteristic of all the other canids are absent in this aberrant species. *See* also references under "Fox" in the Index volume. (K. R. Kn.)

FOXE, JOHN (1517–1587), author of *The Book of Martyrs*, was born at Boston, Lincolnshire, in 1517. A devout and scholarly boy, he was sent to Brasenose college, Oxford, whence he migrated to Magdalen college, holding a fellowship for seven years. But in 1545, being suspect for Protestantism, he resigned his fellowship, and took a tutorship with the Lucy family at Charlecote, Warwickshire, where he married Agnes Randall of Coventry. In 1547 he moved to London, and became tutor to the grandchildren of the duke of Norfolk. He was ordained deacon in 1550 by Nicholas Ridley, and worked for the Reformation, writing several tracts. He also began a Latin history of the persecution and martyrdoms

in England from John Wycliffe onward, but had carried it no further than the year 1500 when Mary's accession (1553) forced him to flee with his wife overseas, hotly pursued by emissaries of Stephen Gardiner, bishop of Winchester and lord chancellor. Proceeding to Strasburg he printed his unfinished martyrology in octavo (*Commentarii rerum in ecclesia gestarum*, 1554), and then spent a year in Frankfurt, where in the violent controversies over the use of the Book of Common Prayer he gave a moderating support to the Calvinistic party of John Knox. When his party was defeated in 1555, he settled at Basel, earning a meagre living by correcting proofs for the printer Oporinus, and writing a burning appeal to the English nobility to restrain the queen from persecuting (*Ad inclytos Angliae proceres*, 1557). But his chief labour was the extension of his martyrology. By aid of manuscripts from England he carried this to Thomas Cranmer's death in 1556, and printed it in folio (*Rerum in Ecclesia gestarum . . . Commentarii*, 1559). He then returned to London with his family, and devoted himself to the completion of his great work. Ransacking registers and using the memories of eyewitnesses, he enlarged and rounded off his story. The book was printed in March 1563 by John Daye under the title *Acts and Monuments of These Latter and Perilous Days*. It was a big folio, written in English, and adorned with woodcuts. It made a great sensation and immediately acquired the popular name, *The Book of Martyrs*. But Foxe was not satisfied. There were errors to amend, and much fresh material was flowing in. For seven years more he laboured, to the lasting detriment of his health, and in 1570 produced his second edition, not a little improved, in two gigantic volumes. This was the crown of his achievement: for he made few changes in his third (1576) and fourth (1583) editions.

Foxe was ordained priest in 1560 by Edmund Grindal, bishop of London, but having Puritan scruples refused all preferments save two prebends—at Salisbury (1563–87) and Durham (1572–73). But he often preached, and a sermon delivered at Paul's Cross (*Of Christ Crucified*, 1570) had a wide sale. In the plague of 1563 he ministered to the victims and wrote a beautiful tract of consolation. For Archbishop Parker he edited in 1571 *Reformatio Legum Ecclesiasticarum* (the proposed revision of canon law) and *The Gospels, Anglo-Saxon and English*. He was much in request as spiritual counselor, and never feared to speak his mind even to the greatest. When Anabaptists in 1575 and Jesuits in 1581 were condemned to death Foxe wrote vehement letters to queen and councilors begging a reprieve. His integrity, warm heart and social gifts won him friends of all classes: among them Lord Burleigh and Sir Francis Drake. He died on April 18, 1587, and was buried in the chancel of St. Giles, Cripplegate, his parish church, amid a great concourse of mourners.

Foxe's monument is his book. It spoke straight to the heart of Elizabethan England. It was installed in churches, read aloud by Drake on the western seas to his shipmates, praised by Knox, archbishop Whitgift and William Camden. But it speaks also to our cooler age. It is indeed prolix, unsystematic, carelessly edited, one-sided, oversharp, sometimes credulous. But it is honest and it is strong in facts. It opens a window upon the English Reformation by preserving much firsthand material unobtainable elsewhere. Foxe's ready pen and deep compassion for suffering can make his death scenes very moving. The charges of deliberate falsification brought against him by Alan Cope (1566), Robert Parsons (1603) and some moderns have no substance. Despite faults the book lives and it deserves to live.

See J. F. Mozley, *John Foxe and His Book* (1940). This book reviews the whole case and clears the controversial air, vindicating Foxe from the gravest charges made by S. R. Maitland (1792–1866) and his followers. It also proves (against Maitland) that the long memoir of Foxe inserted into *Acts and Monuments* (1641) was written by his younger son, Simeon Foxe (1568–1642). (J. F. Mz.)

FOXE (Fox), **RICHARD** (*c.* 1448–1528), English bishop and statesman and founder of Corpus Christi college, Oxford, was born at Ropesley, near Grantham, Lincolnshire. He probably studied at Magdalen college, Oxford. He was in Paris (1484) in the service of the earl of Richmond, afterward King Henry VII, and on Henry's accession (1485) he became the king's principal secretary, lord privy seal and bishop of Exeter (1487). He negotiated a treaty with James III of Scotland (1487); as bishop of Bath and Wells, he concluded the treaty of Étaples (1492) with France, and he was chief commissioner in the negotiations that secured the Magnus Intercursus (1496) with the Netherlands. Meanwhile Foxe had been translated (1494) to the politically important see of Durham, where he defended Norham castle (1497) against a Scottish raid in the interests of the pretender Perkin Warbeck; in the same year he negotiated Perkin's retirement from James IV's court. In 1498–99 he finally obtained James's consent to a peace treaty that arranged for his marriage (1503) to Margaret, elder daughter of Henry VII. This treaty consummated Foxe's work in the north, and in 1501 he was translated to Winchester. In that year he concluded the negotiations for the betrothal of Prince Arthur to Catherine of Aragon and in 1508 obtained by a further treaty the betrothal of the king's younger daughter, Mary, to the future emperor Charles V.

Foxe's share in framing the financial policy of Henry VII's government made him sometimes unpopular, but he was subsequently one of a small group of Henry's executors who heard cases brought against the late king's ministers for unlawful acts. He was high in favour at the opening of Henry VIII's reign, but after 1511 Wolsey's rapid rise undermined his influence. Foxe was not in sympathy with the embroilment of England in continental wars, and in 1516 he resigned the privy seal. He congratulated Wolsey on the peace of London (1518), but when war broke out again in 1522 he opposed in convocation the subsequent demand for taxation. During his last years he was mainly engaged in the administration of his diocese. He was totally blind during this time, and, according to tradition, spent much time praying in the chantry chapel he had prepared for his burial at Winchester. He died at Wolvesey, Winchester, the episcopal castle, on Oct. 5, 1528.

Foxe was a patron of scholars and learned institutions. He was elected chancellor of the University of Cambridge for the year 1500, and was master of Pembroke hall (1507–19). Lady Margaret Beaufort made him one of her executors and, with John Fisher, bishop of Rochester, he was principally responsible for her foundation of St. John's college and the Lady Margaret professorships and readerships. He edited (1508) the Sarum *Processional*, translated the *Rule of St. Benedict for Women* (1517) and built and endowed schools at Taunton and Grantham and gave gifts to Magdalen college, Oxford, and to Pembroke college, Cambridge. He crowned his career by the founding (1515–16) of Corpus Christi college, Oxford, where provision was made for the teaching of Greek. Desiderius Erasmus lauded the institution where the reader in theology was instructed to follow the Greek and Latin Fathers rather than scholastic commentaries. Reginald Pole was one of its earliest fellows and the Spanish humanist Ludovicus Vives came from Italy to teach Latin there. The college possesses several portraits and other relics of its founder.

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FOXGLOVE, biennial and perennial herbs of the family Scrophulariaceae, comprising the genus *Digitalis*. It contains about 20 species found naturally in Europe, western Asia and the Canary Islands. The common or purple foxglove, *D. purpurea*, is common in dry hilly pastures and rocky places and by roadsides in various parts of Europe; it ranges in Great Britain from Cornwall and Kent to Orkney, and is sparingly naturalized in North America. Foxglove flourishes best in siliceous soils. Its characters are: stem erect, roundish, downy, leafy below, and from 18 in. to 5 ft. or more in height; leaves alternate, ovate or elliptic-oblong, and dull green, with the undersurface downy and paler than the upper; root of numerous, slender, whitish fibres; flowers $1\frac{1}{2}$–$2\frac{1}{2}$ in. long, pendulous, on one side of the stem, purplish crimson, hairy and marked with eyelike spots within; corolla bell-shaped with a two-lipped broadly obtuse mouth, the upper lip entire or obscurely divided; stamens four, two longer than the other two (didynamous); capsule ovate and pointed; and seeds numerous, small. It normally flowers in June, and ripens its seed in August, but may occasionally be found in blossom as late as September.

J. HORACE MCFARLAND CO.

COMMON OR PURPLE FOXGLOVE (DIGITALIS PURPUREA)

Many varieties have been raised by cultivation, with flowers varying in colour from white to deep rose and purple. The common foxglove is commercially cultivated in Michigan and Oregon as the official source of digitalis, a valuable drug in certain types of heart disease (*see* DIGITALIS). Other, but nonofficial, species of *Digitalis* are also grown in Spain and France, especially *D. lutea*.

The foxglove, probably from folk's-glove (*i.e.*, fairies' glove), is known by a great variety of popular names in Britain. In the south of Scotland it is called bloody fingers; farther north, deadmen's-bells; and on the eastern borders, ladies' thimbles, wild mercury and Scotch mercury. In Ireland it is generally known as fairy thimble. Among its Welsh synonyms are elves' gloves, fox's gloves, redfingers and dog's fingers.

In France it is called Our Lady's gloves and Virgin's fingers. The German name *Fingerhut* (thimble) suggested to Fuchs, in 1542, the use of the Latin adjective *digitalis* (of the finger) as a designation for the plant. Other species of *Digitalis* are grown in England for ornament, notably *D. ambigua*, with yellow, brown-spotted flowers; *D. lanata* of eastern Europe, with white and purple flowers; and *D. lutea* of Europe with yellow or whitish flowers. Few are grown in the U.S., except in cooler regions. (N. TR.)

FOX HUNTING: *see* HUNTING.

FOX INDIANS, an Algonkian-speaking tribe who call themselves Mesquakie (Red-earth people) and who live in Tama county, Ia., on land that they purchased from 1857 on. When they first met Europeans, in the mid-17th century, they were allied with the Sauk (*q.v.*) in Wisconsin, where they warred against the French, then the English, and (though unconquered) eventually retreated to Illinois and Iowa. The Sauk are now mainly in Oklahoma and the Fox in Iowa, with no special relationship except that they are officially grouped together as the Sac and Fox.

The Fox practised a characteristic Woodland culture, with summer villages based on women's gardens of corn, beans and squash; their winter hunting bands ranged over wide areas. A peace chief and council of elders administered tribal affairs; important decisions were discussed by the whole tribe until disagreement ended. War parties rallied about men whose skill and reputation made them leaders. Nuclear families were grouped into clans which were mainly ceremonial organizations; descent was usually counted through males.

Changed as they are in economy and appearance, the Fox Indians maintain their community, as in the past, against all attempts to destroy it and probably are the most culturally conservative Indian tribe in the U.S. outside the southwest. They hold their land as a tribe and pay taxes on it to the state. Their clan and ceremonial organizations are much alive, although the Christian missions and the peyote religion (*see* PEYOTISM) claim a few families. The women grow gardens as of old; but the Indians do little commercial farming and generally earn their livings in a variety of occupations in neighbouring towns. The Indian language is the language of the home. The government maintains an elementary school on the settlement, and most Indians subsequently graduate from the nearby Tama high school. The tribe elects a business council to handle its funds and its relations with the government. In the early 1960s the Fox numbered about 500. *See* also ALGONKIAN TRIBES.

See T. Michelson, "Contributions to Fox Ethnology," Bureau of American Ethnology *Bulletin 85* (1927); C. Callender, *Central Algonkian Social Organization*, Anthropological Publications of the Public Museum of the City of Milwaukee (1961); F. Gearing *et al., Documentary History of the Fox Project, 1948–1959* (1960). (S. TX.)

FOXTAIL GRASS, the name given to perennial grasses of the genus *Alopecurus*, comprising about 50 species, natives of cool north temperate regions. Of these the meadow foxtail (*A. pratensis*) is extensively cultivated in Europe as a pasture grass, and is also naturalized in North America. Various species of *Setaria* are likewise called foxtail grass, of which the yellow foxtail (*S. lutescens*) and the green foxtail (*S. viridis*), widely naturalized from Europe in North America, are often troublesome weeds.

See also GRASSES.

FOX TROT, probably the most popular, diversified and widespread of all modern ballroom dances. The music is in 4/4 time. The speed at which the music is danced determines the basic fox trot rhythms; slow steps require half notes, fast steps require quarter notes.

The slow fox trot consists primarily of walking steps taken with a strong push-off from the supporting foot, followed by straightening and flexing the knees in stepping, which gives the sleek, smooth style that is characteristic of the dance. A chassé (step side, close step) is taken in conjunction with the walking steps; the standard figures are: two walking steps, chassé, or one walking step, chassé. Numerous variations and combinations of the steps are done in all of the standard ballroom positions.

The fast fox trots—Peabody and one-step—are done almost entirely on the balls of the feet in a light, breezy manner. Pivot turns are frequently executed.

See also DANCE: *Technique of Modern Social Dancing.*

FOY, EDDIE (EDWIN FITZGERALD) (1856–1928), U.S. comedian, was born in New York city on March 9, 1856. As a child he sang and danced in the streets of New York and Chicago to help support his family. He gained his first professional recognition in the western boom towns, beginning around 1878. By the time he returned to Chicago in 1888 to appear in a series of extravaganzas, he had adopted the clown make-up and eccentric comic business that became his trade-marks. Between 1904 and 1913 he played the leading comic roles in a series of Broadway musical comedies, among them *Piff! Paff! Pouf!* and *The Earl and the Girl*. He entered vaudeville in 1913 with a highly successful act that included his seven children and appeared with them in one motion picture. He retired in 1923 but returned to the stage in 1927 and died in Kansas City, Mo., on Feb. 16, 1928, while on a farewell tour. (O. G. B.)

FOY, MAXIMILIEN SÉBASTIEN (1775–1825), French general of the Napoleonic Wars who won popularity as a liberal deputy under the Restoration, was born on Feb. 3, 1775, in Picardy. He passed into the artillery and had a horse battery in the army of the North in 1793–94 and in the army of the Rhine in 1795–97. At the end of Moreau's retreat in 1796 the heroic defense of Huningen bridgehead under Gen. Jean Abbatucci made Foy a major. Masséna made him a staff colonel of infantry at the battle of Zürich (1799), but Foy was again in the artillery in Marmont's corps in 1804 and went to the Dardanelles as a technical officer in 1807.

Foy next served with Junot in Portugal, and with Junot's help he at last won the rank of infantry general of brigade (Nov. 1808). He felt, however, that his promotion had been slow and thought that the suspicion of his having voted against Napoleon Bonaparte's life consulship might have caused the delay (in fact there were many good officers a little older than he). The next six years of war in Spain made him a good infantry general. He was always prominent, yet his misadventures were many. It was his brigade that Wellesley surprised when he took Oporto (May 1809); he was driven down Busaco hill in rout (Sept. 1810); his division was broken by German cavalry in the retreat from Salamanca (July 1812); he led 16,000 men irrelevantly in Biscay while the battle of Vitoria was being lost; and in four successive battles in the Pyrenees his division missed the heavier fighting. However, Foy could speak and write well (his interviews with

Napoleon on Masséna's behalf are admirably described), and Napoleon made him general of division in Nov. 1810. Yet he had to wait till the Hundred Days before he was made a count of the empire (May 25, 1815), and he did not have a corps command, though he noted that the army needed new leaders. He received his 15th wound before Hougoumont farm at the battle of Waterloo. After the second Restoration, Foy was elected deputy for Aisne in the national assembly of 1819. His eloquence made him leader of the liberal opposition until his death on Nov. 28, 1825.

See M. Girod de l'Ain, *Vie militaire du général Foy* (1900).

(I. D. E.)

FRACASTORO, GIROLAMO (1478–1553), Italian physician and poet who opened the way to modern concepts of infection and epidemic diseases, was born at Verona. He studied at Padua and became professor of philosophy there in 1502, afterward practising as a physician in Verona. Fracastoro's theory of contagion (printed in 1546) was that it was due to the passage of minute bodies, capable of self-multiplication, from the infector to the infected, a theory that bears a superficial resemblance to modern doctrine. The term "syphilis" apparently originated with him, being taken from his principal work, a kind of medical poem entitled *Syphilis sive Morbus Gallicus* (1530). Fracastoro also was the first to describe typhus fever. In 1517, when the builders of the citadel of San Felice (Verona) found fossil mussels in the rocks, Fracastoro took the view—following Leonardo da Vinci—that they were the remains of animals once capable of living in the locality. He died at Casi, near Verona, on Aug. 8, 1553; and in 1559 the town of Verona erected a statue in his honour. His complete works were published at Venice in 1555, and his poems were collected and printed at Padua in 1728.

FRACTION, in mathematics, represents one expression divided by another. When anything is divided into a number of equal parts, one or more of these equal parts can be expressed as a fraction. Thus, when one foot is divided into four equal parts, three of these parts are three quarters (or three-fourth parts) of the foot; written as $\frac{3}{4}$ ft. The fraction $\frac{3}{4}$ may also be written $3/4$; in general, written as $\frac{a}{b}$ or a/b. Here a is the numerator and b the denominator of the fraction; both are its terms. When, as in $\frac{3}{4}$, both terms are natural numbers (positive integers) the fraction is simple. When a is less than b it is called a proper fraction; otherwise it is an improper fraction. Thus $\frac{9}{7}$ or $\frac{7}{7}$ are improper simple fractions; $\frac{3}{4}$ is proper and simple. A fraction can also be regarded as the result (quotient) of a division. For instance, $\frac{3}{4}$ can be considered the quotient $3 \div 4$, obtained by dividing 3 by 4. The denominator may therefore never be zero. If a and b are not natural numbers, they produce a complex fraction, such as $\frac{1\frac{1}{2}}{3\frac{1}{4}}$, or $\frac{\sqrt{2}}{\sqrt{5}}$.

Since the terms of a fraction may be multiplied by the same number (p) without changing the final quotient ($\frac{a}{b} = \frac{pa}{pb}$), $\frac{a}{b}$ and $\frac{pa}{pb}$ are called equivalent. Thus, the two equivalent fractions $\frac{18}{27}$ and $\frac{20}{30}$ both can be reduced to the equivalent $\frac{2}{3}$. Two simple fractions can be changed to equivalent fractions with the same denominator; for example, $\frac{2}{3}$ and $\frac{3}{4}$ are respectively equivalent to $\frac{8}{12}$ and $\frac{9}{12}$.

Laws of Operation.—The laws governing the fundamental operations with fractions are shown below:

Addition: $\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$; *e.g.*, $\frac{3}{4} + \frac{2}{3} = \frac{9 + 8}{12} = \frac{17}{12} = 1\frac{5}{12}$

Subtraction: $\frac{a}{b} - \frac{c}{d} = \frac{ad - bc}{bd}$; *e.g.*, $\frac{3}{4} - \frac{2}{3} = \frac{9 - 8}{12} = \frac{1}{12}$

Multiplication: $\frac{a}{b} \times \frac{c}{d} = \frac{a}{b}\frac{c}{d} = \frac{ac}{bd}$; *e.g.*, $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12} = \frac{1}{2}$

Division: $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$; *e.g.*, $\frac{3}{4} \div \frac{2}{3} = \frac{3}{4} \times \frac{3}{2} = \frac{9}{8}$

Raising to a power: $\left(\frac{a}{b}\right)^2 = \frac{a^2}{b^2}$; *e.g.*, $\left(\frac{2}{3}\right)^2 = \frac{4}{9}$

Taking a root: $\sqrt[3]{\frac{a}{b}} = \frac{\sqrt[3]{a}}{\sqrt[3]{b}}$; *e.g.*, $\sqrt[3]{\frac{8}{9}} = \frac{\sqrt[3]{8}}{\sqrt[3]{9}} = \frac{2}{\sqrt[3]{9}} = \frac{2\sqrt[3]{81}}{9}$

The last example shows a change from a fraction with an irrational root, $\sqrt[3]{9}$, to a fraction with an integer root, 9. This was done by multiplying numerator and denominator with the same number $\sqrt[3]{81}$, since $\sqrt[3]{9} \times \sqrt[3]{81} = 9$.

When, in a simple fraction all common factors have been removed from both terms, the fraction is said to have been reduced to its lowest terms, or to be irreducible; *e.g.*, $\frac{15}{27} = \frac{5}{9}$; here $\frac{5}{9}$ is irreducible.

Extension of the Concept.—Fractions can also be considered in which the terms are functions of one or more variables, such as $\sin x / \cos 2x$, or $(x + y) / (x \sin y)$. When both terms are polynomials they constitute a rational fraction; for example $(x \times y) / (x^3 + 7y^3)$. Here again there are equivalent fractions which may be reduced; *e.g.*,

$$\frac{x^2 + 2xy + y^2}{x^3 + y^3} = \frac{(x + y)^2}{(x + y)\ (x^2 - xy + y^2)} = \frac{x + y}{x^2 - xy + y^2}$$

The laws governing the fundamental operations also hold when the terms are functions.

Decimal Fractions.—When the denominator is ten or a power of ten such as 100, 1,000 and so on, it defines a decimal fraction; for example, $\frac{2\,7}{1\,0\,0}$. Decimal fractions have been used by the Chinese in metrology (*q.v.*) for several millenniums; Liu Hui (3rd century A.D.) expressed a length, which we write 1,355 ft., in corresponding decimal terms. The facility with which medieval Chinese mathematicians used decimal fractions may have led to the study of such fractions in Muslim countries. Complete mastery of decimal fractions was shown in the works of the Persian astronomer al-Kashi (early 15th century), who computed π in 16 decimals. In western Europe decimal fractions appeared in several books during the Renaissance, but their systematic use began with Simon Stevin, in his *Thiende* (1585). Stevin's notation was still clumsy, but he influenced John Napier, who introduced the modern notation in his book on logarithms (1619). This opened the period of the great tables of logarithms (Henry Briggs, E. de Decker, A. Vlacq) in which decimal fractions were taken for granted. By the 18th century the present notation for decimal fractions, either with decimal dot or decimal period, was generally in use.

Other Types of Fractions.—Fractions with denominator 60 or powers of 60 are called sexagesimal, and were extensively used in ancient Iraq, where in cuneiform script a position system was used in which, for example, 12,35 might mean $12 + \frac{35}{60}$. This so-called Babylonian method, in use about 2,000 B.C., was taken over by such Greek astronomers as Ptolemy (*c.* A.D. 125), who rewrote it in Greek symbols. The method was again taken over by later Islamic and European mathematicians, and it is still used in the measurement of angles, where 5° 17′ 39″ means $5 + \frac{17}{60} + \frac{39}{3,600}$ degrees.

Other types called unit fractions (with numerator 1) were introduced by the ancient Egyptians and also later adopted by some Greek and Latin writers. Fractions with arbitrary denominators appear in ancient Chinese documents, in works by Indian, Greek, Latin and modern writers.

After thousands of years during which fractions were written in a variety of notations, the bar between numerator and denominator began to appear in Arabic and medieval Latin manuscripts. It came into general use in 16th-century books on arithmetic which treated fractions in much the same way they are now used. *See* also Continued Fractions; Arithmetic; and references under "Fraction" in the Index volume.

Bibliography.—Any book on elementary arithmetic has a chapter on fractions, for example, W. I. Layton, *College Arithmetic* (1959). On the history of fractions, *see* D. E. Smith, *History of Mathematics*, vol. ii (1925, 1957); F. Cajori, *History of Mathematical Notations*, vol. i (1928); J. Needham, *Science and Civilization in China*, vol. iii (1959); D. J. Struik, "Simon Stevin and the Decimal Fractions," *Mathematics Teacher* (Oct. 1959).

(D. J. S.)

FRACTIONAL DISTILLATION: *see* Distillation: *Fractional Distillation and Rectification.*

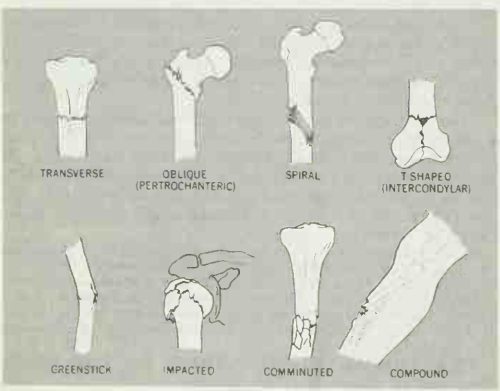
FRACTIONATION, in chemistry, consists in separating into fractions materials which differ in rates of crystallization,

boiling points or other characteristics, rendering possible a sharp separation. Gases may be separated by fractional combustion, as in burning oxygen out of the air to secure the nitrogen (*see* NITROGEN, FIXATION OF). Fractional crystallization requires conditions favourable for the crystallization of one component in a reasonably pure state. Further purification is obtained by redissolving and recrystallization. Various conditions, temperature and a choice of solvents are important, as well as a knowledge of the characteristics of the solids to be separated. Fractional distillation is dependent upon differences in boiling points, the best example being the concentration of alcohol (*see* ALCOHOL). Here the lower boiling point of the alcohol allows its removal in a high state of purity from the water with which it is admixed. Fractionating columns are of various designs, the object in all cases being to concentrate to a high purity with low heat consumption. Complex mixtures of liquids are often separated by several distillations, in the course of which one after another is removed, according to predetermined conditions. (*See* DISTILLATION.) Fractionation may also be applied to precipitation, where one material after another may be thrown out of a mixed solution, depending upon the reagents used.

FRACTURES AND DISLOCATIONS are the commonest injuries involving the bones. A fracture is a break in the normal continuity of a bone. A fracture is called simple (closed) when the overlying skin is not broken and the bone is not exposed to the air; it is called compound (open) when the bone is exposed, either as a result of the injury destroying the skin over the bone or of the broken end of the bone piercing the skin. The terms transverse, oblique, spiral and T-shaped refer to the direction of the fracture line. A transverse fracture line goes directly across the bone, an oblique fracture line crosses it at an angle and a spiral fracture line winds around the bone. A T-shaped fracture line goes transversely across the bone near a joint and the smaller piece of bone near the joint is split longitudinally.

Incomplete, greenstick, complete, impacted and comminuted are terms that describe the position the broken ends of the bone assume following the injury. An incomplete or greenstick fracture occurs when the bone appears to bend but does not completely break into two separate pieces, the latter condition being termed a complete fracture. An impacted fracture occurs when the broken ends of the bone appear to be jammed together by the force of the injury. A comminuted fracture is one in which the ends are shattered into many pieces. A pathological fracture results when a bone weakened by disease breaks from a minor injury.

A dislocation is a disruption of a joint, leaving the ends of the bones that meet to form the joint out of contact with each other. In simple dislocation, the joint surfaces are not exposed to the air. When the joint surfaces are exposed by destruction of overlying skin or by the end of the bone being driven through the skin the dislocation is called compound. A congenital dislocation is one that is present at birth as the result of defective formation of the joint. An acquired dislocation results from an injury. A recurrent or habitual dislocation is a repeated dislocation of the same joint. A pathological dislocation occurs as the result of a disease that weakens the capsule and ligaments about the joint.



FROM W. A. NEWMAN DORLAND, "ILLUSTRATED MEDICAL DICTIONARY"; REPRODUCED BY PERMISSION OF W. B. SAUNDERS COMPANY

VARIOUS TYPES OF FRACTURES

Injuries that cause dislocations may cause fracture of one or more of the joint surfaces at the same time. This condition is called a fracture-dislocation.

Causes.—A fracture is produced by an injury forceful enough to overcome the resistance, whether normal or weakened, of the involved bone. In direct external injuries the force is applied directly at the point of fracture, as in the case of fracture of the forearm as the result of a blow with a weapon. In indirect external injuries the force is transmitted from a distance to the point of fracture; for example, fracture of the upper arm may occur as the result of a fall on the outstretched hand. In internal injuries the force is provided by the pull of the muscles that attach to the fractured bone; an example of this injury is a fracture of the upper arm as the result of throwing a ball.

Conditions that weaken the bones and predispose to fractures may be classified as normal or pathological. The normal predisposition exists in infants and young children whose bones have not fully matured and in elderly people, especially women, who normally undergo a weakening of the bone with age. Many pathological conditions involving the skeleton, most commonly the spread of cancer to the bones, result in weakening of the bones. In persons with such pathological conditions fractures may occur as a result of very minor injuries.

Dislocation of a joint is caused by an injury forceful enough to overcome the resistance of the ligaments, muscles and capsule that hold the joint in place. Dislocation of a normal joint most commonly follows an injury in which the force is transmitted along the length of the bone and thrusts the end of the bone through the tissues surrounding the joint, but it also may follow direct injuries in the region of the joint.

Habitual, or recurrent, dislocations are those that reappear following an original injury as the result of improper healing of the tissues or of the joint's being made defective by the original injury. Subsequent repeated dislocations may then occur with minor injuries or even with ordinary movements of the joint.

Pathological dislocations result from diseases that weaken the capsule of the joint or make the joint defective; such dislocations frequently follow minor injuries.

Diagnosis.—The recognition of fractures and dislocations is based upon the history of the injury, the symptoms the injured person experiences, the visible signs of the injury and X-ray examination. The history of the manner in which the injury occurred is helpful in localizing the area of the fracture or dislocation, particularly in the case of young children who may be unable to indicate the region in which the pain is felt. A history of a minor injury causing a fracture or dislocation leads to a search for an underlying cause. The commonest symptoms of a fracture or dislocation, *e.g.*, of a limb, are pain and tenderness to the touch at the site, a sensation of grating or grinding on attempting to use the injured limb and an inability to use the injured limb. The most frequently seen physical signs of a fracture are deformity of the injured part, swelling in the region of the fracture, discoloration of the overlying skin, abnormal mobility of the bone and a grating sensation felt at the point of the fracture when the strength of the injured bone is tested. The physical signs present in most instances of a dislocated joint are deformed appearance of the injured joint, swelling of the tissue about the joint, discoloration of the overlying skin and inability to use the injured limb or to move the dislocated joint. X-ray examination of the injured bone or joint is of great value in the diagnosis of fractures and dislocations and is also helpful in indicating the type of treatment to be given, since it reveals the type and extent of the injury more accurately than does the physical examination.

Healing.—All fractures, regardless of cause, attempt to heal in the same fashion. The injured bone very quickly produces new tissue that extends across the fracture line and joins the broken

pieces together. In the early stages of healing this new tissue is soft, puttylike in consistency and easily injured. As time passes the body deposits bone minerals in this new tissue, which gradually hardens and cements the broken pieces firmly together. At this stage the new tissue is called the fracture callus and, because of the minerals deposited in it, is faintly visible on an X-ray film. In the latter stages of healing this hardening callus becomes transformed into mature bone. As the callus gradually changes into bone the union between the broken pieces becomes firmer until the area of fracture has become transformed into one solid piece of bone.

Several factors may govern the healing of a fracture, including the type and severity of the injury. In severely injured bone or in certain types of fractures the blood supply to the broken bone may be destroyed. This bone is then unable to produce new reparative tissue to heal the fracture. Proper realignment of the broken bone promotes prompt healing since it makes it possible for the new reparative tissue to bridge the gap between the broken ends of the bone. If other tissues such as muscle or tendon have been driven in between the broken ends of the bone they must be removed so the ends of the bone may be brought together. Adequate immobilization of the broken bone is necessary to achieve union. When the bone has been realigned it must be maintained in one position and must not be allowed to move, else the new delicate fracture callus will be injured and will not cement the ends of the bone together. If the immobilizing apparatus is removed before healing has united the broken ends, motion may weaken the callus and allow the ends of the bone to spring apart.

Despite proper realignment and adequate immobilization, infection about the broken bone may retard or prevent healing by killing the new reparative fracture callus tissue. Other factors such as diet, age, general health, vitamins, syphilis and race, which are popularly thought to play important roles in fracture healing, have been shown to be of only minor importance. A child's bone heals more rapidly than does an adult's, but advancing age does not retard healing or make it more difficult.

Dislocations involve injuries to the muscles, ligaments, tendons and capsule of the joint—the elements that hold the ends of the bone in contact. Dislocations heal by forming a scar between the cut or torn edges of these soft tissues. This healing process will take place whether the bones have been replaced in their proper position or not. The injured joint tissues heal more quickly than do broken bones.

Fracture-dislocation injuries heal by a combination of the two processes just described.

Treatment.—The proper treatment of a fracture or dislocation is dictated by many interrelated factors. The patient's age, general health, associated injuries, occupation and the type and location of the fracture must all be taken into consideration in the treatment of an individual patient, although many of these features have no direct bearing on the healing of the fracture itself. The emergency care of injuries suspected of having caused fractures or dislocations consists of controlling heavy bleeding with bandages or tourniquets, bandaging with clean bandages areas where skin has been torn or badly cut, splinting the injured limb without trying to straighten the deformity and gently transporting the patient to a place where medical care may be given (*see* also First Aid: *Injury to Bones and Joints*).

Simple Fractures.—The treatment of simple fractures consists of realigning the broken ends of the bone if they have been displaced and then preventing motion between them until sufficient time has elapsed for the fracture to heal. Minor fractures with no displacement of the broken ends of the bone require no realignment. Incomplete fractures, which constitute the majority of fractures in children, and fractures involving bones that do not have powerful muscles attached to them may frequently be realigned by manipulation. The broken bone is grasped with one hand on either side of the fracture and manipulated with the hands until the desired position is attained.

Fractures involving bones that have powerful muscles attached to them or fractures in which the bone is shattered into many pieces often require more extensive care to realign them. The pull of the muscles may cause the broken ends of the bone to be pulled apart. In these cases a steady, continuous pull is put on the injured limb to counteract the pull of the muscles after the bone ends have been realigned by manipulation. The pull is applied by weights attached to the injured limb and suspended in such a fashion that gravity furnishes the pull—the traction method of treatment. Traction is maintained until healing has progressed to the point at which the ends of the bone will not pull apart even when the weights are released.

Certain fractures cannot be realigned either by manipulation or by traction. This condition usually is the result of a shattering injury or fracture in which muscle and other tissue is driven between the broken ends of the bone and cannot be dislodged. In these instances a surgical operation is necessary to realign the bone, after which it is immobilized in one of several ways.

Minor fractures may be held with simple bandages or slings. Fractures that require manipulation for realignment are immobilized by splints or casts made of rolls of plaster of paris. The limb is held in the proper position and the cast applied. Following hardening of the plaster of paris, slings, canes or crutches are used by the patient to further protect the injured limb. When traction is utilized to hold the bone ends together, sandbags, slings or casts may be used in addition. Fractures that are treated by surgical operation are many times fixed internally by means of metal pins, wires, screws, rods, nails or plates. In these cases casts or splints often are not necessary to maintain stability of the broken bone.

Immobilization is continued until the fracture callus is strong enough to maintain union of the broken bone without external support, as determined by gently testing the strength of the bone and by X-ray examination. Following removal of the splints or casts, complete use of the injured limb may not be permitted until further healing has taken place.

As soon as healing permits, gentle exercises to strengthen the injured limb are begun. Hinged casts, removable splints, crutches, canes, walkers, hot water pools, slings and braces are all devices that are used to protect the partially healed broken bone at this stage. Violent exercises that cause pain are avoided. Complete use of the limb is allowed when the fracture callus has been transformed into bone and the bone is solidly united. Metal devices used to fix a fracture may or may not be removed by a second operation after healing is complete.

Compound Fractures.—Compound fractures present a more serious problem than do simple fractures. The wound produced by the loss of skin over the bone or by the bone's piercing the skin frequently becomes infected by germs introduced at the time of injury. If the infection extends about the broken ends it will inhibit the ability of the bone to form the fracture callus and thus will prevent healing. Ordinarily healing will not take place until the infection has been brought under control.

When a patient is seen within the first few hours after a compound fracture an operation is indicated. The broken bone is realigned and all tissues about the wound that have been exposed to germs are cut away in an attempt to remove all contaminated tissue before an infection can become established. The wound is then sewed together or skin is grafted over it and the fracture is kept immobilized by closed methods (application of splints or casts). The patient is protected against tetanus and treated with drugs in a further effort to prevent infection. If by these procedures infection is avoided and the wound heals, the fracture is then treated as a simple fracture.

In cases where these measures fail or where infection has developed before treatment can be started, all treatment is directed against the infection. Healing infections about fractures is frequently a prolonged, serious and difficult procedure. The fracture is placed in the best possible alignment and maintained by closed methods. After the infection is cured the fracture may be treated as a simple fracture.

Fractures in Joints.—Another serious problem is a fracture that extends into a joint and destroys the normal smooth surface of the joint. If the surface is made rough and uneven by the injury and heals in this irregular alignment, the joint is likely to be perma-

nently stiff and painful. Unless the surface of the joint can be accurately realigned by manipulation or traction, surgical operation is necessary.

Simple Dislocations.—These are treated by repositioning the dislocated ends of the bones in their proper position, usually by manipulation. Occasionally it may be necessary to employ traction. Following reduction of the dislocation, the involved joint is immobilized by bandages, slings, splints or casts until the torn tissues about the joint have healed. Gentle motion of the joint is then begun. Painful motion is avoided. Complete function of the injured limb is not permitted until partial painless motion has been restored.

Compound Dislocations.—These are treated in the same fashion as compound fractures. Recurrent dislocations and congenital dislocations are special problems that in most instances require surgical reconstruction of the defective joint. (*See* ORTHOPEDIC SURGERY.)

Fracture-Dislocations.—These are the result of severe injuries. Frequently a loose piece of bone remains jammed between the ends of the dislocated bones and may have to be removed surgically before the dislocation can be reduced. Even if the fracture can be realigned and the dislocation reduced by manipulation or traction, motion of the involved joint must be restricted longer than in a simple dislocation to allow healing of the fracture.

Complications.—The major complications of a broken bone are failure to heal, healing of the bone in a position that interferes with the limb's function, and loss of function in the injured limb despite healing of the fracture in good position.

Failure of broken bones to heal may be due to inadequate immobilization, infection, massive destruction of bone or injury resulting in loss of blood supply to major portions of the bone; in certain instances the fracture may fail to unite for no known reason.

Healing in an improper position, or malunion, with resulting deformity, is usually caused by failure to realign the bone properly. Malunion results when injuries have destroyed large portions of the bone so that deformity must be accepted in order to salvage a limb. Injuries to the growth centre of bones in children cause malunion and subsequent growth in a deformed manner.

Loss of function in a limb despite healing of a fracture usually is caused by the prolonged immobilization necessary to achieve healing of severe fractures, by heavy scarring following infection from compound fractures or by heavy scarring from associated wounds while the limb is immobilized. Stiffness in joints may follow even minor injuries to a limb. The cause of this phenomenon is unknown.

The major complications of dislocations are stiffness and pain in the joint and development of a recurrent dislocating joint. The usual causes of the pain and stiffness are failure to reduce the dislocation, irreparable damage to the joint by injury, heavy scarring in the surrounding tissues during healing, and prolonged immobilization. Recurrent dislocating joints are produced by improper healing of the surrounding tissues or damage to the joint surfaces.

Bone Grafting.—Bone grafting is a surgical procedure in which one or more pieces of bone are placed across or packed around the broken ends of bone that have failed to heal. (*See* ORTHOPEDIC SURGERY; TRANSPLANTS, TISSUE AND ORGAN.) This operation stimulates the ends of the broken bone to produce fracture callus, provides a framework for the callus to grow across the break, and the grafted bone is thought by some to produce callus of its own. It has been shown that bone obtained from the patient himself makes a graft superior to bone obtained from another person, an animal or a "bone bank." Bone grafts are useful in bridging large defects in severely damaged bone, correcting deformities and bringing about healing in fractures that have failed to unite by other methods. *See* also BONE; BONE, DISEASES AND INJURIES OF; JOINTS AND LIGAMENTS; JOINTS AND LIGAMENTS, DISEASES AND DISABILITIES OF; SKELETON, VERTEBRATE. (W. F. E.)

FRAGONARD, JEAN HONORÉ (1732–1806), one of the best-known and most typical French painters of the 18th century, was born in Grasse on April 5, 1732, the son of a glovemaker. His father articled him to a notary, but he showed such talent for painting that his employer suggested a change of pro-

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DETAIL FROM "THE SWING" BY JEAN HONORÉ FRAGONARD; 1765. IN THE WALLACE COLLECTION, LONDON

fession. He entered the studio of F. Boucher, was sent on to J. B. Chardin, and six months later, having learned little, returned to Boucher (1750) who this time gave him serious attention. In 1752 Fragonard won the Prix de Rome with a picture of "Jeroboam Sacrificing to the Idols" (École des Beaux-Arts, Paris), but before leaving for Rome he spent three years at the École des Elèves Protégés, where he studied under F. Lépicié, M. Dandré-Bardon and C. Van Loo. Finally, in 1756, he arrived in Rome.

Despite this wealth of tuition, Fragonard learned all he knew from Boucher and from his own studies from nature in the Roman Campagna. On the eve of his departure, Boucher warned him to avoid the old masters and to concentrate on artists with whom he had a temperamental affinity, such as F. Albani and G. B. Tiepolo. In Rome he became friendly with the landscape painter Hubert Robert, with whom he spent many long days sketching; in 1759 the rich Abbé de Saint-Non arrived from Paris and the three men passed the summer at the Villa d'Este. Saint-Non engraved Fragonard's red chalk drawings of the gardens (many of which are now in the museum at Besançon), and they won the approbation of his superiors at the French Academy in Rome. He returned to Paris via Venice in 1761 with his style completely formed.

In 1764 he was admitted to the French Academy on the strength of his "Corrésus et Callirhoé" (Louvre, Paris). The king bought the picture but did not pay for it until some time later. After 1767 Fragonard ceased to exhibit in the Salon and was no longer considered a "serious" artist by his contemporaries. He accepted commissions from rich financiers (who paid promptly) and from actresses and demimondaines, and worked mainly on decorative projects for, among others, Mme de Pompadour, Mlle Guimard, and Mme du Barry, who commissioned from him in 1771 a series of panels for Louveciennes on the theme "Le Progrès de l'Amour dans le Coeur des Jeunes Filles" ("The Progress of Love in the Hearts of Young Girls," now in the Frick collection, New York city). The subject matter of his small paintings became slighter and more allusive, as "Le Baiser à la dérobée" ("The Furtive Kiss," Hermitage, Leningrad), "La Chemise enlevée" ("The Stolen Chemise," Louvre) and "La Balançoire" ("The Swing," Wallace Collection, London) will testify.

In 1773 he was taken to Italy by one of his patrons, Bergeret de Grandcour, who has left a charming account of the journey. They visited all the main towns and returned to Paris via Vienna, Mannheim and Dresden. Fragonard was rich, happy and famous, but he was also closely identified with the way of life of the *ancien régime*, and his fortunes fell with the Revolution. Thanks to his former friendship for the young Jacques Louis David, whom he had chosen to complete his decorations for Mlle Guimard, Fragonard was protected from reprisals and even appointed to the committee of the new Museum des Arts. He died in Paris on Aug. 22, 1806.

Fragonard is represented in the major French, British and American collections and notably in the Louvre, the Wallace Collection, and at Chantilly, Besançon, Amiens, Nantes, Grenoble, Avignon and Marseilles. His finest landscape, "La Fête à Saint-Cloud," is at the Banque de France in Paris. Of his few engravings, the most important is "L'Armoire" ("The Wardrobe," 1778).

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FRAME DESIGN. Before the 15th century in Europe frames hardly existed separately from their architectural setting and, with the altarpieces or the carvings they surrounded, formed an integral part of the decorative scheme. These surrounds sometimes took the form of simple moldings, but more elaborate examples followed the architectural style of their period.

As, during the 15th century, paintings were more generally used as wall decorations and domestic furnishings, so the frames tended to be treated independently. The principle of their design, however, remained much the same. This applied to all frames, whether of painted and gilded wood, carved walnut or metal.

During the middle ages small portable mirrors with plates of burnished metal, glass or crystal were enclosed in frames of ivory, ebony or metal, set with pearls and precious stones.

BY COURTESY OF THE TRUSTEES OF THE NATIONAL GALLERY, LONDON

PAINTING OF A 15TH-CENTURY MIRROR FRAME WITH INSETS DEPICTING THE LIFE OF CHRIST, A DETAIL FROM JAN VAN EYCK'S PORTRAIT OF THE ARNOLFINI MARRIAGE; 1434

In Italy in the 15th century the design of frames followed the fairly austere architecture of the period, but in the later Renaissance this relative simplicity gave way to carvings of foliage, richest during the baroque period. In the 16th century, although designs were to some extent common throughout Europe, there appears to have been a preference in the northern countries for frames of a less ornate design than in southern Europe, which were more susceptible to Italian influence. Picture frames made in the Low Countries and England were often of ebony or ebonized wood, the dark colour sometimes relieved with inlay. Henry VIII owned a frame of "black Ibonye garnished with silver." Others were still sometimes constructed with the panel painting they surrounded, and their simple moldings were applied, or less frequently carved, in the solid. They were then painted and gilded, grained or marbled. Ebony continued to be popular during the 17th century. At the same time carved and gilded frames in the Italian manner were also produced in the northern countries.

From the 16th century, the increasing manufacture of mirror glass made mirrors more general and the design of the frames usually conformed to that of picture frames.

During the middle and later decades of the 17th century frames began to form one of the principal features of rooms, whether for mirrors, pictures or an overmantel, and a wider variety of materials was employed. Veneers of walnut, olive and laburnum wood, marquetry, japan (the European imitation of oriental lacquer), panels of oriental lacquer cut to fit the frame, ebony, tortoise shell and *verre églomisé* were also used. Those of carved and silvered wood imitated the lavish silver frames made for the richest houses and often formed part of a suite of table and candlestands. They continued to be made during the latter part of the 17th and throughout the 18th century, though in gilded wood rather than precious metal. Particularly elaborate naturalistic carving was fashionable for frames made in Holland and England during the latter years of the 17th century. In England Grinling Gibbons and his followers were responsible for several sets of mirror, picture and overmantel frames designed as an integral decorative scheme for a room; examples can be seen at Petworth house, Sussex, and Chatsworth, Derbyshire.

The use of suites of frames developed as improved techniques in glass manufacture enabled larger pieces to be used for mirrors,

These were hung not only over fireplaces but between windows, thus increasing the apparent size of a room. These "pier glasses" were at first combined with the architecture; *e.g.*, the Galerie des Glaces in the palace of Versailles. "Mirror rooms" soon became fashionable all over Europe, another example being that in the Amalienburg, Nymphenburg, near Munich. Although rooms paneled with glass were not built in England, very large mirrors with frames designed in the neoclassical taste became popular under Robert Adam's influence during the latter decades of the 18th century.

"COUNTRY LIFE"

MID-18TH-CENTURY CARVED AND GILDED FRAME, SURROUNDING A PORTRAIT OF THE 3RD VISCOUNT DOWNE BY SIR JOSHUA REYNOLDS

The type of Italian picture frame with exuberant carving evolved during the baroque period remained fashionable for a long time and was never completely abandoned. Simpler types persisted, however, especially those known as Maratta frames, named after the artist Carlo Maratti and consisting of a simple molding with a line of carved foliage as decoration. Frames with a "swept" outline, introduced in the 17th century, remained popular in France throughout the reign of Louis XV. During the 1740s English mirror frames in the heavy, Palladian architectural style began to give way to more delicate designs which were much influenced by European rococo examples and which, though light and elegant, were far from simple. The asymmetry of the rococo was easily adapted to the design of picture frames, and *chinoiserie* designs were particularly popular. These were prepared by joiners and then embellished by the carvers, the design sometimes being associated with the subject of the painting.

During the neoclassical revival in the last third of the 18th century, both in Europe and in England, there was a return to simpler outlines and a greater austerity in ornament. Early in the 19th century the architectural forms of late 18th-century mirrors continued in fashion alongside those ornamented in the taste of the Greek and Egyptian revivals. After the first two decades, however, frame design for both mirrors and pictures became increasingly eclectic. Elaborate baroque designs returned to general favour, and revived rococo designs known as Lawrence frames were fashionable for many years. Reproduction of Dutch 17th-century frames in ebony and tortoise shell were made to surround Dutch paintings of that period for mid-19th century collectors. Since 1919, however, the trend has been toward an ever increasing simplicity for contemporary paintings and mirrors. In some cases paintings may be framed merely with a batten, while the extensive use of glass in modern architecture reduces the need for mirrors to give light to a room and thus lessens the opportunity to design frames for them.

Miniature frames have generally followed the design of picture frames on a small and simpler scale, though in metal rather than wood. They were often set with pearls and precious stones if they were small enough to be worn as pieces of jewelry. After the later years of the 19th century, when photographs took the place of portrait miniatures to a great extent, stamped silver was the material most often used for their frames. (E. M. Mu.)

FRAMINGHAM, a town in Middlesex county, Mass., 21 mi. W.S.W. of Boston. Settled in 1650, it was named after the English home (Framlingham) of Gov. Thomas Danforth who owned the land. It was incorporated in 1700. Power and rail developments assisted in limited industrial development in the 19th century. It is the site of the first normal school in the country, founded in 1839 in Lexington and moved to Framingham in 1853; in 1932 it was renamed State Teachers college. The state reformatory for women is located in the town.

After World War II, increasing use of the automobile and the development of superhighways, particularly the Massachusetts turnpike, made the community a retail-industrial centre and residential area for the Greater Boston industrial complex. Among the firms introduced at this time were scientific concerns and regional distributors to the industrial leaders: paper and allied goods, auto assembly, textiles and chemicals. Framingham was chosen for the site of the first suburban shopping centre in the nation, Shoppers World (but it was the second to be completed, in Oct. 1951). It has limited town meeting government. For comparative population figures *see* table in Massachusetts: *Population.* (R. C. Mo.)

FRAMLINGHAM, a market town of East Suffolk, Eng., lies 90 mi. N.E. of London by road. Pop. of civil parish (1961) 2,005. Dominating the town are the remains of the castle; a splendid late 12th-century curtain wall 44 ft. high and 8 ft. thick with 13 towers, built by Roger Bigod, 3rd earl of Norfolk. Excavations in 1954 showed that the castle was built over a 7th- or 8th-century Anglo-Saxon cemetery and that there may have been pre-Conquest earthworks. The first recorded grant of the site (1100) was made by Henry I to the Bigod family, who held it until 1306. Edward II granted it to his half-brother Thomas of Brotherton, created earl of Norfolk in 1312. From him it descended first to the Mowbrays (through Margaret, countess of Norfolk, who was created duchess in 1397 at the same time that her grandson, Thomas Mowbray, was created the first duke of Norfolk), and later to the Howards who, apart from three periods when the head of the family was attainted, held it until 1635, when it was sold to Sir Robert Hitcham, who bequeathed it to Pembroke college, Cambridge, in 1636. In accordance with his will all the buildings within the curtain wall were demolished, and a poorhouse, still standing, was erected. The fabric is now in the care of the ministry of works. The great 15th- and 16th-century church of St. Michael contains the tombs of the Howards and the helm worn by Thomas Howard, earl of Surrey, English commander at the battle of Flodden.

Half a mile from the station is Framlingham college, founded by public subscription in 1864 as a memorial to Prince Albert. (D. Cn.)

FRAMPTON, SIR GEORGE JAMES (1860–1928), English sculptor and craftsman, the author of some noted public monuments, was born in London on June 16, 1860. He studied under W. S. Frith and at the Royal Academy schools, where he won a traveling studentship. During 1888–90 he studied in Paris under A. Mercié, by whom he was much influenced. At the beginning of the 1890s he was attracted by the arts and crafts movement (*q.v.*) and experimented with decorative sculpture, using various materials such as bronze, ivory, marble and jewels combined in one work. His principal statues include those of Mrs. Alice Owen at Owen's school, Islington, London; Queen Victoria at Calcutta, at Leeds, at Southport and at Winnipeg; and (all in London) Quintin Hogg in Langham place, Peter Pan in Kensington gardens and Edith Cavell (a conspicuous failure) in St. Martin's lane. Frampton became a royal academician in 1902 and was knighted in 1908. He died in London on May 21, 1928. (R. Gs.)

FRANC, originally a French coin but now also the title of a number of national currencies of different values, notably those of France, Belgium, Luxembourg, Switzerland, most French and former Belgian overseas territories and some African states. The name was first applied to a gold coin minted by King John II of France in 1360 which bore on one face the legend, *Johannes Dei gratia Francorum rex* ("John, by the grace of God, king of the Franks"). As this coin also carried the figure of the king on horseback it was known as the *franc à cheval* to distinguish it from another coin of the same value later issued by Charles V of France. The latter coin was called the *franc à pied* because it showed the monarch standing on foot under a canopy. During the 17th century the minting of gold francs ceased, but the name was freely applied by the French public to the new unit of exchange then introduced—the livre tournois, a gold coin subdivided into 20 sols. In 1795, to symbolize the political changes that followed the Revolution of 1789, the government of the French republic introduced a new franc currency. The first coin was a five-franc silver piece; gold coins worth 20 francs (napoleons) were coined in quantity

later. The livre tournois, which was exchangeable into the new currency at a rate of 81 livres to 80 francs, continued to circulate in France until 1834.

The franc was formally established as the monetary unit of France in 1799 and made divisible into 10 decimos and 100 centimes. It was reaffirmed in this position by the more elaborate law of 1803, which also introduced a fixed relationship of 15½ to 1 between gold and silver in monetary uses. The franc has continued to form the basis of the French monetary system ever since, although it has been subject to stresses that have greatly reduced its international standing and its purchasing power, mainly in the 20th century.

During the 19th century the stability of the franc, coupled with France's dominant position in Europe, led to widespread use of the franc as the basis for the currencies of other countries. The currency system introduced in Belgium after that country gained its independence from the Netherlands in 1831 provided that the Belgian franc should be maintained at parity with the French franc and permitted French gold and silver coins to circulate freely. In 1850 the Swiss government, following the reform of the constitution, decreed that the French franc should supersede all existing currency in Switzerland. The new lira currency introduced in Italy in 1862, shortly after that country's unification, was directly linked to the French franc on a parity basis. In 1865, when France, Italy, Belgium and Switzerland joined together in a plan for strengthening European economic ties through the formation of the Latin Monetary union, the French franc was made the medium of exchange for external transactions. The union, which was later joined by Greece and, on a limited basis, by Spain, Venezuela and other countries, did not formally end until 1926, but for practical purposes it broke up during World War I. With its disintegration, the French franc lost its dominating position in the European currency field, and thereafter there were no special links between the minor franc currencies. (*See* MONETARY AGREEMENT.)

French Franc After World War I.—The decline in the price of silver having forced France and other Latin Monetary union countries in 1873 to abandon the practice followed since 1803 of giving both a gold and a silver standard for currency purposes, France entered World War I with a gold standard currency only. The gold link was soon severed, however. During the war period the franc was pegged at the prewar levels of 25.22 fr. to the pound sterling and 5.18 fr. to the U.S. dollar. But after the exchange was freed in 1918 the franc fell until a level of 264 fr. to the pound was reached in July 1926. At that point, with the country on the verge of financial collapse, the Poincaré ministry undertook reform with the result that it became possible to stabilize the franc on a gold basis in 1928 at rates of 124.2 fr. to the pound and 25.51 fr. to the dollar. Following the departure of Great Britain and other countries from the gold standard in the early 1930s, the French balance of payments deteriorated. This and internal financial crises led to the abandonment of the gold standard and to three successive devaluations of the franc between Oct. 1936 and May 1938. From a level of 74.60 to the pound and 15.13 to the dollar at the end of 1935, the franc had fallen to 176.63 to the pound and 43.83 to the dollar four years later. During the German occupation a rate of 20 fr. to the reichsmark was maintained, but the real value of the franc fell rapidly as a result of inflationary forces. Nevertheless, although black market quotations indicated that by the autumn of 1944 the franc had fallen to about 800 to the pound and 200 to the dollar, the new rates fixed after France was liberated were 200 to the pound and 49.63 to the dollar. This overvaluation of the franc impeded postwar economic recovery and the exchange was therefore adjusted to the more realistic level of 480 to the pound and 119 to the dollar at the end of 1945. But the economic situation continued to deteriorate mainly because of inflationary stresses stemming from the budget deficit and rising wage rates. In consequence the franc had to be devalued twice in 1948 and again in April 1949 to 1,097 to the pound and 270 to the dollar.

When sterling was devalued in Sept. 1949, the franc was again reduced against the dollar to 350, but raised against the pound to 980. In Aug. 1957 tax changes for certain trade purposes and a new exchange rate for foreign tourists reduced the franc to 420 against the dollar although the official rate remained at 350.

Various measures of financial rehabilitation were adopted in France in 1958 and 1959, and the spectre of a never-ending price inflation was dispelled. On Jan. 1, 1960, a new monetary unit, the "new franc," was established by the French government as the legal unit of value. On the proposal of the French government, in which the International Monetary fund concurred, the par value of the new franc was fixed, effective the same date, at .180000 grams of fine gold per new franc or 20.25 U.S. cents per new franc.

Belgian Franc.—In 1925 Belgium made an unsuccessful attempt to stabilize its currency, which had depreciated severely after World War I. A second attempt in 1926, aided by an international loan of $100,000,000, proved successful and established an exchange rate of 175 fr. to the pound and 36 to the dollar. To facilitate trade a new unit known as the belga, with a value of five francs, was then introduced to govern external business, but the franc was retained for internal purposes. The new gold standard currency came under pressure in the 1930s as a result of the devaluation of other currencies and had to be reduced in value in terms of gold. During the German occupation in World War II an exchange rate of 12½ fr. to the mark was enforced. After the country's liberation in 1944 the currency system was wholly reformed. The belga was abolished and a new franc currency introduced with an exchange value of 176.6 to the pound and 44 to the dollar. The new rate overvalued the country's currency a little and advantage was taken of the world currency realignment of 1949 to reduce its gold value by 14%, establishing it at 50 to the dollar and 140 to the pound. Throughout the 1950s the Belgian external payments position was sound, and the new structure was maintained without difficulty.

Luxembourg Franc.—Before World War I Luxembourg had a franc currency linked to the German mark. The Luxembourg franc was valued at 80 pfennigs. After Luxembourg entered an economic union with Belgium in 1922 the duchy's currency was directly linked to the Belgian franc on a parity basis. Thereafter Belgian notes and coins circulated freely in Luxembourg.

Swiss Franc.—With the collapse of the Latin Monetary union, Switzerland began to mint Swiss francs in large quantities to end its former dependence on foreign currencies. Thereafter its currency depreciated less than other leading world currencies, partly because Switzerland remained neutral in World War I and World War II and partly because the Swiss government pursued firm monetary policies. The Swiss franc was one of the few world currencies that retained its freedom of movement throughout the 1950s.

During World War I the Swiss franc maintained at 25.22 Fr. to the pound and 5.18 Fr. to the dollar. These were the rates chosen when stabilization took place upon return to the gold standard in 1929. The gold value of the franc had to be reduced in 1936 because of the devaluation of many other currencies that took place in the 1930s. In 1940 a slight increase was made in the gold value of the franc and the new level was maintained during and after World War II despite the fact that many other European currencies were considerably reduced in value. During the 1950s the value of the Swiss franc remained remarkably stable; its official parity by 1960 was .203226 grams of fine gold or 4.37282 Fr. per U.S. dollar.

(C. G. T.; Jo. M. L.)

FRANCE, ANATOLE (pseudonym of ANATOLE FRANÇOIS THIBAUT) (1844–1924), French writer, whose universal reputation as a novelist, critic and as a master of literary style was crowned in 1921 by the award of the Nobel prize for literature, was born in Paris on April 16, 1844. His father, who kept a bookshop on the Quai Malaquais, passed on to him a taste for good books. His teachers at the Collège Stanislas gave him the foundation of a solid humanist culture. When he was still very young he decided to devote himself to literature. To follow his vocation and at the same time earn a living he joined the firm of Alphonse Lemerre, the publisher of the Parnassians (*q.v.*). The

influence of the *Parnasse Contemporain* is apparent in his collection of *Poèmes dorés* (1873) and in his play *Les Noces corinthiennes* (1876). The young Anatole France of this time was regarded as a refined artist, more intent on form than on the play of ideas, a fervent devotee of ideal beauty, already cynical about human institutions.

This ideological skepticism appeared in some of his earliest stories: *Le Crime de Sylvestre Bonnard* (1881), the hero of which is a learned philologist in love with his books and bewildered by everyday life; *La Rôtisserie de la Reine Pédauque* (1893), in which belief in the occult is discreetly mocked; *Les opinions de M. Jérôme Coignard* (1893), in which, more daringly, the great institutions of the state, the magistrature and the army are minutely examined by an ironic and perspicacious critic. But the writer only lightly condemned social abuses. At that time his chief cares were more personal. His marriage in 1877 to Marie-Valérie Guérin de Sauville ended in a divorce in 1893. In 1883 he had met Mme Arman de Caillavet. The fervent and tormented passion which she evoked in him is more or less reflected in *Thaïs* (1890) and later in *Le Lys rouge* (1894), but these two stories remain above all pure works of art, for the archaeological setting of *Thaïs* and the Florentine setting of *Le Lys rouge* carry the reader away from his usual surroundings and problems.

There is a marked change in the four volumes collected under the title *Histoire contemporaine* (1897–1901). The first three, *L'Orme du mail* (1897), *Le Mannequin d'osier* (1897) and *L'Anneau d'amethyste* (1899) depict ironically, under the disillusioned gaze of Professor Bergeret, who stands for the writer himself, the principal notabilities of a provincial town and mainly describe the intrigues which surround the candidature for the bishopric of two rival priests, the Abbé Lantaigne and the Abbé Guitrel. The closing episodes of this rivalry take place when all France is beginning to be passionately concerned by the Dreyfus affair; M. Bergeret, who until then has held himself aloof from political strife, takes the part of the Jewish captain unjustly condemned for treason by the military courts. Appointed to the Sorbonne, the Dreyfusard professor is pursued by the anger of the anti-Semitic troublemakers of whom the majority hope for the restoration of the monarchy; but he braves them, defends the republic and manifests his sympathy for the socialism of Jean Jaurès.

This participation of the hero in the controversy, which is chiefly described in the last volume of the cycle, *M. Bergeret à Paris* (1901), is the story of Anatole France himself, who, from about 1900 onward, introduces his social preoccupations into nearly all his stories. His hostility toward the bourgeois order is proclaimed with startling vigour in *L'Affaire Crainquebille* (1901), which tells the story of an unfortunate greengrocer falsely accused of having insulted the police. In his humble station Crainquebille is, like Dreyfus, a victim of the law, but he is above all an example of those waifs whose distress should be succoured by any truly humane social order.

Nevertheless, Anatole France did not subscribe to socialism without a good deal of self-questioning. *L'Ile des Pingouins* (1908), in which the history of the French people after the Dreyfus affair is retold in allegorical form, in its closing pages allows one to guess at the uncertainties of the author who has but little belief in the ultimate arrival of a fraternal society. A very fine novel set in the period of the Terror, *Les Dieux ont soif* (1912), shows how the best causes may be spoiled by the spirit of fanaticism. Another allegorical story, *La Révolte des Anges* (1914), involves a frequently bitter meditation on violence and the exercise of power.

Anatole France decidedly doubted that men were wise enough to eliminate their own bad instincts, and World War I reinforced his profound pessimism. However, he continued to struggle for social justice and liberty of conscience until his death, at his home near Tours on Oct. 13, 1924. But sometimes he tried to forget the troubles of the times and took refuge in contemplating the tender world of his childhood. *Le Petit Pierre* (1918) and *La Vie en fleur* (1922) completed the cycle of reminiscences begun earlier in *Le Livre de mon ami* (1885), and these pages, which are for the most part autobiographical, are among the most delicate and moving in all his writings.

Sensitivity touched with irony is the most constant quality in the work of Anatole France. An alert and very careful artistry assures its expression. His taste, formed by classic traditions, is clearly though not rigidly defined in the articles which he wrote between 1886 and 1893 for *Le Temps* (some of which were published in *La Vie littéraire*, 4 vol., 1888–92), and it remained constant ever after. Anatole France was not receptive toward what was new and daring in the various schools; he condemned the grandiloquence of lyricism, the crudity of realism and above all obscurity claiming profundity as excuse or justification. His style is at once skilful and lucid; he himself defined its virtues in *Le Jardin d'Épicure* (1895), a collection of thoughts in which he tried to summarize his wisdom: "A good style is like a ray of light which shines through my window as I write and which owes its pure brilliance to the close union of the seven colours of which it is composed. A simple style is like white light. It is complex, but does not appear so."

Toward the end of his life Anatole France was attacked both by traditionalists for having compromised the authority of the state by the subversive daring of his social and religious criticism and by the literary avant-garde, who denounced his art as being outdated in its very perfection. His posthumous fame suffered from these convergent attacks, though by mid-20th century the truly considerable place of his art in the history of modern literature was generally recognized.

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FRANCE (RÉPUBLIQUE FRANÇAISE), a country occupying part of the Atlantic margin of Europe between latitude 51° 9′ and 42° 23′ N. and between longitude 4° 44′ W. and 8° 10′ E. It comprises an area of 212,821 sq.mi. (including Corsica, *q.v.*, 3,367 sq.mi.) and is thus the largest country in Europe excluding the U.S.S.R. It extends for more than 600 mi. from Dunkerque in Flanders to the Spanish frontier in the Pyrenees, and its maximum breadth from the tip of the Brittany peninsula to the Rhine is roughly the same distance. Except on the northeast, where it marches with Belgium, Luxembourg and Germany, France is bounded by natural frontiers in the form of sea and mountains.

From the Belgian frontier to the western tip of Brittany, France's northern frontier is formed by the Straits of Dover and the English channel (La Manche). In French Flanders the coast line is straight, flat and bordered by dunes. Then a long stretch of rocky, chalk cliffs follows in Picardy and Normandy, though these are sometimes separated from the sea by accumulations of sediments swept alongshore by the drift of the sea. In western Normandy the coast juts out northward in the steep and rocky Cotentin peninsula. Beyond this the northern coast of the Breton peninsula is rugged and indented by numerous bays, and is fringed by reefs and islets. The long western, Atlantic coast consists first of the rocky, indented coast of Brittany north of the Loire estuary, then the coast of La Vendée, Aunis and Saintonge, between the estuaries of the Loire and the Gironde, which is low lying, with occasional headlands and silted re-entrants, and finally the flat, straight coast line of the Landes extending southward almost to the Spanish frontier at the western end of the Pyrenees. The southern frontier with Spain is formed by the crestline of the Pyrenees, these mountains forming a formidable, continuous barrier right from the Atlantic to the Mediterranean seaboard. The flat coasts of Roussillon and Languedoc, with lagoons behind the sweeping curve of sand dunes that tie what were once offshore islands, are succeeded beyond the extensive delta of the Rhône by the picturesque, rocky coast of Provence to the Italian frontier.

On the east, the Alps form the frontier with Italy; farther north the Jura mountains form the frontier with Switzerland. Farther north still the German frontier leaves the Rhine near Karlsruhe and passes through the hilly country of the Vosges and

Hunsrück to Luxembourg; the frontier with Belgium runs through the foothills of the Ardennes and through the featureless plain of Flanders to the North sea.

Presenting broad faces to the western and southern seas, France is a maritime state with open access to seaways and external relations outside Europe. Along its long land frontier on the east it is linked inextricably with central Europe.

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I. PHYSICAL GEOGRAPHY

1. Geology and Structure.—Three main types of structural unit, matched elsewhere in peninsular Europe so that in this respect as in others France epitomizes the continent, contributed to the build of the country. They are: (1) The Hercynian massifs, stumps of ancient mountains that now form highland blocks composed largely of ancient crystalline and compacted sedimentary rocks. They are represented by the Massif Central, the Armorican massif, the Vosges, the Ardennes, and some fragmentary areas in the southeast to which Corsica also belongs. (2) The great basins of only slightly disturbed sedimentary rocks, represented by the Paris basin, the Basin of Aquitaine and the basins of the Rhône-Saône trough. (3) The mountain systems of recently folded and overthrust rocks that comprise the Pyrenees and the Alps, together with the less heavily folded Jura.

Since Archean times France has experienced two major periods of mountain building, separated by a long period of relative quiescence. The Hercynian massifs are the skeletal remains of the first of these orogenies, toward the end of the Paleozoic era, after the Coal Measures had been laid down. Thus the coal fields are marginal to them in their situation, having been preserved under sediments round their edges, or in basin pockets. The Armorican massif in northwestern France is the remnant of a northwest-southeast arc, which converged in the Massif Central with a north-east-southwest arc that is represented by the Vosges and the Ardennes and is continued eastward into central Europe. The Alps and the Pyrenees represent the second or Alpine orogeny, which began earlier in the Pyrenees but culminated in the Alps in the middle of the Tertiary era. In the long period between there was time not only for a vast amount of denudation of the earlier structures but also for the accumulation of great thicknesses of sediments, laid down mainly under marine conditions. The positions of the older massifs, by the resistance they offered, naturally guided the outlines of the later folding, and both massifs and basins show the repercussions of the later earth movements, the former chiefly by dislocation and block movement, the latter by flexuring and warping. Differential erosion has subsequently etched out the dipping strata of varying resistance to produce scarpland scenery, which is especially well developed in the eastern and southeastern parts of the Paris basin. The Armorican massif, most remote from the Alpine pressures, was least affected by dislocation and uplift. The Massif Central was most affected, and its dislocation and fragmentation in slablike structures were accompanied by extensive volcanic activity that persisted into very recent geological times. Part of the limestone floor of the Basin of Aquitaine was uplifted en masse and incorporated into the southwest of the Massif Central as the distinctive limestone plateaus of the Causses. Calcareous rocks are especially widespread outcrops in the sedimentary basins, but whereas the basins for long intercommunicated through straits, during the later phases of accumulation of their sediments they were separate, and each has its distinctive succession of rocks, individual to its special circumstances of deposition. Thus whereas the Tertiary era contributed important beds of limestone to the central part of the Paris basin, the Tertiary rocks of the Basin of Aquitaine are chiefly sands and marls.

The intermittent recession of the Tertiary seas is reflected in the production of staged series of planation surfaces in the present day landscape. Most of France escaped the Quaternary glaciation that so profoundly affected northern Europe, but the high mountain areas of the Alps and Pyrenees nourished extensive glaciers, which debouched into the neighbouring lowlands and spread out sheets of drift there. The northeast of France, in the Paris basin, was near enough the edge of the main glaciated area to receive from it an extensive covering of fine, wind-borne dust known as *limon*. Relief and drainage are discussed more fully in *Geographical Regions* below.

2. Climate.—Situated in middle latitudes on the western margin of the continent of Europe, France is liable almost everywhere and at any season to experience the penetration of depressions bringing maritime air masses and frontal rain. It lies widely open to maritime influences along its long seaboards but is so broadly attached to the continental trunk to the east that the continental influence is strong and winter anticyclones often extend their grip over the country. The mild winters in maritime situations contrast with the appreciably more severe conditions inland to the east, and there is also a clear tendency for summer to become the wettest season of the year away from the Atlantic and Mediterranean coasts.

Average January temperatures, reduced to sea level, range from 7° C. (45° F.) in places on the Atlantic and Mediterranean coasts, where frost may occur on fewer than 20 days, to only very little above freezing point in the centre of the Paris basin and in Alsace-Lorraine. Over much of the Paris basin frost is likely to occur on more than 60 days. Altitude appreciably reduces winter temperatures and large areas of the Massif Central, high Alps and Pyrenees have long, severe winters, with frost occurring on more than 100 days and snow remaining unmelted until late in the year. Summer temperatures show the primary control of latitude, ranging from a July mean below 17° C. (62° F.) along the Channel coast to one of nearly 22° C. (72° F.) in Provence. The commencement date of the wheat harvest shows a progressive retardation from earlier than the end of June in Mediterranean France to later than the first week of August in areas near the Channel coast.

The great range of altitude and varying degrees of exposure to maritime influences make for great contrasts in the total amount of precipitation received in different districts. Parts of the Mediterranean coastlands and of Alsace on the average receive barely 20 in. of rain in the year, whereas the higher parts of the Massif Central, Alps, Jura and Pyrenees get more than 80 in. But over most of the lowlands of France the amount is between 25 and 40 in. More pronounced regional differences are shown in the frequency with which rain occurs. Parts of Mediterranean France record rain on fewer than 50 days in the year, and the fine dry summers there have a well-deserved reputation; but on the heights of Brittany and Normandy it rains on more than 200 days in the year. There are corresponding differences between northwest and southeast in quotas of sunshine. The climatic advantages of the south, especially in respect of summer warmth and sunshine, are reflected by the modern distribution of the vine, the northern limit of its cultivation running eastward from the mouth of the Loire by Paris to the Rhineland, just including the Champagne district.

The otherwise climatically favoured district of the delta and lower valley of the Rhône experiences a severe disability in the form of a local wind, the mistral, whose violent blasts of cold air descend from the Alps and Massif Central, channeled by the Rhône valley, and sweep across the exposed lowlands to the south. The tramontane winds experienced in the plains of Roussillon and Languedoc are sudden descents of cold air from the high ground of the eastern Pyrenees and Massif Central respectively.

(Ar. E. S.)

3. Vegetation.—Originally all of France, except the higher mountains, carried forest vegetation. The parts of the countryside which are without forest and are now wasteland, heath, pasture, etc., are due to man. There are two main types of vegetation: non-Mediterranean and Mediterranean.

Non-Mediterranean Vegetation.—From Brittany to the northeast and in central France (the lowest plateau of the Jura, Morvan and round the Massif Central) characteristic plants are European beech (*Fagus sylvatica*) and durmast or sessile oak (*Quercus petraea*). The forests are dominated by one or other species according to the region and the action of man. Under the oaks the chief component of the brushwood is the hornbeam (*Carpinus betulus*). There are no vines, except in a few scattered districts (Champagne, Aubois) and this non-Mediterranean region is chiefly under crops and grass.

In the greater part of the west, where heathland is common, and of the southwest, and in the main alluvial valleys grow oak and sweet chestnut (*Castanea vesca*); on ground poor in limestone, pedunculate oak (*Quercus robur*); and on deep, clayey soils, tauzin oak (*Quercus toza*). The latter keeps markedly to the coast, from Anjou to the Pyrenees. Birch, which prefers limestone soils, is dominant in some districts. In the Paris basin, the Loire valley and on the western edge of the central plateau, the oak dominates; toward the south the beech thins out and hornbeam disappears. In the alluvial valleys of the Rhine, the Saône, and the valleys of the Lannemezan, and in the Basque country, the sessile oak gives way to the pedunculate oak and the elm (*Ulmus campestris*). A frequent type of countryside in this part of France is that of the heathland with ericaceous plants, gorse (*Ulex*), petty whin (*Genista anglica*), etc.; southward from the Loire valley the vine takes an important place. On the southern Atlantic seaboard the maritime pine (*Pinus pinaster*) forms large forests, chiefly plantations. However this variety grows of its own accord along the coast as far as the Quiberon peninsula. In the northern part of the Basin of Aquitaine, along the valley of the Rhône and those of its tributaries, and that of the Saône as far as the plateau of Langres, along the Jura and in Haute Alsace, pubescent oak (*Quercus pubescens*) is to be found. It represents there the clearest element of Mediterranean influence.

Characteristic of the mountains are the silver fir (*Abies alba*), often with beech; the spruce (*Picea excelsa*) in the Alps, Jura and Vosges but introduced elsewhere; Scots, mountain and Swiss stone pines (*Pinus sylvestris, P. mugo, P. cembra*); the European larch (*Larix decidua*); and finally the beech with other deciduous trees such as maples, *Sorbus* and elms. Above the tree line, which is generally composed of conifers such as mountain pine, spruce and larch, comes the alpine zone.

Mediterranean Vegetation.—The southeast of France is covered by a Mediterranean flora. Holm oak (*Quercus ilex*) is characteristic, while its place is taken by cork oak (*Quercus suber*) on non-limestone soils, where the winters are not too cold (Provence, Roussillon). The degeneration of these forests has given rise, on limestone, to *garrigue* or heathland bearing kermes oak (*Quercus coccifera*) and, on flint, to *maquis* (from which the French resistance movement in World War II took its name) or scrubland (*e.g., Erica arborea* or tree heath, *Cistus* or rockrose). In lower Provence the Aleppo pine (*Pinus halepensis*) and holm oak are predominant; this is also true of the right bank of the Rhône, but there they have spread as a result of the degeneration of the oak plantations and are not considered to be native to the district. In the Maures and the Estérel mountains, which have flinty and relatively moist soil, the maritime pine (*Pinus pinaster* var. *mesogeensis*) and cork oak are predominant. The Mediterranean region is everywhere fringed by pubescent oaks which extend a long way from the coast and join up with the belt of the same trees mentioned above, in the non-Mediterranean region. The olive and the vine are characteristic throughout the Mediterranean region.

In the mountains (Maritime Alps and the eastern Pyrenees) are to be found, from the lowest levels upward, oaks and chestnuts, Scots pine, Mediterranean beech, mountain pine, larch (*Larix decidua*) and Swiss stone pine; this zone is followed by alpine vegetation, which is more scattered than in the non-Mediterranean region.

Corsica bears an entirely Mediterranean vegetation. A variety of pine (*P. laricio*) is widespread there at the level of the larch. The upper limit of trees on the island is formed by an alder (*Alnus suaveolens*). The alpine vegetation of the island, from 6,000 ft., resembles that of the mountains of north Africa.

(L. E.)

4. Animal Life.—France enjoys a fairly large diversity of animal life. It is a crossroads where animals of several origins have met and mingled in various proportions. As a whole it is the westerly part of the Palearctic region to which belong all its faunistic components. The seas bordering the French coasts are inhabited by a great variety of marine animals belonging to the cold or temperate zones of the boreal area. There are great differences between the Atlantic and North sea coasts and the Mediterranean.

Habitats have greatly changed in France since the beginning of human settlement and the extension of cultivation. In northern and central France, the climax corresponds probably to deciduous forests, largely cleared since the middle ages. Therefore many animals proper to dense forests have been greatly reduced in numbers, like the wildcat and the red deer, and some of them have even disappeared, like the bison, aurochs and the lynx.

Because of its various origins the French fauna is relatively rich: there are about 90 species of mammals, 400 birds, 25 amphibians, 27 reptiles; the number of species is also high among most of the invertebrates. The northern element is largely distributed over northern and central France, especially in the plains open to the north and northeast. Among these animals rank several rodents, like the pine vole, some reptiles, like the smooth snake and the viviparous lizard, and many birds: rook, willow tit, fieldfare, marsh warbler. Sea birds like the fulmar, gannet, kittiwake and arctic tern (all of which nest in Brittany) have the southern limit of their breeding range in France.

The southern element occurs along the Mediterranean border, from which many animals moved northward. Among the insects of Mediterranean origin rank many Hymenoptera (wasps) and Orthoptera, especially abundant and well diversified in Provence and in the *garrigues* and *maquis* of the southern slopes of the Massif Central (praying mantis and cockroaches). The amphibians and reptiles are also numerous: the painted frog among the first, the geckos, tortoises, green lizard, eyed lizard, three-toed sand skink, ladder snake, Montpellier snake among the others, are specifically of Mediterranean origin. The same is true of many

birds: the roller, the bee eater, the pallid swift, the black-eared wheatear, the black wheatear, the blue rock thrush, several warblers (like the Sardinian warbler, the subalpine warbler, the fan-tailed warbler), the calandra lark, the crag martin, the rock sparrow. The Camargue, a large swampy area between two branches of the Rhône, is the only known place in Europe where flamingos nest, together with little egrets, night herons, squacco herons and pratincoles.

Some of the mountain fauna are of boreo-alpine origin and now are only found in the far north or above 5,000 ft. This is true of many insects, like the *Colias palaeno* among the butterflies, and the ptarmigan and the alpine hare. Many mountain dwellers, like the chamois, ibex and marmot, are never found at low altitudes in modern times. Others, however, found refuge in the mountains as the plains became more and more cultivated, and this happened to the bear (probably extinct in the French Alps since 1937, but still surviving in the Pyrenees) and to the eagles, lammergeier (only in the Pyrenees) and vultures (in southern France).

France has very few endemics. Besides a reasonable number of invertebrates, especially insects, there is only one mammal, the water mole or western desman (*Galemys pyrenaicus*), an insectivore found in northern Spain and proper to the Pyrenees, related to a form still living in Russia. Corsica is inhabited by several endemics, because of its insular position: the mouflon, a wild sheep also found in Sardinia and introduced into several European countries, and a peculiar bird, the Corsican nuthatch, the nearest relative of which lives in North America.

Because of its mild winter climate, a higher proportion of France's avian population is more sedentary than that of northern or eastern Europe. France provides, also, winter quarters for many migrants from the north and the east, especially many ducks, geese, hawks, and passerines like rooks, starlings, thrushes, robins, wagtails and even some warblers.

Several nature reserves and national parks preserve the last remains of a fauna formerly spread over the whole country. Rare species like the beaver, still found along small rivers of the Rhône basin, are protected by law. (J. P. Do.)

II. GEOGRAPHICAL REGIONS

The surface of France shows a well-balanced distribution of highlands and lowlands. The lowland areas in the northeast (Paris basin), the southwest (Basin of Aquitaine) and the southeast (Rhône-Saône valley) intercommunicate easily by lowland gaps that separate the highland areas of south-central France (Massif Central), northwestern France (Armorican massif) and the frontier mountains and highlands (Pyrenees, Alps, Jura, Vosges and Ardennes).

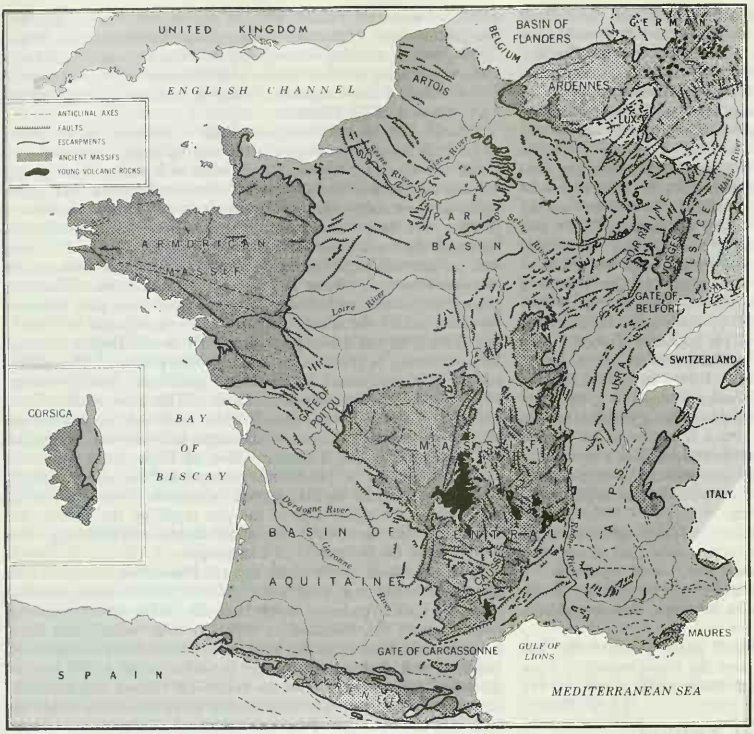
The highest and most extensive mountains are the Alps in the southeast, with the central crystalline massifs of the mountain system in French territory rising to peaks above 10,000 ft. and culminating in Mont Blanc at 15,771 ft. The Alps, however, are penetrated by a number of great valleys, gouged out further by ice action. The Pyrenees, separating France from Spain, do not reach such great heights, though there are a few peaks above 10,000 ft. On the French side they rear up from the lowlands of the Midi as a steep and very continuous wall. The Massif Central is a block of high plateaus, with inset down-faulted basins and deeply incised valleys, and a superstructure of lava flows and volcanic cones, the latter forming the culminating peaks slightly above 6,000 ft.

1. Paris Basin.—The nucleus of France, in the lowland area round Paris, occupies the centre of a structural basin that extends between the margins of the old blocks of Armorica to the west, the Massif Central to the south and the Vosges, Ardennes and Rhineland to the east. In this basin a vast thickness of Mesozoic and Tertiary sediments, mostly marine, was laid down, but under varying conditions of deposition, so that there is an alternation of limestones, sands and clays. In Tertiary times, flexuring and warping of these sediments, accompanying the uplift of the marginal blocks, have imparted a number of important alignments and where, near the margins, the rocks are considerably tilted, differential erosion has subsequently developed pronounced scarpland relief. The oldest sediments, of Triassic age, are represented only in Lorraine, but Jurassic and Cretaceous rocks, chiefly limestones and chalk, form extensive girdling outcrops surrounding the central Tertiary area, which itself consists chiefly of limestones. The symmetrical development of these successive rings is truncated on the northwest by the English channel.

A large part of the structural basin is drained by the Seine river, with its major tributaries converging upon the vicinity of Paris. In the east, however, the drainage of Lorraine is independent and the Moselle and Meuse, superimposed from a rock cover that has now been stripped away, carry drainage northward through the Ardennes-Rhenish massif. In the southwest, late tilting of the basin floor has allowed the lower Loire to cut back and capture drainage from the Massif Central that was earlier directed toward the Seine in the centre of the basin. Thus the present-day Loire makes a great curve westward past Orléans. On either side of the lower Seine drainage, coastal areas in Picardy and Normandy are drained independently to the English channel by such rivers as the Somme. The Tertiary area of the centre, round Paris, consists of low, limestone platforms, usually covered with *limon* and then especially fertile. The tract south of the Marne is known as Brie (*q.v.*), while north of the Marne are Valois and Soissonnais, and in the angle between the lower Oise and the Seine, Vexin Français. East of Paris, these limestone platforms end in a prominent escarpment, the steep margin (*falaise*) of the Île-de-France, which extends from the Oise to the Yonne. On either side of the gap made by the Marne, the lower slopes of the escarpment, about Reims and Epernay, form the *vignoble* ("vineyards") of Champagne.

In places where sterile sands cap the limestones, there are still extensive forests (*e.g.*, Compiègne, Senlis), but the *limon*-covered tracts are open stretches of arable land, devoted to wheat and sugar beet. Variety is introduced by the trenchlike valleys that cross the area from east to west. Their alluvial floors are occupied by meadows and market gardens, and the talus slopes at the foot of the usually steep valley sides are lined with villages and orchards. Increasingly Greater Paris is spreading its tentacles up these valleys. On the left bank of the Seine, beyond a strip of picturesque broken country, with sandstone ridges that carry tracts of forest, such as Fontainebleau and Rambouillet, is the uniform tract of richly farmed *limon*-covered limestone country known as Beauce (*q.v.*) extending south toward the Loire from which it is separated by the infertile sand and gravel tract of the Forest of Orléans, and west toward the damper, hilly districts of Perche and Maine.

Southeast of Paris, beyond the escarpment of the Île-de-France, an arcuate belt (about 40 mi. wide) of dry, chalk country forms the heart of Champagne. There the chalk is unredeemed by any *limon* cover, and was largely poor sheep pasture until, in the 19th century, extensive plantations of conifers were established and agriculture was extended. The towns and life of Champagne are largely concentrated in the main river valleys that traverse the chalk belt. Beyond the chalk is a narrower girdle of clay country, in the northern part of which a local occurrence of resistant sandstone forms the rugged block of the Argonne, a natural bastion on the eastern approaches to Paris. Still farther southeast, successive belts of the Jurassic limestone formations (Portland, Corallian and Oolite) form dry stony plateaus that end in outward-facing escarpments, overlooking narrow clay vales. These plateau surfaces mount toward the high, heavily wooded Langres plateau, dominating the plains of the Saône valley. In the southwest its escarpment forms the Côte-d'Or, with the vineyards of Burgundy. These Jurassic limestone plateaus and clay vales continue northeastward into Lorraine, outside the Seine drainage basin. The winding Meuse is deeply trenched into the Corallian limestone plateau some distance behind its east-facing escarpment (Côtes de Meuse), but the Moselle flows at the foot of the Côtes de Moselle, along which the minette ironstone outcrops. Farther east rather heavy clay country, with salt deposits and a buried extension of the Saar coal field, is varied by more limestone beds that form slight, eastward-facing escarpments and provide lighter, limy soils. The ground rises in the east on the extensive outcrop of sandstones,



EILEEN WARREN

STRUCTURAL REGIONS OF FRANCE

infertile and heavily forested, that flank the Vosges and farther north extend to the margin of the Rhine plain. With its relatively severe climate and generally only moderate or poor soils, Lorraine is less important agriculturally than most of the Paris basin, but its modern economy is distinguished by the development of its far greater mineral wealth and large-scale industry based upon this. Its historical associations and modern economic ties are close with adjacent areas to the east and north, and it is somewhat apart from the rest of the structural basin of which it forms a part.

The extreme characteristics of chalk country that are in evidence in Champagne are modified northward, and in the upper Oise basin at the western foot of the Ardennes give way to a tract of clayey country, Thiérache, once unproductive and ill-drained but now an important dairying district. Beyond Thiérache, in Picardy, the chalk landscape dominates the north of the Paris basin right to the Channel coast. There, however, the chalk is often covered with a coating of clay-with-flints or *limon* or both, and Picardy does not match the dryness and infertility of Champagne. Generally it presents a smoothly undulating, shaven countryside, with great stretches of arable fields devoted to wheat and sugar beet. In contrast are the inset trenches of the main river valleys, such as that of the Somme, with flat, damp alluvial floors, in places intensively used for market gardens. North of the Somme estuary alluvium is also present in a narrow coastal fringe (Bas Champs) in front of the chalk cliffs. Near the Straits of Dover, the crest of the Artois anticline in the chalk, there marking the limit of the structural basin, has been breached to expose the underlying rocks in the varied district of Boulonnais, a continuation of the English Weald. To the southwest also, behind Dieppe, on the borders of Normandy, another breached anticline gives the distinctive Pays de Bray. Farther west, toward the lower Seine, the Pays de Caux is yet another stretch of *limon*-covered chalk plateau extending to the inhospitable cliff coast between Dieppe and the mouth of the Seine.

West of the lower Seine with its estuary ports and industrial development centred upon Rouen, the Channel coastlands in Normandy present further tracts of chalk plateau, often covered with impermeable clay-with-flints, and damper also by reason of their maritime climate, so that farming is more pastoral and cider-apple orchards are ubiquitous. Toward the edge of the Armorican massif, which includes the Cotentin peninsula, a succession of narrow, south-north outcrops of rocks that underlie the chalk give an alternation of limestone plains (*e.g.*, Campagne de Caen) and clay vales (*e.g.*, Bessin).

The plains of the Loire, in the southwest of the Paris basin, lack any pronounced relief but show sharp contrasts of soil type and fertility. The chalk and limestone belts of the Seine basin continue west beyond the Loire, but between the two rivers, in Gâtinais, the chalk has been extensively overspread with infertile debris from the Massif Central. The nucleus of the old duchy of Berry, west of the Loire, was the extensive belt of limestone that lies north of the Lias clay vale, fringing the northern margin of the Massif Central. The limestone passes north under chalk, the uptilted edge of which forms the Sancerrois hills near the Loire. The northward slope of the chalk is coated with clay-with-flints, giving rather heavy soils. The chalk in turn passes under an extensive spread of Tertiary sands and clays, lying within the great curve of the Loire. This district, Sologne, is pitted with ill-drained hollows and is still only partly reclaimed. Other barren stretches of debris brought down from the Massif Central cover parts of the limestone belt of Berry. Such are Boischot, astride the Indre, and, farther west, Brenne, north of the Creuse, and there is another infertile gravel tract north of Tours, the Gâtine de Touraine, between the Loire and Loir valleys. Threading and unifying this southwestern part of the Paris basin is the great valley of the Loire itself. Along with the lower valleys of its tributaries it offers considerable areas of alluvium, often sandy, between steep valley sides that are favoured for vineyards. In Touraine peninsulas of calcareous plateau give tracts of open *campagne* country between these valley lands, with their finely varied pattern of intensively cultivated small holdings.

Outside the metropolitan area of Greater Paris and the industrial areas of Lorraine and the lower Seine, the Paris basin remains profoundly agricultural, though many old-established market towns have experienced growth with the development of modern industries, some of which have roots in medieval handicrafts.

2. Northeastern France.—Outside the Paris basin, along France's northeastern frontier, lie a variety of regions, extensions of physical units of Belgium and Germany. With the ore field of Lorraine, these northeast frontier districts contain most of France's mineral wealth and the country's principal heavy industries, as well as important concentrations of textile manufactures.

In the extreme north, beyond the chalk crest of the Artois anti-

cline, France includes part of the Basin of Flanders behind Calais and Dunkerque. The chalk, dipping northeast, passes under an infilling of sands and clays before the frontier is reached. Until the modern exploitation of the buried coal field a rural landscape extended the characteristic scene of Picardy over the Artois anticline into this area, but it is now dominated by mining and industry and is closely associated with the old-established centres of industry in Flanders in the upper basins of the Lys and Escaut, forming an industrial complex centred upon Lille. In this area of subdued relief and sluggish streams, the canalized rivers are connected by a dense network of canals, linking them also with Dunkerque and by the Oise with the waterway system of the Paris basin.

Farther southeast France also includes the westernmost part of the Ardennes massif, and thence the frontier runs across the scarplands of Lorraine to the Rhine, skirting the Rhenish massif. The upper plain of Alsace and the Vosges massif, which flanks it on the west along a steep fault-line escarpment, lie within France.

The Vosges massif (*q.v.*) is the counterpart of the Black Forest on the opposite side of the Rhine trough. Its granite core is exposed in the south, where it forms the highest area, with smoothly rounded summits (*ballons*) that exceed 4,000 ft. This block of granite highland is a formidable barrier, with high cols between the deep-cut, glaciated valleys, and it is skirted by main routes, which use the Belfort gap (Trouée de Belfort) to the south and the Col de Savergne to the north. Flanking the crystalline area on its northern and western sides are extensive tracts of infertile sandstone that are heavily forested. Above the forested slopes, the summit area of the High Vosges, with its wet severe climate, is rough summer pasture. The deep valleys have well-developed pastoral farming, as well as considerable industrial development, including textile factories, and old-established wood and glass industries.

Beneath the highlands, on the low-lying floor of the Rhine plain, between the damp flood plains of the Rhine and the Ill, are extensive tracts of coarse gravel, still in part forested but elsewhere extensively covered with rich *limon* soil. There the plain, with its sheltered, dry and sunny climate, is richly cultivated. Along the foot of the Vosges, where the swift mountain streams have spread out fans, is an especially rich strip, with vineyards and orchards, and a string of villages and market towns. Apart from its agricultural wealth, the plain of Alsace has the great river port of Strasbourg and an important cotton textile industry, centred upon Mulhouse. Since 1870 this has been duplicated in the valleys of the western side of the Vosges in Lorraine.

3. Armorican Massif.—In northern France west of the Paris basin the Armorican massif, composed of hard, ancient rocks that form hilly, broken country and give poor soils, includes the Breton and Cotentin peninsulas and the *bocage* country of western Normandy, Maine and Anjou, together with an extension in Vendée south of the fertile lower Loire valley. Extensive areas of degraded woodland and heath have persisted until modern times, but piecemeal encroachment by enclosures for farmland have created the irregular patchwork of small, hedge-bounded fields, with numerous trees, which gives an illusion of well-wooded country and is characterized by the name *bocage*. Since the beginning of the 19th century *bocage* has been greatly extended at the expense of the waste. A damp, maritime climate and poor soils are reflected in largely pastoral farming, and this emphasis has increased.

In Brittany the fundamental contrast is between the interior (l'Argouet or "land of trees") and the populous coastal fringe (l'Armor or "land of the sea"), favoured with additional resources: an exceptionally mild climate and seashore fertilizer available to improve the soil, fishing from numerous little ports of the rocky, indented coast line and, increasingly, the tourist industry. In the interior the old plateau surface is ribbed by ridges that have sombre, even skylines (Montagne d'Arrée, Montagnes Noires, Landes de Ménéz and Lanvaux). They correspond to the outcrops of the hardest rocks, granite and quartzite, and are aligned more or less parallel with the north and south coasts, in conformity with the trend of the old folds. Outcrops of softer shales form the interior basins of Rennes and Châteaulin. The coast is very irregular, but the indentations make no great penetration of the massive peninsular block except at its western end. Rivers from the high ground flow to the north and south coasts across the grain of the country in narrow entrenched valleys to drowned mouths, and their lower valleys impose an additional obstacle to communications from the east. Altogether Brittany is isolated and remote from France, into which it was incorporated only at the end of the 15th century. The Celtic speech extended throughout the peninsula in the 9th century, but its limit has subsequently receded westward in face of the spread of French. Brittany, however, remains a highly distinctive province, with a large measure of survival of ancient traditions and archaic ways of life.

Although the iron ores of the lower Loire and the Normandy margin near Caen are exploited and elsewhere there are kaolin and slate quarries, there is very little industry anywhere in the Armorican massif, except along the estuary of the Loire. Elsewhere there are few large towns.

4. Massif Central.—This extensive plateau, covering roughly one-sixth of France, stands as a great highland bastion in the southern half of the country and is the source of many of its rivers. Although the highest points, in the volcanic mountains of Auvergne in the centre, are only a little above 6,000 ft. (Puy de Sancy 6,188 ft.; Plomb du Cantal 6,096 ft.), large areas of summit plateau exceed 3,000 ft. and experience long and severe winters with much snow. Differences in elevation and exposure are responsible for much variety of climate between different parts of the massif, and there are striking local contrasts between high, exposed mountains and sheltered basins or valleys alongside. But, generally, as a highland area the Massif experiences a climate that is appreciably colder and wetter than that of the surrounding plains, and the high ground practically everywhere receives more than 40 in. of annual precipitation.

Although by reason of its physical history it is the most varied of the ancient massifs of France, the predominant character is plateau. An early Tertiary peneplain surface, developed in the ancient folded rocks, has later been uplifted, deformed and fractured, and in parts vigorously dissected by rejuvenated streams. From the area of greatest uplift in the southeast, where the Cévennes dominate the lower Rhône valley and the plain of Languedoc in a great escarpment, gashed by the valleys of Mediterranean torrents, the block has been tilted north and west, so that most of its drainage flows to the Loire and Garonne river systems. Only short, swift streams drain the east and southeast margins to the Rhône and the Mediterranean. In the southwest extensive tracts of younger, Mesozoic limestones, laid down in the Basin of Aquitaine, have been uplifted en masse and incorporated into the highland as the Z-shaped group of high plateaus known as the Causses, between the Cévennes and the southwesternmost crystalline plateaus, the Ségalas and Montagne Noire. The arid, boulder-strewn and scantily vegetated high Causses surfaces, between 2,000 and 4,000 ft., are broken into isolated blocks by the Lot, Aveyron, and the Tarn and its tributaries, flowing in deep narrow gorges, often with precipitous walls, 1,200–1,600 ft. below the plateaus.

The extensive tracts of granite, gneiss, schists and other old crystalline rocks yield siliceous, acid soils and provide an impermeable, streaming surface, in striking contrast to the soils and hydrology of the limestone Causses. Little of the natural woodland cover is left, but since the mid-19th century some reafforestation has been effected, notably in the Cévennes and the plateau of Millevaches. Since the beginning of the 19th century reclamation of the waste has added considerably to the area of *bocage* landscape, with small, enclosed fields, largely under grass. Such pastoral country is widespread on the lower plateaus of the west. The district names Ségalas and Châtaigneraies point to rye and sweet chestnut as important features of the traditional economy, in contrast to wheat and walnut, which were typical of the Causses. The prevailing economy is more specialized upon rearing livestock and is concerned primarily with cattle, but in the Causses sheep continue to be the mainstay, though they are now kept to supply the Roquefort cheese industry rather than for wool.

Parts of the old peneplain surface have been uplifted, often as

slablike masses such as the Montagnes de la Margeride; other portions have foundered along lines of fracture, and tectonic basins are now inset among the surrounding plateaus. The Loire connects the basins of Le Puy, studded with volcanic hills, Forez and Roanne. Another series of small basins is strung out along the upper Allier, ending northward in the long trough known as the Limagne. Beyond a northward prong of the Forez plateau, the lowlands of the Loire and Allier converge in Bourbonnais. The basins and valleys are naturally floored with material derived from the adjacent highlands, and vary accordingly in fertility. They often suffer the disadvantage of containing a considerable proportion of naturally ill-drained land; but they have a sheltered, mild and dry climate as compared with the inclement highlands and, in varying degrees, they are pockets of lowland agriculture and population concentration, including local urban and industrial development. In the east of the Massif, from the Morvan in the north, a series of pastoral highlands (Charolais, Beaujolais, Lyonnais, Vivarais), blocks of crystalline plateau aligned northeast-southwest, flank the Rhône valley. In intervening synclinal grooves sedimentary rocks, including Coal Measures, have been preserved. These provide valley routes and industrial areas (Le Creusot, St. Étienne), based upon these routeways and the local resources of high quality, if not abundant, coal. Electrically operated textile industries have also penetrated from the Lyons area up the valleys into the highlands flanking the Rhône valley. Other pockets of coal are responsible for small, isolated industrial concentrations elsewhere round the margins of the massif.

Below the fragmented peneplain surface are tectonic basins and gorgelike valleys; above are some upstanding residual masses of specially resistant rocks such as the Montagne de Limousin, and a superstructure of volcanic material, consisting of cones of ash and lava, such as the Cantal and Mt. Dore and the chain of "puys" overlooking the Limagne by Clermont-Ferrand, and flows of basaltic lava that form extensive plateaus (*planèzes*), such as Aubrac, St. Flour and Cézallier and those of Velay surrounding the basin of Le Puy. The rich basalt soils provide exceptionally good pastures as well as wheat fields at high altitudes, but the height of the volcanic mountains of Auvergne introduces a zone of high seasonal pastures, of value only during the short summer, and there an Alpine economy concerned with cheese making still obtains, though these areas are no longer reached by transhumant flocks of sheep from Languedoc.

Although in human terms a *pôle répulsif*, skirted by main routes and ill served with secondary roads and railways, so that it has remained a rural backwater of poor farming and backward ways, offering little to hold its population in face of the attraction of an easier and better livelihood outside, the Massif Central is not without its pockets of wealth, in the form of localized areas of greater fertility or of small, scattered coal fields and centres of industrial development. The human associations of different sectors with the adjacent lowlands, rather than with each other, are of long standing and inevitable, although, in the centre, Clermont-Ferrand has recently greatly strengthened its sphere of influence over the surrounding areas of highland and plain. Nevertheless, marginal towns such as Limoges in the northwest, and Lyons and St. Étienne in the east, increasingly command large areas of the Massif, and other smaller marginal market towns have strengthened their influence, especially since the development of motor transport and bus services. (*See* also Massif Central.)

5. Basin of Aquitaine.—Between the northwest of the Massif Central in Limousin and the southern extension of the Armorican massif in Vendée is the lowland gate of Poitou, rich cornland on limestone plains, diversified by sheets of gravel that still carry woodland and heath. The gate of Poitou connects the Paris basin with the Basin of Aquitaine, a great triangle of lowland occupying the southwest of France between the Massif Central, the Pyrenees and the Bay of Biscay. In the southeast, between the Montagne Noire, a southwestward projection of the Massif Central, and the central Pyrenees, another lowland gap, the gate of Carcassonne, provides easy connections with the Mediterranean coast in Languedoc.

Aquitaine itself is of the Midi, but has damp summers, unlike the Mediterranean coastlands, and the olive does not extend west of Castelnaudary in the gate of Carcassonne. Since the 17th century, maize (corn) has become an important crop in addition to wheat, and the vine is widespread. The lowlands lie largely within the drainage basin of the Garonne, emptying into the Bay of Biscay by the great estuary of the Gironde, but independent streams farther north (the Charente and Sèvre) and in the extreme southwest (the Adour) flow directly into the sea.

Limestones, sands and marls form the sedimentary infilling of the Basin of Aquitaine, but Tertiary and younger rocks occupy a larger proportion of the area than in the Paris basin, nor are there such pronounced scarplands. The chief distinction is between the great valleys and the interfluve platforms. The Garonne valley, occupying the trough of the basin, and the converging valleys of its tributaries present wide valleys with extensive tracts of usually light, sandy, easily cultivated, if not always very rich, soils. The low-lying flood plains are used for meadows or market gardens, as near Toulouse, while the higher, flanking terraces are under corn and vines. Between the valleys, the interfluves have rather compact, clayey soils, characteristically devoted to wheat and maize. Armagnac, with especially extensive gravelly tracts, is a vine-growing area, noted for brandy; but the low slopes bordering the Gironde estuary and, at its head, the peninsula (Entre Deux Mers) between the Garonne and Dordogne comprise the major wine-producing district, in the vicinity of Bordeaux.

Flanking the Massif Central are limestone platforms, which reach the coast north of the Gironde. Angoumois and Aunis on the north, Champagne Charentaise and Saintonge on the south, are drained by the Charente river. Although this country is still noted for cognac, dairying is now a more important activity than viticulture. Farther southeast, the Causses of Périgord and Quercy are lower and less severe than the Grands Causses. Their dry, stony plateau surfaces are mainly sheep pastures, but the entrenched valleys of the Dordogne and Lot provide rich strips of irrigated meadows, orchards and vineyards. Farther south, Albigeois and Lauragais are other limestone tracts at the southwestern foot of the crystalline uplands of the Massif Central. The Lauragais plains stretch right to the limestone fore-ridge of the central Pyrenees, the Plantaurel, but farther west Lannemezan is a great apron of gravel that has been spread out in front of the mountains. It is a dry, bare district, drained fanwise by the Adour and by tributaries of the Garonne, and offers little but sheep grazing.

Along the coast north of the Gironde estuary, limestone promontories are continued by offshore islands, Ré and Oléron, but along the lower valley of the Sèvre are extensive areas of reclaimed marsh (Marais Poitevin) and along the coast farther south accumulations of silt form other fringes of marsh, such as near Marennes. These amphibious areas now present a checkerboard of plots, meadows and market gardens, between drainage channels. South of the Gironde is the smooth, unbroken coast of the Landes (*q.v.*), sweeping right to the Pyrenees. Behind the coastal dunes, a sandy plain, underlain by iron pan that interferes with natural drainage, has been extensively planted with pine forests since the mid-19th century.

Until the discoveries of oil and natural gas near their Pyrenean margin, the economy of the southwestern plains was almost purely agricultural, based upon polyculture or, locally, specialized viticulture and hardly affected by mineral working and industrial development.

6. Pyrenees.—This folded mountain chain extends for about 270 mi. between the Bay of Biscay and the Mediterranean sea, forming a remarkable natural frontier between France and Spain. The mountain system, which exceeds 50 mi. in breadth in the central portion, is developed mostly on the Spanish side, and the French face is very wall-like. The highest peaks exceed 10,000 ft., but it is the continuity of the high crestline along the frontier that makes the Pyrenees such a formidable barrier. From the Pic d'Anie, 54 mi. from the Atlantic, to Mt. Canigou, within 30 mi. of the Mediterranean, there is no pass below 5,000 ft. The great U-shaped transverse valleys of the French Pyrenees invariably end in culs-de-sac.

The western Pyrenees, approximating to the *département* of

Basses-Pyrénées in the Basque country, are the lowest portion, with easy passes below 3,000 ft. In addition to the historic pass of Roncesvalles, two railway lines cross this western portion. The mountains there consist entirely of sedimentary rocks and, exposed to the Atlantic, are very wet and exceptionally verdant. The valleys have rich diversified farming in which maize is especially important and in which cattle are reared. The cider apple, not the vine, is typical.

In the central Pyrenees the difficult crossings (*ports*) are only slight notches in the crests near the snowline and are inaccessible in winter. The high crystalline massifs of the mountain core are separated by great transverse valley troughs, shaped by glaciation, where autonomous mountain communities have persisted till modern times. Permanent snow fields are not extensive, but the altitude range is responsible for a well-developed Alpine economy making use of extensive high pastures that become available as the snows melt. Cultivation of maize and haricot beans, and, at higher altitudes, potatoes, in the valley lands is associated with the movement of livestock between them and the high summer pastures. On the French side especially, the transhumance of sheep has greatly declined. In this central portion, there is also more development of fore-ranges on the French side. In front of the crystalline axis are ranges of sedimentary rocks, including the limestone Plantaurel and Petites Pyrénées, through which the Ariège and Garonne break north toward Toulouse. Some outgrowths of old metalworking industries, once based on small ore bodies that occur in the mountains, persist in valley market towns which, with the spas, are developing increasingly as tourist centres. Over the centuries ironworking has contributed, with the grazing of sheep and goats, to bring about the deforested condition of the mountains. In the 20th century the water resources of the high central Pyrenees are being extensively developed by great hydroelectric power schemes.

The eastern Pyrenees maintain a considerable height right to the coast, where the rocky headlands of the crystalline Albères massif shelter little fishing ports. A number of troughlike valleys debouch into the plain of Roussillon, which occupies a downfaulted basin between the eastern end of the Pyrenees and the outlying crystalline massif of the Corbières to the north. The mountains have some cork-oak and chestnut woodlands, but much is scrub, impoverished by long grazing by sheep and goats. Mediterranean cultures, including the olive and especially the vine, extend up the valleys to fairly high altitudes in this drier eastern portion of the Pyrenees. (*See* also PYRENEES.)

7. French Alps.—From the Swiss frontier by the Lake of Geneva to the Mediterranean coast on the French Riviera, the western Alps sweep in a great arc as a wide belt of mountains along the eastern frontier of France. Toward the south, the north-south lines of structure and relief intermingle with west-east lines of earlier (Pyrenean) folding in the southern Préalpes.

In the northern French Alps the longitudinal zoning of the structure is clearly expressed in the relief. The core of the mountain system is a series of uplifted, crystalline massifs, represented by Mt. Blanc, Belledonne, Grandes Rousses, Pelvoux and other blocks. East of them, toward Italy, are heavily overfolded and uprooted masses of varied sedimentary rocks, forming multiple ridges, traversed by the high mountain valleys of the upper Isère (Tarentaise), Arc (Maurienne) and Romanche (Oisans). West of the crystalline massifs, the outer ranges of the Préalpes consist of folded material, chiefly limestones, but still attached to its roots, although some superstructure of "nappe" material (huge overthrust folds) is represented in the north. Between the outer ranges of the wet, heavily forested Préalpes, which rise to about 6,000 ft., and the higher crystalline massifs, the special feature of the northern French Alps is the great groove (*sillon alpin*) etched out along a strip of Jurassic marls. It is the gathering place for the rivers issuing from the high intra-Alpine valleys and for the routes that follow them to the frontier crossings. Lowland gaps that break the Préalpes into a series of blocks (Chablais, Bornes, Bauges, Chartreuse and Vercors) offer easy communications between this groove and the country west of the Alps. The great alpine glaciers of the Ice Age, debouching by these gaps, have further shaped them and have left them cluttered with moraines, behind which lakes Annecy and Bourget are dammed. The gaps of Annecy and Chambéry are no longer tenanted by through rivers, and, except for the northern part, drained westward to the Rhône by the Arve river, the Isère carries the drainage collected in the *sillon alpin* to the Rhône past Grenoble.

South of the Vercors, the zoning is much less clear in the southern part of the French Alps. The intra-Alpine zone continues southward along the Italian frontier, but the crystalline core is represented only by the isolated massif of Mercantour. By far the greater part of the mountain system consists of the outer zone of the limestone Préalpes, but there is no continuous longitudinal groove behind them. The general absence of longitudinal valleys in this tangle of wild, limestone mountains, and the constriction of the rivers, such as the Durance and Verdon, into gorges between more open valley basins, developed in softer rocks, is responsible for the fragmentation of the mountain country into isolated compartments.

Differences between the northern and southern parts of the French Alps are greatly emphasized by the climatic contrast. The north is much wetter, and, especially in the Préalpes, is heavily forested. The buildings make liberal use of timber, and the forests play an important role in the economy. Farming, freed by the development of modern communications from the need to achieve local self-sufficiency, is increasingly directed toward cattle rearing and dairying, cultivation in the valleys being especially concerned with fodder crops. Above the forests are extensive summer pastures, the "alps." Elaborate vertical movements of livestock and human beings, integrating the altitudinal zones, are still found in the high intra-Alpine valleys, though seasonal occupation and cultivation at intermediate stages are less practised than formerly. There are some striking differences between sombre, forested, north-facing slopes (*ubacs*) and favoured sunny slopes (*adrets*), where cultivation and settlement climb high.

The southern French Alps are drier and much less wooded, a degraded scrub vegetation being more characteristic, and bare rock is much in evidence. Stone buildings, roofed with tiles, prevail. Although the altitudinal limits of successive vegetation zones and of settlement are higher, the south is altogether poorer, less accessible and more thinly peopled. The rural economy associates cultivation and irrigated meadows in the valleys with the rearing of sheep (not cattle). Modern extension of irrigated meadows has led to decreased use of the poor mountain grazings, and the old practice of long-range transhumance from the Mediterranean lowlands has also greatly declined.

With increasing penetration of the French Alps by good motor roads, the tourist industry is assuming an ever-increasing role. The Alps lack important mineral wealth, but their great waterpower resources, especially in the wetter north, where the streams also have a more regular regime, have undergone great development since the first hydroelectric power scheme was initiated near Grenoble in 1885. The power generated in the Alps is mostly transmitted to industrial areas outside, especially to that of Lyons, but some metallurgical and chemical works have been brought to sites near the generating stations, and cement and other industries have grown along the great highways, especially in the gaps of the northern Préalpes. Over large parts of the French Alps, however, chronic depopulation persists. (*See* also ALPS.)

8. French Jura.—Northwest of the Alps, in front of the northern part of the French Préalpes and the Swiss Foreland beyond the Lake of Geneva, the arcuate limestone highland of the Jura extends for about 160 mi. between the Rhône and the Rhine. The Franco-Swiss frontier runs through the Jura but the greater part of the Jura lies on the French side. The mountains, of generally simple, folded structure developed in limestones, are narrow at both ends of the arc, but in the centre the folding peters out westward, and beyond the fold ranges is an extensive plateau that overlooks the Saône plain by a bold escarpment, with vineyards on the favoured slopes of re-entrant valleys. The crests of the Jura mountains are usually about 3,000 ft. high, but exceed 5,000 ft. in the Crêt de la Neige. In the ridge and valley area the rivers, among which the Doubs and Ain are the master streams, zigzag between rela-

tively open, longitudinal valleys (*vaux*) through narrow, steep-walled *cluses* that breach the limestone ridges (*monts*). The plateau Jura shows the typical land forms and hydrology of limestone country. In parts, however, where it is coated with glacial drift, the surface is ill-drained.

The wet and once densely forested Jura highlands have been extensively cleared for pasture. Although the winters are severe, a highly developed dairying economy prevails, with co-operative organization for cheese making. Because of its situation, the French Jura is traversed by some important routes, which have stimulated the growth of its tourist industry as well as having contributed to the growth of manufacturing industries. These are highly skilled industries, carried on in workshops and small factories, and are based upon long established woodworking (and now plastics). Watchmaking, introduced from Switzerland, and other precision industries are also important, and in the south, within the orbit of Lyons, there are textile manufactures. These Jura industries, especially a feature of the mountain valleys, now use hydroelectric power, generated by the swift streams. Altogether the Jura is a remarkably populous mountain area. (*See* also JURA.)

9. Rhône-Saône Lowlands.—Between the Massif Central and the Alps and Jura mountains, the Rhône-Saône valley occupies a structural depression that consists of several compartments linked by the river. It is neither physically nor climatically a unit. In the north a late-Tertiary lake occupied the site of the Saône plains. The lacustrine deposits that form their surface, about 600 to 800 ft. above sea level, vary according to their derivation. In the north and west siliceous material from the Vosges predominates, and there are extensive forests on sheets of infertile sands. Farther south, on the favourably exposed lower slopes of the limestone escarpments of the Côte-d'Or and Mâconnais, are rich vineyards. In the east calcareous material from the Jura forms the surface of the fertile plain of Bresse, where the warm, moist summers favour the cultivation of maize, which is grown along with wheat, sugar beet and tobacco. Occupying extensive tracts north and south of the Rhône as it crosses the lowland toward Lyons are the moraines and outwash material of the Alpine glaciers. These deposits overspread the southern part of the old lake floor. North of the Rhône, the Dombes is an ill-drained area of hummocky moraine country, only partly reclaimed. To the south, in Bas Dauphiné, a gravel apron at the foot of the Préalpes is trenched by the valleys of the Alpine tributaries of the Rhône, notably the Isère, which are strips of richer farming between intervening ridges that still carry much woodland. South of the Saône confluence at Lyons, the Rhône hugs the western wall of its valley and in several places cuts into the old rocks of the Massif Central. Its valley is a succession of gorge sections and more open basins, such as those of Valence and Montélimar, which are separated by a bar of limestone. Below Montélimar, when the Rhône emerges from the defile of Donzère, its lower valley opens out in a funnel-shaped lowland that was recently a gulf of the sea. In the Rhône valley vineyards and fruit trees are much in evidence, but the characteristic plants of the Mediterranean climate, including the olive, are restricted to the area south of Donzère, gateway to the Midi. (*See* also RHÔNE.)

10. Mediterranean Coastlands.—The coastlands bordering the Mediterranean sea in the south of France, from the eastern end of the Pyrenees to the southern end of the Alps on the Italian frontier, consist of a variety of physical elements, which are given an underlying unity by their distinctive climate and associated features of vegetation and crops. Material from the highlands that back these coastlands has infilled the margins of a recently more extensive sea, and staged surfaces rise from the coast and lower valley floors to the mountain margins. In the west the plain of Roussillon is enclosed between the eastern end of the Pyrenees and the Corbières massif. There follows the plain of Languedoc in front of the Cévennes and their fringing limestone platforms. These lowlands west of the Rhône lie behind a regular dune and lagoon coast. The Rhône delta, a flat triangular area below Arles known as the Camargue (*q.v.*), is backed by terraces of older, coarser material, along the line of the Costière. East of the main distributary channel of today, a great spread of coarse gravel, the Crau, is the product of a former Durance river. The Durance now flows west toward Avignon across the plains of the Comtat-Venaissin (*q.v.*), north of an outlying limestone range, the Alpilles. Farther east, in Provence, among the tangle of limestone mountains of the southern Préalpes, which come right to the sea in a rocky cliff coast, are structural basins where marl depressions give pockets of good soil much interrupted by scarped limestone hills. Patches of cultivation are scattered among the rocky outcrops, which are incompletely clothed with scrub (*garrigue*) and pine-woods. From Toulon to Cannes are the crystalline blocks of the Maures and the Esterel, with softer, rounded outlines and more massive coastal features. They differ also because of their acid, instead of limy, soils and are extensively covered by cork-oak and chestnut forests. Still farther east, the north-south ridges of the limestone mountains end in rocky promontories and islets along the magnificent Riviera coast.

The traditional basis of the Mediterranean economy, cultivation of wheat, vine and olive, has been largely replaced in Mediterranean France by more specialized cultures. Where irrigation is available, as on the valley floors of the plain of Roussillon, in some parts of the Crau, and especially in the plains of the Comtat-Venaissin, watered from the Durance, an intense development of market gardening has taken place, with cypress windbreaks giving protection against north winds. Elsewhere on unirrigated land there are varying degrees of specialization upon the vine, reaching an extreme of monoculture in the plain of Languedoc. In some areas the warm, sunny climate is exploited for the cultivation of exotic or out-of-season flowers, as round Hyères. In this area of old cities of Roman foundation, set amid a Mediterranean countryside, great commercial and industrial development has taken place in modern times around Marseilles, and along the coast farther east opulent resorts have sprung up. (AR. E. S.)

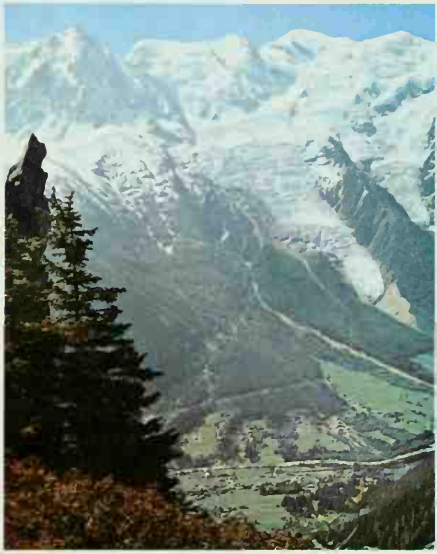
III. THE PEOPLE

Racial Types.—The channeling of the great physical zones of Eurasia on French territory encouraged the convergence of racial types. Although it is impossible to know what traces have been left in the present-day inhabitants by the distant occupants of the Paleolithic, in them survivals of all the peoples who have helped to form them since the Campignian culture can at least be distinguished. Mediterraneans (Iberians and Ligurians), Celts, Germans and Latins have left their mark. From this derives the composite character of its ethnography, and to it it owes its national unity. At the beginning, however, two dominating influences are distinguishable: that of the Celts and that of the Romans. Through the first of these, whose immigration stretches from the 6th to the 1st century B.C., the French people have connections with middle Europe where, in the Bronze Age and then in the Hallstatt and La Tène periods, their ancestors had built up an initial civilization. They spread over a region in which they found an agricultural civilization. This they enriched. Then, adaptable and receptive, welcoming novelty, they willingly took in all the later elements which were brought to them by Roman civilization, and what it brought with it of oriental wealth.

No region of France can be characterized by the presence of any single racial type. There is a frequent mixture of kinds. Nonetheless certain provinces owe their ethnical features to the marked predominance of one or other of the great racial groups of western Europe.

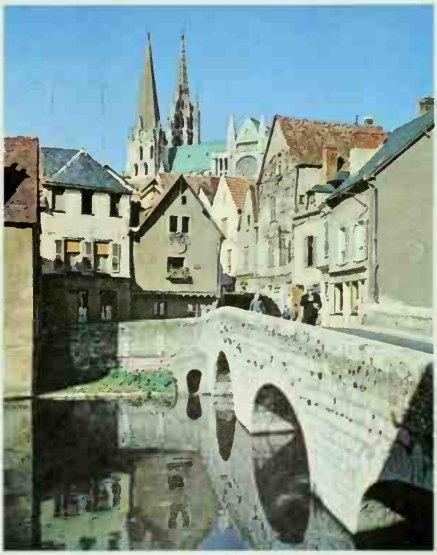
In the distribution of cranial indices the most striking phenomenon is the preponderance of brachycephaloids. Most of these brachycephaloids belong to the western variety of the Alpine race. They seem to have been long established in their principal area (from the Neolithic), and moreover it is also known that these peoples took part, in historic times, in the brachycephalization current throughout all western Europe. Broadheads are dominant in two principal areas. The largest occupies almost all the region to the southeast of a line drawn between Charleville-Mézières and Mont-de-Marsan. It takes in the slopes of the Massif Central, the northern Alps, Morvan, and the Jura, Lorraine and Luxembourg. The most distinct forms are to be found in the Cévennes

View of Paris and the Seine River upstream, as seen from Notre Dame Cathedral



Chamonix, a tourist and winter sports resort in the French Alps. Mont Blanc, in the background at left, is the highest point in Europe

The pleasure-boat harbour of Cannes, a fashionable French Riviera resort



Street scene of an old quarter of Chartres, a cathedral city in northern France on the Eure River

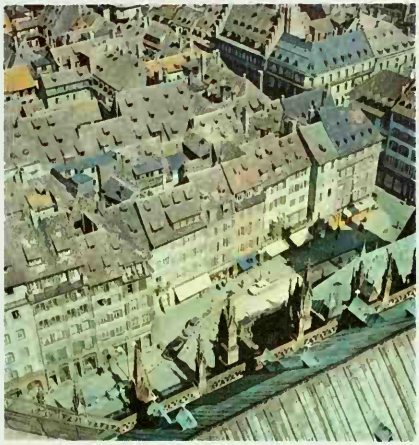
The remains of St. Bénézet's Bridge, built 1178–88, across the Rhône River at Avignon, southeastern France. Broken down and repaired several times, it has remained as at present since 1680

PHOTOGRAPHS, (TOP LEFT) A. L. GOLDMAN—RAPHO GUILLUMETTE, (TOP RIGHT) JOSEF MUENCH, (OTHERS) FRED BOND—PUBLIX

FRANCE

Aerial view of the port of Bordeaux, a city at the head of the Gironde Estuary in south-western France, famous for its wine trade since the Middle Ages

View of an old part of Lyons, long a major commercial and industrial centre of southern France, situated at the confluence of the Rhône and Saône rivers



Part of central Strasbourg, seen from the tower of its cathedral, with highly packed buildings, typical of the congested inner parts of old European cities

Aerial view of Le Havre, the major seaport of northern France, at the mouth of the Seine. The harbour has 14 basins, one of which can accommodate the largest transatlantic liners

Aerial view from the south of Marseilles, France's second city and major Mediterranean port. The old nucleus lies alongside the ancient harbour (the Greek Lacydon). The modern dock extensions stretch northward to the Nerthe Peninsula

PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT, BOTTOM) SPIRALE—RAPHO GUILLUMETTE, (TOP RIGHT) JEAN MICHEL BRAULT—PHOTO RESEARCHERS, INC., (CENTRE LEFT) J. BARNELL—IMAGE INT'L. FROM PUBLIX

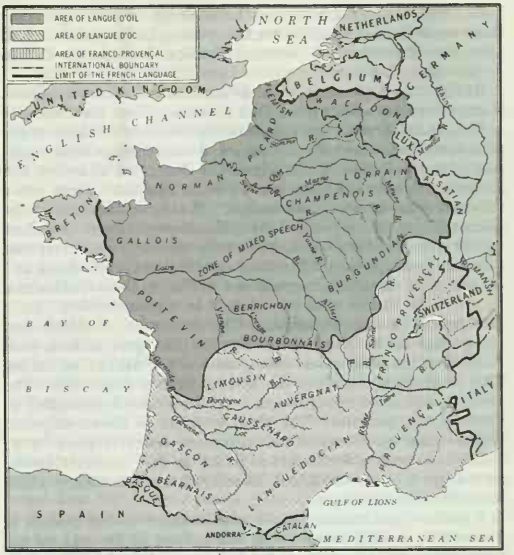
(Haute-Loire and Lozère) with figures of 87 or more, which is the reason why this branch of the western Alpine race is sometimes given the name "Cévenol." Small in stature, in general squat and thickset, broad-faced, with a short, somewhat thick nose and with brown skin and hair; these characteristics are easily identifiable as those of the typical Auvergnat. The second area where this type is dominant coincides fairly closely with the region known as the Armorican massif (Brittany and the surrounding regions). There are found occasionally small groups, broader in features, who have sometimes been compared to Laplanders.

The region of the dolichocephaloids is more dispersed and also more mixed in its types. At the southern edge of the main region of the Alpine type, there is a band of dolichocephaloids of Mediterranean type, which differs in intensity and stretches from the Bay of Biscay to the Franco-Italian frontier. In the west they spread over the Pyrenees. They go the length of the Rhône valley as far as the outskirts of Valence. Another area, this time attached to the Nordic type, follows the coast of the English channel. But the most remarkable factor is the existence of a dolichocephalic area separating the Alpine of the Massif Central from those of the Armorican massif. While the somatic characteristics of these Périgordians allow them to be classed with the Mediterraneans, they do not thus complete admixture of the two types. Perhaps there is some very ancient factor involved, possibly an influence from the south, of which the last Iberian invasion is an echo. This area extends from Poitou to the Loire.

The ethnography of France, both by its composition and by the general distribution of anthropological types, may be said to form a compendium of European ethnography. There are, though, marginal zones where no type dominates the rest. Moreover, France is a country that welcomes exiles and it has taken in foreigners of widely differing origin in many regions. The anthropological analysis of these newcomers has still to be made. But the extraordinary power of assimilation of the French race rapidly dissolves them. Education and the use of the language as much as the way of life make the son of the immigrant—even the refugee who is only a temporary immigrant—into a Frenchman distinguishable from the others only by the sound of his name.

Language.—After the Roman conquest Latin spread rapidly throughout Gaul. The languages spoken before the Celtic invasion vanished save for Iberian and Ligurian place names. The Celts themselves have left only place names, including the names of their tribes which survive in many towns and a small number of words. To the Latin base, which itself evolved and gave birth to dialects of analytical character, were added words of Germanic origin (Frankish). In the end a northern dialect, that of the Île-de-France, prevailed. From the reign of Francis I, when it was substituted for Latin in public documents, it became the official state language. Foreign words have enriched it over the years, from Spain and Italy in the 16th and 17th centuries, from England in the 18th and 19th and the United States in the 20th. But its essential character has not been altered. In the 18th century French became the language of the cultivated classes of Europe. Today it is spoken by all Frenchmen from the Rhine to the Atlantic, and from the English channel to the Mediterranean. Even those who still use the old dialects in everyday life understand, speak and write French as their mother tongue. The French Revolution reinforced linguistic unification, the third republic completed it. School and military conscription in the 20th century are fast killing the local dialect languages or patois.

Modern French is a Neo-Latin tongue or one of the Romance languages (*q.v.*). Its syntax is analytical and its vocabulary comes for the most part from popular Latin, enriched from the 14th century onward with words borrowed from classical Latin, for abstract ideas. The spoken word is no different from the written. It has been shaped by generations of moralists and analysts who worked to give it the utmost clarity. Although the mute *e* gives it great suppleness, it is not as musical as Italian and it does not have the same fullness of sound as Spanish. It is an instrument for the expression of lucid and definite ideas rather than of lyricism, and of an irony more subtle than humour. It answers the needs of the French mind which drives back the shadows from



BASED ON THE MAP "DIALECTES ET FRONTIÈRES LINGUISTIQUES EN FRANCE," FROM A. DEMANGEON, "LA FRANCE," LIBRAIRIE ARMAND COLIN

MAJOR FRENCH DIALECTAL AND LINGUISTIC GROUPINGS

reality, at the risk of impoverishing it, and which is constantly testing the efficiency of its intellectual instrument. Every Frenchman is a born grammarian and Caesar's remark about the fondness of the Gauls for the art of using words still holds.

Although they are being driven back by the national language, the regional dialects survive, mainly in rural communities. They form two groups: the Neo-Latin dialects and the rest. The last group consists of Flemish, low Breton, Basque or Euskarian and Alsatian. Flemish is spoken only in a narrow coastal belt along the North sea. It does not even reach Calais and is receding, although it is related to the Belgian Flemish group. Low Breton is not a survival. In the first centuries A.D. Latin was spoken throughout the Armorican peninsula. The Celtic dialects (Cornish, Tregorrois and Vannetais) came in the 6th century with the immigration of peoples driven from Britain by the Saxon invasion. At their widest expansion they spread as far as the basin of the Vilaine, but were soon confined to an area whose borders, from the lower end of the Bay of St. Brieuc to the mouth of the Vilaine, have receded very slowly and are fraying at the edges. Basque, whose affinities lie in the Caucasus, covers a gradually shrinking area. Alsatian is an Alemannic dialect related to others spoken in Baden and Switzerland.

The Neo-Latin dialects dislodged with the victory of French form two groups distinguished by the word for "yes," the *oc* of the southern dialects as compared with *oïl* of the northern. The *oc* languages (*langue d'oc;* Limousin, Gascon, Languedocian, Provençal and Catalan) are the common tongue of the Provençal civilization which spread over the western Mediterranean in the 12th and 13th centuries. In the 19th century F. Mistral and his followers made a remarkable effort to give Provençal the dignity of a literary language. This coincided with the Spanish Catalan renaissance, echoed in the province of Roussillon. The *oïl* languages (*langue d'oïl*), the purest source of French, are centred on the banks of the middle Loire and on the Île-de-France. The Bas Maine, Champenois, Picard and Walloon (Wallon) dialects belong to the same group as Francien, the low Latin acquired by the Franks. All the efforts of regionalists to restore the old forms of speech have not stopped the inevitable progress of French. Remarkable results have been achieved: the Breton theatre, and above all the works of the Provençal literary renaissance centred

round Mistral and the school of the Félibrige. Their importance is, however, limited, and they are the creations of learned archaism. (*See* also PROVENÇAL LANGUAGE; FRENCH LANGUAGE; CELTIC LANGUAGES; CATALAN.)

Religion.—A country with a dominant Catholic tradition, France lived for a little more than a century, from the Consulate (1799) to 1905, under the regime of the concordat; that is to say of a compromise between the state and the religious sects recognized by it: Roman Catholicism, the Reformed churches and Judaism. After 1830 Islam was added to this list. There was a religious administration and budget. The encroachments of the hierarchy into the province of the civil authority were to be judged by the *conseil d'état* (appeal by writ of error). In point of fact after the consolidation of the third republic, on the one hand, and on the other the final disappearance of the spirit of Gallicanism (*q.v.*) in the church with the triumph of ultramontanism (*q.v.*), this regime became impossible. The separation of church and state under the law promulgated Dec. 9, 1905, gave each its freedom. But the conflict was transported to the field of education. This problem is one which has divided France since 1880. The lay state considers education as a public service independent of any religious doctrine. The church wishes to have recognized the doctrinal autonomy of the education which it gives to its followers even outside matters of faith. In fact the non-Catholic sects adapt themselves without difficulty to the state schools which respect their beliefs.

A phenomenon common to all western countries but evident in France to a marked degree is the falling away of the mass of the people from the religious groups. It is associated with the growth of industrialization and urbanization. While rural communities in general remain more attached to the traditional faith, the townspeople, particularly in suburban districts, are in process of de-Christianization. This movement has been closely studied by French sociologists, above all by Catholic sociologists who are looking for efficient methods of reclamation. But it is not peculiar to Roman Catholicism. In France the effects of this movement, together with a rationalist one, have formed an uninterrupted current in the spiritual history of the country, whose path may be followed even under the most doctrinaire regimes (the Libertins in the reign of Louis XIV). Nonetheless, between the total separation which amounts almost to hostility (anticlericalism or rather anti-Catholicism) and the extreme forms of piety, there are many shades of difference which make it hard to define the word "Catholic" and consequently to establish any really valid statistics (*see* also ANTICLERICALISM). Is it enough to have been baptized, as most Frenchmen have, to be a Christian? Again, is it enough to be a Catholic through habit, without perhaps believing much of what the church teaches, or to be a Catholic when it is useful in the important events of life? The smallest monograph on any parish shows how deceptive figures are. Statistics are impossible. The same may be applied in part to the Reformed churches, and it also explains the paradox that France, the oldest daughter of the church, is a field of missionary work.

The faithful are more numerous in the rural areas which are little affected by change (Flanders, Brittany and the Armorican peninsula, the Basque country and the south of the Massif Central) but in the large towns there are also enlightened and fervent Christian communities. In many cases what French Catholicism has lost in quantity it has gained in quality. It is supported by a learned clergy with very high moral standards. The secular clergy are helped by the religious orders, which were exiled under the law on religious communities but have now returned and attract those with vocations. At its head is the hierarchy of 17 archbishops, some of whom are cardinals, and the bishops. The archbishop of Lyons has the title, now purely honorary, of *primat des Gaules*. The hierarchy's unity of action is guaranteed by periodic meetings but obedience to the Curia Romana is very strict. In spite of its submission French Catholicism has kept some very distinct national characteristics. It is true that great mystical manifestations are not unknown to it—witness the grotto at Lourdes and the basilica at Lisieux; but since the middle ages it has been the religion of a people devoted to reason, who want to reconcile the demands of reason and of faith. It is undeniable that there is a bias toward intellectuality inside the church.

The French Protestant community, which was diminished by the persecutions of the 17th century, is chiefly attached to the Lutheran Church and to Calvinism. Outside the large towns and Alsace, its principal home is the region of the Cévennes—its holy land. It is also spread over the southwest and the west. Judaism, at the heart of which are elements from the Rhine (Ashkenazim) and later from eastern Europe driven out by persecution, which have submerged the old southern elements (Sephardim), is almost exclusively an urban religion.

By the early 1960s a considerable number of North African Muslims were resident in metropolitan France.

This section would be incomplete if no mention were made of the role played in the intellectual and moral life of the nation by the different masonic sects and similar groups, and all kinds of intellectual society. They have played a part in the liberal evolution of the country which is difficult to estimate.

Customs.—The whole history of France is a movement toward centralization and unification. It has tended to reduce moral and spiritual differences to a common type which evolves with time, at any rate in outward appearances. Still, a keen observer such as Paul Vidal de la Blache can pick out and describe the differences in the regions of France, everything which goes to make up the pleasant and varied characteristics of the country.

This is not a contradiction. It is due first to the fact that this diversity is in shades rather than in oppositions. This again is due to the long predominance of the rural element in the French population, which is not by nature very inventive. It hangs on to the forms, habits and customs which through the ages have come to it by the channel of the urban centres. This is clearly proved by the collections in the museums of popular arts and traditions. Finally, account must be taken of the adaptation of ways of life to different environments. It was not until the agricultural revolution of the second half of the 19th century that resistance weakened as the size of the rural population diminished. This movement speeded up after World War I. There has been a revival of interest in folklore and popular traditions, stimulated by tourism, not always very refined in taste. *Son et lumière* spectacles have achieved outstanding success throughout the country.

Every country—every region in fact—has its own features. This is expressed by the food that people eat. Goethe already noted that eating white bread and drinking wine distinguished the French from their Germanic neighbours. But there is an immense difference in regional cooking; each region has its special dishes whose flavour is brought out by a great local wine, or even by a special local wine. There are dishes which are peculiar to Bordeaux, to Lyons or to Bresse. The regional character is also expressed in collective manifestations: the village fairs in the north, which witness to a full rural life while at the same time being survivals of a strong municipal civilization; the village festivals of central France; the Breton processions whose religious character often hides practices anterior to Christianity. These characteristics are demonstrated by the style of rural houses, at the same time a legacy of the past and an adaptation to the needs of the regional system of cultivation: the farm in Picardy with its closed courtyard may be opposed to the house of the peasant of Lorraine which is all depth, its gable end facing on the single street of the village; the cottages of Caux with their outhouses spread over the field; the long, narrow farmhouses so widespread in most regions of France. In the south there are the winegrowers' houses with the staircases on the outside, in the southwest houses with galleries, houses with unequal-sloping roofs, tall houses, chalets in mountainous regions, making a picturesque collection.

They sheltered a people which preserved its oral traditions expressing the diversity of its temperaments. The funeral rites of the Armorican Bretons have not ceased to influence men's attitudes. Jokes and proverbs in all the Seine and Saône country and in the middle Loire are stamped with the light, lively wit and the often malicious and somewhat bitter irony which characterizes the

psychology of a people in whom mystical impulses and skeptical reserve are to be found side by side. All these characteristics, of which French literature (*q.v.*) gives a magnified picture, are discernible in popular tradition. (M. So.)

IV. ARCHAEOLOGY

From France has come the most complete record of human history in Europe. The easy routes which lead from the Mediterranean northward and the comparatively mild (Oceanic) climate that France enjoyed even in the late glacial period, together with the fact that France itself spans several vegetation zones, were probably largely responsible for this.

Paleolithic Cultures.—The earliest undoubted remains are a wide scatter of flint artifacts made from both cores and flakes which, on geological evidence, belong to the two earlier interglacial phases of the Pleistocene epoch (more than 100,000 years ago). These show considerable technical differences (Abbevillian, Acheulian and Levallois industries) but no settlements or skeletons associated with tools had been found by the early 1960s. A skull of this period from Fontéchevade suggests that the artifact makers were near human. The river terraces of northern France, especially those of the Somme, provide good dating evidence for the tools, since the rhythm of glacial and nonglacial phases is clearly shown (as at Carrières-sur-Seine, and Fréville and Amiens).

In the third interglacial and the beginning of the last glacial phase (about 70,000–40,000 years ago) there is more evidence, most of it belonging to a near-human race (*Homo neanderthalensis; see* Man, Evolution of; Neanderthal Man). Bodies and settlements have survived in the caves in which they periodically camped. These show them to have been skilful hunters (perhaps with spears and throwing stones), fire users, skinworkers and flint knappers (Mousterian industry), who ceremonially buried some of their dead in caves such as that at Le Moustier. They are also the first known people to adapt themselves to a major climate change. The early history of true man (*Homo sapiens*) in France is well attested for they regularly used caves, especially in the southwest (the valley of the Vézère, near Les Eyzies, has the most famous concentration). Their arrival can be dated by geological and carbon-14 methods to about 40,000 years ago, and there is little trace of an overlap in time with the Mousterians. For about 30,000 years, groups with only slight physical and cultural differences (Châtelperronian, Aurignacian, Solutrian, Magdalenian and Tayacian) maintained themselves by hunting, fishing and gathering (*see* also Cro-Magnon Man). The large migratory herds (reindeer, buffalo, mammoth and horse) were hunted with increasing success as bone harpoons and spear throwers were added to their equipment. A wide range of tools for working bone, skin, stone and probably wood has been identified. Elaborate sympathetic magic was practised, apparently by specialized magician artists in selected caves, and some of the dead were ceremonially buried, together with food and ornaments (as at Grimaldi on the Italian riviera).

Mesolithic Cultures.—The final retreat of the glaciers (about 10,000 years ago), which brought dense forest to most of France, destroyed the way of life of these people and their descendants (Azilians, Tardenoisians and Maglemosians) survived only by adopting the bow and arrow for deer hunting or by taking to fishing in the warmer seas. They had acquired the technique of making composite tools with microlithic flints and materially were little different from some present-day primitives. Their remains are less well known than their predecessors for they lived more often in open settlements (such as that at Téviec) than in caves.

Neolithic Cultures.—The knowledge of domesticated animals and cereals arrived relatively late in France, reaching it along both the Danube-Rhine and Rhône-Seine routes. Across the Rhine *c.* 4000 B.C. came a few nomadic, loess-farming, pottery-using groups (Danubians), but they do not seem to have penetrated west of the Seine or the Jura. It is possible that some hunters (Tardenoisians) understood domestication or that they acquired some imported animals, and the long-lived Campignian culture seems a successful adaptation to domestication by an originally Mesolithic people. A well-defined farming culture appeared at about this time along the Mediterranean coasts and spread inland up the Rhône valley. It was distinguished by its pottery (incised with a *Cardium* shell) and its rite of collective burial in caves, which showed it to belong to the settled village-dwelling farming communities of the central Mediterranean. Groups related to it and to Iberian (Almerian) farmers succeeded in adapting themselves to the forests of central France and reached Brittany before 3000 B.C. At the hilltop settlement of Camp de Chassey, for instance, they retained their plain and incised pottery, their leaf-shaped arrowheads and their ground stone axes, but appear to have changed to a nomadic form of agriculture with increased stockbreeding and hunting. This may well have been the result of an admixture with the Mesolithic hunters whose chisel arrowheads, microlithic flints and antler ax sleeves are found in their settlements. Other groups from Switzerland (Cortaillod) were moving westward into the Jura and beyond, *c.* 3000 B.C.

Linked with the earliest farmers in Brittany and with later Neolithic cultures elsewhere in France is the burial of the dead in collective tombs made by stones weighing many tons (megaliths), covered by earth or stone mounds. These are found in most areas of France and have similar grave goods but vary sufficiently in plan and construction for two main traditions to be distinguished: round barrows covering chambers reached by a narrow passage often with engraved stones (passage graves); and almost rectangular barrows and chambers without passage (gallery graves). The former are found near the Atlantic coasts, with a concentration in Brittany (*see* Brittany: *Archaeology*), and are related to the tombs of Portugal and south Spain. The gallery graves stem from the west Mediterranean islands and the lower Rhône valley, where there are concentrations, with others in Brittany and the Paris basin. A female figure, probably connected with the Mediterranean cult of the mother goddess, is carved on some of the stones. Avenues of stones and single standing stones are found in the same regions (*see* Carnac). The majority of the tombs seem to belong to the 2nd millennium B.C.

Bronze Age Cultures.—By 2000 B.C. a knowledge of metalworking (gold, copper and tin) had reached France, once again from the south and east. This was probably a result of prospecting for ores by the established civilizations of the east Mediterranean. The spread of megalithic monuments (especially of the passage-grave type) and of the Bell-Beaker folk are to be connected with it. The tanged daggers, wristguards and buttons of the latter show their southern origin and the uniformity of their pottery and their single-grave burial rite show the speed of their movement. From this prospecting developed the transcontinental metal trade and industry which is such a feature of the Bronze Age.

In France this was coupled with increased trade in Armorican stone and Grand Pressigny (Touraine) flint. The forms of many of the metal objects, especially the tangless daggers and the pins, show that they come from the Unetice or Aunjetitz (Bohemian and central German) culture. An actual movement of people from the east seems indicated by the rite of single burial under round barrows which had become common in north and central France by 1400 B.C. Part of this movement was by sea along the English channel and reached Brittany. A distant connection with the Aegean (1600–1200) is also suggested by beads of faïence, amber and jet and by the form of the bronze weapons of the period. Remains of settlements of this period are rare but the increased number of hoards of true bronze objects, and of round barrows, suggest a flourishing and relatively well-equipped population still using weapons (rapiers and palstaves) and ornaments of central European type.

During the last millennium B.C. another and larger migration westward took place by people who probably practised a more settled form of agriculture but are known mainly from their cemeteries of inurned cremations. Their abundant metalwork included tools such as sickles, axes (winged and socketed) and single-edged knives. In many regions they formed hybrid cultures with existing groups. In western France, especially along the Atlantic coasts, a distinctive metal industry (tanged swords and socketed axes) flourished at this time and traded with Portugal and Britain.

Early Iron Age Cultures.—The knowledge of iron as that of bronze reached France from the east and south. A few objects belong to the 8th century but iron became commoner during the 7th and 6th centuries B.C. when war bands, perhaps coming as conquerors rather than exterminators, invaded eastern France. Their metalwork, especially their safety pins and bronze vessels, like their horse-drawn chariots, show north Italian and Etruscan influence. Large barrows covered the bodies of rulers buried with rich grave goods (as at Vix and Châtillon-sur-Seine) and great banked and ditched enclosures often with stone walls or wooden palisades (Camp de Châteaux) served as tribal refuges. First Burgundy and then Champagne became centres of these new (Hallstatt) cultures, which by the 5th century B.C. had spread over most of southern and eastern France. From a slightly earlier period (8th century) iron-using Greek traders had been visiting the mouth of the Rhône and the Mediterranean coast (well shown in the settlement and cemetery at Cayla de Mailhac). The foundation of a colony in 625 B.C. at Massilia (Marseilles) is only the best known of a number of Ionian settlements, such as that at St. Blaise, which flourished for centuries. Trade to the north developed rapidly as the iron and salt of Burgundy and the ores of Brittany and beyond were exploited, the latter via the Loire. Metalwork and pottery as well as wine were imported and profoundly influenced local fashions so that by about 480 B.C. a new series of cultures (La Tène; *q.v.*) can be said to have evolved from the older ones. From this time on Greek and Latin documents supplement the archaeological evidence. The bulk of the population was Celtic-speaking and was subdivided into a number of tribal confederacies often at war with each other. These were governed by aristocracies and an intertribal priesthood (the druids). Iron was in common everyday use and a large settled population was in evidence. Among smiths and professional potters a new and beautiful art style combining Mediterranean and local traits developed. Many of the tribes minted their own copies of Greek and Roman coins and the fortified camps were turned into towns (like Entremont and Bibracte). There was still a movement of population from farther east and during 150–100 B.C. much of northeastern France was occupied by the Germanic Belgae. Other Germanic tribes were pressing across the middle Rhine. (For pre-Roman archaeology *see* also EUROPE: *Archaeology: Western and Central Europe.*)

Roman Provinces of Gaul.—Conquest by the Romans began in 123–121 B.C. with the occupation of the Mediterranean coast and was completed in 59–54 B.C. (*see* GAUL). Remains of this conquest include sacked Celtic forts (like Alesia and Gergovia; *qq.v.*) and Roman marching camps and siege works (like Nointel).

The political history of the province from 54 B.C. to 500 A.D. is known from literary sources but much detail and nearly all of the social history has been provided by excavation. Particularly close dating is possible through the complementary evidence of pottery, coins and inscriptions. Buildings and other engineering works were so substantial that many still remain and a few of the best examples are given below to indicate the wealth of the evidence.

One of the first postconquest actions was the construction of a road grid of which tunnels and bridges (St. Chamas) and many long stretches of track still survive. Settlements were encouraged to develop along Italian lines (1st and 3rd centuries A.D.) with careful planning and elaborate public buildings. Walls (Arles and Tongres) with elaborate gates (Nîmes and Orange) surrounded them; forums, temples, theatres, public baths and amphitheatres (Orange, Nîmes and Arles) were built and private houses (Vaison) laid out round them. Water was often supplied from far away (Pont du Gard, Nîmes).

In the country districts a variety of houses from peasant huts to *villas* (Chiragan) and shrines (Perigueux) have been excavated and mines and quarries (as at St. Béat) have been found.

The decay and destruction of the Roman province can be traced on many sites in the 4th and 5th centuries A.D. and the refortification of the towns (le Mans) can be seen.

See also ARCHAEOLOGY; ROMAN ARCHITECTURE.

(J. A. AL.)

V. HISTORY

The foundation of Massilia (Marseilles) about 600 B.C. by Greeks from Phocaea in western Asia Minor affords the first approximately accurate date in the history of the country that later became France. Though at this date there were Ligurians settled between the Durance river and the Mediterranean and Iberians south of the Garonne, the greater part of the population of the country consisted of Celts. Waves of Celtic immigration had begun not later than the 8th century B.C. and had ended with the establishment of the Belgae between the Seine and the Rhine. The Gauls, or Galli, as these Celts were called, kept a feeling of ethnical relationship but were split up into a number of peoples and never achieved complete political unity.

THE ROMANS AND THE BARBARIANS

In the 2nd century B.C. the Arverni managed to impose their authority for a short time over a part of Gaul. The intervention of the Romans in 121 marked the end of Arvernian predominance and led to the formation of a Roman province covering the whole of southern Gaul. The first Germanic invasions, by the Cimbri and the Teutoni, showed how weak Gaul was: it was the Roman army, led by Gaius Marius, that saved the country by crushing the Teutoni at Aquae Sextiae (Aix-en-Provence) in 102 B.C. The conquest of Gaul by Julius Caesar in 57–52 was made easier by the disunity of the Gallic peoples: Vercingetorix was only partly successful in rallying them, and his heroic defense of Alesia was broken. Thenceforward Gaul was under Roman rule and the country was divided by the emperor Augustus into provinces under Roman governors. The Gallic tribes, however, retained their identity as *civitates*, or local communities. As Gaul began to enjoy the benefits of Roman civilization, Latin gradually replaced the Gaulish language. Two revolts, however, in A.D. 21 and 69, briefly revived the memory of independence. (*See* also GAUL.)

The passage of the Cimbri and Teutoni across Gaul had revealed the danger on the eastern frontier, and Julius Caesar's intervention had come about because the German Ariovistus had been threatening the Celtic tribe of the Helvetii. Under Augustus the Romans attempted to safeguard Gaul by pushing their frontier into Germany as far as the Elbe river, but were defeated in the battle of the Teutoburg forest (A.D. 9) and had to withdraw to the Rhine. A later incursion into Germany (A.D. 83) led to the establishment of a limes, or fortified line, running from Cologne to Regensburg, but Germanic pressure breached this and in the 3rd century the Romans had to withdraw to the Rhine again. Then, on Dec. 31, 406, the Vandals and other peoples, themselves under pressure from the Huns in eastern Europe, burst across the Rhine.

The barbarians to whom Gaul now lay open were groups of tribes, not a single nation, and many of them had such a reverence for Rome that they sought Rome's assent to their presence. The Visigoths (*see* GOTHS) were settled by the Romans as *foederati*, or allies, first in Gallia Narbonnensis, the future Septimania, in 412, then in western Aquitania in 418; and the Burgundians, who had followed the Vandals across the Rhine but had settled in the region of Speyer and Worms, were in 443 installed by the Roman general Aetius in Sabaudia (the region between Geneva and Grenoble, including the later Savoy). In partnership with the Roman landowners on large estates, the new *foederati* were at first loyal to their treaties: both Visigoths and Burgundians sent troops to fight on the side of Aetius in the great battle of the Catalaunian plains against Attila's Huns (451). Euric, however, king of the Visigoths from 466 to 484, rejected the fictitious sovereignty of the Romans in 475, just before the fall of the Western Roman empire, and brought all Gaul south of the Loire under his rule. The Burgundians likewise advanced southward as far as the Durance, westward into the Rhône-Saône valley and northward toward Besançon and Langres, for which they were contending with the Alamanni (already firmly established in Alsace).

Meanwhile the Franks (*q.v.*) had made their appearance. The Ripuarian Franks had crossed the Rhine and were spreading through the region of Cologne and the Eifel; and the Salian Franks, starting from Toxandria (Dutch Brabant), had worked their way along the Scheldt, occupied at least part of the rest of Brabant

and Flanders and advanced as far as the region of Tournai and Cambrai. About 480 the powerful Euric, whose Visigothic kingdom extended from the Loire across the Pyrenees to Andalusia, seemed better placed than any other barbarian king to achieve the conquest of the whole of Gaul. The Visigoths, however, and the Burgundians also, were Arians, and the bishops of Gaul, deeply hostile to the Arian heresy, withheld their support, which was finally to be given instead to the Salian Franks as soon as their king, Clovis, was converted from paganism to Catholic Christianity.

The Merovingians (6th–8th Centuries)

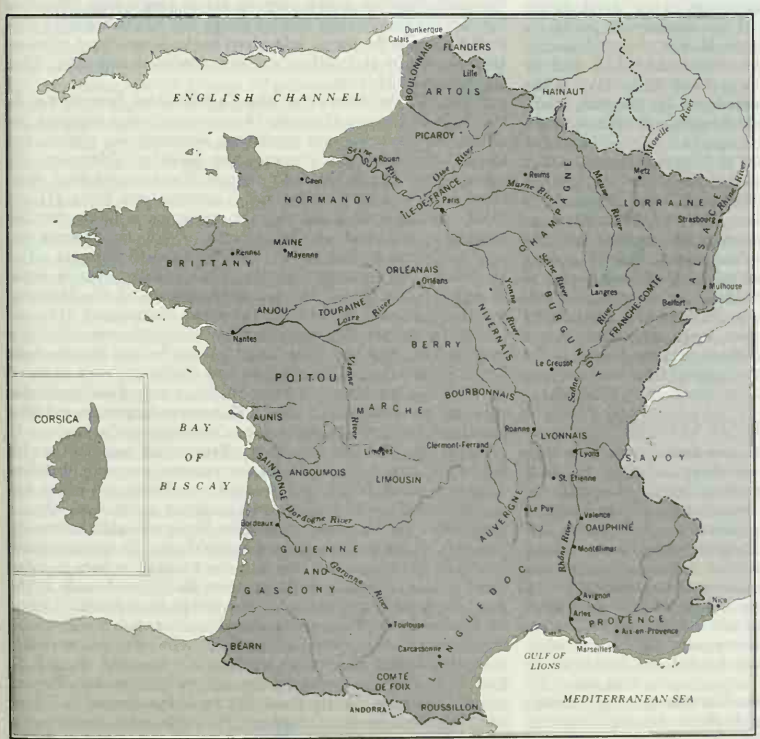
Clovis.—In 481 or 482 Clovis succeeded his father, Childeric, as leader of a tribe of Salian Franks settled in the region of Tournai. The young king began by an attack on Syagrius, who, at the head of a small army, was ruling over a "kingdom of Soissons" and claiming to be the rightful representative of the Romans. Clovis defeated Syagrius and advanced southward as far as the Loire.

According to the traditional account by Gregory of Tours (6th century), it was after his marriage to the Catholic Burgundian princess Clotilda that Clovis swore, during a battle against the Alamanni, to be converted to Catholic Christianity if Clotilda's God gave him the victory; he won the battle and was baptized by Remi, bishop of Reims (Gregory dates these events at 496, but A. van de Vyver proposes 506). Thenceforward Clovis was regarded by the Catholic bishops as the defender of the faith against the Arian kings. Though he was unable to conquer the Burgundian kingdom completely, he utterly routed the Visigothic king Alaric II at Vouillé, near Poitiers, in 507. The Visigoths, driven back on Spain, lost all their territory north of the Pyrenees except Septimania (the region of Narbonne), so that Clovis could now add Aquitania to his kingdom. On his return from this campaign Clovis received the consular insignia from the Byzantine emperor Anastasius I—a titular distinction probably without political significance. Clovis got rid of his kinsmen, the other Salian kings, by a series of murders and imposed his rule on the Ripuarians. At the Council of Orléans, over which he personally presided in July 511, he was able to appear as the head of a national Frankish Church. It was in the last years of his reign, moreover, that Clovis had the *lex Salica* drawn up, a Latin draft of the Salian customs in the domain of penal law. By the time of his death (Nov. 511) Clovis had not only established his dynasty, the Merovingian, but also had created a great Frankish kingdom in Gaul, the *regnum Francorum*, which was to give its name to the Francia of the Carolingians and eventually to France. (*See* also Clovis.)

The Successors of Clovis (511–751).—After the death of Clovis his house produced no monarchs worthy to rank with him. Neither the Roman law nor the influence of Christianity was strong enough to preserve the unity of the state. The Frankish custom of partitioning the royal domains at the death of each king to the exclusion of the female line, as though the kingdom were a private estate, coupled with the rapacity of the princes, caused constant wars within the kingdom.

On the death of Clovis in 511 his kingdom was divided between his four sons. Theuderic (Thierry) I received what was later to be called Austrasia, the eastern kingdom, including Reims, Cologne, Metz, Trier and the Alamannic and Hessian areas; Clodomir received Orléans and Tours in the Loire valley, with Chartres, Sens, Auxerre and also Poitiers; Childebert I received Paris and the Seine valley, the Somme valley and the northern coast westward to Brittany, with Nantes and Angers; and Clotaire I received the kingdom of Soissons-Tournai, including the ancient Salian territories. For the first 50 years after this partition the Frankish kings did indeed achieve much to continue the work of Clovis. On Clodomir's death (524) his kingdom was divided between Childebert I and Clotaire I; on the conquest of Burgundy (534) that kingdom also was shared between Childebert and Clotaire; and Theudibert (Thibert) I, son and successor of Theuderic I in Austrasia, received a share of Provence, annexed in 537. Expeditions were also launched into Italy, Spain and Germany.

Theudibert's son Theudibald having died in 555, Clotaire I was able to reunite the whole *regnum Francorum* when Childebert died in 558. On Clotaire's death in 561 a fresh partition was effected between his sons; Charibert I became king of Paris and of the western regions; Guntram king of Burgundy and Orléans, with Arles and Marseilles; Sigebert I king of Austrasia; and Chilperic I king of Soissons-Tournai. There followed a long period (567–613) in which quarrels within the dynasty checked the progress of Merovingian power. Chilperic and Sigebert shared Charibert's kingdom between themselves at his death (567), but after the murder of Chilperic's wife, Galswintha, sister of Sigebert's wife, Brunhilda, their envies and ambitions against one another were let loose. When both kings were dead (Sigebert in 575,



EILEEN WARREN

HISTORIC PROVINCES OF FRANCE, 1789

Chilperic in 584), Brunhilda and Chilperic's widow, Fredegund, impelled their children into continuing warfare. Furthermore, though Brunhilda's son Childebert II was able to annex Burgundy-Orléans after Guntram's death (592) and to leave Austrasia and Burgundy-Orléans to his sons Theudibert II and Theuderic II, respectively, and though after Fredegund's death (597) Brunhilda's two grandchildren won some successes against Clotaire II, Chilperic's son by Fredegund, nevertheless in 612 Theuderic II overthrew his brother Theudibert and annexed Austrasia for himself. On Theuderic II's sudden death, however, Brunhilda tried to make his son Sigebert II king of the Austrasians, who thereupon appealed at last to Clotaire II. The execution of Brunhilda and Sigebert (613) reunited the whole kingdom again, under Clotaire II.

Throughout all this dynastic chaos royal authority had of course grown weaker and weaker. Brunhilda had had to strive all the time against the encroachments of magnates and bishops. Clotaire II's edict of 614, which renewed the privileges of the church, confirmed the magnates in their possession of the property granted by the previous kings and restored property that had been confiscated, was promulgated in order to bring peace back after half a century of troubles; but it serves to show how much the magnates had aggrandized themselves. Furthermore, Austrasia, Burgundy and Neustria (the western areas) had each been developing distinctive characteristics, which naturally strengthened the tendency of the kingdom to fall apart.

For a few years under Dagobert I, successor of Clotaire II from 629 to 639, there was a revival of royal power. There followed a long decadence, marked by meaningless partitions and by perpetual minorities (for Dagobert's successors *see* MEROVINGIANS: *Table*). As early as the 6th century, however, the disorders of the Frankish kingdom had served to enhance the power of the so-called mayors of the palace, controllers of the royal *domus* ("household") or *palatium; i.e.,* of the ambulatory court by which each kingdom was governed (*see* MAYOR OF THE PALACE). These mayors came to dominate the *rois fainéants* ("do-nothing kings") of the 7th century and of the first half of the 8th. While some were content with personal supremacy in one kingdom, others sought to re-establish a unified Frankish realm and the rule of the state over the church. Ebroïn, the greatest of the Neustrian mayors, not only suppressed his rival in Burgundy, Leger, bishop of Autun, but also held his own against Pepin II the Younger, the Austrasian mayor; but after Ebroïn's death Pepin defeated the Neustrian mayor Bercharius at Tertry (687). Pepin then acknowledged the Neustrian king Theuderic III, at that time the only surviving representative of the Merovingian dynasty, as king of the whole *regnum Francorum,* but retained for himself control over the mayoralties of Austrasia, Neustria and Burgundy. From this point the kingdom was governed by Pepin and his descendants, the Carolingians, though Merovingian kings continued to rule nominally until the deposition of Childeric III by Pepin III the Short at the end of 751. *See* CHILDEBERT; CHILDERIC; CHILPERIC; CLOTAIRE; DAGOBERT I; EBROÏN; SIGEBERT. (C.-E. P.)

THE CAROLINGIANS (8TH–10TH CENTURIES)

The Merovingians had been unable to prevent power from slipping into the hands of the counts and other magnates. As each region of the kingdom sought protection against its own particular enemies, military men rose to the foremost place and the kingdom itself, continually divided among the heirs of successive kings, had finally fallen apart into a number of large territorial units without any common interests. Eclipsed by the mayors of the palace, the young kings who succeeded one another after Dagobert I were incapable of reigning effectively: they no longer had enough property to distribute in return for loyal service and they lacked the authority to direct military operations against the hostile forces on their frontiers—particularly those beyond the Rhine, where Frisians, Saxons and Slavs were all threatening the kingdom.

Pepin the Younger and Charles Martel.—Among the mayors the rich family descended from Pepin of Landen (Pepin I) held a position of especial importance. Too eager to supplant the Merovingians in Austrasia, Pepin's son Grimoald had provoked a reaction in which he and other members of his family were massacred (662). Profiting from this experience, Grimoald's nephew, Pepin II the Younger (Pepin of Herstal), embarked on the policy that was eventually to make possible the replacement of the Merovingians by his descendants, the Carolingians (*q.v.*). He imposed his own authority over the Neustrian and Burgundian mayoralties after his victory at Tertry (687), thus establishing the hegemony of the Austrasian mayors; he won military prestige by his brilliant defense of the kingdom; he built up a reputation for godliness by endowing monasteries and churches and promoting the missionary work of Anglo-Saxon monks in pagan Europe; and he showed great discernment in his distribution of rewards, which were ample enough for him to appear generous but small enough not to ruin his own holding.

Pepin the Younger and his son Charles Martel were confronted with a hard task. The reunification of the Frankish territories was achieved when Charles made himself mayor of Neustria and Burgundy as well as of Austrasia (717), but the Frisians and the Alamanni had still to be fought and the Saxon incursions into the Rhineland had to be repulsed. A series of campaigns and family alliances stabilized the situation but without achieving any decisive result. At the same time bands of Muslims from Spain were devastating Provence and Muslim activity was also helping to foment dissidence in Aquitaine. Charles Martel's victory in the battle near Poitiers (sometimes known as the battle of Tours) in 732 put an end to Muslim intervention in the southwest.

To succeed in its designs the Frankish government had to seek alliances abroad (for instance with the Lombards against the Muslims) and to exploit rivalries within the kingdom. To maintain the force of cavalry that Charles Martel developed, funds had to be provided for the warriors, and these funds had to be taken from the church, which the Merovingians had richly endowed. This "secularization" of church property led to long-lasting difficulties between the Carolingians and the clergy and was in apparent contradiction with the liberal help given to the Anglo-Saxon missionaries directed by St. Boniface and backed by papal authority. (*See* also CHARLES MARTEL.)

Pepin III the Short and the Carolingian Accession.—At the death of Charles Martel in 741 many problems remained unsolved: Aquitaine was still unsubdued, Burgundy was restless, and the situation in distant Provence was doubtful. Moreover, the succession to Charles Martel's mayoralty was shared on a territorial basis between his two sons, Carloman and Pepin III the Short, and there was a risk that the weakening of power that the previous century had seen might recur. Carloman, however, retired to become a monk in 747, and Pepin contrived to get rid of his rivals. Negotiations with the papacy finally enabled Pepin to depose Childeric III, the last representative of the Merovingians, in the last months of 751 (or at the beginning of 752) and to transfer the kingship to his own house with the consent of the pope and the backing of the clergy. When he and his two sons, Charles (the future Charlemagne) and Carloman, were anointed by Pope Stephen III at St. Denis in 754, a sacred and inviolable character was bestowed on them. This was to become an enduring feature of the royal tradition (*see* CORONATION; PAPACY).

Strengthened by this new dignity, Pepin could do more than his father had done. His most urgent concern was with dissident Aquitaine, which he finally succeeded in reducing and which was thenceforward for many years under military occupation. On the frontiers of the kingdom, meanwhile, Pepin was able to develop the work of his predecessors on bolder lines. In the southeast, Bavaria was brought perforce into the Frankish sphere of influence; and, in accordance with promises that he had made to the pope, Pepin took up arms in 755 and 756 to force Aistulf, king of the Lombards, to restore lands seized from the church. This military intervention against the Lombards, however, was certainly unpopular among the Franks and was not repeated when Pope Paul I asked for pressure to be brought to bear on Aistulf's successor, Desiderius. At the same time Pepin inaugurated an important reorganization of the kingdom. His capitularies were designed to make him the ultimate arbiter of all questions; to impose his moral authority everywhere; to reform the clergy and to bring it

entirely under the Roman obedience; and finally to put an end to the anarchy that had prevailed in France.

Charlemagne and Louis the Pious.—On Pepin's death (768) the royal domain was divided between his sons Charlemagne and Carloman, but this new partition was ended by Carloman's early death (771), whereupon Charlemagne simply annexed his brother's territories. Thenceforth, thanks to the groundwork laid by his ancestors, Charlemagne could proceed to that *dilatatio regni* or "swelling of the kingdom" whereby Frankish power was extended far beyond the frontiers of ancient Gaul or even of modern France. To the north, the Rhine was crossed and the Frisians finally conquered; to the northeast, Saxon resistance was savagely broken in a series of campaigns over more than 20 years; farther east, the Slavs were pushed back beyond the Elbe river, Bavaria was totally incorporated into the empire, the Avars were defeated, and the Frankish frontier was pushed forward to meet that of the Byzantine empire in Croatia; to the southeast, the greater part of Italy was subjected after the overthrow of the Lombard Desiderius, while the papacy, so often protected by Frankish armies, hung upon the king's decisions; and to the southwest the Spanish march, or mark, was secured against the Muslims beyond the Pyrenees and friendly relations were established with the Christian princes holding out in the northwest of the Iberian peninsula. Charlemagne was still engaged in his work of unification when Pope Leo III crowned him in Rome on Christmas day, 800 (*see* CHARLEMAGNE; HOLY ROMAN EMPIRE). Thenceforward Charlemagne used the ambiguous title "august emperor governing the Roman empire" instead of the honorific title of *patricius* that the papacy had conferred on Pepin the Short and on his sons. The Byzantines, however, recognized his imperial title only after 12 years of conflict and negotiation.

Charlemagne's plans (806) for dividing his territories among his sons came to nothing through the premature deaths of two of them, so that on Charlemagne's death (814) the legitimate survivor became sole emperor as Louis I (*q.v.*). Louis the Pious, as he is called, was imbued with the notions of unity preached by the churchmen. With a view to giving the constitution of the empire a less vague form, he abandoned the ambiguous style that Charlemagne had adopted and styled himself simply "august emperor"; but he always considered his dignity to be personal to himself and for his lifetime only, an office conferred on him in token of his having been made answerable before God for the governance, together with the church, of the people of Christendom. These ideas found expression in his *Ordinatio imperii* of 817, a statute designed to maintain the unity of the empire on the spiritual plane while allowing its division into several kingdoms for purposes of material administration: his eldest son, Lothair, was to be associate emperor and was also to rule over the original Frankish lands, while the two younger sons, Pepin and Louis the German, were to be kings of Aquitaine and of Bavaria respectively. Far removed from Charlemagne's views, Louis I's exalted idea failed to meet the practical exigencies of the times. None of the succeeding emperors could maintain this glorious fiction.

The Carolingian Administrative System.—In the absence of any arbitrating authority, the partitions of the Frankish kingdom in the Merovingian period had forced the rival kings to compete for the support of the magnates, whose power had thus been unduly enhanced. At the same time the royal domain in land had been small, and by dispersing it in gifts to warriors and to the church the Merovingians had reduced themselves to powerlessness. Aware of this, the early Carolingians exercised a far stricter control over their sources of revenue.

The first necessity was to entrust the administration of every pagus, or district (French *pays*), to an official who would have no power except that of an agent of the king. This official was the comes, or count, to whom the king delegated full authority within his district. The count's conduct, however, was supervised by the *missi dominici* sent to make inspections on the king's behalf; and for his maintenance the count had only the usufruct of the property granted to him by the king, who could take it back at the count's death or at his recall from office. A large local staff helped the count in his functions.

For the surveillance of the least dependable regions, the king could rely on his vassals, or *vassi*, men bound to him (1) by a special homage which engaged them personally to his service; and (2) by the tenure of a benefice or fief which might even remain with their heirs as long as they remained faithful. This linking of benefice and service, the feodo-vassalic relationship, was the origin of feudalism (*q.v.*). The status of the vassals thus appears to have been higher than that of the counts.

The bishops and the abbots were also expected to play their part in the Carolingian administrative system. Continually enjoined to live in accordance with the rigorous precepts of their vocation so that the king could have confidence in their integrity, they had on the other hand everything to gain by supporting the king against the land-hungry lay magnates. Louis the Pious, moreover, between 816 and 819 issued a remarkable series of ordinances regulating the life and status of the clergy.

Freemen were linked directly or immediately to the king by an oath of fidelity which precluded any intervening loyalties, and the concentration of power was finally secured by the development, at Aachen, of a central administration capable of resolving the most varied problems provided that they did not call too urgently for a decision. By about 810 reports to the capital at Aachen and written instructions from it were being exchanged so harmoniously that the success of the imperial system seemed unquestionable.

Nevertheless, as early as 812 or 813 signs of inefficiency in the government began to appear. The aged Charlemagne ceased to convene the annual *plaid*, or judicial assembly, and so lost contact with the freemen who would have appeared at it. Instead he leaned more and more on the new administrative aristocracy that he himself had created, and these officials not only slackened in their watchfulness over his interests but also gradually interposed themselves between him and the freemen. Charlemagne even encouraged this process by allowing freemen occasionally to become vassals of the counts or of his own immediate vassals. This tolerance was most unwise, and Louis the Pious at the beginning of his reign took some steps to counteract it, seeing as he probably did how unreliable the loyalty of propertied magnates might be. The violence of his "clericalist" reaction in favour of the church may well have been largely due to his distrust of the lay magnates —whose discontent, of course, it increased.

The system of Louis the Pious was logical but ill-adjusted to his time, and his apparent pusillanimity, following the relaxation of control at the end of Charlemagne's reign, encouraged the magnates to shake off all the restraint in the way of their personal enrichment and aggrandizement. Little by little, against all reason, the kings permitted the re-emergence of local hereditary dynasties; little by little they allowed offices and fiefs, linked together, to become hereditary possessions; and little by little they let the magnates secure a hold over the freemen, who could then be used to bring pressure upon the government. Whenever a crisis occurred in the empire the magnates could now extort new concessions from the king in return for a reaffirmation of their always precarious loyalty.

Thus it was that, when the magnates discovered that the emperor's own sons were ready to connive with them against the emperor, Louis found himself suddenly deserted. Lothair and Pepin of Aquitaine could easily find support for their resistance when Louis sought to carve out a new kingdom for his fourth son, Charles, born in 823 of his second marriage (*see* CHARLES II the Bald, Holy Roman emperor). The long series of crises that ensued, continuing past the death of Louis the Pious (840) until 843, was less important for its effects in the Carolingian dynasty than for its having served to set up a new balance of power weighted in favour of the territorial magnates.

Charles II the Bald (843–877).—Three years after the death of Louis the Pious, Charles came to terms with his surviving half brothers Lothair and Louis the German and concluded with them the treaty of Verdun (843). This treaty, however, was only one of the many agreements of partition that were to affect the Frankish territories up to the end of the 10th century—by which time France had gradually assumed the political contours that the kingdom was to retain, with little change, for the rest of the mid-

dle ages. The treaty of Verdun, in fact, did no more to impair Carolingian unity than Charlemagne's arrangements of 806 or the *Ordinatio imperii* of 817; and even within Charles the Bald's lifetime the eastern frontiers of the kingdom that he received under that treaty were to be changed several times. Charles the Bald's kingdom, therefore, is better designated as Francia Occidentalis, the western part of the Frankish territory, than as France.

Charles had to face the same problems as his father: the magnates were still restless and exacting; the church was still demanding compensation for sequestered property; and both the Bretons and the Aquitanians were trying to assert their independence. The king's difficulties, moreover, were aggravated by the increasing raids of the Northmen or Vikings. These raids served especially to enhance the status of the local powers, who alone could organize a speedy and effective defense: the count or the greatest landowner of a locality would extend his control and protection over neighbouring freemen and their property. Thus the number of mediate vassals rose, and the king might have had to look on in silence while more or less autonomous regions were consolidated. Charles, however, was more capable of asserting himself in a realistic way than his father had been. He surmounted the great crisis of 858, when Louis the German invaded his kingdom, already ravaged by the Northmen and shaken by a revolt of the magnates. From 864 to 870, moreover, his grasp on his kingdom was strong enough for him to undertake some serious reforms.

Nevertheless, Carolingian power in the west was weakened when Charles listened to the appeals of Pope John VIII and yielded to the temptation of the imperial crown, which he received in Rome in 875. To free himself for the pursuit of external ambitions, he officially entrusted the defense of his kingdom to the magnates, demarcating great zones of military command which prefigured the duchies and major countships of France at the zenith of feudalism. He sought alliances with those whom he was no longer able to crush; for example, with the Robertians, descendants of Robert the Strong and ancestors of the Capetian dynasty.

Before setting out on a second expedition to Italy, Charles issued the capitulary of Quierzy-sur-Oise (877), in which he promised the magnates that during his absence no one would do anything to prejudice their position. This temporary provision, extremely favourable to them, was transformed into an inviolable principle by the magnates after Charles's death (Oct. 877).

By force of circumstances feudalism had been established in the kingdom. Charles the Bald had had enough personal authority to withstand any unjust encroachments and moreover he could rely on the support of the church in so doing, but his successors were to prove incapable of following his example with success. The balance was again tilted in favour of the magnates, who now had military strength and vassals of their own, together with a number of regalian rights. The transformation had come about imperceptibly: economic possibilities were too limited and the necessities of defense too urgent for authority to be exercised otherwise than on a local basis; and feudal society was the natural outcome of that process of disintegration which had begun by the 5th century and which the Merovingians and the Carolingians had resisted and delayed.

The Last Carolingians and the Robertian Interventions (877–987).—Charles the Bald's son and successor, Louis II le Bègue or the Stammerer, died in 879, leaving the kingdom jointly to his sons Louis III (d. 882) and Carloman; but when Carloman died (884) his half brother Charles III the Simple was an infant, and in 885 the West Frankish crown was taken by the East Frankish king and emperor Charles III the Fat, only surviving son of Louis the German. Deposed by the East Franks in Germany in 887, Charles the Fat died in 888, whereupon the West Frankish magnates elected as king neither Charles the Simple nor Arnulf (Charles the Fat's successor in Germany), but Eudes, son of Robert the Strong and the first of the Robertians to take the crown away from the Carolingian dynasty. In 893, however, Charles the Simple, with the support of some of the magnates, was crowned at Reims, and thenceforward he and Eudes were rivals till the latter's death in 898. Charles the Simple later had to allow the Northmen to settle permanently in northern France under the treaty of St. Clair-sur-Epte (911?), thus founding the duchy of Normandy. A new revolt of the magnates led to the election of another Robertian, the brother of Eudes, to the kingship as Robert I in 922. After Robert I had been killed in battle against Charles in 923 his son-in-law Rudolph (Raoul) was elected in his place, and Charles the Simple was taken prisoner (to die in captivity in 929). Yet when Rudolph died, in 936, the Robertian candidate for the crown, Hugh the Great, son of Robert I, stood aside for a Carolingian restoration in the person of Charles the Simple's son Louis IV, called d'Outremer ("from Oversea") because he had been a refugee in England since his father's deposition. Louis IV achieved much to revive the prestige of his dynasty and left the crown undisputed at his death to his son Lothair in 954. On Lothair's death in 986 the crown passed to his son Louis V le Fainéant, but already the Robertian Hugh Capet, son of Hugh the Great, was entertaining designs on the monarchy. Louis V's early death (987) was followed by the election of Hugh Capet as king, to the exclusion of the Carolingian pretender Charles, duke of Lower Lorraine, a younger son of Louis IV. The Carolingian dynasty in France was now definitively superseded by the Capetian heirs of the Robertian kings. (*See* the biographical articles on all these kings; *see* also CAPET; HUGH the Great.)

Whatever their personal merits might sometimes have been, the Carolingians after 877 were at grips with a social evolution beyond their control. Occasionally the prestige of the dynasty, consecrated as it was by its link with the papacy, enabled the kings to prevail against their rivals, as Louis IV and his son Lothair did; but the royal house was now impoverished and had no longer any property to distribute as the price for loyalty. The kings were therefore merely tolerated or brought to power according to the interests of the great territorial princes in their quarrels with one another; for example, the dukes of Burgundy or of Normandy and the counts of Flanders or of Vermandois. If they sought alliances with foreign powers to secure themselves, the kings had to pay heavily for them: in order to obtain the friendship of the German king Otto the Great, for example, Louis IV had to cede Lorraine, the only region which could have served as a base for a renewal of Carolingian power.

Even so, the Carolingian dynasty had too much past glory to be left at the head of a kingdom now thoroughly feudalized. The transfer of the royal title to Hugh Capet in 987 was made largely because, despite the great extent of his inherited domain, he was the weakest of the territorial princes and could be expected to trouble no one. (J. DE.)

THE CAPETIANS OF THE DIRECT LINE (987–1328)

The 15 kings of France from 987 to 1328 are collectively called the Capetians of the direct line because from 996 (when the first of them died) to 1316 son succeeded father without interruption and then, on the death of a newborn infant, the crown passed in turn to his father's two brothers. (*See* CAPET.)

The first of these kings was Hugh Capet. A great-grandson of Robert the Strong, he was elected king in 987 on the death of the last of the Carolingians, Louis V. Though the Robertian family had already produced two kings of France between 888 and 923, namely Eudes and Robert I, Robert I's son Hugh the Great had preferred to govern under cover of the last Carolingian. Hugh Capet, however, the son of Hugh the Great, accepted the royal election. (*See* HUGH CAPET.)

In 987 there was nothing to indicate that Hugh Capet's descendants would retain the succession as long as they did. Yet after his death (996) the crown passed from father to son as follows: Robert II the Pious (996–1031), Henry I (1031–60), Philip I (1060–1108), Louis VI (1108–37), Louis VII (1137–80), Philip II Augustus (1180–1223), Louis VIII (1223–26), Louis IX (St. Louis; 1226–70), Philip III the Bold (1270–85), Philip IV the Fair (1285–1314) and Louis X le Hutin or the Stubborn (1314–16). As Louis X's posthumous son, officially reckoned as John I (1316), died a few days after his birth, the crown then went successively to Louis X's two brothers, Philip V the Tall (1316–22)

and Charles IV the Fair (1322–28). It is evident, then, that the main factor which enabled Capetians to occupy the throne for so long a time was their luck, until 1316, in each having a son. The first kings of the dynasty, down to Louis VII, took care to have their sons acclaimed and crowned and to associate them with the throne in their own lifetimes. Philip Augustus, considering the royal power to be solidly established, discontinued this practice, and thenceforward a king was crowned only after his predecessor's death.

In 1328, however, an assembly of magnates was convened to elect the king because Charles IV had left no son. Rejecting the candidature of Edward III of England, grandson of Philip IV on his mother's side, they acclaimed instead Philip of Valois, the son of Philip IV's brother Charles. Thus the direct line of the Capetians came to an end and was replaced by the Valois line.

The achievement of the Capetians of the direct line was indeed remarkable. Working with steady perseverance, they gave their energies mainly to practical politics, without necessarily entertaining any broad, definite ideas or a general plan except that of establishing, organizing and increasing the power of the monarchy. Much of their success was due to luck and to their own ability, but they were also helped by the active support of the clergy, anxious to see peace and order prevail in the kingdom; by the religious character that the ceremony of the king's coronation or consecration gave to the monarchy, endowing the king with special virtues (the popular legend, for instance, had it that he could cure diseases; *see* KING'S EVIL); and by the co-operation, from the 13th century onward, of the growing middle classes. The most enterprising and efficient kings were Louis VI, Philip Augustus, Louis IX and Philip IV.

Growth of the Royal Domain.—The Capetians succeeded to a thoroughly feudalized realm. To make themselves strong, the kings first needed to possess a wide domain and manifold rights allowing them to act in all parts of the kingdom. The royal domain was extended persistently, either by the king's fighting of rebellious lords openly or by his deft use of the rights permitted him as a sovereign (such as confiscating fiefs and intervening in rights of succession).

At the end of the 10th century the Capetians had only a diminutive domain, much smaller and weaker than that of many a great vassal. The essential nucleus of their lands was in the region of Paris, Orléans, Beauvais, Soissons and Compiègne, though they also had various lands scattered all over the kingdom as well as numerous rights (markets, *tonlieux*, justices, etc.), the most important being that which the king exercised over episcopal churches and monasteries (the *régale, dépouilles*, etc.). The aim of the first Capetians was to control the regions within which there were royal lands; to achieve peace by reducing the plundering lords and petty vassals to obedience; and, in some circumstances, to increase their own possessions by confiscating the lands of factious rebels. Louis VI was especially successful in this respect; *e.g.*, in campaigns against Thomas de Marle (*see* COUCY).

Masters of the Île-de-France, the Capetian kings had to defend it against ambitious vassals who held great fiefs outside it. In Robert II's reign Eudes II of Blois had proved a menace (*see* BLOIS, COUNTSHIP OF), and the dukes of Normandy became dangerous after their accession to the English throne in 1066. In the second half of the 12th century, however, the counts of Anjou presented a far greater threat: already holding Maine, Touraine and Normandy, the Angevin Henry Plantagenet in 1152 married Eleanor, duchess of Aquitaine and countess of Poitiers, whom Louis VII of France had divorced, and in 1154 Henry succeeded to the English inheritance also (*see* HENRY II, king of England). The Angevin domains thus stretched across France from the Channel to the Pyrenees.

It was Philip Augustus who did most to break the Angevin power: he not only asserted his claims against theirs as suzerain over Auvergne, but also, in his wars against John of England, conquered Normandy, Maine, Anjou, Touraine and northern Poitou. Then southern Poitou fell to Louis VIII. After long negotiations Louis IX, by the treaty of Paris (1258; ratified 1259), obtained Henry III's recognition of these conquests, which were incorporated into the Capetian domain. Though the English king's rights in the dioceses of Limoges, Périgueux and Cahors (the border of his duchy of Guienne-Gascony) were recognized, the French king was thenceforward the richest and most powerful lord in the kingdom.

The kings of France, moreover, from Louis VII's time, had been contriving to extend their regalian rights over an increasing number of bishoprics. Apart from his successes against the Anglo-Angevin power, Philip Augustus had obtained Artois through his marriage, in 1180, to Isabella of Hainaut and had won Vermandois and Valois in the course of his wars against the counts of Flanders. In Languedoc, thanks to Louis VIII's participation (1226) in the Albigensian crusade, his widow, Blanche of Castile, as regent for Louis IX, was able to reduce the viscounties of Nîmes-Beaucaire and of Béziers-Carcassonne to royal *sénéchaussées;* and in 1271 the deaths of Louis IX's brother Alphonse of Poitiers and Alphonse's wife, Joan of Toulouse, added the county of Toulouse to the royal domain. In Burgundy, Louis IX had bought the county of Mâcon (1239). Lastly, Philip IV the Fair laid hands on Lyons (1290) and also saw the accession of his eldest son, Louis, to the countship of Champagne (1305) on the death of the heiress, Joan of Navarre, whom Philip had married in 1284.

Thus by 1328 the king's *dominium* extended over the greater part of France. With the exception of some small and medium-sized properties, only four large fiefs remained outside his reach: Burgundy, Flanders, Brittany and Guienne. Certain territories within the royal domain, however, had been conceded as appanages to members of the reigning dynasty. This was the case with Anjou and with Artois, belonging to the descendants of Louis IX's brothers Charles and Robert; and likewise with Valois, which had been granted to Philip IV the Fair's brother Charles, father of the future Philip VI.

The Capetian Government of France.—The expansion of the royal domain strengthened the Capetians both militarily (as they had more vassals) and economically. At the same time the general attitude changed toward the king, who gradually came to be considered as a true sovereign. Toward the end of the 10th century, the elected monarch had been considered, at best, as the supreme lord, endowed admittedly with a special mission as regards justice and peace, but limited in his action by feudal custom —and moreover incapable, except in special circumstances, of intervening in large areas of the kingdom outside his own domain. At the dawn of the 14th century, on the other hand, it was generally acknowledged that the king had the special right of taking action anywhere in the kingdom should he so wish. He could make laws, thus breaking with custom; he could require his great vassals to see that his decrees were respected; he could summon people to his courts of justice; and Philip the Fair was able to develop extraordinary taxation on an unprecedented scale. The transformation found expression, at the end of the 13th century, in a reinstatement of the principle of Roman law: *Quidquid principi placuit habet legis vigorem* ("Whatever has pleased the king has the force of law"). Philip the Fair's counselors proclaimed that *Rex imperator est in regno suo,* meaning that the king has imperium throughout his kingdom; *i.e.,* the supreme power of giving orders and enforcing obedience or, in one word, sovereignty.

The growth of the royal domain and of the king's power, together with the progress of ideas, led to a reorganization of the government, chiefly from the time of Philip Augustus onward. New institutions came into being as the kings gradually modified the system—for strictly practical purposes. The result was that the king could at last exercise his authority effectively.

At first the Capetians had extremely simple methods of administering the domain and governing the kingdom. On one hand, there were *prévôts,* or provosts, settled on the lands of the domain, whose duties were to collect revenues either in kind or in money, to administer justice locally and to summon the royal vassals to the *ost* ("host"; *i.e.,* the military force that the king as feudal suzerain could call out). On the other hand, the king had his immediate household of high officers who theoretically assisted him: the seneschal, the constable, the butler, the chamberlain and the head chaplain, who was also chancellor. Lastly, the role of

the assembly of all the king's vassals, the *curia regis,* was to give advice to the monarch, to assure him of military and financial aid in certain well-defined circumstances and to judge insubordinate or treacherous vassals. In practice, however, the *prévôts* soon bought up rights in the areas to which they had been appointed, then enfeoffed their responsibilities, so placing them outside the Capetian's control; they thought more of their own interests than the king's. Likewise, high offices often became the fiefs of great vassals. As for the *curia regis,* only the smaller of the king's vassals attended it.

With Philip Augustus, even perhaps at the end of Louis VII's reign, a considerable change took place. Though the monarchy still remained feudal, the king became more effective as a sovereign and, above all, could administer his domain with increased firmness and authority. He reduced the power of such officers as were within his reach: the seneschalship remained vacant after 1191, and the posts of butler and chamberlain became purely honorary. Only the constable and the chancellor (whose duty of drawing up and authenticating the royal acts of legislation could, however, be entrusted to a keeper of the seals) continued to play an important part in the household; but even so, they were closely supervised by the king. In other respects, in order to control the *prévôts* and to improve the administration of his domain, Philip Augustus created *baillis* ("bailiffs"), who received the title of seneschal in the southern region. Their duties were to ensure order and to administer justice in assize courts—to be held several times a year in one of the towns of their district; to call the vassals to the *ost* and lead them to the meeting place of the royal army; and to collect revenues and taxes of every description and (when such sums as were needed for local expenditure had been deducted) to forward them to the treasury in Paris. In the course of the 13th century, the *bailliages* and the *sénéchaussées* began to be organized on a territorial basis, and *baillis* and seneschals were given deputies. Lastly, in Louis IX's reign, a modification occurred in the *curia regis:* on certain days it would deal only with justice and be named *curia in parliamentum domini regis;* on other days it would deal with royal finances and be named *curia in compotis domini regis.* Soon the members who were present at one meeting or the other gradually specialized, and the two assemblies separated completely. This was the beginning of the *parlement* of Paris on one hand and of the *chambre des comptes* ("chamber of accounts") on the other, both sections belonging to the central administration but having no link with the feudal system.

Toward the end of the 13th century, under the influence of Roman public law, the institutions of the monarchy became less and less feudal and began to assume the characteristics of state control. The *parlement* of Paris expanded, developing subsidiary chambers for *enquêtes* ("inquiries") and for *requêtes* ("claims"); and its jurisdiction, with that of the *chambre des comptes,* was gradually extended over the whole kingdom. For example, the *parlement* took cognizance of appeals from the inhabitants of Guienne-Gascony, a French fief held by the king of England (this action caused several incidents). Furthermore, Louis IX and Philip III took measures to prevent abuses by the *baillis* or seneschals: Louis appointed *enquêteurs* to hear complaints against them. Finally, to take over certain functions of the *curia* and of the household, there emerged a body essential for the government of the kingdom, the *conseil du roi,* or king's counsel. Its duty was to give the king advice and to take part in the appointment and supervision of high officers. In Philip IV's reign, moreover, a large number of general assemblies were convened, and the future estates-general (*q.v.*) sprang from these.

In 1328, because of the Capetian dynasty, the monarchy was strongly organized. It is noteworthy that the Capetian kings of the direct line avoided involvement in doubtful issues abroad, except for the crusades or in order to help the church (*see* below). On the contrary, they deliberately and wisely devoted their energies to the internal affairs of their kingdom and, above all, of their domain. If they passionately fought the kings of England, their only reason for doing so was that those kings held vast fiefs in France.

The Capetians and the Church.—From 987 to 1328, as has already been said, the French monarchy was supported by the clergy, who derived from it help and protection (donations, foundations of monasteries, etc.). Though several kings (such as Robert II the Pious, Philip I and Philip Augustus) incurred ecclesiastical sanctions on account of their private life, the kings generally preserved good relations with the papacy and most often helped the popes. No serious differences arose between them during the Investiture conflict, and the French kings remained at least neutral in the struggles between the pope on one side and the Holy Roman empire on the other (*see* GERMANY: *History;* PAPACY). When Pope Eugenius III left Italy because of the Roman insurrection (1147), Louis VII welcomed him to Paris; when Pope Alexander III had to flee from Rome because of the emperor Frederick I Barbarossa's enterprises (1162), Louis VII likewise gave him shelter on his domain; and Louis IX broke his neutrality when he made it known to Frederick II that he would resist any military attempt by him against the town of Lyons, where Pope Innocent IV had taken refuge (1247). Subsequently, in 1263, the papacy—represented, it is true, by the Frenchman Urban IV—offered the crown of Sicily to Charles of Anjou, one of Louis IX's brothers (*see* CHARLES I, king of Naples and Sicily). While the papacy continued to support Angevin policy in Italy, Philip III of France, in the interests of the same policy, committed himself, in 1284–85, to the disastrous "crusade" against Aragon. The Capetians participated in the crusades more actively than any other dynasty then reigning in Europe: one of Philip I's brothers, Hugh of Vermandois, took part in the first crusade (1095–99); Louis VIII, together with the German king Conrad III, was the chief of the second (1147–49); Philip Augustus, though reluctantly, led an expedition to the Holy Land during the third (1190–92); and Louis IX conceived, organized and commanded the seventh (1248–54) and the eighth (1270), meeting his death at the beginning of the latter. Also, most of the Capetian kings were fighters against heresy, and Louis VIII himself led the last major military expedition into Languedoc against the Albigensian heretics—though in this case the king had a political as well as a religious motive, namely that of subjecting the southern populations to royal control. The final result was the annexation of the county of Toulouse.

Nevertheless, at the beginning of the 14th century there was a serious conflict between Pope Boniface VIII and King Philip IV. Foreshadowed by an altercation about the king's right to tax the clergy (1296), the dispute became violent when the more general question of the royal power as opposed to the pope's authority arose (1301–03). In 1307 the same king began proceedings against the Templars, the suppression of whose order he finally obtained. Even so, grave as those conflicts may have been, no profound gap between Rome and Paris ever existed; and the king's feelings were never disloyal to the Roman Catholic faith.

Intellectual Life in Capetian France.—While they did not interfere directly in the development of thought in France from the end of the 10th century to the beginning of the 14th, the Capetians nevertheless had a share in that development. The order that prevailed under them, the protection that they granted to the learned, and the care that Philip Augustus and his successors took to enhance the prestige of Paris all contributed indirectly to intellectual development.

The schools made great progress under the Capetians. Those of Laon, Chartres and Poitiers and those of the abbeys of Bec, Fleury-sur-Loire and Cluny were soon famous. Always more important than these, however, was the school of Paris. Peter Abelard had taught there early in the 12th century; and within 100 years there had emerged that university which was to be granted privileges by all the kings from Philip Augustus onward. This university made Paris the biggest centre of philosophical and theological studies in Christendom: in the 13th century Albertus Magnus, Bonaventura and Thomas Aquinas were doctors there. In the 13th century, furthermore, universities were founded at Montpellier (if indeed there was not one there already), at Toulouse and at Orléans.

It would, however, be a mistake to think that, on the intel-

lectual level, the Capetian age was stamped only by the growth of scholasticism or by literary studies in Latin. Secular thought and literature in the vernacular developed considerably. The teaching of Roman law, whereby the University of Toulouse won its reputation, produced a great number of lawyers; several among them were Philip IV's counselors. For literature, the epic of chivalry flourished in the 11th and 12th centuries, lyric poetry and the courtly novel (Chrétien de Troyes and Jean de Meun) in the 12th and 13th; cycles of tales included those about the quest for the Grail on the one hand and the *Roman de Renart* on the other; among *fabliaux*, farces and miracles, the *Jeu de Robin et de Marion* by Adam de la Halle and the works of Rutebeuf are outstanding; and the chronicles of Geoffroy de Villehardouin and Jean de Joinville are masterpieces. If we mention finally the development first of Romanesque, then of Gothic art in France under the Capetians of the direct line, it is clear why their kingdom was a main centre of western civilization.

Economic and Social Changes.—In the economic sphere the influence of the Capetians of the direct line was important but indirect, and it would be wrong to suggest they had a conscious, systematic economic policy. In their time, indeed, the conception of such a policy was scarcely possible, the scope of economic thought being necessarily limited because of the inadequacy of communications and technology. Throughout western Europe (with the exception of Italy) men were concerned only with exploiting and increasing their possessions by purely practical and empirical means: they had no general view, no idea of organization. At most, the Capetians had at the back of their minds the desire to lay hands on rich towns and provinces (commercial centres and even areas of production) and to find means of increasing their revenues and taxes; the best-advised among them, however, pursued simply a policy of immediate profit. Yet by enforcing order within the kingdom, by giving it strong institutions and by protecting the merchants—whose possessions, nonetheless, they sometimes despoiled or confiscated (*e.g.*, the Jews and the Lombards, persecuted many a time)—they contributed to the development of the wealth of France.

For the first 250 years of Capetian rule, the economic life of the kingdom depended solely on agriculture and on the land. The lords lived on their domains, on which the peasants worked under their supervision. Industrial activity was rare and to be found only at the family level outside a few regions such as Flanders (textiles). There was little trade, and then only over very short distances, except in certain essentials of living and luxury goods. There were few prosperous towns.

From the middle decades of the 12th century a change became perceptible. Industry was developing, together with commerce; the *métiers* ("guilds") began to organize themselves in certain growing towns. Various factors contributed to speed up this evolution: (1) the increase in population (a major event in the history of the 12th century), which not only provided labour to bring more land under cultivation, so that agricultural production rose, but also tended to disrupt the manorial economy (*see* MANOR); (2) the impact on France of the huge Mediterranean trade which the Italians had long been conducting and through which large quantities of oriental products were now being dispatched all over the kingdom, provoking the export of merchandise in return; (3) the relative plentifulness of gold and currency, which greatly facilitated commerce; and (4) the greater safety along the highways. Henceforth French merchants took to travel; industrial towns became numerous in Flanders, in Normandy and in Champagne; and the local fairs, particularly those in Champagne, attracted large numbers of merchants from abroad. Finally, Paris had been growing larger and richer ever since the Capetians made it, in the 13th century, the capital of the kingdom and the centre of administration. In 1328 its population amounted to more than 200,000 inhabitants.

In the first years of the 14th century, however, a recession began in France as in Europe generally. Flanders felt the competition of the English and Italian textile industries and suffered both from Philip the Fair's campaigns against the count and from social disorder, so that a great depression set in. The amount of currency, moreover, no longer corresponded to the volume of trade, and the Italian market of precious metals was collapsing. Lastly, and particularly in France, a succession of poor harvests brought misery to the countryside and soon to the towns.

Along with the economic change, the Capetian kingdom experienced a social revolution as well. Economic progress and political development combined to promote movement for emancipation in the towns and communes. Numerous towns in the Paris area rebelled against the local authorities (lord or bishop) and themselves took over the administration. At first the kings were opposed to such revolts as subversive of the established order; then, from Philip Augustus onward, they began to give them their support by confirming the communal charters. This promotion of the towns and communes was in fact to the king's advantage: politically, because the lords were thereby weakened; militarily, because local militias were organized for the king's service; and financially, because it produced more taxes and profits. Though in the 13th century the successors of Philip Augustus showed themselves more and more reserved, they never failed to confirm the *franchise* or "freedom" granted to many towns, whether they were communes or not. (*See* COMMUNE [MEDIEVAL].)

The middle class, brought into existence through the growth of commerce, was increasingly favoured by the Capetians, who in turn won its sympathy because a strong monarchy was required to preserve order. At the end of the 13th century, however, the unsatisfactory conditions in which the humble people lived gave rise to social unrest in the towns, especially in Flanders. With this the Capetians could feel no sympathy at all.

This unrest was one of the many symptoms of the difficulties which were to confront the Valois kings later in the 14th century. The Valois inherited from the Capetians of the direct line an organized government and firm institutions but also a precarious economy and political problems difficult to solve. Incidents in Guienne and English reactions against the steps taken by the Capetians in Flanders had already led to intermittent hostilities before the accession of the Valois in 1328 set the scene for the Hundred Years' War.

See the separate biographical articles on the 15 kings of the direct line of the Capetians. (M. PAC.)

THE FIRST VALOIS AND THE HUNDRED YEARS' WAR (1328–1461)

In 1328 the kingdom of France was the most powerful in western Europe: its population was about 15,000,000; the royal power was constantly extending and at certain places had already passed beyond its eastern frontier; and there were now only four great fiefs outside the royal domain, namely the county of Flanders and the duchies of Brittany, Burgundy and Aquitaine or Guienne. In short, within the kingdom, fully engaged at this time on the work of unification, the king's authority was growing continually and deriving support from three very different principles, all of great efficacy; feudal sovereignty, the divine will made manifest in the king's anointing and Roman law. The king's growing power was threatening to reduce to very little the authority of the remaining great vassals and of the numerous lesser lords—whose decisions could, in the last resort, be set aside by the king's *parlement*. The protests of the barons had been finally suppressed by Philip the Fair's three sons, who had succeeded their father in turn.

Accession of the Valois Dynasty.—The death of Charles IV without male issue in 1328 posed the problem of the Capetian succession. For more than 300 years there had always been a son or a brother capable of succeeding to the crown. Now, as at Louis X's death in 1316, it was decided that an assembly of vassals, prelates and notables should elect a new king. This assembly, taking its stand on facts and feelings, overruled the claims of Edward III of England, son of Philip the Fair's daughter Isabella, and chose instead, as Philip VI, the son of Philip the Fair's brother Charles of Valois. The principle whereby women were excluded from the royal succession had not yet been transposed from private to public law. (*See* SALIC LAW OF SUCCESSION.)

This election led to a dynastic crisis and to a crisis in the royal power which the new reigning family of the Valois took more than a century to resolve to its own advantage. The barons who

had taken part in the election thought that the king whom they had elected ought to favour them; and if he should fail to do so there was a risk that some might take the side of the rejected claimants, first Edward of England and later Charles II of Navarre, the son of Philip of Evreux, whose father Louis had been the youngest brother of Philip the Fair and Charles of Valois.

Philip VI (1328–50).—Edward III of England had reason to fear that his duchy of Guienne might be peacefully absorbed into the royal domain by the juridical action of the king of France or even confiscated and that Philip VI might support his enemy, David Bruce, in Scotland. Assured of powerful support from the malcontents in France and from the opponents of the small and exclusive groups of nobles and officials through which Philip VI governed, he accordingly withdrew, from 1337 onward, the homage which he had sworn to Philip in 1329. After some initial setbacks he was able to take advantage of the revolt of the Flemish towns led by Jacob van Artevelde against the pro-French count of Flanders, Louis of Nevers, in order to proclaim himself king of France at Ghent, on Feb. 6, 1340; and in June he crushed the French fleet at Sluis. The stake in the contest that ensued was the French crown, which the English Plantagenets down to the last of the Lancastrians disputed with the Valois. This contest was the Hundred Years' War (*q.v.*), in which years of fighting were interrupted by long truces.

The war forced Philip VI to demand heavy taxes continually from his people. This aggravated the hardships arising from the general economic recession that had begun at the end of the 13th century, when the increase in population outstripped the progress of the agricultural development necessary to feed it. The war thus caused permanent discontent, and this was exploited by the opponents of the king and of the royal power. Philip VI, aided by the pope, who had opportunely released him from his vow to make the crusade (1336), was at first fairly successful in the face of these early difficulties, but he could not for long repress his chivalrous temperament. Thus on Aug. 26, 1346, at Crécy-en-Ponthieu, he unwisely gave battle against Edward, who after landing in Normandy was beating a retreat toward Picardy. The great defeat which he suffered marked the decline of mounted knights in warfare, showing how the undisciplined cavalry charge would henceforth no longer be able to overwhelm resolute and well-entrenched troops of mercenaries and foot soldiers armed with longbows and arbalests under capable commanders. Edward later took Calais (1347), a valuable bridgehead.

The acquisition of Dauphiné (1343–49) by Philip's grandson, the future Charles V, extended French influence from the upper Rhône across the Alps into Piedmont, but neither this nor the acquisition of Montpellier (1349) compensated for the dramatic reverses in the English war. The Black Death, which between 1348 and 1350 wiped out about one-third of the population of western Europe, halted military operations and at the same time brought about grave social and economic upheavals.

John II the Good (1350–64).—Philip VI left a weakened authority and kingdom to his son John II in 1350. The consequences of the Black Death brought discontent both to the nobles, whose revenues from land diminished, and to the townsmen, who saw wages and prices rising. The discontent brought support to the opponents of the new dynasty, born as it was of "a trumped-up king"; and the young king of Navarre, Charles II the Bad, having reached his majority, set himself up against John. Thus it was in an atmosphere of domestic conspiracy likely to lend powerful aid to his rival Edward III that the chivalrous and rather unintelligent John began his reign. The creation of the Ordre de l'Étoile (1350), his riposte to Edward's Order of the Garter, reveals John's own tastes and at the same time his search for new and personal links to secure the wavering loyalty of the great nobles to the crown.

The resumption of the war led, on Sept. 19, 1356, to the battle of Poitiers, a worse disaster than Crécy: the king imprudently attacked the retreating Anglo-Gascon army of Edward, the Black Prince. With better generalship, better arms and better discipline, the Anglo-Gascons triumphed over the anarchical impetuosity of the French cavalry. But this time, however, though he defended himself with the legendary bravery that earned him his title of "the Good," the French king was taken prisoner.

The Regency of the Dauphin Charles (1356–61).—The adversaries of the dynasty and of the unlimited growth of royal power seized upon this new and crushing defeat as a pretext for reasserting themselves. At the estates-general which John II's eldest son Charles, dauphin of Viennois and now regent of France, had to convene in 1356 in order to obtain a grant of money for his father's ransom and for the defense of the kingdom, the bourgeois of the third estate showed a desire to control the government in return for their assistance. At the head of the bourgeois were the representatives of Paris, the only great town in France, led by the provost of the merchants, Étienne Marcel, a cloth merchant whose trade had brought him into contact with the towns of Flanders, Italy and Catalonia, where power was already partly in the hands of businessmen. Marcel wanted to bring about the participation of leading members of the middle class in the task of government and cited the inefficiency of the king's noble advisers, who had squandered away at a complete loss the enormous subsidies previously voted by the third estate. His agitation won popular support in Paris, and the dauphin was obliged to leave the town (1357). But Marcel then assumed the role of a rebel: he allied himself with the king of Navarre, then with the king of England, and finally with the peasants of the Jacquerie (*q.v.*), whom sheer poverty had driven into revolt and who were now ravaging the Île-de-France (1358).

The dauphin, on the other hand, was backed by those nobles who had remained faithful to the king and by the clergy as a whole. Moreover, the captive king's courage and misfortune evoked loyalist sentiments among the mass of the people. The small towns of rural France, having no merchant *bourgeoisie*, could not understand Marcel. Disappointed in his hopes of support from these towns, Marcel found himself finally isolated and besieged in Paris, committed to the treason that the reawakening loyalty aroused by the dauphin prevented him from perpetuating. He was assassinated on July 31, 1358. His death gave to the dauphin the authority which the monarchy had almost lost: the social structure of France would not allow the bourgeois of the towns to control the king's government.

The dauphin Charles hastened to reach a compromise with Edward III, who had been unable to profit fully from France's internal disorders. The provisional treaty of Brétigny in May 1360 assigned to the English, *inter alia*, full sovereignty over the southwestern third of France, but the final treaty of Calais, in October, postponed the date for John's formal renunciation of the ceded territories and for Edward's renunciation of his claim to the French crown. To pay John's ransom of 3,000,000 gold crowns the dauphin obtained from the provincial estates an annual levy of heavy cash subsidies. Released conditionally, John the Good returned to his English prison after the escape of two of his sons who had replaced him as hostages.

Charles V (1364–80).—On John's death in 1364 the dauphin became king as Charles V. Henceforth his political genius was applied to wiping out the consequences of the disasters of the two previous reigns; *i.e.*, to re-establishing in their entirety the royal power and the kingdom of France.

Charles had come to understand better than anyone what dangers threatened a dynasty whose legitimacy was contested. The alliance of Marcel and the Parisian *bourgeoisie* with the Navarrese and with the English pretenders had very nearly succeeded in overthrowing the Valois dynasty and in imposing control by the estates-general over the royal power. Charles meant to establish the dynasty beyond all question, making his consecration by anointing at Reims (1364) the chief basis of his power. He recast the liturgy of the ceremony in such a way that the anointed king, linked directly to God by the mystical bond of the oil sent from heaven for the baptism of Clovis, would be thereby set above all laymen and even churchmen, and so henceforth unassailable.

At the same time Charles inserted into the consecration oath a clause by which the king promised not to alienate in any way the rights of the crown. This part of the oath permitted the king to disregard treaties in which he had been obliged to aban-

don any province in time of defeat. It was in this spirit that Charles, on the pretext that the renunciations which should have completed the Brétigny-Calais treaties had never been pronounced, accepted the appeals brought to his court by certain Gascon nobles (Armagnac and Albret) who were dissatisfied with the Black Prince's taxation in the duchy of Aquitaine. War with England was resumed in 1369. Charles entered it in alliance with the king of Castile, Henry of Trastamara. The Castilian fleet, composed of ships from the Cantabrian and Basque ports, was the most powerful in the Atlantic ocean. It destroyed the English navy off La Rochelle in 1372. On land, profiting from experience and in any case unable to fight in person on the battlefield (because of physical weakness), Charles adopted a new strategy; instead of risking spectacular battles to check English forays across the kingdom, he exhausted the enemy by harrying them and by intercepting their supplies. The author of this policy was the minor Breton noble Bertrand du Guesclin, an excellent trainer of soldiers and of mercenary companies, whom Charles created constable of France (1370). Thus while Charles remained in his rooms in Paris meditating on the political treatises of the great men of the past from Aristotle to St. Louis, the whole kingdom, with the exception of principal ports such as Calais, Cherbourg, St. Malo and Bordeaux, was reconquered in a series of skirmishes, sieges and ambushes without Du Guesclin's having to fight any major battle. As long as the war lasted (from 1369), the king could raise an annual aid or subsidy, which succeeded that raised since 1356 for John the Good's ransom. This was in fact a permanent tax established for the king's benefit but disguised as a levy of a completely feudal character to pay the suzerain's ransom and to defeat his enemies.

At the end of his life, by recognizing Clement VII, the second pope elected in 1378, and opposing the first, Urban VI, Charles V brought western Europe and the church into a grave moral and spiritual crisis. He left the kingdom re-established politically, but financially and economically exhausted by war and taxation.

Charles VI (1380–1422).—Charles V left power to his son Charles VI, who was still a minor. During the king's minority his uncles took over the government. However the eldest of these, Louis, duc d'Anjou, was mainly concerned with trying to secure succession to the throne of Naples, while the second, Jean, duc de Berry, was chiefly devoted to his castles and to his collections. Thus it was the third brother, Philip the Bold, duke of Burgundy, who played the leading part in France. Social unrest had once more broken out in the principal towns as a result of growing economic difficulties. Philip the Bold persuaded the young king to crush the rebellious Flemings at Roosebeke (1382). Then the revolts of the Maillotins in Paris and of the Harelle in Rouen were put down in their turn. Paris came strictly under the control of the king, who suppressed the provostship of the merchants.

On reaching his majority Charles VI in 1388 recalled his father's former advisers, the "Marmousets," and ended the regency of his uncles, who had sought to govern the kingdom in their own interests. A period of financial and administrative reform followed, but the king fell ill with intermittent madness in 1392. His sickness, as his grandfather's captivity had been, was the occasion for the common people to manifest, by prayers and pilgrimages, the strength of the attachment to the person of the anointed king. Authority, however, was reassumed by members of the royal family, who dismissed the royal counselors. Philip the Bold in fact kept power without too much difficulty till his death. The war against England had died down since the young Richard II succeeded Edward III in 1377; the truce of 1389 was renewed for short terms till 1396, when it was agreed to extend it for 28 years. Thus France could at last enjoy a moment's respite and well-being in the last decade of the 14th century.

The dramatic accession of the Lancastrian dynasty in England (1399) and the death of Philip the Bold (1404) brought more complications in the early years of the 15th century: the Lancastrians, for reasons of prestige, wanted to win victories in France; and Charles VI's brother, the young and ambitious Louis, duc d'Orléans, sought to dispute the government of France with Philip the Bold's son and successor, John the Fearless, duke of Burgundy. John the Fearless had Orléans assassinated in a Paris street on Nov. 23, 1407. The court, the nobility and the whole country was divided between those who had condemned the debauched life and dangerous policy of Orléans and those who condemned John's crime. Civil war thus ensued between the Burgundian faction and the Armagnacs, as the partisans of the widow and children of the duc d'Orléans were called, from the title of their leader, the constable, Bernard VII, comte d'Armagnac. The excesses of the butchers under Simon Caboche lost the Burgundians the support of the city of Paris, which had at first been favourable to them (1413). Nothing could better have furthered the designs of the English king, since each party made overtures to the English. Henry V of England disembarked in Normandy, defeated the French army (largely composed of the then dominant Armagnacs) in the battle of Agincourt (1415) and conquered Normandy. The Armagnacs were driven from Paris by the Burgundians in 1418; John the Fearless took Charles VI into his custody; but the dauphin, the future Charles VII, stayed with the Armagnacs. During a meeting at Montereau between the dauphin and John the Fearless, to discuss the possibility of an alliance against the English, John was assassinated by one of the dauphin's followers (1419). Thenceforward the new duke of Burgundy, Philip the Good, ranged himself on the English side. With the connivance of the queen, Isabella of Bavaria, who thus seemed to disown her son the dauphin, Philip forced the mad Charles VI to conclude the treaty of Troyes (1420), whereby Henry V, married to Charles VI's daughter Catherine, was recognized as heir to the French crown after his father-in-law. Never had the idea, so frequently put forward since the 12th century, of the personal union of the French and English crowns and the political union of France and England seemed nearer to realization. When Henry V died, however, 12 weeks before Charles VI in 1422, he left a one-year-old child, Henry VI, to be king of France and England.

Charles VII as King of Bourges (1422–29).—The central and southern part of France (Languedoc, Poitou, Auvergne, Berry, Lyonnais) remained loyal to the dauphin and recognized him as king. Charles VII established his residence at Bourges and part of his administration at Poitiers. His adversaries mockingly called him the "king of Bourges," but they could no more conquer his provinces than he could dislodge them from northern France. There followed some of the saddest years in France's history: foreign merchants ceased to visit a country ravaged by civil war and a court that could no longer afford luxury goods; Paris ceased to be an international focus of commercial and financial activity; the intellectual leadership of Paris was challenged by new national universities in every country (Charles VII founded one at Poitiers, Henry VI one at Caen and one at Bordeaux, and the duke of Burgundy one at Dôle); and the currency was progressively devalued, while prices, even in terms of gold and silver, rose amid the poverty of the masses. The only people who prospered were the mercenaries and professional campaigners, who in some places set themselves as practically independent princes in little lordships.

It was at this moment that Joan of Arc came forward to champion the belief that St. Louis and Charles V had implanted deep in the heart of the whole people of France: the true king was the king anointed at Reims. Neither of the two adversaries had been anointed there, Henry VI because he was still only a child, Charles VII because he was not master of Reims. Born at Domremy-la-Pucelle, near Vaucouleurs (one of the three areas north of the Loire still loyal to the dauphin), Joan felt herself to be inspired by supernatural voices and made her way to Chinon to expound to Charles the general wish that he should be anointed at Reims and thus become indubitably the king chosen by God. She volunteered to join his expedition, and her presence, enhanced by an aura of mysticism, raised the morale of the army. She freed Orléans (May 1429), beat the English at Patay (June) and, after crossing Champagne, saw Charles consecrated king at Reims by the archbishop on July 17, 1429.

Charles VII as King of France (1429–61).—Henceforth Charles VII was king, manifestly legitimate and chosen by God. Though Joan was captured by the English, tried by the church, condemned as a sorceress and, on May 30, 1431, burned at Rouen,

and though the king's followers might quarrel among themselves, the moral forces of the kingdom were now on Charles VII's side. No one attached any importance to the parody of consecration which the bishop of Winchester performed for Henry VI in Paris. Little by little the whole country came to accept the authority of the king whom God had blessed. The duke of Burgundy made peace with Charles at Arras in 1435 and Charles entered Paris in 1436. Even so, the king did not trust the town which had remained strongly Burgundian for so long. He therefore continued to reside at Bourges, at Tours or in the castles along the banks of the Loire, which his successors were to retain as the seat of the monarchy for nearly a century.

Supported by the divine choice manifested in the marvelous circumstances of his consecration and by the almost mystical devotion of his people, Charles VII was now able to lay the foundation for real power: strict control over the French clergy was secured by the Pragmatic Sanction of Bourges (1438), which declared that bishops and abbots were to be elected by cathedral chapters and by abbeys not nominated by the pope, thus ensuring appointment to the king's nominees; regular taxation (1440), conceived as an annual payment made to the head of the state as such, was imposed from 1440; and the product of this taxation was used to maintain a standing army (the *compagnies d'ordonnance* established in 1445). This army conquered Normandy after the victory of Formigny (1451) and Aquitaine after that of Castillon (1453), and was never disbanded; moreover, his powerful artillery enabled the king to batter down the castles of factious nobles. Charles VII, well served by such men as Jean, comte de Dunois, Jean and Gaspard Bureau and Jacques Coeur, could proceed from victory over the English king, establishing the basis of absolute power in France. When the nobles in the revolt of the Praguerie (*q.v.;* 1440–42) tried to withstand him, it was already too late.

Economic prosperity returned when the war was over. The *bourgeoisie*, however, was more and more attracted into the fast-developing administration and soon came to prefer official employment or the life of *rentiers* to active participation in trade or in industry, thus shaping the pattern of French society for several centuries to come.

The Valois dynasty, now at last in undisputed possession of the crown and backed by the devotion of the people, could exploit its new circumstances in order to bridge the gap between feudal monarchy and the absolutism of divine right for which it had paved the way. Of the great fiefs of the early middle ages, only Burgundy, Flanders and Brittany were still practically independent of the crown, though the new power of the ducs de Bourbon (Bourbonnais and Auvergne) had come into being. It remained to be seen whether the last great vassals would submit to the king's growing power or refuse to obey him. (Y. R.)

The Later Valois (1461–1589)

Louis XI (1461–83).—The second half of the 15th century, from the end of the wars with England, was a decisive period for France. Political problems that had existed for several centuries were solved; the social system of the middle ages was undergoing a rapid change; and a modern state was taking the place of the feudal monarchy. Under Louis XI these developments were accelerated, to some extent as a result of Louis's own designs.

Louis had simple tastes and a bourgeois outlook. Mistrustful of the nobles, he liked the common people. Opposed to luxury, he wore old-fashioned clothes decked with relics and holy medals. But his modest exterior went with a very clear idea of his own authority, which he imposed invariably without regard to methods. Modeling himself on the contemporary Italian despots, he was determined to proceed toward absolute government and applied all his resources to this end. Quick-witted and scheming, he preferred intrigue and secret diplomacy to war; but he was sometimes too imaginative to appreciate a situation correctly. His mistakes of judgment were enormous and laid him open to surprises which make one question his statesmanship; he lacked foresight and, indeed, political sense. Thus he owed his successes largely to his skill in extricating himself from a false position and, above all, to the surprising accidents which removed his opponents. His character, good and bad, is precisely summed up in the phrase *universelle aragne* ("universal spider").

On his accession France was barely out of the Hundred Years' War, and there was no proof that it would have anything more than a truce to enjoy. The threat of invasion remained. At home the great territorial principalities, used to independence, were a menace to the kingdom—especially the duchy of Burgundy which, by a series of fortunate acquisitions, had become a formidable power in the controversial borderland between France and the empire. Charles the Bold, who was known as the comte de Charolais until he succeeded his father Philip the Good as duke of Burgundy in 1467, was determined to withstand the king in France, to recover the Somme towns purchased by Louis from Philip in 1463 and to create a wholly independent Burgundian kingdom for himself. At the same time other princes, for instance Francis II of Brittany and Jean II, duc de Bourbon, were ready to join with the Burgundians in coalitions provoked by Louis XI's clumsily severe and arbitrary attempts to reduce their power.

The first such coalition was the Ligue du Bien Public, or League of the Common Weal (1465), in which the comte de Charolais was supported not only by Brittany and by Bourbon but also by the princes of Anjou and of Orléans and by the king's own brother Charles, duc de Berry. Louis had assisted at the birth of this league without suspecting anything. His army met the rebels at Montlhéry near Paris without any decisive result, and the matter was closed by the treaties of Conflans and St. Maur, whereby Louis granted favours and lands to the conspirators, in particular the Somme towns to the duke of Burgundy and the duchy of Normandy, in exchange for Berry, to his brother Charles.

In 1467 there was a new coalition in preparation. To resist it, Louis saw fit to arrange for a revolt to take place at Liège against the Burgundian domination at the very moment when he was to be negotiating in person with Charles the Bold on his own territory at Péronne. News of the revolt arrived when he was in the duke's hands; and he was kept a prisoner (1468) and had to give in, promising to fulfill all previous treaties and making further concessions; he even went with Charles to help in suppressing the revolt at Liège.

Yet another coalition was formed in 1472, this time with the backing of the English, who were preparing a new invasion of France. But Charles the Bold failed at the siege of Beauvais; and when Edward IV landed with a force of 20,000 men he found himself unable to join his ally, who was involved in an ill-advised enterprise on the Rhine. Louis managed to come to terms with Edward and induced him to sign the treaty of Picquigny, whereby Edward was satisfied with an indemnity (1475). The English peril seemed henceforth to be receding.

At the same time Charles the Bold was undertaking adventures that turned his attention away from France. He dreamed of conquests on the Rhine—in Lorraine and in Alsace—to unite his possessions in Burgundy with those in the Low Countries. René II, duke of Lorraine, the Swiss cantons and the Habsburg archduke Sigismund of Tirol were alike threatened by these ambitions, and Louis's diplomacy gathered all these powers into the Union of Constance (1474), which was to deal finally with his adversary. Charles seemed likely to be crushed by a general coalition; then Louis, by an unaccountable change of face, withdrew from the struggle and signed the truce of Souleuvres with him. Charles went to war against the Swiss, who defeated him at Grandson and Morat (1476), then against the duke of Lorraine. He was killed under the walls of Nancy (1477), and this chance occurrence gave Louis XI his victory.

Louis showed himself no better advised in settling the Burgundian succession, which devolved on Charles's only daughter, Mary. He had the right to take all the provinces comprised within the kingdom by marrying the heiress to a prince of his own choosing, who could well have been the dauphin; and he was strong enough to be able to impose this solution. Instead he proceeded to occupy territories piecemeal and by force, while Mary married the Austrian archduke Maximilian, the future emperor. Finally the treaty of Arras (1482) conceded the duchy of Burgundy and

Picardy to France and Franche-Comté and Artois to the dauphin Charles on the understanding that he would marry Margaret of Austria, daughter of Mary and Maximilian, whose dowry these provinces were to be.

With regard to Spain, Louis pursued a policy of intrigue for the acquisition of Roussillon and Catalonia from Aragon. He succeeded in annexing Roussillon and Cerdagne (1463), but in 1469 his plan for marrying his brother Charles, now duc de Guienne, to Isabella, heiress of Castile, came to nothing when she married Ferdinand of Aragon instead. The resultant union of the Spanish kingdoms was a setback for France that was to grow into a lasting threat when Spain, Austria, the Burgundian Netherlands and the Franche-Comté were eventually united under the emperor Charles V.

Within the kingdom Louis had to discipline his nobles and to extend the royal domain at the expense of the princes' territories. He sought to restore everywhere the order that had been compromised for a century by the decline of the king's authority. To this end he meant to break all resistance, laying the foundations of an absolute monarchy. The nobles were treated harshly, the king's enemies imprisoned or put to death; the power of the house of Armagnac was broken, and after the death of René, the titular king of Naples, the duchy of Anjou (1480) and the county of Provence (1481) were incorporated in the royal domain. The church was likewise under control: in reaction against the methods of Charles VII, who had issued the Pragmatic Sanction of 1438 (to exempt the clergy from all obligation toward the pope and to give it the right of free election of bishops and abbots), Louis signed a concordat which gave the pope the right to intervene in the bestowal of benefices. As for the estates-general, they were convened not to formulate the demands of the nation but to approve the king's decisions.

Louis desired above all to have plentiful resources and a strong army. Pressure was put on the towns and on the provincial estates. The *taille* was quadrupled in the course of Louis's reign, and the personnel of the army was expanded through the *compagnies d'ordonnance* and the *francs-archers*. A quantity of artillery was provided. An army of this sort made sure of the submission of the nobility throughout the kingdom.

Louis also concerned himself with reviving economic activity after the devastations of the Hundred Years' War; towns had been depopulated, trade interrupted, the countryside left untilled. The rehabilitation of agriculture was in itself an immense task. Louis recognized these problems and took some effective measures: he tried to introduce a silk industry and gave great privileges to the Lyons fairs. When Louis died in 1483 the kingdom was richer and the king's authority greater than when he came to the throne.

Charles VIII (1483–98).—The 13-year-old dauphin Charles showed no aptitude for government: he was physically degenerate and of poor intelligence. Though he was legally of age, government in the first years of the reign was in the hands of his sister Anne and her husband Pierre de Beaujeu, who became duc de Bourbon in 1488. Anne had the mind and the vitality required for her task in difficult circumstances, where moreover she had to resist the aristocratic reaction inevitable at the end of Louis XI's authoritarian reign. She and her husband, guardians of Charles VIII, began by making concessions. Certain of Louis XI's agents were sacrificed to the anger of the *parlement*, and lands were restored to hostile nobles, of whom the chief was Louis, duc d'Orléans (afterward Louis XII of France), heir presumptive to the crown. They authorized the estates-general to meet at Tours (1484), and for the first time the country districts as well as the towns were represented there. The royal party, however, succeeded in making the estates-general reject the duc d'Orléans' demand that he should be regent and in packing the *conseil du roi* with their supporters. Once supplies had been voted, they could ignore such demands as the control of taxation and the summons of a meeting of the estates-general every two years. The malcontent party next attempted to obtain by revolt what the estates had failed to secure. Thus began *la Guerre Folle* ("the Mad War"), in which the king had to fight the duc d'Orléans and Francis II of Brittany supported by Henry VII of England and the archduke Maximilian. It ended with the royal victory of St. Aubin-du-Cormier (1488).

The death of Francis II of Brittany (1488) was followed by an urgent competition for marriage with his heiress, Anne. To exclude Austrian, English and other rivals, Charles VIII in 1491 married her himself, and it was agreed that if he predeceased her without leaving an heir she should marry his successor as king of France. The marriage secured Brittany for the French crown but broke Charles VIII's engagement to Margaret of Austria, so that he thereby forfeited his rights to Artois and Franche-Comté under the treaty of Arras. At first he tried to hold these territories regardless of the Austrian rights to them, but finally, by the treaty of Senlis (1493), he ceded them to Maximilian. In 1493, likewise, he ceded Roussillon and Cerdagne back to Aragon. He had already agreed, in the treaty of Étaples (1492), to pay heavy compensation to Henry VII of England for the abandonment of English interests in Brittany.

The motive for all this conciliation was to secure the French frontiers from attack in order to free Charles for a new enterprise, namely an expedition to Italy to assert the rights to the kingdom of Naples which he had inherited from the Angevins. This absurd ambition inaugurated a series of Italian wars which lasted for more than 50 years and in which the French kings were to win only momentary glory in return for a vast outlay of men and money. Having borrowed money right and left and having raised a great army, Charles crossed Italy unopposed (1494), without suspecting that he was leaving enemies in his rear. He entered Naples in triumph but had to leave shortly afterward when a coalition, the League of Venice, threatened to cut his communications. He escaped with difficulty from the battle of Fornovo and had lost his conquests when he returned to France (1495). He was preparing another expedition at the time of his death.

Louis XII (1498–1515).—The crown passed to the duc d'Orléans, who had taken part in every aristocratic rising of the previous reigns but had had time to grow wiser. His premature old age won him the reputation of "father of the people," which hired writers handed down to posterity—though in fact his rule was authoritarian and as costly and oppressive as his predecessors'.

In order to keep Brittany united to France, Louis had to marry Charles VIII's widow, Anne, and this necessitated divorcing his first wife, Joan, a daughter of Louis XI. He not only took up his predecessor's Neapolitan claims but also brought forward claims of his own to the duchy of Milan, which he claimed to have inherited from his grandmother Valentina Visconti. In these Italian projects he was aided by Georges, cardinal d'Amboise, his prime minister, who was ready, however, to use French policy to further his own ambition to become pope. Two successive campaigns (1499–1500) led to the conquest of the duchy of Milan. Then Louis allied himself with Ferdinand of Aragon for the partition of the kingdom of Naples. But Ferdinand deceived him, and in 1504 Louis finally had to abandon Naples.

Louis next let Pope Julius II involve him in a league against the Venetian republic. This was the League of Cambrai (1508), which pledged France to another costly and fruitless undertaking. After the victory of Agnadello (1509) Louis had to face the Holy League organized by Julius II to drive the French "barbarians" out of Italy. Though Gaston de Foix was victorious at Ravenna, the French had to evacuate Italy (1512), while the Swiss threatened Dijon and the English landed on the continent.

Louis sought vengeance on the pope by raising the Gallican Church against him. He revived the Pragmatic Sanction of Bourges and summoned a council at Pisa to depose him (1511). But this dispute ended in a setback, and a pontifical council threatened to interdict France. Barren enterprises had ruined the country's fortunes and endangered its renascent prosperity.

Francis I (1515–47).—The new king, Francis, was the son of Louis XII's first cousin Charles, comte d'Angoulême. Twenty years old, he charmed the court with his youth and his handsome bearing, which formed a contrast with his predecessor's appearance. He liked strenuous exercise, hunting and warfare; he had a ready tongue and enjoyed the company of men of letters, who

made out that he had a great mind. In fact his intelligence was ordinary and his culture mediocre and he knew nothing of politics and religious matters, of which he let his advisers take care. His chief statesmen were the cardinal Antoine Duprat and the constable Anne, duc de Montmorency. His mother, Louise of Savoy, also played a prominent part.

Eager to continue his predecessors' Italian ventures, Francis led a magnificent army into Italy and won the battle of Marignano (1515), which secured Milan for him. It was followed by the peace of Fribourg (1516) with the defeated Swiss and by the concordat of Bologna between Pope Leo X and Francis, which finally set aside the Pragmatic Sanction of Bourges and substituted papal acknowledgment of the French king's right to nominate bishops and abbots in France. But Italy, where hitherto the French had had no rivals but the Spaniards, was now to attract other powers; a sequence of lucky inheritances had raised the sovereign of the Burgundian Netherlands, the archduke Charles, to the throne of Spain at the death of Ferdinand of Aragon (1516) and to the succession of the Austrian territories at the death of Maximilian (1519). Elected emperor despite Francis' competition, Charles V now controlled most of western Europe as well as the Mediterranean and the Spanish colonial empire. France was thus threatened on every frontier, and the long struggle for supremacy between the Habsburgs and the kings of France was about to begin.

The rivals looked for allies. Two presented themselves: the king of England, who in pursuance of his Plantagenet ancestors' claims to the French crown could at any moment checkmate Francis I should the latter descend upon Italy; and the pope, who, seated between Milan and Naples, was invaluable to both but always feared the union of north and south. After the meeting on the Field of Cloth of Gold (1520), where Francis had in vain sought an alliance with him, Henry VIII of England turned to Charles V. As for the pope, there remained the alliance made with France after Marignano; but Leo X concluded a secret alliance (1521) with Charles V, who offered him Parma, Piacenza and Ferrara in return for the investiture of Naples.

War began in 1521, in Navarre, on the northern frontier and in Milan. But Francis' endeavours were countered by the flight of Charles, duc de Bourbon, the constable of France, who passed to the emperor's service after the illegal sequestration of his lands (1523). A further expedition ended disastrously at Pavia (1525), where Francis was made prisoner. Taken to Madrid, he signed a treaty (1526) relinquishing all territories that Charles V claimed (Milan, Naples, Burgundy and the suzerainty of Flanders, Artois and Tournai); but on recovering his freedom he refused to put it into effect. Charles had failed to profit from his victory and had been restrained by the astute diplomacy of Louise of Savoy, the regent of France. He could only take vengeance on Francis' allies and on the pope, Clement VII, who was besieged in Rome and made prisoner. Rome itself was sacked by Protestant troops under the constable Bourbon, who was killed (1527). To put a stop to this profitless warfare, the treaty of Cambrai was signed. This modified the conditions of the treaty of Madrid: Francis renounced Italy but kept Burgundy (1529).

The following years were spent in preparing for a new war, which in this case was to be extended beyond the sphere of Italian politics. Francis was in secret communication with the Turks who threatened simultaneously the southeastern frontiers of the empire and the Mediterranean coasts. He was in alliance with the Lutheran princes of Germany, who were forming the League of Schmalkalden (1531) to defend their religious freedom. Christendom was scandalized to see the "most Christian king" allied with infidels and heretics.

A new war was fought from 1536 to 1538 and eventually won by Francis, as a result of the defensive strategy of the constable Montmorency. The war that broke out in 1542 ended merely in a truce, the peace of Crépy-en-Laonnois (1544), since the two parties were alike incapable of winning a decisive victory and coming to a general agreement on matters in dispute between them. Francis was preparing for another war when he died (1547).

Trend Toward Absolutism.—Francis I was of a commanding disposition, and the internal opposition to the royal power was less formidable than in the previous reigns. Italy furnished him an arsenal of despotic maxims; and his chancellors Antoine Duprat and Guillaume Poyet, helped by the jurists of the southern universities, who drew their inspiration from Roman law, were ready to provide the theoretical groundwork for realizing his authoritarian ideas of government. All worked successfully to distinguish the "greatness and superexcellence of the king" from the rest of the nation; to isolate the nobility amid the seductions of a court life full of pleasures and possibilities of favour and high places; and to win over the *bourgeoisie,* at first by bribery and afterward by the hereditary transmission of offices.

The estates-general were never convened; the king put a stop to the system of moderated monarchy that hitherto had allowed the nation's representatives, convened in times of stress, a voice in affairs. Francis had his ordinances registered by the *parlements* regardless of the remonstrances addressed to him. Attempts at resistance met with harsh treatment; the Gallican Church's opposition to the application of the concordat was brutally repressed.

The concordat of 1516 strengthened the king's authority by its settlement of the system of benefices, which lasted until the end of the *ancien régime.* The king nominated the holders of consistorial benefices (bishops and abbots) and so could avail himself of the revenues of the church for his favourites and for public servants. This assured him a faithful episcopate; but though some of these bishops were conscientious, the church not infrequently found itself governed by unworthy men who cared nothing for their apostolic duties.

Francis I's prime concern was to have enough to maintain his court and his army without having to consult his subjects or to diminish his authority. He achieved this by increasing the returns of the *taille,* by raising regular tithes from the clergy and, especially, by organizing a system of state credit consisting of loans from the towns and from the Italian and German bankers, who proved more obliging than the French financiers that he had shaken off. This system was at once useful and dangerous to the state, as the abuse of credit was later to cause formidable crises.

The Reformation.—From the end of the 15th century circumstances in France had favoured a reform of religion. The clergy was in general decadent, both morally and intellectually, and concerned primarily with worldly affairs; and the faithful satisfied themselves with a formal practice that left no place for religious sentiment. The theologians themselves, given over to the barren discussion of formal logic, were not interested in going back to the true sources of Christian thought. At the same time the disputes over royal as against papal authority in the Gallican Church exposed the Roman hierarchy to mistrust and criticism in men's minds. The circulation of ideas and the spread of printing, together with the closer study of the classics and the Scriptures, opened new vistas to the reformers, who at the beginning of the 16th century were dreaming of a regenerated church with dogma and hierarchy intact.

The first attempts were by mystics who wanted to revive religious life; for example, Jean Standonck and, after him, Jacques Lefèvre d'Étaples (Faber Stapulensis) and his whole group of Christian savants at the Collège du Cardinal Lemoine. Erasmus contributed his ideal of humanism. At the beginning of Francis I's reign Guillaume Briçonnet, bishop of Meaux, tried to put this ideal into practice by preaching the Scriptures in a way that made them accessible to the faithful (this constituted the group of Évangéliques de Meaux). But this reformation, hitherto simply moral, ended with an attack on dogma: the study of the Bible and of the Pauline texts and contact with the Lutheran reformers of Germany led to the doctrine of justification by faith and to the limitation of ritual practices. At the same time social changes favoured a refractory attitude toward the clergy and a revolt against the abuses of the church. In the *rebeyne* at Lyons in 1529, for instance, reformist manifestations were combined with bread riots.

Francis I at first favoured the new ideas and the reformers, who had the protection of his sister Margaret of Angoulême, queen of Navarre. But he became hostile when he saw society threatened

by the reformers. The affair of the placards, when broadsides against the Mass were posted in the towns (1534), and the publication of Calvin's *Christianae Religionis Institutio* (1536) made Francis decide for repression. Henceforth edict followed edict proscribing the heretics.

Henry II (1547–59).—The new king's character was less pronounced than his father's. Of slight intelligence and rather narrow, given over to the strictest religious orthodoxy, Henry II exposed himself to the influence of the dominant factions of his entourage. These comprised his mistress, Diane de Poitiers; the constable Montmorency, whom he regarded with an almost filial affection; and the princes of the house of Lorraine, François, duc de Guise, the greatest soldier of his time, and his brother Charles, the cardinal de Lorraine.

The Italian campaigns that occupied the previous governments were continued in the new reign, instigated chiefly by the Italian princes at court; and they conflicted more than ever with the interests of the kingdom. But new enterprises were developed, and the king's political and military fields of action were widened. To maintain the struggle against Charles V, Henry continued his father's practice of German Protestant alliances, which was all the more necessary since the victory at Mühlberg (1547) had assured Charles's supremacy throughout the empire and presented an indirect threat to France. After making an alliance with the German Protestant princes at Chambord (Jan. 1552), Henry occupied the Three Bishoprics (Metz, Toul and Verdun) in Lorraine, which were part of the empire. François de Guise successfully withstood the siege of Metz by Charles V (1552–53), and Henry kept his acquisitions. The Three Bishoprics remained in French hands, and the treaties of Westphalia (1648) were finally to acknowledge their cession to the king of France. This was the first step forward in the policy of expansion toward the Rhine.

Warfare was continued after Charles V's abdication, either in Italy or in the Low Countries. Through Montmorency's lack of experience, French arms suffered a disastrous defeat at St. Quentin which might have left the road to Paris open if the victors had had the means to pursue the operation (1557). But Henry had his revenge on the English for their alliance with Spain: François de Guise took Calais and all the continental territory that they had been occupying for 200 years (1558).

Meanwhile, however, the Protestant party in France was approaching the zenith of its power. Its membership had greatly increased, and after 1555 numerous churches were organized throughout France. Under ministers schooled for the most part at Geneva, they were grouped in synods and assemblies; a national synod took place in Paris in May 1559. The party, moreover, had changed as it grew. Whole peoples in certain provinces, particularly in the Midi, had become Protestant, including the rural population; and nobles had taken the leadership over from the theologians. Henceforth the leaders were the prince de Condé (Louis de Bourbon), the admiral Gaspard de Coligny and Antoine de Bourbon, king of Navarre, whose place was to be taken after 1562 by his son Henry III (afterward king of France as Henry IV).

Repressive measures against Protestantism were even more severe under Henry II than under his father: in the first year of his reign he set up the *chambre ardente* ("burning court") in the *parlement* to try suspected heretics. But Henry's military enterprises abroad exhausted France and set it in opposition to Spain, the great Catholic power, and so prevented his devoting himself wholly to the struggle against the Reformation. He therefore decided that, in order to crush heresy, peace had to be restored and the Italian ventures, the sterility of which had become apparent, renounced. This change of policy culminated in the peace of Câteau-Cambrésis (April 1559). Henry totally and unconditionally gave up his claims on the Italian territories. He even relinquished his positions in Tuscany and also Savoy, which had been French for 20 years and seemed to have been definitively incorporated in the kingdom. The restored Franco-Spanish friendship was cemented by Philip II's marriage to one of Henry's daughters, Elizabeth; and Emmanuel Philibert of Savoy was to marry Henry's sister Margaret. This way of ending the Italian wars was no more reasonable than the policy that had poured France's wealth and strength into them over the past 50 years. However, it enabled Henry to issue the Edict of Écouen (June 2), which seemed to envisage a real civil war against the Protestants and perhaps a campaign in alliance with Spain against Geneva. During the festivities in celebration of the marriages Henry took part in a tournament and received a wound that proved fatal (June 30).

Francis II (1559–60).—The new king, Henry II's son, was a major but too young to govern, and the direction of policy was entrusted to the Guises, uncles of the young queen Mary Stuart, who was also queen of Scotland. François de Guise was commander in chief of the army and his brother the cardinal de Lorraine held the administration. Both were fervent Catholics, in opposition to the Protestant leaders Condé and Antoine de Bourbon. To overthrow the Guises Condé organized the conspiracy of Amboise (*le tumulte d'Amboise,* 1560), which miscarried and was rigorously put down. This was the first resort to violence. To make peace and to rehabilitate the country's finances, it was decided to summon the estates-general at Orléans; but the session had only begun when Francis II died (Dec. 1560).

Charles IX (1560–74).—Francis' brother was a minor at his accession and his guardian was the queen mother, Catherine de Médicis, an intelligent, cultured and crafty Italian who was to take part in the government for nearly 30 years. Her main object was to preserve undiminished the authority of her sons Charles IX and, after him, Henry III. She cared nothing about the truth of any religion and had no solid political principles, striving rather to keep the factions in awe even if this called sometimes for treachery. Her methods, which she pursued ruthlessly, finally destroyed the authority that she meant to reinforce.

At first she thought toleration practicable, in which opinion she had the support of the chancellor Michel de L'Hospital. She summoned the colloquy of Poissy (Sept. 1561), where the best theologians of either side gathered to propound their doctrines. It became obvious that conciliation was impossible for two religions with firm dogmatic systems and differences on essential points; and their encounter at Poissy made reciprocal opposition more pronounced between the Catholics under the *triumvirat* (François de Guise, Anne de Montmorency and the maréchal de St. André, Jacques d'Albon) and the Huguenots under Condé and Coligny. Catherine tried, failing an agreement, to keep the peace by edicts that gave the Protestants a certain freedom in the exercise of their religion: that of Jan. 1562 allowed them the right of assembly outside the towns. This generous tolerance could have saved the religious peace, but the Catholics thought it excessive and meant to oppose the application of the edict.

The peace had already been troubled in the provinces of the Midi. On March 1, 1562, an incident at Vassy between the duc de Guise's troops and the congregation of a Reformed church ended in a massacre. This was the beginning of the Wars of Religion, which the crown was unable to stop for nearly 40 years.

These wars involved no great operations, and there were no decisive battles. Armed bands attacked towns or châteaux and indulged in looting and massacre—exploits which made famous the Protestant baron des Adrets (François de Beaumont) and the Catholic Blaise de Monluc. The hostilities particularly affected the Loire provinces, round Orléans and Sancerre, where the Huguenots were numerous, Dauphiné and Vivarais in the southeast and Gascony and Périgord in the southwest, where the nobles were turbulent and impoverished.

The first war lasted a year. Threatened by an English invasion, which Coligny and Condé had purchased by ceding Le Havre, Guise captured Rouen by assault, but in the attack Antoine de Bourbon lost his life. At Dreux, fought to close the road to German reinforcements hastening to join the English, St. André was killed; but Montmorency (the victor) and Condé were taken prisoner. Guise was assassinated by Jean Poltrot de Méré as he was attacking Orléans (Feb. 1563). Freed from Guise's uncomfortable tutelage and now head of a Catholic party of tried strength, Catherine was able to destroy the unity of the Huguenots with the peace of Amboise (March 1563), by which Condé demanded freedom of worship for the Protestant aristocracy only. Catholics and

Protestants then united to drive the English out of Le Havre.

Within the next four years Charles IX attained his majority, but he left the direction of affairs in the hands of his mother. Catherine wanted to use the peace to bring her conciliatory policy to fruition and restore the country's finances and the king's authority. She traveled over the kingdom presenting Charles to his subjects to enhance his prestige and had a meeting with Philip II of Spain at Bayonne, where plans were laid for joint opposition to the heretics. Her efforts were unsuccessful; the second civil war broke out, and in the course of it Montmorency was killed in the battle of St. Denis (1567).

The peace of Longjumeau (1568) was short-lived. The third war saw real military operations developed in the western provinces and in the Midi, between the royal army under the king's brother, the duc d'Anjou (later king as Henry III), and the Protestant armies of Condé and Coligny. Condé was killed at the battle of Jarnac and Coligny was defeated at Moncontour (1569). The ensuing peace of St. Germain (1570) was another compromise between the parties, but contained a clause of which later events were to reveal the importance: the king assigned to the Protestants four *places de sûreté*, which were to have a Protestant governor and a Protestant garrison and to constitute places of refuge for members of the Reformed religion who could not safely live elsewhere. This seriously affected the sovereignty of the king, and the Protestant party seemed to be threatening the unity of the state.

St. Bartholomew's Day.—To seal the peacemaking it was proposed that Antoine de Bourbon's son Henry of Navarre should marry Charles IX's sister Margaret of Valois; and a further development on the same lines took place when the king, weary of his mother's power over him, drew closer to Coligny in order to prepare for war against Spain in the Netherlands. In 1572 a fleet was prepared and an army raised, while an alliance was made with England.

Catherine de Médicis reacted to this threat with characteristic duplicity. Taking advantage of the princess Margaret's wedding, for which numerous Protestants, including Coligny, had come to Paris, she arranged an attempt on Coligny's life (Aug. 22, 1572). Coligny, however, was only wounded; and Catherine, fearing a Protestant rising and an investigation that might have revealed the truth, prevailed on the king to order a general massacre. This massacre, begun in the night of Aug. 24, lasted several days in Paris and claimed hundreds of victims. Those who were spared, for instance Henry of Navarre, had to abandon their religion. Similar proceedings took place in the other principal towns of the kingdom, but they were not thorough enough to annihilate the Protestant party, which made use of these very happenings to feed the increased virulence of the propaganda conducted by such pamphleteers as François Hotman and Philippe de Mornay (Du Plessis-Mornay). Henceforth this propaganda was aimed at the king himself, indicted as the murderer of his own subjects.

The massacre of St. Bartholomew's day aggravated the conflict between the two religions and provoked a new Protestant rising: several towns in the Midi and Sancerre as well as La Rochelle took up arms, and the siege of La Rochelle was the principal feature of the fourth war of religion. Despite another treaty of peace, the disorders became increasingly serious; the Protestants, during the war, had organized themselves politically and militarily in the southern provinces, which were in fact detached from the scope of the king's authority and had their own assemblies (provincial and general), their own army and their own tribunals.

The Politiques.—Moreover, a section of the Catholics, anxious for peace's sake to allow the dissidents liberty of worship, joined the opposition: these constituted the party of the Politiques or Malcontents, who, as they drew closer to the Protestants, were also called *Catholiques unis*. At their head was the king's brother, the duc d'Anjou, who shortly afterward left France to become king of Poland (May 1573), whereupon his brother François, duc d'Alençon, took his place at the head of the Politiques. This attitude on the part of the princes made anarchy worse.

Henry III (1574–89.)—The duc d'Anjou returned from Poland to succeed his brother Charles but was no more capable of restoring the royal authority than Charles had been. Intelligent and cultured but, because of his sexual abnormality, little respected, he was to try to govern amid the factions without having the strength of character for which the situation called—at times dominated by his adversaries, at others seeking to regain the ascendant by treachery or assassination. Moreover, the situation was more critical than before: Henry III was childless, and the heirs presumptive were his brother Alençon, who was himself childless, and Henry of Navarre, chief of the Protestant party. The question of the succession was the greatest problem of the moment.

Henry III was hardly back in France when the fifth civil war broke out. Though Henry, duc de Guise, won a victory at Dormans, Henry conceded all that the rebel coalition demanded in the peace of Monsieur (May 6, 1576). Alençon received the appanage of Anjou, Touraine and Berry; Henry of Navarre, Guienne; and Condé, Picardy. The Protestants likewise obtained the restoration of their *places de sûreté* and liberty of worship throughout the kingdom except in the neighbourhood of Paris. *Chambres mi-parties*, composed of Protestants and Catholics, were created in all the *parlements* to judge Protestants brought to trial. This was another step in the decline of public authority.

The Catholic reaction to this favouring of the Protestants, which they determined to prevent, was the formation of the Holy League, under the inspiration of Henry de Guise. Grouping several local associations of the same kind, it was composed of common townspeople and directed by parish priests with a few bourgeois, lawyers and officials. It demanded the restoration of Catholicism, the revival of the provincial liberties and control of the government by the estates-general. It was a democratic and antidynastic movement. Henry III thought that the cleverest defense was to declare himself head of the League and to run it in his own interest. He therefore convened the estates-general at Blois, as he had promised (1576). As the Protestants refused to participate, the Catholic majority did as the king wished and agreed to demand the re-establishment of religious unity, thereby nullifying the last peace treaty. War broke out again, and a brief campaign led to the peace of Bergerac (1577), which established, in a somewhat curtailed version, the terms of the previous peace. This was later renewed at Fleix (1580) after the so-called "Lovers' War," which arose out of the intrigues of the wanton Margaret, wife of Henry of Navarre.

Meanwhile Henry had abolished all leagues, and his position seemed to be becoming less precarious. Then came the death of his brother François, which revived in more acute form the question of the succession: Henry III had no heir but Henry of Navarre, which meant that the crown would go to a Protestant prince. The two parties were more than ever at variance. The Huguenots found themselves again the supporters of the hereditary principle and the divine right of kings. The Catholics and the Guises, the latter for their own ends, became the upholders of elective monarchy and the sovereignty of the people. Was it not unthinkable that the crown of the "eldest daughter of the Church" should be allowed to pass to a relapsed heretic? In order to realize their possible succession to the throne the Guises, who had already fabricated a genealogy that led them back to Charlemagne, entered into an understanding at Joinville (Dec. 1584) with Philip II and the pope to set aside Henry of Navarre and to substitute for him Charles, the old cardinal de Bourbon, who on his death would leave the crown to Henry de Guise.

The Guises relied on the reconstituted League, which made rapid progress (1585). Its avowed intention was to resist by force those who sought "to ruin the Catholic religion and the state." Centred in Paris, it had a council and an organization that made it in fact a revolutionary government.

War therefore broke out again: Henry of Navarre, Henry de Guise and Henry III faced each other and sought help from abroad, from Elizabeth of England, from Philip and the pope and from the German princes and the Swiss, who supplied mercenary troops. Henry of Navarre was victorious at Coutras, Guise at Vimory and at Auneau (Oct.–Nov. 1587); but these engagements were indecisive and left the king as helpless as ever between the Protestants and the League.

Events at Paris were decisive. The ever increasing tension made

the Leaguers afraid of a Protestant resort to force, and they called Henry de Guise to their aid. He entered Paris in defiance of the king's prohibition, and the Parisians put up barricades to prevent the king's using force. Henry III took fright and fled, leaving Paris in the hands of a revolutionary council; and the Edict of Union (July 1588), whereby he adhered to the League, consummated his defeat. The estates-general, on the League's demand, were summoned to Blois. But Henry III, to recover the ascendancy from a majority that outvoted him in the League's favour, decided on a resort to force: he had the duc de Guise and his brother Louis, cardinal de Guise, assassinated and the cardinal de Bourbon, pretender to the crown, thrown into prison (Dec. 1588).

Far from restoring the power of the king, this coup finally destroyed it. Henry III had no choice but to ally himself with Henry of Navarre, and the two kings were preparing to take Paris when Henry III was assassinated by Jacques Clément (Aug. 1, 1589).

Economic and Social Developments.—The Hundred Years' War had ravaged the country, disrupted commerce and spread pestilences in France. In the middle of the 15th century the land was untilled, some villages had disappeared and many houses in the towns themselves were dilapidated. The population was falling; in the regions that had suffered most the peasants had left their fields to take refuge in the towns, where the multitude of beggars aggravated the disorder. Workers were scarce and labour expensive. Monetary difficulties made things worse, as precious metals were vanishing while salaries generally rose. The return of peace was not in itself enough to revive the country's economy: the resumption of work and the restoration of lost wealth called for an immense effort.

The most urgent task was to revive agriculture. Of the great landowners who had survived many were bankrupt, and they set about restoring their domains with the help of new farmers, to whom they offered generous conditions; the serfs were emancipated and land was granted for small dues, the rate being fixed once and for all. After half a century of effort the results made themselves felt: fallow land was recovered, and the forest receded. Villages were re-established, and the beginning of the 16th century was a period of real agricultural prosperity. But if the peasants profited from it, their overlords were no longer as well placed as before: tenants paid only low dues, the real value of which decreased as money became cheaper. It was the beginning of a serious crisis, which was to undermine the conditions that had made possible the existence of the rural nobility.

Simultaneously with agriculture, industry and commerce revived, largely because of foreign businessmen, especially Italians, who engaged both in trade and in banking, imported luxury articles and set the flow of international business in motion again.

By the last years of Charles VII's reign the progress brought about by Jacques Coeur, who sent his ships to trade in the Levant and exploited the mines in the midland of France, was already discernible. But this activity developed under Louis XI, who, without having any precise ideas, took an interest in commerce and obtained results: he re-established the Lyons fairs, tried to introduce the silk industry and to develop the wool industry and took measures, with success, to attract stable currency and to impose a sort of protectionism which seems to foreshadow Colbert. Here, too, progress was discernible at the end of the 15th century, and under the following kings prosperity continued.

The 16th century gave a new turn to this prosperity. Voyages of discovery increased the sphere of commercial enterprise: there was the traffic in exotic merchandise, whether brought home directly from the new world or purchased in the great international markets of Spain and Antwerp. The ports of the Mediterranean were not neglected, but those of the Channel and the Atlantic saw a new activity. There was a considerable development of the great international fairs, for instance those at St. Denis and, particularly, at Lyons, which became the centre of commercial life in France. But the most important feature was the discovery of the gold and silver mines of America, which produced, mainly from 1550 onward, a quantity of precious metal that continued to accrue till the beginning of the 17th century. Imported gold and silver flowed from Spain into all the neighbouring countries, and the 15th-century shortage of currency was followed by a surfeit, with various results: trade was stimulated, prices rose and the buying power of money diminished.

Besides real estate, which hitherto had been the basis of wealth, reserves of specie were accumulated for use in the purchase of goods, in industrial enterprise and in credit operations. The banks made use of letters of credit, the deposit system and clearances to maintain the international movement of capital, the principal centres being the exchanges of Antwerp and Lyons.

The men who handled this money gave their help to the governments; the French kings, who were involved in the costly enterprises of the Italian wars, could not go on without more than the usual resources of the treasury. They had to borrow; and from the time of Francis I a system of public credit was built up whereby the needs of the state were met with the help of bankers (mainly Italians or Germans) and of the towns, which themselves borrowed from private persons.

The debt, on which the interest was heavy, grew continuously and imposed a burden that obstructed all attempts to restore the state's finances. The efforts of Michel de L'Hospital, under Charles IX, were wrecked by disorder in the administration and by ever-increasing requirements. Henceforth the government was to live only on loans from the *partisans* (members of syndicates of financiers) who received allotments of the royal domain as concessions or the right to reimburse themselves by collecting public revenues.

This led to far-reaching changes in the various social classes. Those who lived on fixed incomes were affected by the depreciation of the coinage and by the rise in prices: the rural nobility, who had feudal rights that brought returns not liable to change, was declining fast; likewise the *rentiers*, whose rents came from houses or land. The workers were even more affected, since the rise in wages was always slower than the rise in prices. On the other hand, merchants and peasants were becoming richer by buying the lands that the rural nobility were obliged to sell. Prosperous businessmen who bought seignioral domains to which a title of nobility was attached came to compose an aristocracy that was to bring new blood into the noble classes of the 17th century. The houses of Gondi (from Italy) and of Villeroi were parvenus of this kind.

Another consequence of the government's financial policy was the sale of offices. In previous centuries people had tolerated the king's functionaries' selling their charges or passing them on to their children. The kings themselves had sometimes sold public charges, but this was exceptional until Francis I made the system general and created public functions in order to make money out of them. These were the offices, which found buyers because merchants and capitalists were making fortunes that could be employed in raising their dignity and in getting them a share of authority in the state. Thus most of the judiciary or financial charges were turned into offices, which were the property of their holders, incorporated into their patrimony and handed down to their children. The king was thus losing his authority and could neither recruit capable functionaries nor impose discipline.

These difficulties were discernible by the middle of the 16th century and contributed much to the outbreaks of civil war; the ruined gentry, who could find no place in the army since the peace of Câteau-Cambrésis had been signed, were no less susceptible to any political ferment than the destitute workers. But the radical causes of the disorders were to become more general as time went on; the vicious system of finance and the anarchy pervading the administration through the sale of offices became progressively worse even in periods of stability. These evils were, in 200 years' time, to encompass the ruin of the monarchy.

The First Bourbons (1589–1643) and Richelieu

Henry IV (1589–1610).—The new king was a remote cousin of Henry III. As king of Navarre he had only a small domain; and his life had hitherto been that of a Gascon gentleman soldiering at the head of the Protestant armies. However, his mind was of exceptional quality: he had an admirable understanding of politics and could see the significance of events and win the sympathy of

all by an opportune admixture of cordiality and authority. A warrior born for action, with a distaste for sedentary work, he knew how to find capable collaborators to manage his finances and his diplomacy. If he contrived to bring back stability and to redirect the government toward absolutism, he wanted above all to return to the past, without putting into practice the far-reaching reforms that experience might have indicated to him. He it was in fact who created the monarchy of the *ancien régime* with the vices that led to its end in 1789.

His first task was to recover the kingdom. At his accession he controlled only a few strongholds and a small army, as numbers of the Catholic gentry refused to serve a heretic. He had against him the League, which was all-powerful in the towns and controlled by Charles, duc de Mayenne, since the murder of his brother Henry de Guise. The people as a whole would not accept a Protestant king whom the clergy refused to anoint. This opposition looked at first to the aged cardinal de Bourbon as its king, but he died Henry IV's prisoner.

Henry tried to get possession of Paris through the west. He won victories at Arques (1589) and at Ivry (1590) over the League's armies, but failed before Paris. Neither side could prevail through the use of force. Mayenne thought that the time was ripe for a meeting of the estates-general to proclaim him king; and so the estates of the League were assembled in Paris (Jan. 1593). But agreement could not be reached, since the Spanish ambassador was present and proposed Philip II's daughter (who was French on the maternal side) as a candidate for the throne instead of Mayenne. The moderates of the League rejected these Spanish claims and were upheld by the *parlement* of Paris. The pamphlet of the *Satire Ménippée* finally destroyed all respect for the clearly powerless estates. Henry IV, on his part, made this reverse more serious by embracing Catholicism (July 25, 1593); and this conversion, the effect of which was immeasurable, assured his success. He was crowned at Chartres in Feb. 1594 and entered Paris on March 22. The pope gave him absolution in Sept. 1595; and several days later Mayenne himself made his submission. Gradually the heads of the League's government, the seigneur de Villeroi (Nicolas de Neufville) and Pierre Jeannin, went over to the king, and all the provinces recognized him one after the other. Only a few obstinate people kept themselves detached; it was they who inspired Jean Châtel's attempt on Henry's life (1594).

Spain still had to be dealt with and Henry declared war in 1595. The victory at Fontaine-Française did not settle anything, and a Spanish offensive led to the capture of Amiens (1597), which was liberated only after a long siege. But since the defeat of the Armada Spain had been weaker, and Philip II resigned himself to the treaty of Vervins (1598) which confirmed that of Câteau-Cambrésis. The duke of Savoy, Charles Emmanuel I, in his turn was forced to capitulate: the treaty of Lyons (1601) at last brought the frontiers of France to the southern Jura.

Edict of Nantes.—At the same time the Edict of Nantes (April 13, 1598) put an end to religious conflicts, as a result of long negotiations with the assemblies of the Protestant churches. Protestants were given the right to live in the kingdom and equality of citizenship; their worship could be celebrated privately in the houses of *seigneurs haut-justiciers* ("greater nobles"), and publicly in places where it was celebrated in 1576 or where its celebration had been permitted by edicts of 1577, 1579 and 1580 and also in two towns in every *bailliage* or *sénéchaussée*. Whereas all these terms constituted a state of toleration rather than freedom of conscience, there were additional privileges as well, including the right to fortify the places they still held as *places de sûreté* and the right to hold assemblies of the religion. (*See* NANTES, EDICT OF.) The statute was put forward as provisional and so kept the Protestants in suspense but at the same time granted them privileges that amounted to governmental authority and were to prove useful to them as a basis for further insurrections. The Edict of Nantes was neither so reassuring nor so definitive as its appearance suggested; in fact it was registered only with difficulty, as public opinion rightly saw in it a source of future conflicts.

The Government Reorganized.—From 1598 onward, being at peace with the church and having guaranteed the Protestants their freedom, Henry could set about reorganizing the system of government. Apparently of an easy disposition, he was nevertheless resolved to tolerate no opposition. Government became more absolute than under Francis I. The country moreover lent itself to this development, being tired of disorder and anxious only to work for recovery. Henry addressed the *parlements* and municipalities as their master and considered their leaders factious and prevaricating. He no longer convened the estates-general, which had done nothing but stir up trouble since 1560, but summoned only an "assembly of notables" at Rouen, having chosen the members of it himself; even then he presented himself to them "with his sword in his hand."

For his government he relied on councils, which he convened regularly and in which the work of administration was done by a staff of jurists, *conseillers d'état* and *maîtres des requêtes:* these comprised the *conseil des affaires*, the *conseil d'état* and the *conseil des finances*. At the head of the principal departments were the *secrétaires d'état*, the *chancelier* and the *surintendant des finances*. Finally, to safeguard his authority in the provinces, Henry began to make more regular use of intendants, who hitherto had been employed only intermittently. These intendants were the king's representatives whose duty it was to keep the local administrators aware of his authority. Thus emerged the organs of administrative monarchy, which the succeeding reigns did but perfect. In this way Henry eliminated all the disorders that were troubling the kingdom: he suppressed the brigandage that ravaged the countryside and also the conspiracies of the nobles (for example that of the duc de Biron, who had been in secret communication with Spain and was executed in 1602).

Henry's greatest obstacle was presented by the Protestants. They held assemblies with which he had to treat, for fear of provoking a new rebellion. This made difficulties between him and the Catholics, who were always anxious about favours granted to their adversaries. The king's great problem was to maintain equality and peace between the hostile factions.

Economic Rehabilitation: Sully—The first necessity was to recover the prosperity of former days. The king's concern with this matter was prompted at once by pity for his subjects and by a desire to increase the revenue. His attitude is summed up in the famous dictum attributed to him: "Every family should have a fowl in the pot on Sunday." Since he was ill-informed on the subject of finance, Henry relied on his councilors, the most renowned being Maximilien de Béthune, duc de Sully.

Sully was a Protestant gentleman who had served in the royal armies before being admitted to the *conseil des finances*. He was ambitious, and he contrived to get rid of his colleagues and to remain himself alone at the head of the financial administration with the title of *surintendant*. An unsparing worker, capable and honest, he exploited these advantages to win the king's confidence by every means and to make a considerable fortune for himself. He sought to enrich the kingdom by giving support to agriculture; he allowed the peasants a remittance of their arrears of taxes, prohibited the seizure of agricultural instruments and had marshlands drained and roads and canals built.

This renewal of prosperity made it easier for the peasants to pay the *taille*. The finances were also restored, by arbitrary measures liquidating the debts of the state and comparable in fact to a bankruptcy. One reform was above all disastrous because of its remote consequences: an edict of 1604, suggested by the financier Charles Paulet and called the *paulette* after him, inaugurated the *droit annuel* or right to convert an office into a hereditary possession by making a yearly payment of one-sixtieth of the price paid for the life tenure of it. A few of the highest offices were excluded from the effect of the *paulette*, but the edict was so profitable to the treasury that it was constantly renewed. Its immediate result was to enable Sully at last to accumulate reserves of gold, in the vaults of the Bastille. Ultimately, however, it removed the control of the magistracy from the government's hands and served to build up a privileged caste of office-holding families.

Besides the agricultural effort, to which Olivier de Serres contributed, there was the industrial policy inspired by Barthélemy

Laffemas, who wanted "to set up manufactures in this kingdom" and to produce luxury articles for sale abroad, so as to prevent the export of currency. He proposed a customs policy that would exempt raw materials from tariff payment and prohibit the import of manufactured products. Thus began the mercantilism that Colbert was to develop. At the end of Henry IV's reign the kingdom was enjoying real prosperity again, largely a result of the government's efforts and above all of the peace kept since 1598.

Foreign Policy.—The treaty of Vervins did not bring lasting peace. Henry was still mistrustful of the power of Spain, with its Austrian alliance. Taking no account of the repeated setbacks that exposed the final exhaustion of Spain, he maintained a traditional hostility that was potentially dangerous for France. Ostensibly neutral, he nevertheless continued, in association with England, to support the rebellious United Provinces against Spain and the German princes against the emperor.

In 1610 Henry was preparing for war against the Habsburgs on the Rhine to settle the Jülich-Cleves succession—a serious venture that might have brought to nothing all the progress of the years of peace—when he was assassinated by François Ravaillac (May 14, 1610). The assassination may be regarded as symptomatic of a Catholic reaction in favour of Spain.

Louis XIII (1610–43).—With the accession of Louis XIII the unstable character of the monarchy was again made manifest. The organization of a regency in the name of a king who was a minor always proved a hazardous undertaking with the issue depending on the rivalry between factions. The queen mother, Marie de Médicis, was faced by the late king's servants, by rebellious nobles eager to recover their liberties, by an anxious Protestant party and by Catholics who wanted a *rapprochement* with Spain.

Proclaimed regent by the *parlement*, the queen mother yielded to the pressure of the Spanish party and renounced the now impracticable war. French policy was committed to the *rapprochement* with Spain, which culminated in two marriages, that of Louis XIII with the infanta Anne of Austria and that of his sister Elizabeth with Philip III's son, the future Philip IV.

For home affairs, Marie could think of nothing better than to distribute offices and money among the chiefs of both parties. Once the treasury was despoiled and Sully disgraced, she lost all her influence and became the tool of the ambition of a lowborn Florentine, Concino Concini, the future marshal d'Ancre. Thenceforward policy became a matter of petty artifice; after having made a show of drawing the sword against Condé, the leader of the great nobles, the queen regent opened her purse instead. The costly peace of Ste. Menehould (May 1614) marks the first abdication of power on the part of the Bourbon monarchy.

To get support against the restless and hostile nobility, the regent convened the estates-general, which met in Paris in Oct. 1614. The three orders, however, quarreled among themselves and could not reach any agreement on the proposals submitted to them; and when they refused to grant the desired subsidies the assembly was dissolved. The estates-general had once more shown themselves to be powerless; and they were not to be summoned again before 1789.

For the next ten years the affairs of the kingdom were in the hands of favourites who owed their authority largely to intrigues; and policy swayed between the two forces that were emerging in Europe. On the one side was the party of the Counter-Reformation, which sought to restore the Catholic Church's position against the Protestant churches by the union of the papacy with the Austrian and Spanish Habsburgs, abetted by the Jesuits; this in France was the policy of the *parti dévot*, which predominated in the circles surrounding the regent. On the other side the Protestant powers, that is to say the United Provinces of the Netherlands and the German Protestant princes grouped in the Evangelical union, stood together against Spain and relied, in France, on the Protestant party headed by Henry IV's old followers, Henri, duc de Rohan, his brother Benjamin, seigneur de Soubise, and Philippe de Mornay, who feared that the religious liberties obtained with such difficulty might be lost. This party organized itself for resistance even by civil war: the country was divided into *cercles* and an army was raised on funds provided by the churches. It was, as Richelieu later called it, "a state within the state," keeping up its own relations with foreign powers.

This opposition—Protestants anxious about the *rapprochement* with Spain and nobles who wanted to supplant the favourites in high places—rose on several occasions. One rebellion ended in the peace of Loudun (May 1616), which granted governments and pensions to the nobles involved. Concini and his followers saw their power augmented, while Louis XIII grew up in the shadow, humiliated by their tutelage. Nevertheless, Louis was able to get rid of them by supporting a plot against Concini, who was murdered on April 24, 1617; and the regent and Richelieu, whom Concini had brought into the government, were thrust from power. New favourites were installed as ministers, including Charles d'Albert de Luynes, a young nobleman who became a duke and then constable. Soon afterward new risings took place, with the complicity of the duc d'Épernon (Jean Louis de Nogaret); these ended in the treaties of Angoulême (1619) and Angers (1620).

On the other hand, at the instigation of the militant Catholics, Luynes conceived the premature idea of conducting a campaign to break the power of the Protestants in the Midi. There he was repulsed before Montauban, and his death in 1621 spared him from falling into disgrace. His authority and intrigues were inherited, for the next three years, by Marie de Médicis. In those three years there were three different ministers, all mediocre men. In the background stood the subtle personality of the cardinal de Richelieu.

Richelieu.—Born into a family of the petty nobility, Armand du Plessis de Richelieu had at first been bishop of Luçon and had sat in this capacity in the estates-general of 1614. Eaten up by ambition, he had pushed himself into Concini's circle; and when Concini fell he was removed from power. But he eventually insinuated himself again into the government and attained the position of *premier ministre*, which he held till his death 18 years later.

The situation called for a strong-willed man of foresight and energy who could restore order at home and intervene in the events that were troubling central Europe. In his *Testament* Richelieu reveals that the course of action followed by him with an indomitable determination had been planned at the time of his entry into the royal council. "I promise," he told the king, "to devote all my energy and all the authority that it may please you to place in my hands to destroying the Huguenots, to abasing the pride of the great nobles, to restoring all your subjects to their duty and to raising the name of your majesty among foreign nations to its rightful place."

The first objective was to command "the four square feet of the king's cabinet," which involved a permanent struggle. Richelieu had to remain in power—a difficult task with such a master as Louis XIII, who "liked to be governed yet bore being governed with impatience." Louis gradually came to trust his minister but never learned to like him. Richelieu's influence was continually challenged by the queen mother, who accused him of ingratitude, and by the queen, whose Spanish birth made her naturally sympathetic to the *parti dévot* and who also had the mischief-making duchesse de Chevreuse as her favourite. Also the heir presumptive to the crown, Gaston, at first duc d'Anjou, then duc d'Orléans, who posed as the beloved prince in all conspiracies directed against Richelieu and who each time played Judas in the end, had often to be reckoned with. This disaffection in the royal family was naturally exploited by the nobles. Suspicious and irritable, Richelieu frequently believed himself to be threatened when he was not and, in identifying himself with the king, sincerely believed that he was defending the king's authority and not the cardinal's. As long as his position was uncertain he was forced to suppress court conspiracies, time and again displaying merciless severity: Henri de Talleyrand, comte de Chalais, was beheaded for plotting to prevent the marriage of Gaston with Marie de Montpensier (1626); and after the so-called Day of Dupes (Nov. 10–12, 1630), when the two queens and their friends thought that they had secured Richelieu's dismissal, the marshal Louis de Marillac was arrested and his brother Michel, the keeper of the seals, was exiled, the marshal being subsequently executed on a feeble charge of peculation. Some of the conspiracies, however, did lead to armed rebel-

lion: for instance that for which Henri II de Montmorency was beheaded in 1632; and that of the comte de Soissons (Louis de Bourbon), killed at the moment of victory in the battle of La Marfée, near Sedan, in 1641. The final plot, organized by the marquis de Cinq-Mars, would have involved an armed rising with Spanish assistance if it had not been detected in time.

The Protestant rebellion was shorter but more menacing. Richelieu was unwilling to use constraint to reduce the Protestants to orthodoxy; but he demanded their total submission from the political point of view. Although his first acts had shown a tendency to commit himself against Spain (on the question of the Valtellina), the Protestants, supported by England, rose against him. Richelieu, to settle the matter, took possession of La Rochelle after a year's siege (1627–28) and continued the war in Languedoc. When Rohan was defeated in the Cévennes, notwithstanding the help of Philip IV of Spain, Richelieu was able to impose the Edict of Alès (1629) on the Protestants, withdrawing their political privileges, their *places de sûreté* and the possibility of raising armies and leaving them only their religious liberty. This settlement with the Reformed churches lasted for more than half a century.

Richelieu's principal object was to rid himself of domestic problems so as to be able to intervene advantageously in European affairs, to halt the progress of Spain and to "make the king the most powerful monarch in the world." This object explains France's participation in the struggles of the Thirty Years' War (*q.v.*). The early successes of the Habsburg powers, Austria and Spain, in Germany and in the Netherlands, against the Protestant leagues and their allies did not constitute any direct threat to France, but the French nation felt itself menaced and so obliged to take measures against encirclement. With this in mind Richelieu had from the start made his choice between the various available policies, that is, between *rapprochement* with Spain and the system of Protestant alliance; but for a long time the internal situation in France made intervention impossible and the Spanish party endangered his authority. He was restricted to indirect action in Italy: he restored French influence in the Valtellina, which connected the Milanese with Austria; by swift action at Susa he forced the duke of Savoy to make peace; and finally he obtained the succession to the duchy of Mantua for a French prince in the treaty of Cherasco (1631).

Events in Germany called for more resolute action. After defeating the Bohemian Protestants, Ferdinand II had beaten Christian IV of Denmark at Lutter-am-Barenberge (1626); and the Edict of Restitution (1629) marked the Catholic victory, obliging the Protestant princes to surrender ecclesiastical property that had been secularized since 1552. Wallenstein, at the head of his army, enforced the edict and made ready to subject Germany to the emperor's authority. Richelieu put a stop to this advance at the diet of Regensburg (1630), where his closest adviser, Father Joseph, obtained the dismissal of Wallenstein and prevented the election of Ferdinand's son as king of the Romans. At the same time Richelieu was appealing to the king of Sweden, Gustavus II Adolphus, to intervene in Germany, in the hope that he would attack the emperor only, without threatening the Catholic princes. The Swedish army landed in Pomerania in 1630 and won resounding successes. Gustavus Adolphus, soon finding himself master of Germany, sought, in the face of Richelieu's opposition, to establish a great Protestant empire on the ruins of Catholicism. This ambition, even after the death of Gustavus at Lützen (1632), provoked a Catholic reaction just when the Protestant alliance was dissolving as a result of the defeat at Nördlingen (1634) and at the moment of the murder of Wallenstein, whom Richelieu had sought to set up as a rival to Ferdinand in Bohemia. In 1635 the emperor again dominated Germany.

The French had to intervene. They had already taken advantage of the Swedish victories by occupying Lorraine and by establishing themselves at Trier, in Alsace and on the Rhine, so as to have bases for further operations. Simultaneously Richelieu was negotiating with Sweden and with the United Provinces to get their collaboration and to ensure the liberties of the German princes. Finally, on May 19, 1635, France declared war on Spain and on the emperor. At the outset the war went badly for France. The capture of Corbie, near Amiens, by the Spaniards (1636) served to reveal the vulnerability of Paris, so dangerously near the frontier. But Spain was incapable of exploiting its success, and the situation was soon reversed; thanks to Bernhard of Saxe-Weimar and to the comte de Guébriant (Jean Baptiste Budes), Alsace was conquered. Faced with revolts in Portugal and Catalonia, Spain lost Artois in 1640 and Roussillon in 1642. These were Richelieu's last successes and he was considering negotiation to give France recognized possession of its conquests when he died, on Dec. 4, 1642. Five months later (May 14, 1643) Louis XIII died also.

Richelieu's ambitious policy necessitated a firmly grounded authority at home. The disorders of the previous years had shown the need for a resumption of absolutist methods. There was no meeting of the estates-general, but only an assembly of notables (1626). The provincial estates were rarely convened and always kept off politics. An edict forbade the *parlement* to take cognizance of public matters. Journalism, only just created by Théophraste Renaudot, was forced into the service of the government as was the Académie Française. Provincial and municipal privileges met with the same treatment. Richelieu denied to the people the right of criticizing the acts of the government and killed the spirit of public opinion that had been revealed in Jean Bodin's *Six livres de la République*, in J. A. de Thou's *Historia sui temporis*, in Étienne de la Boétie's *Contr'un* and in the *Satire Ménippée*. He was not an enemy of the nobles, to whom indeed he assigned a predominant position in the state, but intended to impose a strict discipline on them, rigorously enforcing the edicts against dueling and demolishing the châteaux of the marauding gentry.

To ensure the submission of the nobles, Richelieu made general the system of intendants, the king's representatives in the provinces, above the *officiers* (whose independence was thus limited). In reaction against the decentralization that had gone together with the League, Richelieu fell into the opposite error of too great a concentration of power. By means of the intendants he began that transformation of the monarchy whereby civilians and bureaucrats were given influence, to the exclusion of soldiers and aristocrats.

Richelieu's policy imposed heavy burdens on the people, so that economic progress had to be a major concern of his. He had clear ideas on industrial and commercial development, and mercantilist principles underlay his projects. These projects, however, were for the future, and he sacrificed them to pursue his foreign policy. He let the disorder subsist and was satisfied with the worst sort of expediency in providing the treasury with the requisite funds. The resumption of war and the excessive taxation had disastrous results: after 1630, among the rural population, insurrections arising from sheer misery were frequent; the *Croquants* rose in the south, the *Va-nu-pieds* in Normandy. Even the *rentiers* of the Hôtel de Ville in Paris, ordinarily a peaceful people, were excited by the curtailment of their incomes and, in 1639 and 1642, were roused to fury. Despite the great work that was accomplished the treasury remained empty and the reforms a dead letter.

Altogether, Richelieu was a statesman rather than an administrator. He looked upon material concerns as of secondary importance; he could organize neither an army nor a navy, neither justice nor finance nor colonies, but at most a police system. His true greatness lay in the art of diplomacy. His work was wholly accomplished in the field of foreign policy, where he displayed most consistency and foresight.

Louis XIV (1643–1715)

Mazarin's Ministry for Louis XIV (1643–61).—A pupil of Richelieu, the cardinal Jules Mazarin continued and completed his work. But the task was not done without many setbacks. The crown fell to an infant, Louis XIV, only five years of age in 1643. The regent, Anne of Austria, was a Spaniard and the prime minister was again a foreigner, as Concini had been. Mazarin did not have Richelieu's elevation of outlook but was highly intelligent and clever at dominating his adversaries. Unscrupulous in his methods, sometimes a trickster and avid for wealth, he justified the attacks made upon him by his enemies. But his talents, furthered by a favourable situation, allowed him resounding successes which made France the premier European power.

Anne of Austria began by getting the *parlement* to annul Louis XIII's will and to commit into her hands "the entire administration of the kingdom," which she forthwith entrusted to Mazarin. Through his adroit diplomacy and the military genius of two young generals, the prince de Condé (Louis II de Bourbon) and the vicomte de Turenne (Henri de La Tour d'Auvergne), France succeeded in defeating the combined strength of Spain and Austria. At Rocroi (May 1643) Condé destroyed the famous Spanish infantry, afterward joining forces with Turenne in Alsace. The Rhineland was freed by the victory of Freiburg im Breisgau (1644), and the generals were again victorious at Nördlingen in Bavaria (1645). Meanwhile Mazarin laboured unceasingly to preserve the Swedish alliance. The Swedes were finally victorious at Zusmarshausen (May 17, 1648), three months before Condé, at Lens (Aug. 20), for a second time defeated the Spaniards. At last the emperor Ferdinand III brought himself to sign the peace that had been under negotiation for seven years.

The Treaties of Westphalia (1648).—The treaties signed at Münster and at Osnabrück settled questions that had been vexing for 100 years, fixed the political structure of the Holy Roman empire and put an end to several territorial disputes (*see* WESTPHALIA, PEACE OF). The emperor recognized the liberties of Germany, which became a "republic of princes," guaranteed by France and Sweden. The states were to enjoy freedom of religion and a political freedom that would allow them to make alliances with foreign sovereigns. Sweden received western Pomerania and the bishoprics of Bremen and Verden. As for France, apart from the confirmation of its receiving the Three Bishoprics conquered in 1552, the acquisition of Alsace safeguarded the Rhine frontier and prevented the Spaniards from uniting Luxembourg to Franche-Comté. These treaties dispelled the Habsburg dream of a unitary Catholic and German empire. No peace, however, was signed between France and Spain.

The Fronde (1648–53).—To achieve the aims of his foreign policy Mazarin had needed more and more money from the kingdom. Careless of the details of financial administration, he had left the task of raising revenue to an Italian businessman, Michel Particelli d'Émery, who as *surintendant des finances* had earned the hatred of the public by the abusive or oppressive expedients to which he resorted. This hatred was reflected on his patron Mazarin. Coupled with enthusiasm from the revolutionary examples then being set by the Catalans, by the Portuguese and, especially, by the English, the discontent culminated in the outbreak of the Fronde, the complex vicissitudes of which are described in a separate article. It is enough here to say that what began as a movement by the "sovereign companies" (*parlement, chambre des comptes, cour des aides* and *grand conseil*) to overthrow the absolutism of royal or ministerial government led to three civil wars (Jan.–March 1649; Jan. 1650–Feb. 1651; and Sept. 1651–Sept. 1653) in the course of which the reforming intentions of the sovereign companies were superseded by the personal ambitions of the princes and of the nobility, often quite willing to treat with Spain. On several occasions, when the usually conflicting interests of their adversaries were temporarily reconciled, Anne and Mazarin had to submit to deep humiliations, which Louis XIV never forgot, but the Fronde ended with Condé a refugee in the Spanish Netherlands, the wretched Gaston an exile on his estates, the cardinal de Retz in prison and Mazarin triumphant in Paris as the king's henceforth unassailable chief minister.

The government had to make good the material losses of its wars. Poverty was worse now than in the last years of the League and called forth a vast work of charity, animated by St. Vincent de Paul. The financial disorder, moreover, was irremediable as long as war went on. The *surintendant* Nicolas Fouquet did what he could to meet requirements, including the lavish upkeep of Mazarin's household.

Treaty of the Pyrenees (1659).—Spain had naturally derived certain advantages from the Fronde, particularly from the military talents of Condé, who had passed to its service. Mazarin applied himself to restoring the position with Turenne's help. For external support he turned to England, despite the royal government's distaste for Cromwell's regime. In Germany he was able to form the League of the Rhine, to keep the empire neutral and to prevent the emperor's helping Spain (1658). This was a step forward in the policy of intervening in the Rhine countries, which developed under the pretext of protecting the liberties of Germany. The recapture of Dunkerque after Turenne's victory in the battle of the Dunes, which resulted in the conquest of Flanders, dealt the final blow to the Spaniards, who were compelled to make peace.

By the treaty of the Pyrenees (1659), France gained Roussillon, with much of Cerdagne, and Artois, with posts in Flanders, Hainaut and Luxembourg. Louis XIV married the eldest Spanish infanta, Marie Thérèse, who renounced her claims to the Spanish throne in return for a dowry of 500,000 crowns. Mazarin had thus realized the policy of Henry IV and Richelieu—the destruction of the Habsburg menace to France and the stabilization of the monarchy. It remained to be seen whether France would be satisfied with this achievement or risk new ventures to complete the destruction or the absorption of a power henceforth negligible.

Personal Government of Louis XIV (1661–1715).—The personal reign of Louis XIV began with Mazarin's death in March 1661. Louis's character was already formed. He was of average intelligence and had a certain practical sense but was sometimes misled by an ambition and a love of glory that obscured the true facts for him. His closely reasoned theory of government is expounded in his *Mémoires*. He found the elements of it in Richelieu's political writings, in Mazarin's teaching and also in his own experience. The Fronde had inspired him with a horror of revolutions, parliamentary remonstrances and disorder in general. He was imbued with a love of order that reflects the classical spirit of the times. His theory was that of absolutism pushed to the extreme: the king is God's lieutenant, responsible to God alone, and can dispose of the property and even of the conscience of his subjects. The superior rights of the people and, with them, the estates-general and the independent courts of justice, all these must be swept away; there could be no individual rights among his subjects; the sole remedy offered for their miseries was prayer and resignation. Thus the nation was to identify itself with the person of the king.

Likewise, the king was not to share his authority with anyone. The function of a prime minister disappeared with Mazarin, and the king governed by himself, with ministers who were merely secretaries. These he chose from among the middle classes, leaving to nobles and to churchmen posts that were honorific but powerless. Hugues de Lionne was foreign secretary until his death (1671); Michel Le Tellier was secretary of state for war and Fouquet was *surintendant des finances*. The king applied himself unremittingly to his task, receiving ambassadors, presiding at the councils to the day of his death and enjoying the exercise of this *métier de roi*.

No one dared question this system of government, though the duc de Saint-Simon describes it in his *Mémoires* as a "long règne de vile bourgeoisie." Never was there such a chorus of flattery round a sovereign. Jacques Bossuet justified the king's philosophy by citations from Scripture, and a troop of writers celebrated his virtues with an enthusiasm that was to capture later generations. The few dissidents incurred the royal displeasure: Fénelon, Vauban and the Jansenists, who were critical, brought disgrace upon themselves.

The cult of the king had its temple at Versailles, which Louis caused to be so appointed as to enhance the brilliant majesty of his person by a sumptuous and artistic environment; he could live there surrounded by his court, far from the Paris that was made hateful to him by the presence of the people and by memories of the Fronde. Attendance at court was the first and only duty in the eyes of a proud prince who noted everything, particularly absentees. Versailles became the centre of the national life and a model for foreign courts.

The reign witnessed no assembly either of the estates-general or of the notables. Most of the provincial estates were not convened, and the provincial or municipal autonomies ceased to be respected. The municipalities were subjugated under the pretext of restoring their finances; and the function of mayor was turned into a hereditary office. The governors of provinces were reduced

to representatives, and authority belonged to the intendants, the general system of the latter being henceforth the basis of the monarchical administration. The *parlements* themselves were confined to their judiciary functions. Only the assemblies of the clergy met regularly, because the king got subsidies and support against the total power of the popes from them. In administrative matters Louis introduced no innovation. Refusing to sanction any radical reform, he devoted himself to organizing in all its details the mechanical system inherited from his ancestors, both in the central and in the provincial administration. During his reign the central government systematically established its authority in the provinces by permanent use of intendants.

Colbert.—Louis's policy required a strong army and prosperous finances. It was Jean Baptiste Colbert who, for 22 years, gave himself up to this work of economic reorganization. He was of modest origin, from a family of Reims drapers. Beginning as secretary to Mazarin, he became *intendant des finances;* then he attained the foremost rank with the title of *contrôleur général des finances*, displacing Fouquet by extremely questionable maneuvers, after which he was made minister of state, *surintendant des bâtiments* and secretary of state for the navy, having thus the entire internal administration of the kingdom assigned to him. If his ambition was unbounded, his capacity for work and his application were not less; in addition to his economic measures, ordinances on civil and on criminal procedure (1667–73) inaugurated the legal system of the Code Louis, which was to be superseded only by the Code Napoléon.

Colbert sought to establish the greatness of the king on the increased wealth of the kingdom and to set up a stable finance that would provide resources for which there would be no call. He was against war and extravagance; that is, against the policy of magnificence to which he had to resign himself and which eventually caused the collapse of his work. His first concern was to set France to work, to get that abundance of money which constitutes "the power and the strength of the state": a mercantilist system already practised and appreciated by his predecessors, but now so amply developed as to be described as *colbertisme.* He wanted every subject of the king to be obliged to work and to produce. He hated idleness and denounced as idle the *rentiers,* the *officiers,* the nobles and the churchmen. He deplored men's inclination to a life of ease and wanted to frustrate it by constraint. Likewise he sought to prevent any slackness by disciplining the workers. The corporate system was substituted for independent work, and detailed instructions were issued to ensure uniformity and high quality in products. As, nevertheless, the small artisans still produced little and proved recalcitrant to his discipline, Colbert endeavoured to substitute privileged and better-equipped manufactories. He thus created the royal manufactories of furniture and tapestries (Gobelin), of carpets, of mirrors and of cloth. The main difficulty was to set up companies and to find capital. Colbert was exacting and raged against opposition.

To complete this work he had to promote commerce and, above all, navigation. Envious of the Dutch, who enriched themselves by carrying the merchandise of other countries, he wanted to compete with them. He therefore had ships built and companies created and initiated a far-reaching colonial policy that was inspired by Richelieu's earlier efforts. He sought new markets and endeavoured to revive French interest in those enterprises in which it had been outstripped by the English and the Dutch trade. He extended New France from Canada to the Mississippi by supporting La Salle in Louisiana; he added to this the French tropical possessions in Guiana; he established the king's authority on the African coast from the Bay of Arguin to the shores of Sierra Leone; and he gained a footing in Madagascar and established the first French trading posts in India. A commercial monopoly of these territories was given to the great royal companies. To defend the colonies Colbert created a navy and for its accommodation Vauban constructed great arsenals at Brest, Le Havre, Dunkerque, Rochefort and Toulon. For the Atlantic fleet he introduced the system of maritime conscription that remained almost unmodified thereafter. As a result of his efforts the French navy, at least until 1692, was in perfect condition.

To support this activity Colbert set up a system of protectionist customs whereby manufactured goods imported into France were taxed while raw materials could be brought in free. The first, relatively liberal, tariff of 1664 was superseded by the tariff of 1667, which was frankly prohibitive and constituted one of the causes of the Dutch War. By this means a favourable balance of trade was to be established; *i.e.*, the kingdom would sell manufactured goods abroad without buying anything for its own consumption and receive in exchange the gold that all this economic activity was devoted to acquiring.

This new wealth paved the way for that restoration of finances which the destitution of the past 50 years necessitated. The first task was to get rid of a debt that was swallowing up all the state's revenue in interest. Colbert succeeded by the classic maneuvers, practical but dishonest; he set up a *chambre de justice*, which terrorized businessmen into canceling their credits and began by making an example of the *surintendant* Fouquet, in contradiction of all justice. This bankruptcy of the state led to the restoration of financial equilibrium. Subsequently, Colbert safeguarded this equilibrium by accumulating revenues; as he could not increase the income from the *taille* without overwhelming the poor and affecting the privileged classes, he preferred to develop the system of indirect taxation, the *aides,* which touched all consumers. He worked at the same time to reduce expenditure, adjuring the king to give up his extravagances. He could thus balance the budget as long as the king showed moderation. But at his death the equilibrium was already compromised, and the final reverse came with the advent to power of less clear-sighted ministers and with the mounting expenditure on the armed forces. Colbert had given the royal finances a moment of respite amid the series of disorders that were to lead to the fall of the regime.

The Army.—At the same time an effort was made to reorganize the army. This work had been begun by François Sublet des Noyers (under Louis XIII) and was taken over by Michel Le Tellier and by Le Tellier's son François Michel, marquis de Louvois. The old army, commanded by undisciplined nobles, was replaced by an orderly organization. Its hierarchy of officers was fixed and its strength was to be kept at its full complement, with volunteer recruits and, later, *miliciens* pressed into service. The commissariat was organized and armaments perfected, with plentiful artillery. Particular attention was paid to the capture and defense of fortresses, the concern of the engineers. This last corps was the creation of Sébastien Le Prestre de Vauban, who remained through the reign the great practitioner of siege warfare and encircled the kingdom with a belt of strongholds specially fortified against artillery fire.

Religious and Ecclesiastical Affairs.—Louis XIV, the "most Christian king and eldest son of the church," considered himself the ruler of the souls of his subjects. Thus he felt himself called upon to establish the unity of the faith and to repress all dissenters, Huguenots, Jansenists or Quietists, whose independence was insupportable to him. Religious division, moreover, was impairing the structure of the state, which was ceasing to provide for the salvation of the people just as it was no longer the guardian of their material interests. For these reasons, gently at first, then more violently as he became still more of a bigot, Louis's absolutism in religious matters asserted itself with the willing consent of a nation in love with the ideal of unity.

Since the peace of Alès, the Huguenots had enjoyed freedom of worship and had prospered in the fields of industry, agriculture and commerce. The clergy, under the influence of the Compagnie du Saint-Sacrement, sought to bring them back to Catholicism, first by persuasion, later by a legal and narrow interpretation of the Edict of Nantes. The king's passion for absolutism, his religious zeal (the more active since he wished to make amends for his injuries to public and to private morals), the financial necessity of increasing the voluntary offerings of the clergy and of gaining their support in his quarrels with the papacy—all these led Louis to identify himself with this religious policy. Between 1661 and 1685 the Huguenots were successively excluded from the diplomatic service and from the municipalities and deprived of their hospitals, colleges, academies and schools. Fines proving inade-

quate, soldiers were quartered upon the recalcitrant under the system of *dragonnades*, which brought about mass conversions. Louis, thinking that an act of authority would settle the matter, revoked the Edict of Nantes (1685). There followed a mass emigration and later the terrible revolt of the Camisards (*q.v.*), who held the royal armies in check in the Cévennes from 1703 to 1711, at a time when the kingdom was threatened with invasion. Nevertheless, Protestantism was not entirely destroyed.

The persecution of the Jansenists arose from the same principles. The theories of Cornelius Jansen, bishop of Ypres, and of the abbé de St. Cyran (Jean Duvergier de Hauranne) revived those of St. Augustine on grace and predestination and inculcated a strict morality in reaction against contemporary licentiousness and against the servile spirit pervading society. The sect attracted many of the disillusioned followers of the Fronde and, because of the brilliance of its writers and thinkers (*e.g.*, the Arnauld family and Blaise Pascal), made a formidable body of opinion. Its centre was Port Royal, near Paris, where the Solitaires had settled. Eventually, when the nuns of Port Royal refused to accept without reserve the bull *Vineam Domini*, they were dispersed (1709) and their convent demolished (1711). The bull *Unigenitus* (1713), which once again condemned their doctrine, reopened a dispute that survived the death of Louis and filled the 18th century with its reverberations. (*See* JANSENISM.)

The much less grave affair of the Quietists likewise arose from the desire for uniformity. That it was even for a moment serious was due to the fact that Madame de Maintenon and the ladies of St. Cyr were waging war upon the mysticism of Madame Guyon (Jeanne Bouvier de la Motte), who had abandoned dogmas and prayers and had given herself up to the pure adoration of God. Fénelon, who had sympathized with her doctrines, was condemned in 1699; and the affair was important only because of his duel with the representative of the principle of authority, Bossuet.

The *libertins*, philosophers such as Pierre Bayle, savants such as Bernard le Bovier de Fontenelle and commentators apart from the main tradition such as Richard Simon, were exiled or kept under surveillance and their writings banned; but their doctrines were to appear again in the 18th century.

Despite his Christian attitude, Louis was constantly in conflict with the papacy through his wish to assert the independence of the temporal power from pontifical authority. This conflict had its origins in the distant past and had flared up in the time of the League; and under Louis XIII the Gallican principles expounded by Edmond Richer in his book *De la puissance ecclésiastique et politique* (1611) had caused long controversy. Under Louis XIV the conflict was aggravated by diplomatic incidents which impaired relations between king and pope, but the principal issue between them was in the matter of their rival jurisdictions, raised now by the question of the *régale*. Louis asserted, even more forcefully than his predecessors, his title to the usufruct of the temporal goods and spiritual rights of bishoprics that fell vacant—and that throughout the whole extent of the kingdom. Nicolas Pavillon and François Étienne de Caulet, bishops of Alet and Pamiers respectively, both of whom moreover were Jansenists, contested this claim and appealed to the pope.

The assembly of the clergy, to whom the question was referred, wanted to make a general pronouncement on "the usage of the power of the popes." Thence emerged the declaration of the Four Articles of 1682, which propounded the principles of Gallicanism, asserting that the pope has power over spiritual things alone, that general councils overrule him, that the rules of the Church of France are inviolable and that papal decisions on matters of faith are revocable only by consent of the church. This declaration widened a break that threatened to become a schism. The pope refused to consecrate the bishops nominated by the king. Louis, worried by the resistance that he was encountering all over Europe, withdrew the Four Articles (1693), although their doctrines continued in practice.

Foreign Policy.—Louis came into power at a time when all danger of a Spanish or imperial hegemony had been dispelled. "Peace was established for as long as I myself should wish it," he said. The traditions of Richelieu and Mazarin and the treaties of Westphalia and of the Pyrenees might have formed the basis of a policy of moderation. But Louis dreamed only of glory and "wanted business abroad," so as to make conquests. The treaties for him were the starting points of new projects: the seizure of the Spanish possessions and then of Spain itself and interference in imperial affairs by means of the League of the Rhine. The reinforcement of the army, the creation of the navy and the financial reforms were motivated only by the need to provide means of action.

As early as 1661 Hugues de Lionne encouraged Louis to use the treaty of 1659 to provoke a quarrel with Spain, and the king was exploiting the slightest incidents to threaten his neighbours. He claimed precedence for his ambassadors at foreign courts over those of other kings and refused to have his ships salute English ships in British waters. The dispute between his ambassador's escort and the pontifical guard in Rome led to a battle in the streets. Most serious was his claim to Spanish territories in the name of his wife, Marie Thérèse, on the ground that her renunciation of her paternal heritage was not valid. This claim compromised the destiny of the Low Countries and disturbed the United Provinces, with whom an alliance had just been made. The purchase of Dunkerque, to which Charles II of England had agreed, likewise disturbed English public opinion; and while he wanted to keep alive the existing hostility between England and the United Provinces, Louis's policy had rather the effect of promoting their *rapprochement* in the face of French encroachment. At the same time political interventions in Lorraine and in Alsace roused the empire and the German princes against France.

War of Devolution (1667–68).—From 1659 Louis was thinking of spoil from the Spanish monarchy, which he accused of not complying loyally with the peace treaty. When Philip IV died (1665) Louis demanded the heritage of Marie Thérèse, invoking the right of devolution although it did not apply to public law (*see* DEVOLUTION, WAR OF). After military and diplomatic preparation, Turenne's army conquered part of the Low Countries (1667). In Feb. 1668 Condé occupied Franche-Comté in 14 days. These successes forced Spain to make peace but caused anxiety among the neighbouring powers, particularly among the Dutch. Johan de Witt organized the triple alliance between the Dutch, the English and the Swedes, which prevented any further French advance. The peace of Aix-la-Chapelle (1668) left France with some strongholds in Flanders, which Vauban fortified. The war ended favourably to Louis, but the result warned him that his very allies were ready to coalesce against him.

Dutch War.—Because it constituted an obstacle to his progress and was responsible for his recent humiliation, Louis wanted to destroy the Calvinist bourgeois power of the United Provinces, against which, moreover, Colbert had grievances on the commercial side. For several years Hugues de Lionne endeavoured to break up the triple alliance; and he contrived an alliance with England (1670) and Sweden (1672) and even made sure of the emperor Leopold I's neutrality, as well as that of the important German princes (1671). Thus isolated, the United Provinces succumbed without much resistance (1672). In two months the French were at the gates of Amsterdam; but Holland was saved by inundation when the dikes were broken, and the republican party of the brothers De Witt, which was inclined to peace, was overthrown. Power was entrusted to the stadholder William of Orange, who broke off the peace negotiations. Louis's excessive demands alienated all the powers, and a coalition was formed between Charles II of Spain, the emperor Leopold, most of the German princes and even Charles II of England, who had to bow to the will of parliament (1673–74). Louis had to withdraw his armies, and the war continued on the Rhine, in the Mediterranean and in Franche-Comté, which was again taken from the Spaniards. The victories of Condé and Turenne restored the situation. The peace of Nijmegen (1678–79) secured the independence of the United Provinces—at the expense, however, of Spain, which had to surrender Franche-Comté and positions in the Low Countries. Louis emerged with profits from a war that should have made him cautious. (*See* DUTCH WARS.)

French policy, on the contrary, became increasingly provocative. Claiming all the feudal dependencies of his newly won provinces,

Louis annexed a number of territories in consequence of decisions made by the *chambres de réunion* set up for the purpose in the Low Countries, in Lorraine and in Alsace, where Strasbourg was occupied (1681). Luxembourg surrendered after a siege (1684). The minister responsible for the execution of this policy was Charles Colbert de Croissy, brother of J. B. Colbert. All Europe felt the threat of these peacetime annexations. The king of Spain was rash enough to declare war, but had neither the allies nor the means to keep it up. In agreement with the emperor, he had to recognize Louis's acquisitions by the truce of Regensburg (1684). France seemed at the zenith of its prosperity, but hatred and hostility were growing on all sides.

War of the Grand Alliance.—Circumstances increased the political tension. The revocation of the Edict of Nantes disturbed Europe, leading to a rupture with Brandenburg and making any understanding with the United Provinces impossible. When Louis intervened to get his protégé the cardinal Wilbelm von Fürstenberg elected archbishop of Cologne, further aggression was to be expected. The powers concerned formed the League of Augsburg, comprising the emperor Leopold and all other sovereigns interested in the defense of Germany (1686). Its strength was increased when William of Orange, son-in-law of James II of England, on the appeal of the Protestant party took the English crown as William III (1688) and became the head of the coalition, from which was developed the Grand Alliance of Vienna (1689).

War had already begun; Louis had taken the opportunity of a dispute about the succession of the elector Charles of the Palatinate to invade the Rhenish provinces. The war developed particularly at sea, as the maritime powers, England and the United Provinces, were anxious to ruin French commerce. The French unity of command gave Louis certain victories over the continually disunited allies: at Fleurus (1690), at Steenkerke (1692) and at Neerwinden (1693) in the Low Countries and at Staffarda (1690) and at Marsaglia (1693) in Italy. But the comte de Tourville, after the annihilation of his fleet at La Hogue (1692), lost the command of the sea, and this changed the position of the belligerents definitively. (*See* GRAND ALLIANCE, WAR OF THE.)

Unable to destroy the coalition, Louis had to negotiate and to reduce his demands continually. The peace of Rijswijk (1697) formulated these concessions. Louis kept Strasbourg, but gave back Lorraine, Mons, Luxembourg, Courtrai and some of the territories incorporated in the kingdom, recognized William of Orange as king of England and renounced certain economic measures of reprisal.

War of the Spanish Succession.—Louis's readiness to make peace resulted mainly from his interest in the question of the Spanish succession, which seemed likely to arise shortly. He had always asserted his rights to the Spanish heritage, bargaining meanwhile with the emperor, who made rival claims. He was aware that the European powers would not agree to Spain's being attached either to France or to Austria. To secure the support of the maritime powers he negotiated the treaties of The Hague (1698) and of London (1699) with William III, whereby certain territories were to go to the dauphin and the rest to a Bavarian prince or even to an Austrian archduke; the emperor, if he rejected this arrangement, would be forced to accept it by the contracting parties.

Charles II of Spain died on Nov. 1, 1700, having named as his sole heir Louis's grandson, Philippe, duc d'Anjou; and Louis, regardless of his undertakings, accepted the testament, risking a coalition of all the duped and disappointed powers. His decision would have been tolerated had he not added further provocations: he asserted the right of the new Spanish king Philip V to the crown of France (Dec. 1700) and expelled the Dutch forces from the towns that they were occupying in the Low Countries (Feb. 1701). This was a challenge to all the powers, who reconstituted the Grand Alliance in the fall of 1701. At the same time Louis recognized the Stuart pretender James (III) as king of England.

France lacked the necessary financial resources: the budget had shown a deficit since 1672, and if the nation's armed forces were comparable to those of the coalition it yet had no commanders equal to Prince Eugene of Savoy or to the duke of Marlborough. Though from 1701 to 1703 fortune was equally balanced, the French were defeated at Blenheim (1704) after the treachery of the duke of Savoy. In 1706 the defeats of Ramillies and Turin led to the evacuation of the Netherlands and of Italy. In 1708 the disaster of Oudenaarde left the northern frontier exposed. Louis was forced to ask for peace from the Dutch but, disgusted by their unwillingness to compromise, began a new campaign and was defeated at Malplaquet (1709). Invasion followed, and Louis was saved from disaster only by his dauntless courage, by the strong will of his secretary of state the marquis de Torcy (Jean Baptiste Colbert, son of the great Colbert) and by the victory of the duc de Vendôme at Villaviciosa (1710). Peace was finally obtained (1) because the Tories, now weary of the war and chiefly anxious to secure mastery of the sea, superseded the Whigs and Marlborough in power in England; (2) because the death of the emperor Joseph, in 1711, made his brother Charles VI emperor in his place, so that if he had won Spain as well, the world-wide empire of Charles V would have been reconstituted, to the disadvantage of all other belligerents; and (3) because the marshal de Villars, in 1712, won the victory of Denain for France. The treaties of Utrecht and Rastatt recognized Philip V as king of Spain, with the Spanish colonies in America; but the Spanish Netherlands, Naples and Milan had to be ceded to Austria and the kingdom of Sicily to the duke of Savoy. England, moreover, obtained Gibraltar and Minorca from Spain and Newfoundland, Nova Scotia and Hudson bay from France.

End of the Reign.—Internal difficulties were as bad for France as were the military disasters. The royal family had suffered such losses that the succession seemed precarious: the dauphin Louis (*le grand dauphin*) and his son and successor as dauphin, Louis, duc de Bourgogne, were dead, so that the heir to the throne, in 1715, was Louis XIV's great-grandson, a five-year-old child. The great ministers of the early years, Lionne, Le Tellier and Colbert, had gone; Louvois had died in 1691; and their successors were the marquis de Seignelay and the marquis de Torcy (both Colbert's sons), the comtes de Pontchartrain (Louis Phélypeaux and his son Jérôme), Michel Chamillart and Nicolas Desmarets.

The policy of grandeur had as its counterpart the ruin of the kingdom. The excessive governmental direction, the raising of the customs tariffs and the wars made industry and commerce waste away. Agriculture was affected, and years of bad harvests led to nationwide famines, as in 1709.

Moreover, the general economy of the country was affected by the general fall in prices, which ruined producers and owners and paralyzed business. The population itself was declining, with the emigration of the Protestants depriving the kingdom of an especially industrious element. All this brought chaos into the royal finances: taxation could not meet the constantly increasing expenditure but crushed the poorer classes; new taxes were evolved, and the government resorted to such expedients as devaluation, borrowing and the sale of more offices. It was the reign of contractors or *partisans* and bankers (*e.g.,* Samuel Bernard), who became the suppliers of the treasury.

The government was criticized by Fénelon and by Vauban in his *Dîme Royale* (1707), and the political literature of the 18th century was already making its appearance. Nothing remained of the splendours of the reign but its artistic and literary achievements.

Louis XIV died having ruined a kingdom that Richelieu and Mazarin had raised to its apogee. He left it enlarged but impoverished. The enthusiasm that had greeted his earlier victories had died away, and his funeral was marked by the rejoicings of the people. (R. DT.; X.)

THE 18TH CENTURY (1715–89)

The Regency (1715–23).—Much of the blame for the chronic weakness of the Bourbon monarchy in the 18th century may be attributed to the onerous legacy of Louis XIV. In 1715 French finances were in ruins; the Gallican Church was divided by Jansenist opposition to the bull *Unigenitus;* and a powerful resurgence of the political pretensions of the lay and judicial aristocracy threatened a return to the civil disorders of the Frondes. These three problems—financial instability resulting from war, religious

dissension arising from the attempt to enforce uniformity, and the revolt of the aristocracy against centralized absolutism—were to harass and weaken the Bourbon monarchy for the greater part of the 18th century. The first symptoms of decline were revealed in the brief but significant period of the regency.

One of the last and most misguided acts of Louis XIV was the attempt, in his will, to fetter the authority of the regent who would govern France in the name of the five-year-old Louis XV during the latter's minority. The claim of Philippe, duc d'Orléans, the prince of the blood nearest to the throne and the nephew of Louis XIV, to the regency was incontestable. His depraved character and dynastic ambitions had, however, made him suspect to the dying king. In his will Louis had, therefore, provided for the establishment of a council of regency, of which Orléans was to be merely titular president without effective power. This council was to be composed of representatives of the old court, the existing ministers and secretaries of state and Louis XIV's two legitimized bastards, Louis Auguste, duc du Maine, and Louis Alexandre, comte de Toulouse, who, to the indignation of the old nobility, had been granted the full rights of princes of the blood, including that of eventual succession to the crown (1714). The decisions of this body were to be taken by majority and the regent was to exercise only a casting vote. The education of the king and the command of the household troops were entrusted to the duc du Maine.

It was easy, however, for Orléans to stultify Louis's attempt to rule from the grave, for in similar circumstances Anne of Austria had set aside the will of her husband Louis XIII. Relying on this precedent, Orléans, by agreeing to restore to the Paris *parlement* the right of remonstrance against royal edicts, induced it to annul Louis XIV's will. Simultaneously, on Sept. 15, 1715, a royal declaration announced a new experiment in conciliar government. This registered a reaction against the ministerial system of Louis XIV in the interest of the high nobility and was designed in accordance with the ideas of Fénelon, who had sharply criticized Louis XIV's absolutist government, and of the duc de Saint-Simon, who had condemned the upstart rule of ministers of nonnoble origin. The controlling organ of the new political system was to be a council of regency appointed by and presided over by Orléans. This was to act both as a co-ordinating authority in matters of high policy, thus superseding the old *conseil d'en haut*, and also as the chief executive. The other councils were to be specialized as regards their competence and subordinate to the council of regency. There were to be seven such councils, each with a membership of ten presided over by a prince of the blood or by a peer. Four (war, admiralty, finance and foreign affairs) replaced former ministries or secretaryships of state; the others (the interior, ecclesiastical affairs and commerce) were new creations. Though the preponderating influence was initially wielded by the nobles, an important place was reserved for representatives of the *parlements;* and members of the old court, the legitimized princes and former ministries were also included. It should also be noted that this system left the former central administrative councils—the council of state and the privy council—undisturbed and that local government still continued to be controlled by the intendants. In fact it was soon found that the Polysynodie, as the new system was called, was too cumbrous a mechanism to work efficiently and on Sept. 24, 1718, the regent restored the four secretaryships of state, suppressing the corresponding number of councils. The other specialized councils were abolished before 1722. The collapse of the conciliar experiment may be explained by the political and administrative incompetence of the nobles, by the regent's preference for working with a restricted circle of trusted associates rather than through the council of regency, and by his decision to entrust the real responsibility for foreign affairs to his secret adviser, the abbé Guillaume Dubois, and to rely for the solution of financial problems on the Scotsman John Law—both of whom were ambitious for ministerial office.

Diplomacy.—The permanent importance of the regency lies mainly in the new Anglo-French diplomatic alliance and in the failure of Law's financial experiments. The former was the achievement of Dubois, who concluded the Triple Alliance of The Hague with Great Britain and the United Provinces on Jan. 4, 1717. This was the culmination of secret negotiations conducted in 1716 with James Stanhope and the British ambassador in Paris, John Dalrymple, earl of Stair. The alliance was designed to ensure the dynastic interests of Orléans against the reversionary claims of Philip V of Spain to the French throne in the event of the sickly Louis XV's death and to protect the Hanoverian succession in England against James Stuart, the Old Pretender. Though Dubois was accused of truckling to the British, this "diplomatic revolution" was consonant with France's overriding need for a period of peace. The object of Dubois was, indeed, to uphold the Utrecht settlement by co-operating with the British government and by reconciling Austrian and Spanish claims in Italy. Under the terms of the Quadruple alliance of Aug. 2, 1718, between the three new allies and the Holy Roman emperor, it was agreed that the emperor Charles VI should receive Sicily in exchange for Sardinia and that the duchy of Parma should eventually, on the extinction of the Farnese male line, pass to Don Carlos (*see* CHARLES III, king of Spain), eldest son of Philip V and his second wife, Isabella Farnese. Spain, whose policy was controlled by Cardinal Alberoni, had already seized Sardinia from the emperor and was launching an attack on Sicily; and Alberoni now set on foot an anti-Orléanist plot in Paris (the Cellamare conspiracy) and intrigued with Charles XII of Sweden to project a Jacobite invasion of Great Britain from Norway. Dubois accordingly joined Great Britain in attacking Spain in 1719 and in forcing Philip V to dismiss Alberoni and to submit, in 1720, to the terms of the Quadruple alliance. Philip V once more renounced his claims on the French throne, while the emperor guaranteed the dynastic rights of Orléans. French mediation in the later stages of the Great Northern War was also successful in bringing peace to the Baltic, though at the cost of sacrificing the Swedish Baltic provinces to Russia at the treaty of Nystadt (1721). After Stanhope's death Dubois was able to make France, for a few years, the predominant partner in the Anglo-French alliance and to effect a *rapprochement* with Spain, which resulted in a Franco-Spanish alliance of March 27, 1721, and in a double marriage contract with the court of Madrid: Louis XV was betrothed to the infanta Mariana, daughter of Philip V and Isabella Farnese; and Don Luis, the heir to the Spanish throne, was to marry the regent's daughter Elizabeth. For these services Dubois was made *premier ministre* in Aug. 1722.

Finances.—The financial problem which confronted the regent on Louis XIV's death was acute. The treasury possessed less than 1,000,000 livres in liquid assets. Net revenue had sunk to 69,000,000 livres, while normal expenditure had risen to 146,000,000. The revenues for 1716 and 1717 had been anticipated almost completely, those for the years 1718–22 partly. State promissory notes (*billets d'état*) to the value of 600,000,000 livres had depreciated to a quarter of their face value, the funded debt amounted to 1,200,000,000 livres and the floating, or short-term, debt to 1,800,000,000. Having rejected the idea of declaring a state bankruptcy, the council of finance, presided over by Adrien Maurice, duc de Noailles, attempted both to carry out immediate salvage operations by making the war profiteers and contractors disgorge their profits and also to carry out fundamental financial reforms. After the failure of these efforts the regent called in the assistance of the Scottish financier John Law.

Law was no charlatan, nor mere adventurer, but a farsighted and shrewd exponent of modern banking and currency theory. His solution for France's financial embarrassments was to rid the state of its dependence on the farmers-general or Company of General Tax-Farmers for the raising of indirect taxes, to hand over the responsibility for the management of the state debt to a financial company and to organize a state bank, modeled on the banks of England and of Amsterdam. French finances could be saved, so he contended, and French industry and commerce promoted by recourse to a "managed" system of paper currency. These ideas were to be implemented in a three-stage operation—first, the creation of a private and, ultimately, a royal bank, to issue a paper currency which would displace the metallic currency; second, the formation of a vast commercial company to take over from the financier Antoine Crozat and then to exploit the resources of Louisi-

ana and other colonial territories; third, the amalgamation of the bank and the company in a state trust to control the whole of French finance, industry and commerce. Certain aspects of this "system" were carried out with success: the private bank of 1716, with its stable "bank money" and discounting facilities, operated well from the outset; government *rentiers* provided the capital for the organization of the Compagnie d'Occident, which absorbed other colonial companies and eventually became the Compagnie des Indes; and progress was also effected in allowing the amalgamated trust virtually to collect the whole of the state revenue, to manage the public debt and to control French commerce. Law's currency schemes, however, foundered when the royal bank found itself compelled to overissue the paper currency to finance the successive extensions of the commercial company. The initial soundness of the Compagnie d'Occident was undermined by excessive speculation in its shares and in those of less respectable enterprises. Law's "system" was also violently opposed by the farmers-general, who organized an "antisystem"; by the *parlement* of Paris; and also by the British ambassador, who was alarmed at the way in which English craftsmen were being employed by Law to found new industries in France. Overspeculation was followed by the collapse of the system in 1720, by the flight of Law and by the painful liquidation of his experiments by the powerful financier Joseph Pâris-Duverney. The effects on the French economy were profound. Though the Compagnie des Indes survived the crash and continued its operations till 1769, many investors were ruined and all future efforts under the *ancien régime* to endow France with central banking institutions were doomed to failure.

Religion.—Nor was the regency any more successful in its handling of the problems created by the bull *Unigenitus*. Though the regent encouraged the Jansenists by making their protector, the cardinal-archbishop of Paris, Louis Antoine de Noailles, president of the council of ecclesiastical affairs and by restoring the political power of the strongly Gallican *parlement* of Paris, he subsequently reversed this policy, on the advice of Dubois. The attempt to impose silence on the opponents of the bull in 1720 no doubt helped to procure Dubois his cardinal's hat (1721), but did nothing to reconcile the Jansenist bishops, who were then appealing against the pope's authority to that of a general church council.

Louis XV (1723–74).—The coronation of Louis XV took place at Reims in Oct. 1722. In Feb. 1723 he attained his majority after his 13th birthday, thus terminating the regency. Orléans died on Dec. 2, 1723, and Louis Henri, duc de Bourbon, as the eldest prince of the blood, was appointed principal minister. Bourbon, who was a political cipher, was dominated by his mistress, the marquise de Prie (Agnès Berthelot de Pléneuf). On her advice he took as his chief financial adviser Pâris-Duverney. Pâris-Duverney attempted to restore financial equilibrium by imposing, in June 1725, a new tax, levied in kind, of 2% on all revenue from land, thus partially abolishing the fiscal exemptions of the nobility. This levy aroused the opposition of the lay, clerical and judicial aristocracy and only realized 5,000,000 livres instead of the 25,000,000 which had been anticipated.

Bourbon then turned his attention to the necessity of providing Louis XV with a wife. The Spanish infanta; to whom he was betrothed, was dismissed as too young, and in 1725 he was married to Marie, daughter of Stanislaw Leszczynski, former king of Poland. This precipitate step alienated Spain, which retaliated by returning the two princesses of the house of Orléans (the widow of Luis and her sister, who was to have another Spanish infante) and by signing an alliance with Austria (April 1725). This second "diplomatic revolution" caused the renewal of the Anglo-French alliance by the treaty of Hanover (Sept. 1725), which in turn led Austria and Spain to come closer together in the first treaty of Vienna (Nov. 5, 1725). When Bourbon tried to use the new queen to get rid of André Hercule de Fleury, the king's former tutor, both he and his mistress Madame de Prie were dismissed (June 1726).

Fleury's Ministry (1726–43) and the Austrian Succession.—At the time when he assumed the direction of policy as minister of state and cardinal, Fleury was already 73. Under his guidance the country recovered from the financial aftermath of the War of the Spanish Succession and the collapse of Law's "system" and reached the highest pitch of economic and commercial prosperity that the *ancien régime* ever saw. By his firm handling of the religious problems presented by Jansenism, Fleury succeeded in imposing the acceptance of the bull *Unigenitus* on the French Church in 1730, though he did nothing to promote the fundamental reforms which would have been the best insurance against the attacks of the *philosophes* later in the century. The charge that he neglected the navy and commercial development has been shown to be unjustified.

Shrewdness, patience, a clear-sighted appreciation of France's true interests in the changing power structure of Europe and a determination to restore the independence of French foreign policy were at the root of Fleury's success in foreign affairs. His main objectives were the preservation of European peace, an alliance with the Spanish Bourbons and reconciliation with the house of Habsburg. In order to prevent general war in 1727 Fleury was prepared to continue the English alliance, while striving for the dissolution of the rival groupings of the major European powers. He first induced the emperor Charles VI, through the preliminary treaty of Paris (May 31, 1727), to allow the fate of the Ostend company to be decided by a congress of the powers at Soissons. He then forced Philip V to abandon Spanish claims on Gibraltar and to restore English commercial privileges (preliminary convention of the Pardo, March 1728). This allowed the English minister Charles Townshend to secure the confirmation of these concessions by concluding with Spain the treaty of Seville (Nov. 1729) in return for promises to promote the claims of Don Carlos to Parma and Piacenza and eventually to the grand duchy of Tuscany. Austria's consent to these terms was obtained by Sir Robert Walpole in the second treaty of Vienna (March 1731), in which he gave Great Britain's consent to the Pragmatic Sanction, guaranteeing the Austrian succession to Charles VI's daughter Maria Theresa. Fleury accepted these diplomatic humiliations not out of timidity, but because he foresaw that Spanish and Austrian interests would be bound to diverge and that, when they did so, French influence could be reasserted. This opportunity came with the crisis over the Polish succession in 1733.

On this issue Austria and Russia, allies since 1726, supported the claims of Augustus III (Frederick Augustus II of Saxony) against those of Stanislaw Leszczynski, father-in-law of Louis XV, who was elected by the Polish diet (*see* POLISH SUCCESSION WAR). After Russian troops had ejected Leszczynski and installed Augustus, war was inevitable. Germain Louis de Chauvelin, Fleury's foreign minister, built up a series of European alliances—with Sardinia, Spain, Bavaria, Sweden and Turkey—nominally in support of Leszczynski, really as a Bourbon combination against the Habsburg. Fleury committed France to the war unwillingly and with the intention of withdrawing from it as soon as possible. His policy was to encourage British neutrality by engaging not to attack the Austrian Netherlands, to terminate the Bourbon-Habsburg vendetta by a cautious *rapprochement* with the emperor, and to prevent Spain from being alienated by his pro-Austrian sympathies. He gave only lukewarm military support to Leszczynski, prevented French troops from penetrating deeply into Germany and, though helping Don Carlos to conquer Naples, restricted the French offensive in northern Italy. As the result of secret negotiations with Vienna he concluded preliminaries of peace with the emperor in Oct. 1735, which were ratified in Nov. 1738 in a general peace treaty known as the third treaty of Vienna. Leszczynski was compensated for the loss of the Polish crown with the duchy of Lorraine, which on his death was to revert to France, while Francis of Lorraine, husband of Maria Theresa, was given the grand duchy of Tuscany. Don Carlos was allotted the kingdom of Naples. In this way Fleury had at last broken the British diplomatic predominance on the European continent, consolidated the first Family compact with Spain (Nov. 1733) and, by guaranteeing the Pragmatic Sanction, had effected reconciliation between the Bourbons and Habsburgs. A by-product of this new French ascendancy in continental affairs was French mediation in 1739 in the Austro-Russian war with Turkey at the treaty of Belgrade. Turkish gratitude for French support resulted in the renewal and exten-

sion of French commercial privileges at Constantinople (capitulations of 1740).

In 1740 Fleury wished to avoid continental commitments and to concentrate on the colonial conflict which had broken out the year before between France's ally Spain and Great Britain. On the death of the emperor Charles VI in October, he tried to maintain this policy by equivocation, immediately recognizing Maria Theresa as heir to the dominions of the Habsburg house of Austria but seeking to procure by diplomatic means the election of Charles Albert of Bavaria as emperor instead of Maria Theresa's husband (*see* AUSTRIAN SUCCESSION, WAR OF THE). The invasion of Silesia by Frederick II of Prussia in December, however, played into the hands of the French war party led by the comte de Belle-Isle, which was intent on a partition of the Habsburg inheritance. It was Belle-Isle who negotiated a treaty of alliance with Prussia in June 1741 and persuaded Fleury to commit France to the continental struggle as an auxiliary of Bavaria. French forces penetrated to Prague in Nov. 1741 and ensured the election of Charles Albert as emperor, with the style of Charles VII, in Jan. 1742. Fleury then wished to withdraw from the war, but the Austrian conquest of Bavaria and the loyalty of the Hungarians to Maria Theresa made this impractical. Then, in Feb. 1742, Walpole was displaced by John Carteret, who induced Saxony to desert the French and mediated a separate peace between Frederick II and Maria Theresa in the treaty of Berlin of July, which provided for the cession of Silesia to Prussia. The French forces were thus isolated in Bohemia and in Dec. 1742 were forced to retreat to the Rhine. At the end of Jan. 1743, when Fleury died, France faced a formidable anti-Bourbon coalition, inspired and guided by Carteret.

Continuation of the War (1743–48).—One consequence of Louis XV's attempt to dispense with a leading minister and to rule himself was to deprive French policy of all effective co-ordination and to place it at the mercy of contending ministers and advisers without portfolio. Among the latter, the cardinal de Tencin (Pierre Guérin) pressed for a declaration of war against Great Britain and promoted invasion schemes in the interest of the Young Pretender, while the duc de Noailles advocated the strengthening of the Spanish alliance and operations in Italy against Sardinia-Savoy. Hermann Maurice de Saxe, who was to prove the most successful general on the French side, urged an invasion of the Low Countries, while at the end of 1744 the marquis d'Argenson (René Louis de Voyer de Paulmy), as foreign minister, promoted far-reaching schemes for the ejection of the Austrians from Italy by the formation of an Italian confederation. Most of these plans were attempted and some simultaneously, with the consequent dissipation of the French war effort. After Carteret had brought over Sardinia-Savoy to the Austrian cause by the treaty of Worms in Sept. 1743, France assumed fresh responsibilities, not directly related to French interests, by concluding the treaty of Fontainebleau (the second Family compact) with Spain in October. France thereby undertook to guarantee Don Carlos' position in Naples, to gain a principality in Lombardy for his brother Don Felipe (the future Philip of Parma) and to recover for Spain both Gibraltar and Minorca.

In the spring of 1744 France formally declared war on Great Britain and on Austria and began a successful invasion of the Low Countries, but this had to be suspended when the Austrians invaded Alsace. From this dangerous situation France was saved only by Frederick's re-entry into the war and his rapid advance into Bohemia in August. When the emperor Charles VII died in Jan. 1745 France might have narrowed the war to an Austro-Prussian struggle for Silesia by supporting the election of Maria Theresa's husband, Francis of Lorraine. Again the war continued, mainly because Argenson was fanatically absorbed in his Italian schemes and because, in Dec. 1745, Frederick deserted the French a second time when he recognized the election of Francis as emperor and extorted Silesia from the Austrians by the treaty of Dresden. Despite the loss of Louisburg in Canada in June and the crushing of the Jacobite invasion of England, the year 1745 was a successful one for the French with Saxe's victory in the Netherlands at Fontenoy (May 11) and Franco-Spanish victories in Sardinia. By the beginning of 1746, however, Louis XV had decided to make peace on the basis of the *status quo*.

When Saxe completed the conquest of the Netherlands in Oct. 1746 by the battle of Rocoux, invaded Holland and defeated the Anglo-Dutch forces in July 1747 at Laffeldt, the English ministry recognized the necessity for peace. Preliminaries were signed on April 30, 1748, and after Austrian acquiescence the definitive peace treaty of Aix-la-Chapelle was concluded in October. As between France and Great Britain, the main principle of the settlement was the reciprocal restitution of all conquests in every continent. France regained Louisburg by surrendering Madras, recognized the Hanoverian dynasty in England and expelled the pretender. The French concluded a separate peace with Great Britain rather than with Austria, partly to end the British naval blockade, partly to prevent the continuation of the war over the Silesian issue and partly to sow dissension between their two main opponents. The price to be paid was the recognition of the conquest of Silesia, the return of the Netherlands to Austria and the failure to honour the obligations assumed under the treaty of Fontainebleau. Little or nothing was said about the troubles which had led to the Anglo-Spanish conflict, and the settlement was only a truce in the embittered colonial rivalry between France and England. Maria Theresa's determination to recover Silesia also made the renewal of the continental conflict only a matter of time.

Internal Affairs (1748–56).—The intervening period of peace from 1748 to 1756 saw the revival of the religious controversies between the Jansenists and the Jesuits and the spread of the influence of the *philosophes*. The religious peace imposed by Fleury was shattered in 1749 when the archbishop of Paris, Christophe de Beaumont, instructed parish priests to deprive of the last sacraments all those who could not produce a certificate to show that they had confessed to a priest who had accepted the bull *Unigenitus*. The Jansenists regarded the exaction of these *billets de confession* as an abuse of the powers of the bishops and appealed for protection to the *parlements*. These thereupon arrested any clergy who refused the sacraments to suspected Jansenists. The consequences of these disputes were important. The Jansenists, reviving the democratic theories of church government sponsored by Edmond Richer in the 17th century, championed the rights and claims of the lower clergy against the bishops. The monarchy, taking sides with the bishops against the Jansenists, found itself violently opposed by the *parlements*.

The general public, alienated by these undignified theological controversies, was increasingly affected by the spread of deism and the anticlerical propaganda of the *philosophes* (*see* ENLIGHTENMENT). Apart from a few materialists such as Lamettrie, Helvétius and the baron d'Holbach, the majority of the assailants of the Catholic Church and of revealed religion were, in fact, deists rather than atheists. The main concern of *philosophes* such as Diderot and Voltaire was to expose and condemn religious intolerance, wherever it showed itself, to oppose the political influence of the Jesuits and to emphasize the need of improving the social and economic position of the underprivileged. Politically the message of the French Enlightenment was not the advocacy of revolution or republicanism, but rather the need for the reform of the criminal law and for social and economic improvement within the context of existing institutions. Diderot and D'Alembert and their collaborators canvassed these ideas in the pages of the *Encyclopédie*, the first volume of which appeared with the royal licence in 1751. After 1759 it was continued with the "tacit permission" granted by the liberal-minded director of censorship, Chrétien Guillaume de Lamoigon de Malesherbes, and the encouragement of Madame de Pompadour.

The Diplomatic Revolution and the Seven Years' War (1756–63).—The end of the period of peace was accompanied by the "diplomatic revolution" or reversal of alliances, whereby France's traditional hostility with the Habsburgs was abandoned for a defensive and then an offensive alliance with Austria. Though it came as a by-product of Louis XV's system of secret diplomacy, the fundamental change would, with proper safeguards, have been fully consonant with the best interests of France. At that time these interests were challenged by Great Britain rather than by

Austria, and France needed a strong continental ally to allow it to concentrate its energies on the colonial struggle. Such was the purport of the first treaty of Versailles (May 1756), concluded with Austria after the outbreak of war with Great Britain (*see* SEVEN YEARS' WAR). This was a defensive treaty in which France undertook to respect the neutrality of the Austrian Netherlands, while Austria was to remain neutral in the Anglo-French conflict. In a secret convention both countries exchanged reciprocal promises of assistance if another power attacked their dominions as an auxiliary of Great Britain. This arrangement, however, was the consequence of Maria Theresa's anxiety to recover Silesia from Prussia; and the French abandonment of the Prussian alliance had been provoked by the concern of George II of Great Britain to protect Hanover first by a subsidy treaty with Russia and then by the convention of Westminster (Jan. 1756) with Frederick II of Prussia. The French connection with Austria was converted into an offensive alliance in May 1757 in the second treaty of Versailles. This was largely the product of French diplomatic isolation after Frederick's unexpected invasion of Saxony in Aug. 1756. In its final form the alliance with Austria was the result not of a calm reappraisal of French interests but of the inertness of French diplomacy as the colonial struggle with Great Britain developed into a global conflict. According to its terms, France engaged to take a principal part in the continental campaigns to dismember Prussia, to finance the war effort of Austria, Saxony, Württemberg and Sweden, and to commit 100,000 men in Germany.

As in the previous war the initial successes in the Seven Years' War went to the French. In the Mediterranean they captured Minorca; in America the marquis de Montcalm occupied key positions before the English colonists had organized their defenses; in India the English East India company was threatened by the marquis de Bussy (Charles Patissier) from the Deccan; in Germany the duc de Richelieu (L. F. A. du Plessis) defeated the Anglo-Hanoverian troops and forced their commander, the duke of Cumberland, in Sept. 1757, to disband his army at Kloster Zeven. The military genius of Frederick II, the strategical insight of William Pitt and the steady pressure of the British economic blockade, applied through superior sea power, gradually turned the tables against France. Early in 1758 the French were driven out of Hanover and Westphalia by Ferdinand of Brunswick, in command of a new Anglo-Hanoverian army. Overseas, British sea power and Pitt's determination to concentrate on the colonial struggle led to the British capture of Senegal and Gorée in Africa, to the conquest of Bengal by Clive and finally to the capture of Quebec and the conquest of Canada. British naval expeditions enforced the surrender of the most important of the French West Indian islands, and combined raids on the northwest of France relieved the pressure on Frederick. Though Étienne François, duc de Choiseul, imparted fresh vigour to the French conduct of the war after Dec. 1758 and secured Spain's naval assistance by the third Family compact (1761), France was unable to stem the tide of defeats and had finally to sue for peace. In Feb. 1763 a separate peace was concluded at Paris between Great Britain and France, together with their respective allies, Portugal and Spain. In North America, France ceded Acadia, Cape Breton Island and Canada to the British, but recovered the islands of St. Pierre and Miquelon and certain disputed fishing rights off the coast of Newfoundland; Louisiana was also surrendered to Spain, as compensation for the Spanish cession of Florida to the British. In the West Indies, France recovered Martinique, Guadeloupe and St. Lucia, but lost St. Vincent, Dominica and Tobago. In India, French trading stations on the Malabar and Coromandel coasts were retained, but the British conquest of Bengal and their control over the Indian princes of the Carnatic and Deccan meant that French political influence in the subcontinent was at an end. In Senegal all except Gorée had to be renounced to the British. Though the treaty of Paris was not the Carthaginian peace sought by Pitt, it destroyed the first French colonial empire.

Last Years of Louis XV (1763–74).—As anticolonialism was strong in France at this point, French public opinion was less disturbed at these losses than by the consequent decline in French prestige in Europe. Choiseul remained in office and did much to revive the sadly depleted strength of the fighting services. Though French territory was increased in 1766 by the reversion of Lorraine and in 1768 by the purchase of Corsica from Genoa, Choiseul's foreign policy was not successful. The increasing influence of Russia in Europe and its alliance with Prussia after 1764 compromised the security of Poland—a client state of France. Choiseul was perhaps less conscious of this danger than Louis XV, who pursued, at this time, an independent policy of maintaining alliances with Poland, Turkey, Sweden and Prussia. Though Choiseul strengthened the Austrian alliance by arranging the marriage of the future Louis XVI to Marie Antoinette, this did not prevent Austria from joining in the partition of Poland in 1772. As France was not consulted, this registered the sharp decline in French influence in central and eastern Europe. Choiseul, however, had fallen from power in Dec. 1770, his dreams of revenge against Great Britain unfulfilled.

Of greater consequence than his failure in foreign policy was Choiseul's omission to uphold the authority and stability of the monarchy in France. He did virtually nothing to improve the national finances and, by seeking to conciliate the *parlement* of Paris, dangerously increased the power of the judicial aristocracy. Choiseul also weakened the church by attacking the Jesuits. In doing so he took advantage of the unpopularity of the Jesuits' militant ultramontanism, their out-of-date educational methods and their intolerant attitude toward the Jansenists. An opportunity for their destruction had been provided by the bankruptcy of some of their commercial establishments in the West Indies as a result of the Seven Years' War. When a judicial decision found the society collectively responsible for the debts of Father Antoine de la Valette—director of the local Indian sugar plantations—an appeal was imprudently made to the *parlement* of Paris. Strongly biased against the Jesuits, this court condemned the statutes of the order as subversive of public morals and the fundamental laws of the state. Though the king and the bishops made strenuous efforts to save the society, its intransigence allowed its enemies to triumph. In 1762 the government took over the property of the Jesuits in France, dissolved their foundations and closed their schools. In Nov. 1764, much against his will, Louis XV was induced to dissolve the society in France and to exile its former members.

Encouraged by this success, the *parlements,* up to 1770, carried their political opposition to the crown to extreme lengths, notably in their attacks on the administration of the duc d'Aiguillon as military commander in Brittany. Though Aiguillon was recalled from his post, Louis XV temporarily quelled the pretensions of the *parlements* by holding a *lit de justice* on March 3, 1766, and by restating in almost despotic terms his legislative omnicompetence (at the so-called *séance de la Flagellation*). He also appointed Aiguillon to be Choiseul's successor as foreign minister in 1770. Between 1771 and Louis XV's death in May 1774, France was governed by the triumvirate of Aiguillon, René de Maupeou, chancellor, and the abbé Joseph Marie Terray, finance minister. This period of firm rule resulted in some financial retrenchment, but, above all, in the destruction of the political powers of the *parlements* and the abolition of the sale of judicial offices by Maupeou in 1771. If this courageous assertion of royal authority against reactionary conservatism had been upheld in the following reign, the way to effective financial and political reform would not have been obstructed.

Louis XVI and the Collapse of the Ancien Régime (1774–89).—At the time of his accession Louis XVI was not yet 20. Though, by contrast with his grandfather Louis XV, he was virtuous and well intentioned, he had received no political education for the role of king in which he was to prove so deficient. Fond of the pleasures of the table and of hunting, Louis was a dull and unresponsive husband for his young and beautiful wife, Marie Antoinette, whose frivolous behaviour and extravagance soon scandalized the more conservative elements of French society and discredited the monarchy (*see* DIAMOND NECKLACE, AFFAIR OF THE). Louis himself had two grave defects of character which were to have serious political consequences: lack of decision and a pathological fear of domination by his ministers. These faults contributed to the chronic ministerial instability of his reign and

compromised the efforts of his reforming ministers to remodel the half-feudal institutions of the *ancien régime*. In this sense, Louis XVI must bear a large share of responsibility for the outbreak of the Revolution and for the subsequent overthrow of the Bourbon monarchy.

The new reign began with sweeping ministerial changes. To accommodate Louis's expressed wish for an experienced and senior adviser to guide his decisions, the aged comte de Maurepas, who had first held office under the regency and who had been dismissed in 1749 through the influence of Madame de Pompadour, was recalled to the ministry. Maurepas, an easygoing and cynical politician, would have been content to work with the triumvirate, but court intrigue soon procured its replacement. The foreign minister, Aiguillon, discredited by his unsuccessful foreign policy, by his quarrel with the *parlements* and, as the friend of Louis XV's last mistress, Madame du Barry, suspect to the new queen, was dismissed in June 1774. He was succeeded as foreign minister by the comte de Vergennes, formerly ambassador at Constantinople and Stockholm. The decision to dismiss the chancellor Maupeou and to replace him by Armand Hue de Miromesnil as keeper of the seals in Aug. 1774 was more serious, since it entailed the restoration of the *parlements* to their former influence in November.

Turgot as Finance Minister (1774–76).—The most important change, however, was the appointment of A. R. J. Turgot as controller general of finance in place of the abbé Terray. Turgot, then at the height of his powers at the age of 47, had distinguished himself as an administrator by his reforming activities while intendant of Limoges and as a constructive thinker by his contributions to liberal economic theory. His genius and determination soon won for him a leading place in the new ministry, where he was supported by his friends and associates Malesherbes and the comte de Saint-Germain (Claude Louis), who were appointed as secretaries of the royal household and of war respectively in 1775.

It was Turgot who endeavoured to set the new administration firmly on the path of reform. His first measure was to reverse the policy of the abbé Terray on the vexed question of the corn trade. In 1770 his predecessor in the effort to mitigate high corn prices had revived the traditional policy of governmental control of the corn trade. Though corn prices fell substantially between 1770 and 1774, this step had provoked opposition from the *parlements* and had led to a series of popular disturbances. This may have predisposed Louis XVI to approve of Turgot's restoration of the freedom of the corn trade as early as Sept. 1774. Though the export of corn was still prohibited and though the decree did not apply to Paris, all restrictions on the movement of corn from province to province and the former obligation of the peasants to dispose of their produce only at the local town markets were now removed. The main intention behind this legislation was to provide, by higher corn prices, an incentive to increase agricultural production—a policy long advocated by the physiocrats, who minimized its social consequences to the consumer. Unfortunately the harvest of 1774 proved a poor one, and corn prices rose excessively in the spring of 1775 and produced a series of widespread agricultural riots known as the "flour war" (*guerre des farines*) in and near Paris. The situation in the capital alarmed the ministers and was saved only by Turgot's firmness in calling out the troops. The minister's courage at this crisis won him the king's confidence, but his policy had aroused uneasiness and some suspicion.

From the first, however, Turgot regarded his main task as that of financial retrenchment. If the annual deficit of 48,000,000 livres was to be reduced, rigid economy in expenditure and careful avoidance of fresh loans and taxes would be indispensable. Turgot approached this task cautiously. Early in 1776 he submitted to the king and council an interim program of measures, known as the Six edicts, intended to reduce the cost of living in Paris for the wage earners, to free trade and industry from restrictive guild regulations and to redistribute the burden of road construction more generally. The first four edicts extended Turgot's earlier edicts on free trade in corn to the capital and suppressed a number of useless offices concerned with the regulation of the municipal markets. Of greater significance were the other two edicts: one abolished throughout France the corporations and guilds, which had restricted admission to many urban industries; the other substituted for the royal *corvée*, borne exclusively by the nonprivileged, a general tax payable by all landed proprietors without exception. These proposals acutely divided the ministry. Maurepas insisted, and Turgot was compelled to agree, that the clergy should be exempted from the proposed road levy. Miromesnil opposed the measure on principle as an attack on privilege. Even stronger opposition came from the general public, the court and the *parlement*. Property, privilege and vested interests were alike threatened, and their conservative defenders reacted sharply. Though Turgot persuaded the king to sanction the edicts and to enforce their registration on the recalcitrant *parlement* in March 1776, the public outcry against the reforms became so violent that the king's resolution was shaken. Turgot's position in the ministry was weakened when his supporter Malesherbes resigned, when Maurepas began to intrigue against him and when, in April, Turgot alienated Vergennes by opposing the latter's proposals for French secret assistance to the American colonies in revolt against Great Britain. It was Turgot's opposition to the policy of supporting the American rebels which turned the king against him and which was largely responsible for his dismissal on May 12, 1776. His warnings that "the first gunshot would drive the state into bankruptcy" and that it had been weakness which had brought Charles I to the scaffold thus went unheeded.

Necker's First Period as Finance Minister (1776–81).—The next finance minister, J. E. B. Clugny, only had time to repeal Turgot's measures before he died a few months later. Maurepas then called in the assistance of Jacques Necker, a Genevan banker who had settled in Paris and had made a large private fortune by speculation. As a former critic of Turgot, Necker was careful not to provoke opposition by radical reforms. He abolished serfdom on the royal domains, however, mitigated the use of torture in criminal procedure and made a limited experiment in the way of local government reform by establishing provincial administrations in Berry and in Haute-Guienne, designed to offset the authority of the intendants. In order to court popularity, Necker attempted to finance not only extraordinary but also normal expenditure by means of loans, which mistakenly were not properly secured by provision for repayment. He even financed the cost of France's participation in the American Revolution after 1778 without increased taxation. His famous *Compte rendu,* published in 1781, was a specious effort to induce financiers to make advances to the government by announcing a surplus of revenue over expenditure amounting to 10,000,000 livres. These accounts related to normal income and expenditure, whereas the actual annual deficit at that time was well above 46,000,000 livres. Thus, though during his period of office Necker added 600,000,000 to the public debt at a high rate of interest, the full seriousness of the financial impact of the American Revolution was not realized until later. However, his attempts to assert greater treasury control over naval and military expenditure and to extend his local government reforms led to his dismissal in May 1781.

Foreign Policy of Vergennes.—Vergennes had two main objectives as foreign minister—to assert French control of the Austrian alliance and to revive French prestige by humiliating Great Britain. He therefore refused to support the emperor Joseph II's designs on Bavaria in 1778 (*see* BAVARIAN SUCCESSION, WAR OF THE) and, in 1785, helped to frustrate the Austrian attempt to reopen the Scheldt and to exchange the Netherlands for Bavaria. From the spring of 1776 Vergennes had connived both at the sending of unofficial military supplies to the American colonists and at the departure of French volunteers. It was not, however, until after the English defeat at Saratoga in 1777 that the French government declared war on Great Britain in Feb. 1778. Spanish participation in the next year did not ensure adequate naval collaboration in European waters. The joint attempt to invade England in 1779 failed, and though Minorca was recaptured in 1782, the siege of Gibraltar was abandoned. A temporary French naval ascendancy in American waters, however, allowed the comte de Rochambeau's

expeditionary force to co-operate with Washington in the decisive victory of Yorktown in 1781. After the fall of Lord North's administration, peace terms were signed at Versailles in 1783. American independence was recognized, and France recovered Senegal and Tobago (as well as St. Lucia, seized during the war). Vergennes was content with this and henceforth, till his death early in 1787, sought to consolidate European peace. In 1786 he and the younger William Pitt concluded a commercial treaty on the basis of a mutual reduction of duties between France and Great Britain.

Calonne and the Assembly of Notables.—Under Necker's successors, J. F. Joly de Fleury from 1781 to 1783 and H. Lefèvre d'Ormesson for a few months, the policy of borrowing continued. Then, in Nov. 1783, Charles Alexandre de Calonne became finance minister. He first set himself to restore public credit, reinstituting a sinking fund to provide for the redemption of the long-term debt, recoining the gold currency and giving a stimulus to industrial enterprise by an extended program of public works. To secure his hold on power, Calonne was lavish in his financial favours to the court. When in Dec. 1785 the *parlement* refused to sanction further government loans, Calonne saw that heroic remedies would have to be applied. By the end of the American Revolution the annual deficit, which Turgot had reduced to 37,000,000 livres, stood at 80,000,000, and by 1787 it had increased to 112,000,000. The short-term debt contracted after 1776 and due for redemption between 1787 and 1797 amounted to about 400,000,000.

In Aug. 1786 Calonne submitted his reform proposals to the king. To circumvent the opposition of the *parlement* and to avoid the summons of the estates-general, he suggested that his proposals should be considered by a quasi-representative assembly of notables. Government expenditure was to be drastically cut, the redemption of the short-term debt spread over a longer period, the stamp duty extended and, in place of the existing *vingtièmes* ("twentieths"), a stamp tax was to be levied in kind on all landowners without exception. The land tax was to be assessed by elective parochial assemblies of landowners, which were to be the foundation for a hierarchical system of district and provincial assemblies with consultative, but not executive, powers. To increase the country's productive power, the internal customs barriers and the governmental control of the corn trade were to be abolished, the *corvée* commuted and the *taille* and *gabelle* (salt tax) reformed. As compensation to the privileged classes, Calonne suggested that the nobility should be relieved of its liability to the capitation (poll tax) and to the commuted *corvée* and that the state should take over the clerical debt. When the assembly of notables met in Feb. 1787, however, the representatives of the privileged classes, led by the clergy, united in opposition to this radical program, refused to sanction Calonne's financial proposals and demanded the communication of the financial accounts and the summons of the estates-general.

Summoning of the Estates-General.—After Calonne's dismissal in April 1787, the assembly's demands were renewed by the *parlement* of Paris when his financial proposals in a modified form were submitted to it by his successor, E. C. de Loménie de Brienne, archbishop of Toulouse. Though the edicts for the establishment of the provincial assemblies, the liberation of the corn trade and the commutation of the *corvée* were duly registered, the *parlement* declared itself incompetent to approve taxes the duration of which had not been fixed and referred the minister to the estates-general. Loménie de Brienne enforced the edicts by a *lit de justice* and exiled the magistrates to Troyes. In September, however, the government was compelled to recall the *parlement* and to renounce the land tax. As the treasury was now empty, the raising of a loan was necessary if bankruptcy was to be avoided. Loménie de Brienne therefore offered to summon the estates-general for 1792 in return for permission to borrow 420,000,000 livres over the next five years. Even this compromise had to be extorted from an indignant *parlement* in a royal session (Nov. 18, 1787).

The final struggle between crown and *parlement* began on May 3, 1788, when the magistrates, fearing a further exertion of royal authority, issued a declaration of fundamental laws, asserting the right of the nation freely to consent to taxation in the estates-general, the sanctity of the privileges of the separate provinces and the irremovability of the judges. It also launched a noisy campaign against arbitrary arrest by means of *lettres de cachet*. To this challenge the government replied by transferring the power of registering royal edicts from the *parlements* to a subservient plenary court, by restricting the civil and criminal jurisdiction of the provincial *parlements* and by curtailing the private jurisdictions of the nobility. Though these measures reduced the *parlement* of Paris to silence, they unleashed a storm of protest from the provincial *parlements*. Riots broke out in Brittany and Dauphiné, where on June 7 a historic demonstration in sympathy with the exiled magistrates of the *parlement* of Grenoble set the pattern for further disturbances and reinforced the clamour for a meeting of the estates-general. With the country seething with unrest, Loménie de Brienne announced on July 5, 1788, that the estates-general would be summoned and, in August, fixed the date of its meeting for May 1, 1789, at Versailles.

This was a capitulation of the monarchy to the united pressure of the lay, clerical and judicial aristocracy, for in June the clerical assembly had declared its solidarity with the *parlement* of Paris. The magistrates, however, overplayed their hand: when Necker, who had returned to the finances after Loménie de Brienne's dismissal in Aug. 1788, recalled the *parlement* of Paris in September, they declared that the estates-general should be constituted in the same manner as they had been in 1614 when last summoned; and this attempt to ensure the political predominance of the privileged orders over the third estate led in the winter of 1788 to popular demands for the double representation of the third estate and for voting, not by order, but in common. In the violent pamphlet warfare that ensued the third estate, roused to a new consciousness of its claims against aristocratic privilege, voiced its demands for national sovereignty and a new constitution. When Necker conceded double representation to the third estate in Dec. 1788 the stage was set for the political triumph of the progressive middle class over the forces of reaction.

The revolution which thus began as an aristocratic Fronde soon assumed the character of a powerful democratic movement whose creed was the union of freedom with equality. (A. Gn.)

The Revolution and the Fall of the Monarchy (1789–92)

The French Revolution (*q.v.*) is generally dated from the meeting of the estates-general at Versailles on May 5, 1789. This body, the only institution in France that could claim to represent the nation, had last met in 1614. For 175 years the representatives of the clergy, nobility and third estate had not been consulted by the crown. If Louis XVI in Aug. 1788 decided to summon them, it was because this step was demanded alike by the 135,000 members of the clergy, many of whom wanted social and ecclesiastical reform, by the 400,000 nobles, who hoped to safeguard their privileges, and by the third estate, as they were called—the whole unprivileged commons of the realm, from merchants and professional men to farmers and labourers, 26,000,000 in all—who were determined to break down the monopoly of property and power in the hands of the privileged minority.

The king might have resisted this demand had not the prestige of the crown been weakened by his own lack of initiative, by the unpopularity of his Austrian queen, Marie Antoinette, by the lack of statesmanship in the honest and competent but slow-moving financier Necker, and by the bankruptcy of the treasury. Nor could he appeal to the army, as his predecessors might have done, since it was infected with democracy from the American Revolution and with the revolutionary sentiments that were spreading throughout the country.

The estates-general of 1789 comprised 300 deputies of the clergy, 300 of the nobility and 600 of the third estate. Formerly there would have been 300 of each order, so that in every contest of opinion the privileged clergy and nobility could have outvoted the unprivileged third estate. The doubling of the number of the third estate's representatives was a concession to social facts and popular opinion made by Necker on behalf of the crown, against the wishes of the clergy and nobility, in Dec. 1788. It meant that if the estates-general met as a single body and the deputies decided

to vote individually (*par tête*), the third estate could, by winning a few supporters from the other orders, carry the day; and thus, because of the indirect method by which the third estate had been elected, the estates-general would be controlled by the middle-class lawyers, professional men and businessmen who represented the mass of the people (suffrage, order by order, had been almost universal). These men were, apart from a minority of the clergy and nobility, the most intelligent class in the country, with the clearest idea of what reforms were required. They had expressed their views both in the *cahiers de doléances* (the credentials presented by each group of deputies, with the grievances and instructions of their constituents) and in the flood of political pamphlets which poured from the press at this time, notably *Qu'est-ce que le Tiers État?* by the abbé E. J. Sieyès, which claimed that the will of the nation should be expressed by the representatives of nine-tenths of its population; that is, the third estate.

National Constituent Assembly Formed.—For six weeks after the formal opening by the king the orders each met in a separate place. But the third estate occupied the great *salle des menus plaisirs du roi*, the only one in which the whole assembly could sit together; and there it met daily, refusing to do any business until the clergy and nobility consented to join it and to constitute a single assembly. On June 17, under the leadership of Sieyès, Jean Joseph Mounier and Honoré Gabriel Riqueti, comte de Mirabeau, the members took the critical step of declaring themselves to be *l'assemblée nationale* and of ordering the payment of taxes to continue just so long as they were allowed to continue in session. The king prepared to quash this declaration at a *séance royale* and ordered the *salle* to be closed meanwhile. The third estate anticipated him (June 20) by meeting in the tennis court (Jeu de Paume) and taking a solemn oath to continue deliberations "until the constitution of the realm is set up and consolidated on firm foundations" ("Tennis Court oath").

On June 23, after ordering the three estates to sit separately and proposing a limited program of reforms to be carried out by the crown, Louis expected the third estate to disperse; they refused to budge, "except at the point of the bayonet." The king, who shrank from violence and could not trust his troops, gave way; he ordered the clergy and nobles to unite with the third estate (June 27) and thus in effect surrendered his prerogatives to a legislature in which representatives of all classes of society sat together as national deputies for the purpose of giving France a written constitution: the National Constituent Assembly.

Fall of the Bastille.—Paris was by geographical position, population and tradition the political and governmental centre of France. The Parisians had anxiously watched the contest at Versailles and applauded the victory of the third estate. When a fortnight later (July 12) they heard that Necker was dismissed and that troops threatened the capital, they gathered in crowds and seized arms; and on July 14, led by soldiers, they stormed the Bastille, an antiquated fort and almost empty prison but also an arms depot that seemed to the poor of the Faubourg St. Antoine a symbol of tyranny and feudalism. The appeal to force succeeded. Within three days the royal troops were withdrawn, Necker was recalled and the leaders of reaction at court, led by the king's youngest brother, the comte d'Artois (later Charles X), were in flight for the frontier. Louis himself visited the Hôtel de Ville, sported the city colours and approved the appointment of Jean Sylvain Bailly as mayor and of the marquis de La Fayette as commandant of a bourgeois municipality and national guard. The first act of the Revolution was over.

Foundation Deeds Enacted.—The constitution that the *cahiers* had demanded and that it was the business of the assembly to provide was supposed to make a change not from a monarchy to a republic but from an absolute monarchy to a limited one. Its fundamental principle was to be the sovereignty of the people, and the king—no longer *roi de France* but *roi des Français*—was to be the executive, but not (as he had been) the fount of legislation and the judicial court of appeal. The three powers of state were to be separated, as Montesquieu had mistakenly supposed they were in the British constitution. But since the Revolution was not merely political but also social and ideological, the limiting of the prerogatives of the crown was accompanied by the abolition of class privilege and the safeguarding of human rights. The Constituent Assembly proceeded at once to enact the foundation deeds of the Revolution: the Declaration of Rights, the abolition of feudalism and the introduction of the suspensive veto. All three measures were hurried through within less than three weeks, partly because it was important not to give the king time to repent of his concessions and partly because the peasants, in their "great fear" of an aristocratic reaction, were attacking the châteaux of their seigneurs, seizing the land, shooting the game and refusing to pay tithes or taxes.

1. The Declaration of the Rights of Man (Aug. 27) was based on the American declaration of 1776 and laid down the "natural and imprescriptible" right of every citizen to liberty, equality, property and security, adding that it was the duty of every citizen to defend these rights, not for himself only but also for others, by sharing in the government, in the armed protection of the community and in the payment of taxes required by it.

2. Feudalism was "abolished" by a few hours' debate on Aug. 4. Though the consequent legislation of Aug. 11 fell short of what the country had expected and though it took four years to complete the work of one night, yet that legislation was sufficiently drastic. The remains of seridom were abolished; all feudal rights were made extinguishable by purchase; seignioral privileges and monopolies were done away with; inequality of taxation ended; civil and military promotion was opened to all classes; justice was to be administered gratis; tithes and other clerical dues were abolished. It was not reform; it was a social revolution.

3. The limitation of the royal veto might have been delayed indefinitely had not the king refused his sanction to the declaration and to the measures of Aug. 4. The assembly was deeply divided between those who shrank from reducing the royal prerogatives and those who wished to deprive the crown of any veto on the will of the people. The suspensive veto (Sept. 11) was a compromise which left the executive with the power to delay and irritate the legislature without controlling it; and its use contributed no little to the fall of the monarchy three years later.

Removal to Paris.—Meanwhile, still delaying acceptance of the measures of Aug. 4, the king had once more given way to the pressure of the reactionary party at court and summoned foreign mercenaries (the Flanders regiment) to Versailles, where the presence of the queen at a regimental dinner gave rise to antirevolutionary demonstrations. The people of Paris—a capital now armed, discontented and short of food—once more intervened. On Oct. 5 a procession led by market women set out for Versailles, followed by detachments of the national guard under La Fayette; their aim was to petition the king for bread and to bring the royal family and the assembly to Paris. Late that night, after playing with the idea of flight, Louis gave way. Early next morning an unruly minority of the crowd, who had spent the night outside the palace, broke into the royal apartments and nearly succeeded in murdering the queen. The majority was not appeased until the royal family agreed to accompany them back to Paris to take residence in the Tuileries—as hostages, if not prisoners, of the Revolution. The court was followed by the assembly, except for about 300 of its more royalist members who feared the revenge of the Paris citizens. The capital now held within its grasp both executive and legislature; the views and interests of its citizens, six times more numerous than those of any other city in France, would sway the debates of the national representatives in the royal riding school (*manège*) on the north side of the Tuileries gardens. The politically minded members of its middle class would debate with those of the deputies who belonged to the Jacobin club (*see* JACOBINS, THE), which met in the Dominican convent close by. Its papers would praise the friends and attack the foes of the "patriotic" program. In its clubs and cafés every measure would be debated; and if need be its spokesmen in the more unruly *faubourgs* could organize a riot or present a petition at the bar of the assembly.

Government and People, 1789–91.—Paris stood at the head of the Revolution; but it did not stand alone. At Lyons, Bordeaux, Marseilles, the great manufacturing and shipping centres of the

south, and in the larger provincial towns all over France, bastilles were falling, feudal municipalities were being ousted by nominees of the *bourgeoisie* and royalist garrisons were giving place to national guards. The centralized system of local government was being swept away.

If Louis XVI had been a man of character and his wife, like the two previous queens, a political nonentity, he might have taken advantage of the overthrow of the privileged orders, whose alliance had compromised his position more than it had strengthened it, to put himself at the head of the Revolution; but he had no gift of leadership, no mind of his own and no ministers fit to advise him. He had read with interest the notes which Mirabeau—the ablest orator and politician in the assembly, but with more ideas than principles and handicapped by a disreputable life—addressed to him in 1790–91; but he did not act upon them. They advised a *rapprochement* with the revolutionary leaders (which he disdained), the organization of royalist support in the country (but the leading royalists were going into voluntary exile) or, as a last resort, retirement from Paris and an appeal to the provinces against the capital (which could mean nothing less than civil war). Louis had a horror of bloodshed. His courage was all passive, his patriotism all benevolent. He preferred to wait for a royalist reaction or for a split between the revolutionary parties, or for a war that might rally the nation behind the crown. Meanwhile the assembly extended its powers from legislative to executive functions. Through its financial, diplomatic, military and other committees it supervised and overruled the ministers; yet it found itself handicapped by royalist generals, by the old-fashioned tradition and personnel of the ministry of foreign affairs, by the passive resistance of local authorities and by the refusal of the people to pay taxes.

An attempt was made to create a feeling of national unity by the Fête de la Fédération (July 14, 1790) held in Paris on the anniversary of the fall of the Bastille; but it would need a national emergency to make this feeling effective. The mass of the people were too busy exploiting the benefits of the Revolution to shoulder their responsibilities. In the countryside the discontent of 1789 had been assuaged by the lightening of feudal burdens, by the occupation or purchase of seignioral land and by the virtual abolition of tithes and taxes. The farmers and *métayers* (sharecroppers) were becoming small landowners with a stake in the country and supporters of the revolutionary regime—so long as it protected their newly won properties and profits. The workers in the big towns, particularly in Paris, were less contented. The year 1788 had brought a bad harvest and a bitter winter; in 1789 half a century's rise in prices reached a peak, especially in the necessities of the poor; and wages failed to keep pace with the rise in prices and rents. The emigration of so many rich people threw great numbers of domestics and workmen out of employment; and the *loi Le Chapelier* (June 14, 1791), which prohibited all professional associations, collective petitioning, strikes or workers' meetings, deprived them of any hope of improving their condition.

Civil Constitution of the Clergy.—The worst problem that the assembly had to face during its first two years was neither the opposition of the king nor the discontent of the workers but the bankruptcy of the treasury. When Necker's loans were not subscribed, when the taxes were not paid and when forced contributions or voluntary gifts brought in too little to be worth collecting, only one remedy remained—a remedy long foreseen and justified by the theory of the monarchy: the nation would take over as its own the property and endowments of the French Church. This was an immense and wealthy corporation, with 150 dioceses, 35,000 benefices and property in land and buildings reckoned as at least one-fifth of all such wealth in the country. Many bishops were very rich, most clergy very poor; the bishops out of touch with the people, the clergy at one with them by birth and way of life. The priest and the Mass, Catholic baptism, marriage and burial were taken for granted by the common people, though increasingly slighted by the educated classes. Protestantism was disliked as un-French, and the Catholic Church in its Gallican form was regarded as a necessary safeguard of public morals. To the middle-class majority in the assembly there would seem to be nothing but gain in nationalizing the church and in using its wealth to pay the way of the revolutionary government.

The clergy themselves had, on Aug. 4, 1789, renounced their tithes and dues, expecting that the state would find them salaries. On Nov. 2, 1789, it had been decreed that "all church property is at the disposal of the nation." Land and buildings were to be sold by auction; clerical salaries (less for the bishops and more for the clergy than under the old system) to be paid by the treasury; and the other liabilities of the church—education, hospitals and the like—to be taken over by the state. This would involve much more than finance. The *Constitution civile du clergé* (Civil Constitution of the Clergy) enacted on July 12, 1790, set up a new church establishment and raised political and ecclesiastical issues of vital importance to the course of the Revolution. It had been worked out on the principle that "the church is within the state, the state is not within the church." The dioceses were rearranged to coincide with the *départements* into which the old provinces had been divided; bishops and clergy were to be chosen, like civil magistrates and local officials, by popular election and to take an oath of acceptance of the constitution. Regulations were laid down to prevent absenteeism, pluralism and neglect of duty.

Some of these changes were intended rather to strengthen than to weaken the church; but even clergy who welcomed reform resented the highhanded way in which the assembly acted. They doubted whether the oath of allegiance to the constitution was consistent with their Catholic faith and duties; they waited to see what the pope would say about it. When the time came for taking the oath (Jan. 16, 1791) Pius VI's attitude was still obscure and nearly half the clergy in the country remained "nonjurors." When he finally decided to condemn the constitution (March 10, 1791) the church was split between "constitutional" and "refractory" clergy, the former, until 1794, receiving state support, the latter deprived of their livings and liable to penalties under a succession of punitive measures. This breach with the papacy strengthened the royalists and *émigrés*, convinced Louis that he must emigrate, alienated many who had greeted the Revolution, and deprived the government of its traditional support from the pulpit and confessional. One of the three bishops who accepted the constitution was Charles Maurice de Talleyrand, who was later to play a major role in diplomacy through 30 years of political change.

The Assignats.—The sale of the nationalized church property was encouraged by the issue of government certificates entitling their holders to purchase houses and land. These assignats (*q.v.*) were soon given recognition as a paper currency and issued in such quantities, in order to meet the growing needs of government expenditure, that gold and silver were driven out of circulation and money values progressively depreciated; by 1793 the purchasing power of 100 fr. was but a quarter of what it had been in 1791. But the assignats saved the Revolution. National bankruptcy was staved off and business enterprise encouraged until the time came when the republican armies could refill the treasury with the indemnities and loot of countries conquered or "liberated."

Flight to Varennes.—By the end of 1790, after 18 months of revolution, there were signs that a new crisis was at hand. The country was being inundated with laws and decrees which the local authorities could not or would not put into practice. The church was divided into two antagonistic parties. The peasantry still suffered under feudal burdens which they could not afford to redeem. The townspeople complained of high prices, unemployment and food shortage. The assembly was increasingly hostile to the king and his ministers, who disliked and obstructed its policy; while Louis, who had never accepted his defeats in 1789, felt strong conscientious objections to the Civil Constitution of the Clergy. Mirabeau, failing in all his attempts to become a minister or to co-operate with Necker (who finally retired in Oct. 1790) or with La Fayette, now counseled Louis to leave Paris for Rouen, the centre of royalist Normandy, and there to raise the white banner of the Bourbons, even though it might lead to civil war. The queen trusted none of these advisers and drew the king into plans for a flight toward the Rhine frontier, to end, if need be, in the arms of Leopold II's troops and the *émigrés*, who would then march on Paris, dismiss the assembly and restore Louis to his throne.

Before his premature death on April 2, 1791, Mirabeau accepted this plan, for want of a better. The refusal of the Parisians, suspicious of some such intention, to let the royal family spend the Easter of 1791 at St. Cloud (April 18) finally determined the king's vacillating purpose, and on the night of June 20–21 he and the queen and their two children, disguised and with forged passports, escaped from the Tuileries and drove off on the road for Châlons and the frontier town of Montmédy. Their flight was not immediately discovered, and they would have escaped had they not been recognized at Ste. Menehould, pursued and eventually stopped, after 24 hours' journey, at Varennes. They were brought back ignominiously to Paris and practically imprisoned in the Tuileries. On June 25 the assembly suspended Louis from his functions, which were only restored when he accepted the constitution of 1791 on Sept. 14.

"Massacre of the Champ de Mars."—Less than a month after the king's return a mass demonstration organized by the left-wing club of the Cordeliers (*see* CORDELIERS, CLUB OF THE) demanded his abdication and the setting-up of a new form of government, which could hardly (though the word was not used) be anything but republican. On July 17, 1791, the petitioners were dispersed from the Champ de Mars, with some loss of life, by the national guard under La Fayette, by order of the mayor, Bailly, and with the approval of the queen. The Jacobin club, which had half-heartedly supported the petition, lost its best members to the new club of the Feuillants (*see* FEUILLANTS, CLUB OF THE) and the leaders of the Cordeliers were proscribed. The people of Paris, however, were preoccupied by a new shortage of bread and did not react to the "massacre."

Constitution of 1791.—Enacted bit by bit during two years of committee meetings, reports and debates, the constitution now came fully into being. The document headed *Décret de l'assemblée nationale du trois Septembre, 1791: La Constitution Française* opened with a revised Declaration of Rights and with a statement of the benefits won by the abolition of feudalism, which by now included the prohibition of religious vows and industrial guilds (*corporations*). Title i added to the rights of man freedom to emigrate, freedom of petition and compensation for property confiscated by the state; it promised a poor law, an education bill, national festivals and a code of civil law. Title ii subdivided the old provinces and *généralités* (associated with feudalism and royal absolutism) into *départements*, districts, cantons and communes, and defined civic status, with generous admission of foreigners. Title iii laid down the constitutional powers and functions of the *pouvoir exécutif* (the king and his ministers), the legislature (to be called *assemblée législative*) and the judicature. Title iv dealt with the army, navy and national guard. Title vii provided a system of safeguards against any revision of the constitution for at least ten years. Yet was this constitution so perfect? Single-chamber legislation by 745 deputies who could not be dismissed under two years; a king who could not dissolve the assembly, could not declare peace or war without its consent, could not choose his ministers from among its members, could not veto, even suspensively, constitutional or financial legislation, had no control over the army or the national guard (an armed force of about 2,000,000 men) and was financially dependent on a civil-list salary; a system of local government by a hierarchy of elected committees with little central control; and a franchise (based on property and wages) confined to 4,000,000 out of 6,000,000 adult Frenchmen, with further discrimination against the working class in the great cities: was there not in these provisions material enough for further dispute, if the crown were to try to regain its prerogatives or the legislature to extend its powers or the workers to assert their rights against the political monopoly of the middle classes? Time was to show the futility of any attempt to impose a rigid form upon a growing organism.

Legislative Assembly.—The defects and paradoxes of the new constitution were indeed hardly less important as factors of the general discontent than was resentment at the flight to Varennes. Thus when it was at last unwillingly accepted by the king (Sept. 14) and the Constituent Assembly was replaced by the Legislative Assembly, it became apparent that the sentiments which had created the constitution no longer existed to enforce it. One of the last acts of the outgoing deputies had been to pass a "self-denying ordinance" excluding themselves from re-election; consequently the Legislative Assembly contained none of the men who had initiated and carried through the Revolution.

The new deputies included a considerable number from the club of the Feuillants and many from those of the Cordeliers and the Jacobins. Within the assembly two groups formed themselves: (1) the majority group, now generally called the Girondins (*q.v.*) but at the time usually called Brissotins after their leader, J. P. Brissot, who were satisfied with the progress of the Revolution in France insofar as it had secured the political ascendancy of the *bourgeoisie* under the constitutional monarchy, but wanted to spread its principles over Europe; and (2) the Jacobin opposition, who wanted more radical reforms in France, particularly from the social point of view, and were not yet prepared to endanger the Revolution's achievement by engaging in war.

The king and queen, fearing not merely for the throne but for their lives, were again secretly asking for foreign intervention and playing with the idea that war might bring the people back to the crown. The Girondins, led by Brissot, preached the mission of the Revolution to emancipate Europe and believed that only war could check counterrevolution. The people grew alarmed at the presence of foreign and *émigré* troops on the Rhine frontier. On Jan. 14, 1792, Brissot brought matters to a head by demanding that the emperor should declare himself still the ally of France under the treaty of 1756, and ten days later he made refusal to give such assurances equivalent to a declaration of war. The death of Leopold II (March 1) only postponed the crisis; his successor, Francis II, took up the challenge. A fortnight later Louis took a step which, if it had been taken earlier, might have saved the throne: he appointed a new ministry nominated by the Girondins, including C. F. du Périer Dumouriez (their ablest soldier but an ambitious careerist), and J. M. Roland, the enemy of Paris. But now such a partnership was impossible; the king and his ministers were agreed upon nothing but war. When, on April 20, Louis formally declared war upon the emperor, he was signing his own death warrant and inaugurating a period of hostilities between France and Europe which was to last almost without a break for 23 years (*see* FRENCH REVOLUTIONARY WARS; NAPOLEONIC WARS).

Neither the king nor the Girondins profited as they had expected from the war. The people did not rally round the throne, since the court was known to be in sympathy with the *émigrés* and their foreign protectors, and the Tuileries was regarded as an outpost of the enemy. In the assembly the war party was opposed by those who saw war as promising only military defeat, bankruptcy and perhaps the dictatorship of a reactionary or ambitious general. This opposition, inspired by Maximilien de Robespierre, whose platform was the Jacobin club and the *Défenseur de la Constitution*, was justified by events. The troops on the Belgian frontier, disorganized by revolutionary ideas and distrustful of their still largely aristocratic officers, were thrown back in their first offensive and murdered one of their generals. When Brissot's party tried to shift the odium of defeat onto the king, he dismissed the Girondin ministers. They attempted a more direct way to power by disbanding the household troops, establishing a camp of provincial volunteers, the *fédérés*, under the walls of Paris and organizing a mass demonstration within the Tuileries (June 20, 1792). Louis was persuaded to don the cap of liberty (*bonnet rouge*) and to drink to the health of the nation; but his passive courage and the dignity of the queen defeated this attempt to coerce the crown.

The Attack on the Tuileries and the Paris Commune.—It was left to the Parisian Jacobins, led by an insurrectional committee from the more republican sections of the city, in conjunction with the *fédérés* of Marseilles, to organize an armed attack on the Tuileries (Aug. 10, 1792). The national guardsmen of the royalist sections, detailed to defend the palace, went over to their republican comrades who were attacking it; the royal family was persuaded to avoid bloodshed by taking refuge in the assembly; the attackers massacred most of the Swiss, whom Louis had ordered

to cease fire; and the mob sacked the royal apartments. Forty-eight hours later the monarchy was once more "suspended," as it had been after Varennes, and the royal family was immured in the *petite tour* of the old Temple as prisoners of the insurrectional Paris commune. There followed an interregnum of six weeks during which the assembly was still the nominal legislature and the executive a provisional ministry appointed by the Girondin majority. In fact the Paris commune imposed its will on both.

What was this commune? For the elections of 1789 Paris had been divided into 60 districts, and these wards had acquired many of the functions of local government, while electing representatives to a central *municipalité* (city council) popularly called the commune. By the municipal law of 1790 the 60 districts had been redistributed into 48 sections, with the intention of destroying their independence, but the 1,800 or so "active citizens" (*i.e.*, voters) in each section soon asserted their right to organize and arm themselves, to express their political opinions and to support the claims of the commune against the assembly. They were also ready to nominate an insurrectional committee to take the place of their elected representatives when a special plan had to be carried out; and it was a committee of this sort that had organized the attack on the Tuileries and was now to dictate its will to the Legislative Assembly. On Aug. 11 the distinction between "active" and "passive" (voteless) citizens was abolished and the election of a new assembly, the Convention, decreed; and on Sept. 3 a new decree for the reorganization of national defense was introduced. Meanwhile suspected counterrevolutionaries were attacked in Paris, and a persecution of refractory Catholic priests was inaugurated.

Georges Danton was the representative of the commune in the provisional executive and its most active member. His call to arms sent thousands of citizen volunteers to the front; it was he who proposed dictatorial powers for a standing committee of the assembly, which developed into the famous committee of public safety. Yet he was later to inspire the peace overtures after the defeat of the Prussians at Valmy; to join Robespierre in his opposition to the anti-Catholic campaign of the Paris commune (*e.g.* Pierre Chaumette) and of some of the provincial agents of the Convention (*e.g.*, Joseph Fouché); to endanger his party popularity by trying to save the king's life; and to lose his own life in opposing the terrorist policy of the committee that he had originated.

September Massacres.—The departure of volunteers for the front toward the end of August was made the excuse for the summary execution of about 1,200 priests, royalists, aristocrats and even criminals and prostitutes whose presence in the prisons was alleged to be a danger to the unguarded civil population. The massacres were initiated by the *comité de surveillance* of the commune on which J. P. Marat sat. The responsibility for these massacres was afterward attributed by some to Marat, by others to the Girondins and by others to the Jacobins.

The First Republic Under the Convention (1792–95)

The National Convention of 1792, elected under the influence of the fall of the throne, the prison massacres and the invasion of the northeastern frontier (the Prussians at the beginning of September were within 140 mi. of Paris), numbered 750 deputies, comprising lawyers, businessmen, merchants, manufacturers, tradesmen, a fair proportion of professional and literary men, a handful of aristocrats (including Louis Philippe Joseph, duc d'Orléans, called Égalité), a very few members of the working class and one Englishman, Thomas Paine. One out of every three of its deputies had sat in the Constituent or Legislative Assemblies. There were three main groups: (1) the Girondins, who were in the majority; (2) the Jacobins, now often designated as the Montagnards because of their raised seats on the *montagne* ("mountain") at one end of the *manège;* and (3) the Plaine, or independents of the centre. All were at first united in the defense of the country and in the founding of a republic. But no sooner had the first aim been attained, as it seemed, on the very day the Convention met, by the victory of Valmy (Sept. 20) and the second secured, next day, by the laconic decree *La Convention nationale décrète à l'unanimité que la royauté est abolie en France,* than the underlying differences between Jacobin and Girondin became apparent and a struggle began which ended in the destruction of both parties. The struggle was embittered by personal antagonism: Madame Roland (Manon Phlipon), who had great influence over the Girondins, hated Danton and Robespierre. As the Montagnards derived their support from Paris, so the Girondins turned to the *bourgeoisie* of the provincial administrations. The predominance of the Girondins in the Convention, as measured by their success in the fortnightly elections of its president and in their majorities on its committees, lasted just so long as Dumouriez' invasion of Belgium went well (battle of Jemappes, Nov. 6, 1792), the assignat did not depreciate too rapidly (its serious fall began at the end of the year) and the republic did not become involved with new enemies. The Girondins might have surmounted even these difficulties if they had not been worsted in three domestic controversies: the fate of the king, the new constitution and the claims of the commune.

Execution of the King.—The country had been of one mind in its rejection of the monarchy but was still royalist enough at heart to shrink from the logical sequel, the king's trial on charges that in any common case would involve the death sentence. To Robespierre, to Antoine de Saint-Just and to the Montagnards, Louis Capet, as the king was now called, was just another traitor, who had from the first been hand in glove with the enemies of the Revolution, who, under Mirabeau's advice (revealed by the discovery of the "iron chest" at the Tuileries, Nov. 20, 1792), had planned civil war and by whose orders patriot citizens had been shot down on July 17, 1791, and Aug. 10, 1792. Girondin deputies retorted that under the constitution of 1791 Louis was still inviolable or (alternatively) that he could not be held responsible for acts committed since the abdication implied in his flight to Varennes. There was no formal trial but after interrogation before the Convention Louis was found guilty by an almost unanimous vote. A Girondin proposal for a plebiscite, which was expected to evoke the royalism of the countryside, was defeated by a large majority. The final vote as to the sentence—exile, imprisonment or death—was taken by *appel nominal; i.e.,* each deputy voted separately and might state reasons for his decision. Out of 721 deputies, 361 declared for death *sans phrase*—a majority of one. A final proposal for postponement (*sursis*) of the death sentence was defeated by 70 votes. On Jan. 21, 1793, Louis was taken to the Place de la Révolution (modern Place de la Concorde) and there executed, amid cries of *Vive la nation!*

A king deposed by national consent and named a traitor by a National Convention would inevitably be a centre of intrigue, whether in prison or in exile. Public safety demanded the death sentence. But his execution could not remain a domestic affair. The Jacobin leaders, who had engineered it, thought of it as consolidating their party, uniting the country and challenging the crowned heads of Europe. Every deputy was now branded either as a regicide or as an *appelant* (one who had voted for the plebiscite with the hope of saving the king's life). The *appelants* would soon fall under the charge of royalism; the regicides would have every motive for remaining in power and arming the republic against a monarchist reaction under which their property, if not their lives, would be forfeit.

Fall of the Girondins.—The weakness and disunity shown by the Girondins during the king's trial was matched by their failure to carry through the primary work of the National Convention, the creation of a French republic. Eight months after their first meeting the deputies had dealt with only 6 out of the 368 articles of the marquis de Condorcet's draft constitution, and this was known to be designed on such party lines that a Jacobin "shadow" constitutional committee was already preparing a rival document. This committee's proposals became the nucleus of the constitution of 1793—a skeleton plan on extremely democratic lines which never came into force but played an important part, at first as Jacobin and afterward as anti-Jacobin propaganda.

The constant attacks on the Paris commune by Roland, the minister of the interior, inspired by his wife, exasperated public feeling in the capital. On the other hand Dumouriez, having been

defeated at Neerwinden (March 18) and driven from the Netherlands, planned with the connivance of the Austrians to march on Paris and set up a dictatorship. When he failed to carry his army with him and went over to the enemy it was easy for the more revolutionary sections of Paris to form an insurrectional committee and to organize another attack on the Tuileries—the seat (since the transference there of the assembly from the *manège* on May 10) of a Girondin majority that seemed to them to be once more betraying the country. But this was a bloodless revolution. On May 31 national guardsmen seized key positions in the capital. On June 1 they surrounded the Tuileries with arms and guns. On June 2 the Convention sat all day, invested by thousands of armed and unarmed citizens who would not let the deputies go home till they had accepted a Jacobin resolution decreeing the suspension and arrest of 29 leaders of the Girondin party and of two ministers, Étienne Clavière and Pierre Lebrun-Tondu. Several of the expelled deputies (*e.g.*, J. B. Louvet and Maximin Isnard) escaped and survived; many (*e.g.*, Brissot, Armand Gensonné and Pierre Vergniaud) were guillotined in the proscription following Charlotte Corday's murder of Marat (July 13). Some who escaped from detention and tried to raise revolt in Normandy were outlawed and perished by execution or suicide (*e.g.*, Jérôme Pétion de Villeneuve and Charles Barbaroux). Of 63 leaders of the party only 25 survived the Revolution.

The Jacobin Regime and the Committee of Public Safety.—After the fall of the Girondins the Convention on June 24, 1793, approved a new constitution, which included provisions for universal suffrage and also for referendums on some legislative projects. This constitution, however, never became effective. The Jacobins, supported by the Parisian *sans-culottes*, took advantage of the emergency created by war and by internal rebellion to set up a dictatorship, the *gouvernement révolutionnaire*. On Oct. 10 the Convention was to decree that "the provisional government of France will be revolutionary until there is peace." It had already, on Oct. 5, broken symbolically with the past by introducing the French Republican calendar (*q.v.*). The main features of the new regime were a small powerful executive, a legislature deprived of initiative, a centralized administration and a ruthless use of powers of summary arrest and execution.

The committee of public safety (*comité de salut public*) originally set up on April 6 took final shape with the exclusion of Danton on July 10 and with the addition of Robespierre on July 27, of Lazare Carnot and C. A. Prieur-Duvernois (Prieur de la Côte d'Or) on Aug. 14 and of J. N. Billaud-Varenne and J. M. Collot d'Herbois on Sept. 6. All its members were deputies, re-eligible and re-elected monthly without change. They divided up among themselves the supervision of the army (Carnot, Robert Lindet and Prieur-Duvernois), of the navy (André Jeanbon Saint-André), of local administration (Collot, Billaud) and of foreign affairs (Bertrand Barère de Vieuzac); while Georges Couthon, Saint-Just, M. J. Hérault de Séchelles and P. L. Prieur (Prieur de la Marne) were often away on special missions and Robespierre was responsible for expounding the policy of the committee and maintaining its liaison with the Convention. But the whole committee met daily for conference and the signing of papers and in theory all its members were jointly responsible for the acts of each. It had no chairman or secretary, and if it was called "Danton's" committee before July 10 or "Robespierre's" after July 27 it was because Danton and Robespierre were in turn the dominating members—Danton by his patriotic reputation during the crisis of 1792 and Robespierre by his long experience in revolutionary party politics, his established position at the Jacobin club, his consistent championship of "the people" and the high moral tone of his speeches, backed by a reputation for incorruptibility and a flair for party intrigue.

This formidable committee soon succeeded by hard work and efficient centralization in extending its control over the ministries and administrative bodies, the judges, generals and *commissaires* of the republic, whom it appointed, purged or dismissed at will. Its dictatorship was exercised by leave of a diminished Convention, the most active members of which were employed on missions away from the capital and which became increasingly subservient to its demands; it ruled by consent of the country and the commune, so long as there was fear of foreign invasion and a fair share of the benefits of the Revolution. In local government the Jacobins returned to the centralization of the prerevolutionary regime. The departmental and district *directoires*, still centres of Girondin sympathies and *fédéralisme* (the theory that regarded Paris as no more than one of the 84 federated *départements*), were purged or overruled; while by an elaborate system of reports from *députés en mission*, *commissaires* and *agents nationaux* the committee of public safety kept itself informed as to what went on in the armies, the court and the administrative bodies of the republic. The authority of the committee rested ultimately upon its ruthless use of force: its traveling agents with power to dismiss, arrest or send to trial in Paris unsuccessful generals, officials who obstructed or opposed the government, dishonest contractors, profiteers and the like; its local or occasional courts (such as those dealing with armed revolt in the provinces), which might have power to inflict the death penalty; and the Revolutionary tribunal in Paris, whose public prosecutor, A. Q. Fouquier-Tinville, compiled dossiers concerning persons under arrest and presented them for trial, and whose judges and jurymen, appointed and paid by the government, had personal as well as patriotic reasons for a ruthless interpretation of the wide laws against disloyalty and conspiracy.

Why did a regime so powerful and so efficient fail? First, because it had to fight constantly against opposition in the provinces stimulated by traditional anti-Parisian feeling (particularly in the trading and manufacturing centres of the south) and by the intrigues of royalist agents, nonjuror clergy and revengeful Girondins—opposition which flared up into civil war in the west (*see* VENDÉE, WARS OF THE) and armed rebellion in the south, at Lyons, Marseilles and Toulon. The government's savage measures of repression made it the more detested. The second reason for failure was economic. The depreciation of the assignats (the real value of 100 livres was 25 in July 1793 and not more than 30 a year later) discouraged farmers from selling their produce in the towns; the needs of the army necessitated wholesale requisitioning; in Paris (whose population of more than 500,000 was constantly on the edge of food shortage) bread and meat had to be rationed; a scheme to ensure supplies by enforcing the sale of consumer goods at fixed prices (the *maximum*) proved unworkable; and the coastal blockade enforced by the British fleet brought ruin to the ports and overseas trade. Munitions factories, no doubt, provided a living for many whom the liquidation of large fortunes and the closing down of luxury trades had left unemployed; but this brought little improvement in wages or working conditions.

Soon the grievances of the working class in Paris and the demand for the introduction of the democratic constitution of 1793 took shape in a movement to which J. R. Hébert, who had succeeded Marat as the most popular journalist of the time, gave his name. Its attempt to overthrow the committee was quashed; but the execution of 18 Hébertists on March 24, 1794, while it left the movement without leaders, also provided a fresh argument against the guillotine, most of whose victims were no longer priests or aristocrats but ordinary citizens accused of hoarding, profiteering or the various offenses included under the Law of Suspects (Sept. 17), which gave wide powers of arrest on suspicion. From the ruin of *hébertisme* a new movement emerged, led by Danton and by Camille Desmoulins, asking for the constitution of 1793, for a political amnesty for the Girondins and for a mitigation of the Terror—in which executions throughout the whole of France (with Parisian totals in parentheses) had numbered 110 (21) in Sept. 1793; 180 (59) in October; 500 (61) in November; 3,380 (66) in December; 3,500 (61) in Jan. 1794; 800 (77) in February; and 600 (126) in March. Yet the committee saw in *dantonisme* an attack upon themselves and their monopoly of power; and within a fortnight Danton, Desmoulins and 13 of their associates followed Hébert and his 17 to the scaffold.

Thermidor and the Reaction.—During the next three months the dictatorship of the committee was intensified, but from fear, not from confidence; and differences between its members, hitherto concealed by their common front against *hébertisme* and *dantonisme*, became irreconcilable. Carnot quarreled with Saint-Just over the conduct of the campaign in the Netherlands. The

mainly anti-Robespierrist *comité de sûreté générale* (constituted on Oct. 17, 1792, to deal with crimes against the Revolution and empowered to supervise government officials) was offended by the proceedings of the *bureau de police générale*, through which Robespierre and Saint-Just overrode its police functions. Robespierre's plan to nationalize religion in the form of a *culte de l'Être Suprême* (inaugurated on May 7) was disliked both by Catholics and by anticlericals and contributed matter for attacks upon his too obvious pose as a prophet and martyr of republican idealism. The Revolutionary tribunal struck out ferociously against supposed prison conspiracies and plots to assassinate the Jacobin leaders; and the number of executions rose again from 1,100 (258 in Paris) to 1,300 (688) between April and June. The enforcement of the *maximum* caused a degree of popular discontent that could not be assuaged by Saint-Just's unworkable plan (laws of Ventôse) to distribute the confiscated property of suspects to poor citizens or Barère's scheme for state pensions and sickness benefits. Robespierre's law of 22 Prairial, designed to speed up the work of the tribunal and (so they alleged) to remove the deputies' exemption from summary arrest, provided those who feared proscription with arguments to win over the moderates in the Convention and organize a movement against the committee.

On 8 Thermidor year II (July 26, 1794), after six weeks' retirement from public life, Robespierre hit back in a speech full of appeals to those who would no longer hear them and of threats that he could no longer enforce. Next day the deputies shouted him down and decreed his arrest. The commune declared for him; the Convention replied by a decree of outlawry. He was arrested at the Hôtel de Ville, with his brother Augustin, François Hanriot, Couthon and Saint-Just. The same guillotine that on 9 Thermidor executed 45 anti-Robespierrists executed, in the following three days, 104 Robespierrists and brought the number of victims for the month up to the total of 935 in Paris alone. As Robespierre, for five years the champion of the people, was carried through the streets to his death on 10 Thermidor, he was greeted with derisive cries of *A bas le maximum!* The Jacobins were rejected by the class whose interests they had claimed to champion but whom in fact they had neither trusted nor consulted. Some of their leaders had used their power to save the country; some had thought to reform it; all had punished and killed because they were afraid. The narrower the basis of their tyranny grew, the more easily it was destroyed.

The coup of July 1794 was primarily a reassertion of the rights of the Convention against the committee of public safety and of the nation against the Paris commune. It was followed by the disarming of the committee and the tribunal, the emptying of the prisons, the purging of the clubs and *sociétés populaires* that had been cells of Jacobinism and the recall of the Girondin's. In Paris the *jeunesse dorée* or "gilded youth" staged anti-Jacobin demonstrations; in the provinces massacres of Jacobins under the white terror were hardly less bloodthirsty than the massacres of their opponents under the red. The abolition of the *maximum* (Dec. 1794) was followed, however, by just such a food shortage as it had been designed to prevent. The rump of the Jacobin party seized the opportunity to demand once more the constitution of 1793 (Germinal year III; March–April 1795). Their opponents retaliated by proscribing those members of the committee who had escaped at Thermidor (Barère, Billaud) and by executing Fouquier-Tinville and the judge of the Revolutionary tribunal, M. J. A. Herman. The food and finance crisis, however, soon led to another outbreak, that of Prairial (May 1795), which was suppressed by the execution or suicide of the last few Jacobin leaders and followed by a renewal of the white terror in the Midi. This in its turn roused the royalists to a countereffort. They took advantage of discontent and disorganization in the republican army to land an *émigré* force in Quiberon bay, transported by British ships and joined by Chouan rebels. But they were met and annihilated by Lazare Hoche (July 20–21, 1795), and more than 700 of the invaders were summarily executed.

Constitution of the Year III.—In the flush of this success the Convention decided to introduce the constitution of the year III, a republican revision of the monarchical constitution of 1791 with a wider franchise, a second chamber (no longer dangerous now that the privileged orders had been destroyed) and an executive designed to prevent either dictatorship or democracy. The mistake (as it now seemed) that the deputies of 1791 had made in refusing re-election was to be avoided by a decree that required the re-election of two-thirds of the new legislature from the personnel of the old. This measure, together with the restriction of the vote to the wealthier *bourgeoisie*, roused one more public revolt, that of 13 Vendémiaire year IV (Oct. 5, 1795), which was only suppressed by force and by the skilful use of artillery by a young Corsican officer, Napoleon Bonaparte. Then the Convention, which had founded the French republic and saved the country from civil war and foreign invasion, came to an end on Oct. 26, 1795.

The Directory (1795–99)

The government of the Directory, as it is generally called from the executive of five *directeurs* set up by the constitution of the year III, lasted for four years (Nov. 1795–Nov. 1799). This it was able to do because the two chambers—the *anciens* and the *cinq-cents*—included representatives of all parties in the country, from royalists to regicides; because the legislature had no control over the executive, and the executive none over the legislature; and because the treasury and the judiciary were independent of both. The five original directors were L. M. de La Revellière-Lépeaux, J. F. Reubell, Paul Barras, Charles Letourneur and Carnot. Though inheriting many of the centralized powers of the committee of public safety (control of foreign policy, of the army, of the police and of local administration), they had no funds to finance their projects or courts to enforce their will. If they were to remain in power—the one ambition that they all shared—they must play off one rival interest against another, by a policy of political seesaw (*bascule*) or, in the last resort, appeal to arms. The pattern set by the recurrent crises of the past year would be preserved; a royalist revival would be met by concessions to Jacobism; a Jacobin revival would bring better terms for the royalists. The Quiberon affair and Hoche's suppression of rebellion in the Vendée, coupled with the continued depreciation of the currency and a recurrence of food shortage, encouraged François Babeuf, an eccentric Jacobin who wanted to enforce the constitution of 1793 and had long entertained utopian designs for an equal distribution of land and income, to head a *conspiration des égaux*, supported by leftist Jacobins such as Michel Philippe Buonarroti, who were by now beginning to revere Robespierre and Saint-Just as prophets and martyrs of socialism. Babeuf was executed (May 28, 1797), but in the anti-Jacobin reaction that ensued the royalists won the elections of the year V, carried the constitutionalist François de Barthélemy onto the Directory in the place of Letourneur and brought forward measures in favour of the *émigrés* and counterrevolutionary clergy. The policy of *bascule* could not cope with this situation, and in Sept. 1797 recourse was had to the argument which was to decide all political issues for the next 18 years—the army.

The Army and the Italian Campaign of 1796–97.—The emergence of the army as the decisive political factor was the most important event of the years 1794–99. How had it come about? The volunteers who, with a stiffening of veterans and the help of the royal artillery, had won the day at Valmy and Jemappes had virtually disappeared during the winter of 1792–93. The new army created by the Jacobin government in 1793–94 was formed by the compulsory enlistment of all Frenchmen between 18 and 25; these recruits were "amalgamated" with the remains of the old army—one old soldier to every two new; and this meant the republic was able to put into the field no fewer than 13 armies, totaling about 750,000 men. On the whole they represented pre-Terrorist Jacobinism at its patriotic best, and their disciplined isolation lent itself to uniformity of opinion and a professional *esprit de corps* which the party politicians of Paris regarded with apprehension. Many officers of the new army had been elected from the ranks; many of its generals were appointed less for military experience than for patriotism and loyalty to the government —they had been politicians before they were soldiers. Supervised and spied upon by civilian *commissaires aux armées*, they chafed

under governmental control; and a sufficiently successful general, such as Bonaparte in Italy, might shake it off.

Every victory of an army in the civil war (Lyons, Marseilles, Toulon) had increased the soldiers' dislike of the civilians who stabbed the country in the back; every victory on the frontiers increased their confidence in themselves and in their generals and their readiness to impose their will on a government which too often starved them of food and arms. As this danger of military intervention increased, so was the government itself tempted to call on the support of a successful general.

Napoleon Bonaparte's appointment to the army of Italy and the Alps (March 2, 1796) had been followed by a spectacular series of victories: Millesimo (April 13) and Dego, leading to an armistice with Sardinia (April 28); Lodi (May 10), followed by the occupation of Milan (May 15), and an advance to Brescia (May 27) and Verona (June 3), securing all Austrian Lombardy; a fortnight's march into central Italy—Bologna, Livorno, Florence (June 30); Field Marshal D. S. von Wurmser defeated at Castiglione (Aug. 5) and invested in Mantua (Sept. 15); Rivoli (Jan. 14, 1797) and the capture of Mantua (Feb. 2); a second expedition into central Italy—Bologna (Feb. 1), Ancona (Feb. 9) and Tolentino, where a treaty was signed with the papacy (Feb. 19); and finally an advance on Vienna by Gorizia (March 22), Villach, Klagenfurt, Judenburg, Graz and Leoben (April 13), where Bonaparte signed preliminaries of peace with Austria (April 18). (*See* French Revolutionary Wars.)

Since then, Bonaparte had established his headquarters at Mombello, outside Milan, in a style almost royal, confident in the devotion of his troops and in the prestige accruing from the vast quantities of captured flags, money and works of art which, after providing for the upkeep of two armies, he had been able to send to Paris.

From 18 Fructidor to 18 Brumaire (1797–99).—It was natural that Barras, La Revellière-Lépeaux and Reubell, when they were faced by the crisis of Sept. 1797, should remember the loyal addresses that Bonaparte had sent from the army at Milan and that his envoy Gen. Pierre Augereau should be put in command of the Paris garrison which enabled them to carry through the *coup d'état* of 18 Fructidor year V (Sept. 4, 1797), whereby Carnot and Barthélemy were expelled from the Directory and P. A. Merlin (Merlin de Douai) and François de Neufchâteau appointed in their places.

Two years were yet to run before the second Directory outlived its success of Fructidor and gave way to the consular government of Nov. 1799. It was a period of undisguised dictatorship, penalizing priests, royalists and *émigrés* (of whom about 1,100 were shot or deported to Guiana and thousands held in prison), suppressing opposition papers, purging and overriding local authorities, reducing the legislature to impotence and re-establishing the police regime of the Terror, though without its Law of Suspects, its tribunal or its guillotine. But it was a dictatorship that could remain effective only so long as the people were diverted from politics to war and found in victory abroad a compensation for hardship and repression at home.

France was indeed living on its frontiers. At sea the British blockade prohibited any but short-distance coastal traffic (cabotage), and privateering was soon countered by the introduction of the convoy system. But plans for the invasion of Ireland or England were constantly revived: an attack on the Channel Islands (1793), Hoche's fruitless attempt to land in Bantry bay (1796), the American colonel William Tate's few hours' Welsh invasion at Fishguard (1797) and J. J. A. Humbert's Irish expedition (1798) pointed the way to the invasion of England, which Bonaparte declared impossible in the spring of 1798 but seriously undertook in 1801–05. The French colonies in the West Indies had either fallen to the British navy or were prevented by the blockade from exporting the sugar, coffee and other goods that Europe could not obtain elsewhere. On the continent the republican armies held firm in the Netherlands, along the Rhine and on the crest of the Alps, till Bonaparte's seizure of Malta and Egypt in 1798 and his invasion of Syria roused Russian as well as Turkish hostility. With the appearance of a Russian fleet in the Adriatic and a Russian army in Lombardy in the spring of 1799 all the successes of the last three years were in jeopardy. The crisis was met by the introduction of conscription (*loi Jourdan*, Sept. 1798) and by a fresh stiffening of the Directory with Jacobins and generals on June 18, 1799 (30 Prairial year VII), when La Revellière-Lépeaux, Merlin and J. B. Treilhard (who had taken Neufchâteau's place) were superseded by J. F. A. Moulin, L. J. Gohier and Pierre Roger Ducos, Reubell having already been replaced by Sieyès in May 1798. Defeat was at last turning to victory in Switzerland (Zürich, Sept. 25, 1799) and in the Netherlands (Alkmaar, Oct. 18) when the return of Bonaparte from Egypt brought upon the scene the one man capable of finishing the war, reorganizing the government and exploiting the gains of ten years of revolution.

The situation that Bonaparte found in Paris in Oct. 1799 was very different from what he had left 18 months before. The new landowners wanted security of property against the threat of a royalist restoration; the clergy wanted recognition and reunion with the papacy and their parishioners wanted the priest, the Mass and the church bell; merchants, manufacturers and shopkeepers wanted peace and social order; and the politicians wanted a new constitution, which would somehow secure stability without despotism and a republic without Jacobinism. Bonaparte set himself to sound public opinion and was soon convinced of what shrewd observers had foreseen during the past ten years—that the Revolution could only be consummated in a military dictatorship. The *coup d'état* of 18 Brumaire year VIII (Nov. 9, 1799) got rid of the Directory and the constitution of the year III; and the law of 19 Brumaire made Sieyès, Ducos and Bonaparte consuls.

The Consulate (1799–1804)

The constitution of the year VIII (4 Nivôse; Dec. 25, 1799) had been devised by Sieyès to provide a balance of powers, with no unchecked control; but by a stroke of the pen, which substituted an active first consul for a figurehead "grand elector," Bonaparte secured for himself the last word on all policies and appointments and transformed the constitution into an instrument of autocracy.

Government Organization.—The legislature was now divided into a *tribunat* which talked, a *corps législatif* which voted and a *sénat conservateur* which "guarded the constitution." The executive was in effect the first consul, whose decisions were taken after consultation with his honorary associates, the second and third consuls (J. J. R. de Cambacérès and C. F. Lebrun from 22 Frimaire), and with a *conseil d'état* divided into administrative sections consisting of counselors selected from the national list of eligibility. There was no cabinet, Bonaparte finding it more effective to consult ministers individually. Sometimes he delegated semiministerial functions to members of the *conseil*. Legislation was initiated in the *conseil* and submitted to the *tribunat* and *corps législatif;* but it was not long before Bonaparte found this process too slow and employed the *sénat* to give his decisions force of law as *sénatus-consultes* or went over the head of the legislature by means of direct orders to his ministers. Legislation by decree, the Jacobin way of dealing with urgent issues, now became normal; political measures were dictated like army orders and diplomatic business dealt with in the same way as maneuvers in the field.

This autocracy was erected upon a basis of universal suffrage. Six million Frenchmen elected 60,000 of themselves onto a *liste communale,* from which justices of the peace and local officials were chosen; the 60,000 were reduced to 6,000 (*liste départementale*) and 600 (*liste nationale*) by further elections within their own number. From these lists of names the departmental and national representatives were chosen. The members of the legislature were chosen by the *sénat;* the mayors of all large towns were chosen by the first consul or by his personally appointed *préfets* and *sous-préfets,* who ruled the *départements* as the intendants had ruled the *généralités* of the prerevolutionary regime. Bonaparte counted on this pretense of representative government to keep the country content, and his coinage, as late as 1809, bore on the obverse his head, with "Napoléon Empereur," and on the reverse the inscription "République Française." It would add little to describe in detail the transition from the first consulship of 1799 to the

life consulship of 1802 (16 Thermidor year X) and the empire of 1804 (*see* NAPOLEON I). Both steps were excused by attacks upon the head of the government and designed to substitute the guarantee of a *de jure* dynastic succession for the *de facto* insecurity of a self-appointed ruler. Neither did much more than regularize methods of government already established in practice.

In fact, however, the real security of the regime instituted by Napoleon rested on its appeal to all parties, its legislative achievements, its solution of the church question and its military successes. From the first Bonaparte made a point of employing in his service men of energy and ability whatever their political past—a few irreconcilable Jacobins and royalists excepted. Of the first 29 members of the *conseil d'état*, 10 were lawyers, 13 administrative officials, 4 generals or admirals. Having chosen the best men, he trusted them, and continuity of policy was secured by long tenure of office: 7 of the original members were still in office at the end of 15 years; 35 more served for 10–15 years. As the members of the committee of public safety had done, they specialized in finance, war, the navy, justice, foreign policy or police; but all the sectional committees met in the first consul's apartments at the Tuileries. Bonaparte presided, took the sense of the meeting and made his own decisions.

Public opinion, which had feared Robespierre's committee and despised the Directory, soon came to respect the work of Bonaparte's *conseil*. The cleverly timed and worded plebiscites which confirmed the Napoleonic regime were genuine evidence of the loyal approbation of the people. Even Jacobins forgave the censoring of the press and the reintroduction of indirect taxation; even royalists regarded the empire as easing the way for a Bourbon restoration.

Bonaparte's administrative reforms were secured through the centralized system by which the *préfet* of each *département* was responsible for the supervision of mayors and communes, for the maintenance of roads and bridges, for the distribution of food, for the suppression of brigandage and for the upkeep of schools, prisons and hospitals. Able men were appointed to these posts and supported by the personal interest and energy that Bonaparte himself gave to the work: letters answered, complaints considered and every detail mastered by a mind that could deal with small things as readily as great. The administrative system was reinforced by a hierarchy of courts rising from *juges de paix* through tribunals of *arrondissement* and *département* to the *cour de cassation;* and most of the judges were appointed by the first consul. The judicial system had worked well under the republic: it worked even better under the empire.

The Code.—Neither courts nor officials, however, could function effectively until the state of the law was known. There had been no codification of French law since the time of Colbert and the code of Louis XIV; and the Revolution had enacted thousands of additional laws and decrees with little reference to the principles or practice of the past. Bonaparte set a committee of lawyers to work to draw up a code of civil, criminal and rural law which should reduce this new legislation to order in the light of Roman principles and French tradition. The civil code, finally enacted in 1804 and known as the Code Napoléon (*q.v.*) from 1807, was logical and laconic, providing in about 120,000 words not merely a legal guide for French citizens but also a framework into which the laws of many other countries were later fitted. Only in some of its provisions, notably as to marriage, divorce and parental authority, it registered a reaction (which Bonaparte approved) against the liberal views of the Revolution.

The Concordat.—The other fundamental act of the consulate, upon which Bonaparte counted to reinforce the code, to add the sanctions of religion to those of reason and to enlist the authority of the church under the banners of the state, was the concordat signed in 1801. For ten years, from 1791, the French Church had been split into two parts: a "constitutional" church served by bishops and priests who took the oath prescribed by the Civil Constitution of the Clergy, and a "refractory" church whose bishops were mostly in exile and whose clergy, though some still worked in secret, had refused to conform. Since 1795 no state support had been given to either body. The papacy had anathematized the French Church settlement and refused to consecrate any bishops under it; its clergy were cut off from any communication with Rome. Bonaparte was determined to enlist the clergy on the side of his regime. On his way back from Marengo in 1800 he made proposals to Pius VII for a reconciliation of the papacy and the French Church. After difficult negotiations, these took shape in the concordat of 1801 and in the *loi des cultes* of 1802, by which Bonaparte attached, without the pope's consent, the so-called "organic articles," strengthening the hold of the state over the church. From this time *départements* and dioceses coincided, and the exhortations of the bishops and clergy supported the orders of the *préfet* and his officials in the raising of recruits, the payment of taxes and the upholding of public order. There was even a catechism in which Catholic children were taught that "to honour and serve the Emperor is to honour and serve God himself" and that those who did not do so would "render themselves worthy of eternal damnation." The concordat not only gave Bonaparte the support of the clergy and their congregations, it also deprived the royalists of their chief argument and ally against his regime.

Education, Censorship and Police.—Behind code and concordat lay an educational system that picked out clever boys from the *bourgeoisie* to be trained in *lycées* (secondary schools) as officers or civil servants (the more liberal education of the *écoles centrales* was suppressed), though primary education was neglected and girls were trained only as housewives; a censorship that suspended all but a few government papers primed with official news and prescribed what operas and plays should be performed; and a police system that, under the expert control of Joseph Fouché, relied more on careful espionage than on imprisonment or execution, though in an emergency—the Opéra plot (1802) or the conspiracy of Charles Pichegru and the affair of the duc d'Enghien (1804)—punishment was quick and severe. Bonaparte spared no trouble to patronize art and literature, to conciliate merchants and manufacturers, and to entertain the canaille (which he always feared) by providing food and work for the poor, by beautifying Paris with new streets and triumphal arches, by exhibiting pictures in the Louvre and captured banners at the Invalides, by holding reviews and by fetes and fireworks.

THE FIRST EMPIRE (1804–14)

Three of Bonaparte's greatest achievements—the pacification of Europe (the peace of Amiens), the appeasement of the church (the concordat) and the life consulship—were celebrated by a joint ceremony at Notre Dame on Easter day, 1802. The more magnificent coronations of Napoleon two years later, as emperor of the French in Paris (Dec. 2, 1804) and as king of Italy at Milan (May 26, 1805), already pointed to the causes of his fall: a state of war with England and therefore with the continent; an uneasy alliance with the papacy that would soon engender a fatal feud; the first move toward the divorce of Josephine; and the creation of an imperial court, whose formalities and flattery gradually degraded the character of the empire and of the emperor. This new orientation of French history is marked by the fact that, whereas for five years after Marengo (June 1800–May 1805) Napoleon seldom left Paris and never traveled outside French territory, one day out of every three during the next nine years was spent abroad, in the endless and fruitless pursuit of that complete control of the continental ports and capitals which would enable him to exclude English ships and subsidies from all Europe and to force London to accept terms of peace dictated from Paris.

Wars of the Empire.—During the consulate the defeat of the Austrians in the Marengo campaign of 1800 and in the battle of Hohenlinden (Dec. 3) had led to the treaty of Lunéville (Feb. 9, 1801); and the treaty of Amiens with England, the result of exhaustion on both sides, had followed (March 27, 1802). War with England, however, had broken out again in May 1803. Bonaparte thereupon intensified his preparations for the invasion of that country, and two years were spent in training an expeditionary force, building landing craft and planning naval movements to obtain command of the Channel. When these finally failed in Aug. 1805, two months before the battle of Trafalgar (Oct. 21) made the whole enterprise impracticable, and when Austria was known to be

arming, the Grande Armée was suddenly diverted to the Rhine. After the battle of Ulm (Oct. 19) and the French occupation of Vienna (Nov. 14), the combined Austrian and Russian armies were defeated at Austerlitz on Dec. 2. Ten months later Prussia, which had missed its chance of intervening before Austerlitz, foolishly declared war; within a week its armies were destroyed at Jena and Auerstädt (Oct. 14, 1806). Russia remained, and checked Napoleon's winter advance into Poland at Eylau (Feb. 8, 1807); but next spring Napoleon marched again, won a lucky victory at Friedland (June 14) and concluded with the emperor Alexander I the treaty of Tilsit (July 7).

At this moment Napoleon had achieved all that he might reasonably expect: Italy reconquered, Austria weakened (but antagonized, and its power of recovery underestimated), Prussia treated as a French dependency and Russia induced, by specious offers in the near east, to close the Baltic to British shipping—thus completing that retaliatory blockade of the sea from the land which already extended from the Adriatic to the North sea and was designed to exclude Great Britain's exports and ruin its economy. The one gap in the circle was the Iberian peninsula. Yet neither Spain nor Portugal offered so profitable a market for British goods as their possessions overseas, which were beyond Napoleon's reach and were thrown open to England by his attack. Napoleon could not bear to see Lisbon, Cádiz and Gibraltar in the hands of the British navy; and he needed subsidies from Spain, his nominal ally. So he embarked in 1808 on the Peninsular War (*q.v.*) that dragged on for six years, absorbed about 300,000 of his best troops and discredited his fame by the capitulation of Bailén and the convention of Cintra (1808) and the forced abdication of the Spanish royal family. His own short visit to the country at the end of 1808 was ended by the news that Austria, helped by British subsidies, was again arming. There followed the war of 1809, which began with a minor but brilliant victory at Eckmühl (April 22), a second occupation of Vienna (May 13) and a defeat at Aspern-Essling (May 21), and ended in a hard-won but decisive victory at Wagram (July 6). The treaty of Vienna the same year once more punished Austria without disabling it.

Napoleon thought he had secured the emperor Francis' support when in the spring of 1810, having divorced Josephine, he married Francis' daughter, the archduchess Marie Louise, in the hope that she would give him a son and heir to continue his dynasty. A year later (March 20, 1811) the king of Rome was born. Once more Napoleon seemed to be at a summit of power. The agreement of Tilsit, however, though reaffirmed at the conference of Erfurt a year later (Oct. 12, 1808), was breaking down under the pressure of the continental system, which deprived Russia of British goods without giving it any compensation in French markets; and while the tsar resented the continued presence of French troops in Prussia and feared Napoleon's designs on Poland, Napoleon remained apprehensive that Russia might support a fresh rearming of Austria. Moreover Napoleon's imperial claims, not those of an individual any longer but those of a dynasty, more than ever offended the Habsburgs and the Hohenzollerns, not to mention the deposed kings of Spain and Naples and the tributary princes of Germany; while his appeals to the precedent of Charlemagne embittered his relations with the papacy. The war with Russia upon which Napoleon now embarked (1812) was the expression of a state of mind that had been growing upon him for ten years, belief in war as a more effective argument than diplomacy, and the desire to destroy a rival power disguised as a crusade to liberate Poland and rid Europe of the threat of a "barbarian invasion." (*See* further Napoleonic Campaigns for the international politics and for the military history of this period.)

Fall of Napoleon.—With the retreat from Moscow the Napoleonic edifice came toppling down. The defection of Prussia from the French alliance enabled the Russians to seize in turn the lines of the Niemen, Vistula and Elbe. The tributary states of western Germany only waited for a safe moment to declare against their "liberator." Austria, for whom Metternich (priding himself on being the one man able to outwit Napoleon) had through five years of planning prepared just this opportunity for revenge, at last threw its armies into the fight. Even Bernadotte, now prince royal of Sweden, turned against his old commander. At Leipzig (Oct. 18, 1813) Napoleon's hastily recruited second army was surrounded and destroyed, and the remnants were driven across the Rhine. Peace talks at Châtillon (Feb. 1814) came to nothing; then Napoleon's third army, striking right and left against the allied invaders, was put out of action by the surrender of Paris (March 30, 1814), and Napoleon signed his first abdication at Fontainebleau on April 11. His defeat was the result not merely of military failure, though that was what hurt him most, but of the damaging effect of his economic policy, which had sacrificed French commerce to the attempt to destroy British trade, and the industries of his allies to the promotion of those of France; to the burden of requisitioning, recruiting and taxation imposed upon every country that he had conquered or "liberated"; to the five years' imprisonment and bullying of Pius VII, which sacrificed the benefits won by the concordat; and to the war weariness and disillusionment of the mass of the French people, who showed no enthusiasm either for national defense in 1814 or for a Napoleonic restoration in 1815.

The First Restoration (1814) and the Hundred Days

With the return of the Bourbons in the person of Louis XVIII, a brother of Louis XVI, the Revolution came back to its starting point and France received the constitutional monarchy based upon the bourgeois predominance that it had desired in 1789. The charter of June 4, 1814, known as *la Charte octroyée* (as having been "granted" by the king to his subjects and not accepted from them), established a bicameral parliamentary system after the English model. The king was to appoint ministers, to convene and, when occasion arose, to adjourn or to dissolve the chamber of deputies and to sanction legislation passed by it and by the chamber of peers.

The Hundred Days.—Here the history of the Revolution should end. All that happened in 1815 was an anticlimax. The Napoleon who returned from Elba in March 1815 had lost the magic of victory. The veterans of the Grande Armée came to his call; but many of his generals refused to take up arms against what they had recognized as the legitimate government. The clergy were content under a Bourbon king. The merchants hated the idea of another war. The constitutionalists, despite Napoleon's liberal *Acte additionnel* (June 1), suspected that a victory in the field would be followed by a restoration of the empire. As soon as the allies, who were still arguing with one another at the Congress of Vienna (*q.v.*), heard of his return and of the flight of Louis XVIII, they acted with unexpected promptness and unanimity, declaring that Napoleon "had placed himself outside the pale" of society and recalling their armies for a fresh invasion of France. Napoleon struck first at Brussels, in front of which a Prussian army under Blücher and a mixed British, German and Dutch-Belgian army under Wellington were caught almost unprepared. The Prussians retreated from Ligny and the British from Quatre Bras. Napoleon pressed on, but not quickly enough, being confident of isolating and destroying Wellington; and at Waterloo (June 18) he met with such stubborn resistance that Blücher was able to come up in time to turn a defeat into a rout (*see* Waterloo Campaign, 1815). Napoleon's second abdication followed four days later and on July 8 Louis XVIII entered again into his capital.

(J. M. T.; X.)

The Second Restoration (1815–30)

Louis XVIII (1815–24).—Although the events of the first Restoration had raised doubts of the Bourbons' fitness to rule, the allies could not agree upon any alternative. Ten days after Waterloo, therefore, Louis XVIII was once more in France. The Hundred Days did much to complicate his task, since the allies were now resolved to punish the French people for the support that had been given to Napoleon. The second treaty of Paris (Nov. 1815) modified France's eastern frontier to its detriment, imposed an indemnity of 700,000,000 fr. and subjected the eastern *départements* to a period of occupation by allied troops. In France the rifts in society were widened and the bitterness engendered by Napoleon's adventure was reflected when the elections of Aug. 1815 returned an Ultra (extreme royalist) chamber known as *la chambre introuvable*, and

when Catholic royalists in the south paid off old scores in a minor white terror. The forces of revolution and counterrevolution were no less opposed than before, and in spite of the liberalism of the charter of 1814, it would be far from easy for the king and his government to recreate a national unity and rally all Frenchmen to support the new Bourbon experiment in parliamentary monarchy.

The violence of the white terror was, however, a transitory phenomenon. Although malcontents in France, as elsewhere after 1815, formed secret societies and occasionally attempted insurrection, the main importance of the period lies in the parliamentary struggle and the gradual acclimatization of constitutional habits.

If England was taken as the chief pattern of constitutional government, the working of parliament in France was often very different. There were two chambers, that of peers and that of deputies, but members sat in a semicircle, an arrangement that made more for oratory and less for informal debate. The king was not obliged to choose his ministers from the majority and there were no disciplined parties. But there soon emerged three fairly definite groups whose struggle for power makes up most of the parliamentary history of this time. On the right, the Ultras (largely representing landed interests, the aristocracy, the clericals and former *émigrés*) may be called the party of the counterrevolution, because of their opposition to the egalitarian and secularizing principles of the great Revolution; but they did not aim at restoring the *ancien régime* with all that that implied, being rather concerned with manipulating the new constitutional machinery in order to regain an assured political and social predominance. On the left, at first very few in number, were the Independents, a miscellaneous group of Bonapartists, Liberals and Republicans, whose chief bonds were distrust of the Bourbons, dislike of clericalism and belief in the Revolution and national sovereignty. In the centre the Constitutionalists, opposed to revolution and to reaction alike and sincerely concerned to operate the regime of the charter, comprised many men of great intellectual distinction and enjoyed the support of the king, whom they provided with most of his ministers before 1820.

Louis indeed saw the unwisdom of much of the Ultras' policy and knew that many of them had no conception of the real temper of the nation. This was shown in 1816 when he at length dissolved the *chambre introuvable* and when fresh elections gave the Constitutionalists a comfortable majority. For the next four years, during the ascendancy of Élie Decazes, ministers and parliament worked more harmoniously, and much of the constructive work of the Restoration was achieved. The finances were overhauled and credit restored, and financial buoyancy enabled France to pay the war indemnity and so to be rid of the army of occupation in the shortest possible time, namely three years. The last occupying soldier left French territory in Nov. 1818. In the same year the *loi Gouvion-Saint-Cyr* established the basis upon which France's army was recruited during the next half century. Henceforward it was essentially a small professional force, raised by the conscription of an annual levy chosen by lot—in the first place for six or eight years. A military spirit was carefully cultivated, and governments might hope to rely on such a force as a defense both against foreign invasion and against internal disorder; but, unwilling to put arms into civilian hands, they omitted to provide for an effective trained reserve.

The Constitutionalists also legislated concerning the franchise and the press. Measures of 1817 and 1818 confined the vote to men over 30 years of age who paid 300 fr. a year in direct taxes and eligibility to men over 40 who paid considerably more; and the press laws of 1819, the most liberal of the Restoration period, abolished censorship as a restraint upon libel and allowed press offenses to be tried by jury instead of by special police tribunals. Yet the Constitutionalists' days of power were soon numbered. The great increase in the number of Independents elected in 1819 caused widespread alarm and helped to split the Constitutionalists' ranks. When in 1820 revolutions broke out in various parts of Europe and a fanatic assassinated Charles Ferdinand, duc de Berry, the third heir presumptive to the crown (Feb. 13), the Ultras quickly exploited the situation and induced the aging king to dismiss Decazes and to form, under the duc de Richelieu (A. E. du Plessis), a cabinet much further to the right, which paved the way for their accession to power. The electoral laws were drastically revised: *scrutin de liste*, whereby the elector voted directly in the chief town of his *département* for as many deputies as were allotted to the *département*, was replaced by the system of *scrutin d'arrondissement*, its great rival throughout the 19th century, in which he cast a single vote in the chief town of the *arrondissement*; the wealthiest electors, who paid 1,000 fr. or more in direct taxation, were given a double vote. As a result, the 1821 elections were an Ultra triumph, and a new cabinet was headed by one of their ablest leaders, the comte de Villèle. In 1823, not content with this success, they rigged the electoral arrangements still further, made parliament septennial and secured a new chamber so zealous that it was dubbed *la chambre retrouvée*.

Thus Louis XVIII had abandoned a middle-of-the-road policy and by the time of his death was much under Ultra influence. But despite the swing to the right the dynasty appeared to be firmly established. The country as a whole was economically prosperous; the activities of the Charbonnerie and other secret societies, notably in 1822, had been easily repressed; the regime had gained prestige from the speedy payment of the war indemnity and evacuation of foreign troops, from its subsequent admission to the Concert of Europe and from the success of the war undertaken in 1823 to restore the authority of Spain's Bourbon king, Ferdinand VII.

Charles X (1824–30).—Louis XVIII was succeeded by his brother Charles, hitherto the comte d'Artois, a man of much personal charm but far less political sense, who had long been the avowed chief of the Ultras. With him as king, the Ultras might be expected to fulfill their program and maintain their ascendancy for a long period. Clerical control of education, already largely secured, was confirmed when in 1824 a prelate, D. A. L. de Frayssinous, became minister of education and ecclesiastical affairs; in 1825 the *émigrés* who had lost their estates in the Revolution were compensated, on a nominal basis of 1,000,000,000 fr., with interest derived from a conversion loan. But an extraordinary law making sacrilege a crime punishable by death (1825) remained a dead letter, and the Ultras failed in their attempt to renew the territorial aristocracy by re-establishing the right of primogeniture (1826). In fact, although they had reduced opposition in the chamber, they were unable to stifle it outside. Villèle's conversion loan antagonized many middle-class investors, and people in all sections of society were alienated by the growing influence of the church. The reappearance of the Jesuits, the activities of other religious societies (in particular the sinister role erroneously attributed to the Congrégation, a society founded in 1801 to revive religious life in France), the prominent part taken by the royal family in religious ceremonies all helped to fan the flames of anticlericalism and to strengthen opposition. Furthermore Villèle's dismissal of Chateaubriand from his post as minister of foreign affairs split his own ranks and antagonized one of the most powerful writers in the country. The royalists were divided still further when in 1826 the Gallican comte de Montlosier (F. D. Reynaud) published a resounding attack upon clericalism. A violent press campaign ensued, which Villèle could see no way to counter save by a more drastic press law; but this was virtually rejected by the chamber of peers, often notable for its sense and moderation during this period. Accordingly, late in 1827, when his government had incurred still more odium because of its peaceable foreign policy—the battle of Navarino in which the Turkish fleet was destroyed was fought against his instructions—and its dissolution of the Paris national guard, Villèle decided to pack the upper house and to dissolve the lower in the hope of securing a more disciplined chamber through new elections. He was disappointed. The opposition gained a majority of 60, and after a brief attempt to continue in office Villèle resigned (Dec. 1827).

With an ill grace Charles X bowed to the storm and in Jan. 1828 replaced Villèle by a cabinet headed by the vicomte de Martignac and recruited largely from the right centre. This cabinet pursued a conciliatory policy that relieved tension. But it never had the king's loyal support or confidence. Charles continued to intrigue with his old friends and, in 1829, replaced Martignac by the prince Jules de Polignac and a cabinet still more fanatically Ultra and

unpopular than that of Villèle. Such a choice was a challenge both to the chamber and to public opinion, tantamount, as Metternich declared, to a counterrevolution. As soon as the chambers met in March 1830 there was a clash. The king's speech from the throne implied that he would brook no opposition; but the deputies replied with an address of no confidence. Charles's answer was to dissolve the chamber and order new elections. Thus the problem whether or not the king must choose his ministers from the majority and part with them when they lost the confidence of parliament came to a head.

The dissolution was followed by intensive campaigning, but neither official pressure nor Polignac's ambitious foreign policy, with the brilliant campaign against Algiers (June–July 1830), was of any avail to win support for the ministry. The opposition returned still stronger from the elections of July. Yet Charles remained obdurate. The result was a disastrous one for the monarchy.

Revolution of 1830.—The act that precipitated revolution was the publication on July 26 of three ordinances: the chamber was once again dissolved; freedom of the press was virtually abolished; and the electoral law was modified so as to reduce the electorate to about 25,000 persons, almost all landed proprietors. In issuing the ordinances Charles invoked article xiv of the charter, which empowered him in case of need to make the necessary regulations and ordinances for the safety of the state. But his action was wholly contrary to the spirit of the constitution. Printers' strikes and journalists' protests were followed by armed demonstrations, and soon barricades were erected all over the capital. After three days of fighting (*les trois glorieuses*, July 27–29) the insurrection triumphed. Blind to the dangers of the situation, Charles had taken no serious precautions to ensure the success of his coup; and when he sought to preserve his throne by making concessions it was too late. When at last he abdicated in favour of his grandson the duc de Bordeaux, known to French Legitimists henceforward as Henry V but to others, generally, as the comte de Chambord, the fate of the dynasty had been decided in Paris. The elder branch of the Bourbons was set aside, and the duc d'Orléans, Philippe Égalité's son Louis Philippe, who had fought at Jemappes in 1792, was now hailed as a citizen king devoted to the Revolution.

The July Monarchy (1830–48)

The revolution of 1830 was a victory of the *bourgeoisie* over the aristocracy, most of whom remained loyal to Charles X. It was a triumph for Paris and a vindication of the charter and of popular sovereignty. The upper middle class now secured the political and social ascendancy for which it had striven in 1789. The new king became not Philip VII, king of France, but Louis Philippe, king of the French, and the deputies themselves imposed upon him a revised charter (*Charte bâclée*). The chamber of peers was transformed from a hereditary into a nominated house, the censorship and the special tribunals were abolished, the franchise was extended, the alliance of throne and altar came to an end, the white flag of the Bourbons was replaced by the tricolour and a law of 1833 was to provide for the establishment of state-aided primary schools in every commune. Yet, although these changes were generally accepted, the revolution of 1830 initiated a period of considerable unrest. At home economic difficulties, accentuated by the revolution and by the hard winter that followed, led to unemployment and to widespread distress, and numerous workers' demonstrations culminated in a veritable insurrection at Lyons in Nov. 1831. In Paris, too, there were violent political demonstrations against Charles X's unpopular ministers, as well as anticlerical riots in which the archbishop's palace was sacked.

Moreover, there were sharp differences of opinion about the purpose of the revolution. While the moderates, soon known as the Party of Resistance, held that its aims had already been achieved, the Party of Movement, headed by Jacques Laffitte and others on the left, regarded it as the first step in the initiation of a new era of liberty and wished the government to pursue an active policy abroad as well as at home and to support the revolutions which, inspired by France's example, broke out in Poland, Italy and Belgium. Louis Philippe, however, was opposed to rash adventures, and his prudence helped to consolidate his government's position in Europe. He agreed with Talleyrand, now French ambassador in London, that France must join with Great Britain in solving the Belgian question and in forcing the Dutch to recognize Belgian independence. He resisted all temptation to annex Belgian territory and refused the new Belgian throne for his son Louis, duc de Nemours. Thereby he secured England's friendship without diminishing French prestige. In Italy, too, while refusing to support revolution, he demonstrated France's abiding interest in Italian affairs and concern with the balance of power by sending French troops to occupy Ancona (1832–38) so long as Austrian soldiers remained in the papal states.

But the Orléans government found that the task of establishing a regime acceptable to all Frenchmen was far from easy. Louis Philippe's assumption of the crown created a new schism, that of Orleanists and Legitimists, and it might have been better for the royalist cause in France had he been content to act as lieutenant governor of the kingdom or regent for Henry V. As it was, his government faced insurrectionary fire from two flanks. On the right there were the irreconcilable Legitimists who regarded him as a traitor and some of whom followed the duchesse de Berry in a futile attempt to raise the Vendée in 1832. On the left there was the Bonapartist pretender Louis Napoleon (the future Napoleon III), who made two equally futile attempts at insurrection in 1836 and 1840; and, much more formidable, there were the Republicans. These had gained, in the 1820s, many new adherents among workmen, students and others and, in the July revolution, had seized the Hôtel de Ville in Paris and made a bid for power. After a momentary acceptance of the new regime they resumed their opposition, intensified their propaganda and multiplied their secret societies. Confined mainly to urban areas, they were more formidable than the Legitimists, being more concentrated and better versed in insurrectionary technique; and their vigour attracted new recruits from among the discontented. Thus the government had to face several Republican outbreaks, of which the 1834 risings in Paris and Lyons were the most serious. Numerous attempts to kill the king were also a feature of the first decade of his reign (*see*, for instance, Fieschi, Giuseppe Maria). The consequence of such disturbances was that the government took repressive measures and identified itself increasingly with the Party of Resistance, to which Louis Philippe, by no means content to be a king who reigned but did not govern, was in any case temperamentally inclined. The right of association was restricted in 1834 and the press laws were considerably revised. By the end of the 1830s opposition had been muzzled or driven underground, and during the ascendancy of the historian François Guizot from 1840 to 1848 some years of internal peace and prosperity ensued.

But this stability was illusory, since the basis of the regime was rapidly being undermined. A movement to extend the franchise had been set on foot without success before 1840, and Guizot was no less unyielding when a new campaign was launched in 1847. Thus the regime which claimed to represent the *juste milieu* kept the vote from an important and growing section of the middle class that included many educated men and confined it to the 200,000 wealthiest citizens, among whom the new aristocracy of the manufacturers was conspicuous. This failure to broaden the basis of the regime politically was the more serious because of the government's neglect of social problems.

Industrialization had gained considerable momentum after the late 1820s, especially in the cotton and textile industries of Alsace, Normandy and the Nord, the silk industry in and around Lyons and the metallurgical industries of the Loire basin and Lorraine. It led to the sudden growth of towns and of an urban population that lived a precarious existence in crowded and unsanitary conditions, subject to long working hours, to disease and to sudden unemployment. This new proletariat was primarily interested in the improvement of its living and working conditions, but successive governments pursued a rigid policy of laissez-faire, holding that it was none of their business to interfere between employer and employed. The only significant social measure, the first Factory act of 1841, remained largely ineffectual for lack of an adequate system of inspection. When the government and the ma-

jority of the employers gave no thought to their relief the workers naturally looked elsewhere. They found many prophets and teachers to give them encouragement, as this period of French history was conspicuous for the fertility of the ideas provoked by the new phenomenon of industrialization. While the ideas of the comte de Saint-Simon were immensely important for their emphasis upon industrial power and its efficient organization, J. C. L. de Sismondi attacked the principle of laissez-faire and advocated state intervention to regulate the use of property, Louis René Villermé and others investigated and made public the evils of working-class conditions, and a host of theorists and reformers put forward proposals for the regeneration of society. It was now that socialism for the first time became a factor of importance, with the pre-Marxian Communists, heirs of Babeuf, with the Christian Socialists influenced by the great liberal Catholics Lamennais and Lacordaire, with the Fourierists, whose leader is regarded as the father of consumers' co-operatives, and with the supporters of state socialism such as Louis Blanc, who published his *Organisation du travail* in 1839. These movements and the writings of such people as Flora Tristan and P. J. Proudhon (whose famous *Qu'est-ce que la propriété?* appeared in 1841) did much to arouse a social conscience. They meant, moreover, that many who looked to a republic for salvation envisaged it now as a social democracy. Underneath the seemingly calm surface there was a great fermentation of ideas, which was strengthened by the presence, in Paris especially, of many foreign political exiles and by the existence of a new cheap press.

The turning point of the latter part of Louis Philippe's reign came with the economic crisis of 1846, which originated in the failure of the wheat and potato crops over a great part of northern and western Europe. The price of flour rose sharply—1847 was known as "the year of dear bread"—purchasing power declined and the agricultural depression was soon followed by an industrial one, on top of which came a financial crisis resulting largely from overspeculation in the first French railways and from a shortage of investment capital. Thus Guizot had to face widespread discontent, which was aggravated by revelations of corruption in high places and by the setbacks and unpopularity of his foreign policy. During Adolphe Thiers's ministry of 1840 the Anglo-French entente had been virtually shattered by the eastern crisis, when France's championship of its Egyptian protégé Mohammed Ali had led to a rift in the Concert of Europe (*see* EASTERN QUESTION) and to a danger of war in which France risked complete isolation. Guizot had temporarily patched things up; but the conclusion of the Spanish marriages in 1846—when the king's son Antoine, duc de Montpensier, married the infanta María Luisa Fernanda (the heiress presumptive of Spain)—led Lord Palmerston to think that he had been tricked. This made the rupture final and encouraged Guizot and his master to align themselves more closely with the conservative powers. The unpopularity of such an alignment when the breezes of liberalism were once again stirring throughout Europe was not mitigated by the completion of the conquest of Algeria and even in parliament, in the manipulation of which he had shown himself a past master, Guizot's tenure of power looked less secure. It was in such an atmosphere that, in 1847, the new movement for parliamentary reform, the famous "banquets campaign," was launched.

Revolution of 1848.—The culminating banquet, arranged to take place in Paris on Feb. 22, 1848, was banned. Nonetheless on that day crowds gathered near the rendezvous and demonstrated against Guizot. Barricades and red flags also appeared in working-class districts, and Louis Philippe, alarmed by these signs of public feeling, at last dismissed his unpopular minister. It looked as though all trouble was over. Unfortunately, as the result of an incident in front of the ministry of foreign affairs on Feb. 23, troops fired upon a crowd of demonstrators. The temper of the populace at once changed, and peaceful manifestations became armed insurrection. On Feb. 24 Louis Philippe, now more than 74 years old and greatly discouraged by this new turn of events and by his lukewarm reception when he reviewed the national guard, abdicated in favour of his ten-year-old grandson Louis Philippe Albert, comte de Paris, and withdrew to exile in England where he died three years later. But his departure did not save his dynasty, for the revolutionaries ignored his grandson's claims and set up a republic.

Thus another attempt to found a permanent system of government after the English pattern had foundered, and a revolution in Paris was once again meekly accepted by the provinces. There was no attempt to raise the Orleanist standard. The house of Orléans had represented little more than a useful expedient of middle-class governance, and once the middle classes began to lose faith in it there was none to defend it.

THE SECOND REPUBLIC (1848–52)

While parliament would doubtless have accepted a regency for the comte de Paris, its authority was swept aside when the Palais Bourbon was invaded by crowds and when revolutionary leaders set up a republican government at the Hôtel de Ville. This proclamation of a second French republic aroused the gloomiest fears and the most extravagant hopes in France and Europe. Both were to prove unwarranted. The new rulers of France, most of them middle-class lawyers and journalists, might abolish slavery in the French colonies but were not the men to set Europe ablaze in a new revolutionary crusade for the emancipation of peoples; in spite of a good many fine words the second republic was eminently pacific. Nor on the other hand could they transform France into the blissful socialist utopia imagined by some of their supporters. In fact the new regime laboured from the outset under two serious disadvantages. Its leaders were themselves divided and they represented but a minority of the country at large. As in 1830, so in 1848 there were two opposing views of the purpose of the revolution, and the provisional government at the Hôtel de Ville represented an uneasy compromise between them. For the majority, including Alphonse de Lamartine, the revolution was a political change whereby a monarchy with a restricted franchise was to be replaced by a free democratic republic based upon universal suffrage; but for the minority, men such as Blanc and A. A. Ledru-Rollin, it also heralded a social and economic transformation. The clash between these two conceptions was at the outset symbolized by the unsuccessful attempt of the extremists to supplant the tricolour by the red flag. But although Blanc and his friends were a minority in the government they had many supporters in the streets, and their colleagues were obliged to make important concessions to their ideas when they reduced working hours, proclaimed the right to work, appointed Blanc chairman of a permanent commission to investigate labour problems and established *ateliers nationaux* (*see* NATIONAL WORKSHOPS) to relieve the more acute unemployment. This was a radical departure from the laissez-faire policy of the July monarchy. Equally radical politically was the decision to give all Frenchmen over 21 years of age the vote. The decree of March 5 fixing elections to a national constituent assembly increased the French electorate from about 200,000 to approximately 9,000,000, many of whom, in spite of the education law of 1833 and the growth of the press, were illiterate. However generous the gesture, it contributed to the undoing of the republic, for acceptance of the February revolution did not mean that the majority of Frenchmen had become convinced republicans. Not only were they not so, but measures such as the addition of 45 centimes to direct taxation, rumours of Socialist threats to private property and reports of continued disturbances in the capital aroused their fear and distrust. Thus although most candidates called themselves republicans, a great majority of the new deputies were returned as Conservatives and champions of order. The Radicals and Socialists won only 100 seats out of 876 and clearly still represented only an urban minority whose preoccupations were very different from those of France as a whole. The result was growing tension between the majority in the new assembly and the extremists in Paris, who on May 15 made a vain attempt to set up at the Hôtel de Ville a new government more to their liking.

The June Days.—The great clash occurred, however, over the problem of unemployment which the upheaval of the revolution had itself increased. The *ateliers nationaux* as set up by the provisional government and organized by A. T. Marie (de Saint-

Georges) and Émile Thomas were a travesty of those envisaged by Blanc and became little more than a gigantic system of outdoor relief which attracted the idle and workless from far and near, demoralized them and increased the risk of disorders. The assembly therefore decided that the *ateliers* must be dissolved, young bachelors enrolled in the army and the rest given employment privately or sent to public works in the provinces. Toward the end of June the executive commission, which had succeeded the provisional government when the assembly came into being, implemented the decision, and dissolution was decreed. Thereupon the workers, furious at what they considered the government's treachery in ignoring its guarantee of the right to work, determined to resist, and the working-class districts of the capital rose in sympathy with them (June 23–26, 1848). The insurrection of the June days, unlike the earlier disturbances, was less a political affair than an outbreak of the class war, a rising of exasperated and often hungry workers in defense of what they believed to be their rights; and as such it was fought and repressed with great ruthlessness. But it had important political consequences. It thoroughly alarmed the middle and upper classes, it discredited the Socialists, and it led to the restriction of many of the liberties granted earlier. The host of clubs, born of the February revolution, were placed under supervision, new press laws introduced and working hours again lengthened. "The Republic is dead," exclaimed Lamartine, and this was certainly true of the social republic, for the conservative tendencies of the assembly and temper of the country at large were immensely strengthened. Socially, moreover, the June days laid bare and intensified the unhappy new cleavage between the proletariat and the rest of society in France.

The Prince-President and the Coup d'État.—The republic, however, continued in name, and the constituent assembly proceeded with its main task of constitution making. The new constitution voted in Nov. 1848 reflected the reaction against parliamentary monarchy after the English pattern and harked back to 1789. It insisted on the separation of powers and on a single chamber or legislative assembly elected by universal suffrage. But it provided that the president of the republic should also be elected by universal suffrage, it devised no machinery for resolving any conflict between executive and legislature and it made the constitution very difficult to revise. These were to prove grave defects.

The first part of the new dispensation came into being when the president of the republic was elected in Dec. 1848. The man elected was the enigmatic conspirator Prince Louis Napoleon, who had spent most of his life out of France but had been chosen deputy by a number of *départements* in by-elections earlier in the year. Many of those who knew him personally thought him a nonentity, but he bore a magic name which stood for order, glory and prosperity and which the growth of the Napoleonic legend and his own clever propaganda helped to popularize. He received an overwhelming majority, handsomely defeating such leading republicans as Lamartine, Ledru-Rollin and Louis Cavaignac. His election was to complete the overthrow of the republic, for he regarded it as his mission to restore the empire.

During the next three years Louis Napoleon worked for his ambition with patience and astuteness, building up a personal following, winning popularity by a series of tours in the provinces and putting his henchmen in control of the army; he also gained the support of the majority of French Roman Catholics by using French troops originally intended to defend the Roman republic against Austria for the restoration of Pope Pius IX and by supporting the *loi Falloux* of 1850, which gave to the free or private schools mainly run by religious orders the recognition for which they had been contending for 30 years. The main obstacle to his designs was the legislative assembly that had been elected in May 1849. The majority of the new deputies were royalist, yet unable to restore the monarchy because the schism between Legitimists and Orleanists remained unhealed. Accordingly all that they could do was to try and resist the pretensions of their rivals. But their action in disfranchising a large number of republican voters, in spite of Louis Napoleon's opposition, by a modification of the electoral law in 1850 and their refusal to amend the constitution to permit his immediate re-election as president enabled him to represent them as reactionary and obstructive. By the summer of 1851 relations between executive and legislature had become decidedly strained, and the political future appeared the more uncertain because the term of each was due to expire in 1852. Determined to retain his power but debarred by the assembly from doing so, the president had no recourse save to a *coup d'état*, which after careful preparations he carried out on the night of Dec. 1–2, 1851. The chief party leaders were arrested, the chamber was occupied by troops and the assembly was dissolved. Full universal suffrage was promptly restored, and the president announced that a new constitution would be promulgated and submitted for popular approval through the typical Napoleonic device of a plebiscite. Although not formally restored until Dec. 2, 1852, the empire was virtually in being from the day of the *coup d'état*.

The Second Empire (1852–70)

Although he had broken his oath to the constitution and there was a show of republican resistance in the south and elsewhere, Louis Napoleon's *coup d'état* was widely popular. The plebiscite in Dec. 1851 approved it by an overwhelming majority, and the vote in favour of the restoration of the empire was almost as large. For most Frenchmen were tired of parliamentarianism and of internal unrest and ready enough for a time to surrender constitutional liberties to a strong government if it could ensure continued order and increasing prosperity. It remained to be seen whether Napoleon III, as Louis Napoleon now became, could recreate a real unity among Frenchmen, rally them around an authoritarian government and establish a dynasty. During the first eight years the omens were good.

Constitution of 1852.—Napoleon's system of government and the constitution of 1852 gave little scope for political activity. The upper house or senate consisted of nominated or ex officio members; the lower house or *corps législatif* sat for only three months in the year and could neither choose its own president nor publish its debates. General elections occurred only once every six years and then were subject to strong official pressure and to the gerrymandering of constituencies. The press was strictly controlled and all members of parliament, magistrates and officials were required to take an oath of allegiance.

Thus political life was effectively stifled, the number of political daily papers dropped sharply and even in 1857 the elections returned only five opposition deputies, many opponents of the regime being either in exile or preferring to abstain from active politics if being a deputy meant taking the oath.

Economic and Social Affairs.—The absence of political excitement was compensated by economic activity, splendour at home and prestige abroad. The great depressions that had started in 1846 and had been aggravated by the disturbances of 1848 had come to an end. The second empire saw a great French economic development in which much of the economic structure of modern France was built. The railways, begun under Louis Philippe, were more than trebled in extent, and the fact that most of the big lines radiated from it made Paris more than ever the economic, social and intellectual capital of the country. Encouraged by the emperor, Saint-Simonians like the brothers Émile and Isaac Pereire founded great credit institutions such as the Crédit Mobilier or joint-stock banks such as the Société Générale. In consequence there was intense speculative activity and a big increase in the number of small investors. At the same time France's overseas trade was nearly quadrupled in value between 1851 and 1869, while the progress of industrialization had transformed the country by 1870 into a considerable industrial power. These developments had social and international significance. The growth of towns continued, while families, for example that of Paulin Talabot, built up financial empires extending well beyond the French frontiers. There was a greater concentration of wealth in the hands of a few and a still greater contrast between their wealth and the poverty of the many. But if France now counted much more as a financial and industrial power it must be remembered that these developments directly concerned only relatively small sections of the total population. Essentially France remained a land of artisans and peasants.

Splendour also entered into Napoleon's calculations. Whereas the July monarchy had appeared drab and humdrum and the second republic disorderly, the second empire shone by its magnificence, by its public ceremonies (in which the army often took a conspicuous part), by its great exhibitions (1855 and 1867) and, after the emperor's marriage in 1853 to the beautiful Spanish countess Eugénie de Montijo, by its sumptuous court fetes.

Foreign Affairs, to 1860.—But the crucial issues depended now, far more than under the Restoration or July monarchies, on foreign policy, since his name, his ambitions and his system of government all impelled Napoleon to a forward policy abroad. There initially he obtained remarkable success. Suspect at the outset as a parvenu adventurer, he was by 1856 recognized as the foremost sovereign on the continent. A lifelong student of Napoleon I's career and his imitator in so much, he saw that his uncle's great blunder had been to antagonize England. So when in 1853 Russian intervention in a dispute concerning the Holy Places of Jerusalem reopened the Eastern Question and once again imperiled the existence of the Ottoman empire, he seized the opportunity to stand by Great Britain and engaged France to fight in the Crimea as an indispensable ally. The Crimean War brought France no tangible gains but was of great importance diplomatically. The English alliance gave Napoleon respectability while the defeat of Russia and the holding of the peace congress at Paris in 1856 brought France prestige. Once again the empire shone in comparison with the two preceding regimes. Moreover, the birth of an heir, Napoléon Eugène Louis, the prince imperial, in 1856, enhanced the dynasty's prospects of continuance.

Italian War of 1859.—This brilliant opening was soon clouded, for Napoleon's ambitions to overthrow the Vienna settlement and redraw the map of Europe led him into courses wholly contrary to France's traditional interests and impaled him upon the horns of a dilemma. As a Bonaparte and a former Carbonaro who had taken part in the Romagna rising of 1831, he had particular sympathy with Italy; and many of his entourage urged him now that he was emperor to espouse the Italian cause. (*See* ITALIAN INDEPENDENCE, WARS OF.) Felice Orsini's dramatic attempt upon his life in Jan. 1858, instead of deterring him, impelled him to action. In July, at a secret interview with Cavour at Plombières, he promised Sardinia France's aid for a war against Austria which should rid Italy of the Austrian yoke "from the Alps to the Adriatic" and regroup its states in an Italian confederation under the presidency of the pope. For its services France was to receive Nice and Savoy. Had all gone according to plan Napoleon might well have scored a signal triumph, earning the gratitude of the Italians for their liberation, and the applause of his own people for an addition to his territory in defiance of the treaties of 1815 and for a solution of the Italian question that would have eliminated Austria and made the Italians grateful clients of France. Unfortunately, once the war had broken out in April 1859, events outran his control.

Pope Pius IX was highly unpopular, and a series of plebiscites in central Italy favouring union with Piedmont swept away Napoleon's papal confederation before it had begun to take shape. Moreover, the strength of Austria's resistance, Prussia's menacing attitude on the Rhine and criticism at home led him to make peace before he reached the Adriatic. The war was successful as far as it went, and Napoleon obtained Nice and Savoy; but it was at a high cost. He had disappointed the Italians by not completing the expulsion of the Austrians; he had given the impetus for the union of the whole of the peninsula under the house of Savoy in spite of his wish to keep it divided; and he had aroused the bitter hostility of the pope yet found himself obliged, in deference to French Catholic opinion, to maintain French troops in Rome to preserve what remained of the temporal power of the papacy. By annexing Nice and Savoy in spite of public protestations that he had no designs on them he did much to alienate England.

Approach to Liberalism.—The Italian war was also a turning point in the internal politics of the second empire. It estranged the French Catholics because of the diminution of the temporal power and thus impelled Napoleon to angle for the support of the left by granting an amnesty (Aug. 1859) that led to the return of many political exiles, by relaxing control of the press and by extending the powers of the legislature. At the same time the Anglo-French commercial treaty negotiated with Richard Cobden in Jan. 1860 marked a step in the direction of greater freedom of trade and was a notable departure from the rigid protectionism characteristic of French economic policy since early in the Restoration. But these changes, instead of winning Napoleon fresh supporters, angered many manufacturing interests and encouraged his political opponents to take advantage of their greater freedom. Once again there emerged an opposition comprising both the left and the right: after ten years the emperor had failed both to disarm all the adherents of former regimes and to win the allegiance of the masses of the industrial workers, who were increasingly attracted by the socialist theories of Proudhon, Marx and Bakunin. In the elections of 1863 opposition candidates polled about 2,000,000 votes and gained 35 seats and, significantly, the big towns such as Paris, Lyons and Marseilles voted mainly Republican. This new opposition, which included such notable figures as the Legitimist A. P. Berryer, the Orleanist Thiers and the Republican Jules Favre, pressed for further liberal reforms and a return to full parliamentary government. It was the opposition to the authoritarian empire that now attracted the main political and journalistic talent, and the regime was weakened by the lack of outstanding personnel.

Seven Weeks' War.—In Europe after 1860 Napoleon seems to have cherished two main ambitions, to complete the liberation of Italy by inducing Austria to cede Venetia and to win territory in the Rhineland or Belgium for France as a reward for services in assisting either Austria or Prussia toward the unification of Germany. He achieved the first by devious means but failed ingloriously in the second. The German question was the crucial issue for the balance of European power in the 1860s, and in his handling of it Napoleon, now a victim of a painful disease and aging rapidly, fumbled disastrously. He negotiated with both Prussia and Austria but failed or neglected to secure from either binding agreements to further his own territorial designs. When the Seven Weeks' War began in 1866 he expected that it would be a protracted affair in which he could profitably intervene as mediator. He was completely taken aback by Prussia's swift and overwhelming victory over Austria. Austria did indeed appeal for Napoleon's good offices and cede Venetia, which he proceeded to hand over to Italy; but as he hesitated to back his mediation by force Prussia could disregard his suggestion that France should be compensated for the alteration in the balance of power by an extension of its eastern frontiers. The fact that France was obliged to accept the unification of northern Germany under Prussian hegemony without any compensation was universally recognized as a grave blow to French influence and prestige. The simultaneous failure of the costly expedition to Mexico, where Napoleon had hoped to create a new French sphere of influence by setting up an empire under the Austrian archduke Maximilian, was a further blow. (*See* also SEVEN WEEKS' WAR.)

Liberalism Extended.—In consequence of these setbacks Napoleon found it necessary to appease French opinion by fresh liberal reforms. In 1867 he granted the *corps législatif* the right to question ministers of state and relaxed the laws controlling the press and public meetings. In 1869, after general elections had increased the opposition votes to 3,000,000, he finally decided to restore parliamentary government. In Jan. 1870 Émile Ollivier, one of the five opposition deputies of 1857, formed the first ministry of the second empire that was responsible to parliament, and in May the French people were asked to pronounce in a plebiscite their approval of the reforms introduced by the emperor since 1860. This recourse to the plebiscite, denounced by the Republicans as a denial of parliamentary sovereignty, was a clever move, for it was an invitation to give a vote of confidence in the empire. As such, it was a signal success: more than 7,000,000 persons, nearly as many as had approved the *coup d'état* of 1851, once again voted "yes." In spite of a growing number of strikes, the multiplication of revolutionary societies and the 1,500,000 "noes" (mainly in the big towns), the empire seemed to have gained a new lease on life. Yet within four months an egregious blunder in foreign policy was to precipitate its downfall.

Franco-German War.—Ever since 1866 French feeling against Prussia had been growing, and in July 1870 the news that Prince Leopold of Hohenzollern-Sigmaringen was candidate for the vacant throne of Spain aroused great excitement and fears of encirclement. When Vincent Benedetti, the French ambassador in Berlin, induced King William I of Prussia to secure the withdrawal of this candidature, France won a great diplomatic victory. But Ollivier and his foreign minister, the duc de Gramont, threw it away by proceeding to demand a formal guarantee that the candidature should never be renewed. This was an insult to the Prussian king, who had given his word, and it gave Bismarck the desired opportunity to provoke France into a war that would enable him to complete Germany's unification. The famous Ems telegram goaded both French and German opinion, and the French government, in spite of the warnings of Thiers, declared war on July 19. (*See* FRANCO-GERMAN WAR.)

Although such a war had been expected and was confidently accepted by the majority of Frenchmen, France was diplomatically and militarily ill-prepared. Napoleon's attempt after 1866 to form a triple alliance with Austria and Italy had broken down, largely because of his reluctance to abandon Rome; and his wise proposals for military reforms had been frustrated largely because of the unimaginativeness of the high command and the parsimony of the *corps législatif*, both of which completely underestimated Prussian power. The result was an overthrow almost as swift as that of Austria in 1866 and still more complete. The French armies fought with accustomed gallantry, but they were outgeneraled, outnumbered and outmaneuvered. Defeat followed upon defeat, and with each new blow trust in the empire ebbed away. By the end of August, Marshal Bazaine was blockaded in Metz and the fate of the empire depended upon the only remaining force of any size, the army commanded by Marshal MacMahon and accompanied by the emperor. It attempted a junction with Bazaine only to meet defeat in the great battle of Sedan. On Sept. 2 the whole army capitulated and, with it, the emperor. The empress Eugénie, who had acted as regent in Napoleon's absence from Paris, had no hope of maintaining a regime that had brought such disasters upon France. On Sept. 4 there was a bloodless revolution in Paris, and a republic was once again proclaimed. The empress fled to England and was later joined by Napoleon, who died there in 1873 a sick and broken man. The second empire like the first had ended in defeat and invasion. (J. P. T. B.)

THE THIRD REPUBLIC TO 1914

Government of National Defense.—The capitulation at Sedan on Sept. 2, 1870, left the deputies of the *corps législatif* debating what sort of government should take the place of the empire. The Republican opposition fell into two groups: the moderates led by Jules Simon and Jules Favre, and the radicals led by Léon Gambetta. As in 1830 and 1848, they decided to proclaim the new republic at the Hôtel de Ville. Favre and Gambetta did this on Sept. 4 and proceeded to set up an emergency government of national defense. Headed by Gen. Louis Jules Trochu, governor of Paris, it was composed of the deputies for Paris and of those who had been elected in Paris but had chosen another constituency. The men whom Paris had chosen, including Favre, Simon and Gambetta, now ruled France.

A fortnight later Favre, as minister for foreign affairs, met Bismarck at Ferrières. He failed to come to terms, so the government was confronted with the threefold task of defending Paris, seeking foreign support and rousing the provinces to defend the country. On Sept. 19 the German armies besieged the capital. Thiers was sent on a tour of the European capitals to seek foreign help. On Oct. 7 Gambetta, as minister of the interior, escaped from Paris in a balloon, floated safely over the German lines and reached Tours. There he created virtually a personal dictatorship and infused fresh energy into the war effort of the provinces.

The government failed in all three tasks. The siege of Paris lasted four months, and the city endured great hardships. Thiers failed to gain foreign help. Gambetta raised large forces by a *levée en masse*, but they were sadly short of arms and supplies. On Oct. 27 Bazaine capitulated at Metz. Gambetta's new levies met with successive defeats. The winter was exceptionally severe, and the food supplies of the besieged capital ran out. On Jan. 18, 1871, the king of Prussia was crowned as emperor of Germany in the Hall of Mirrors in the palace of Versailles. Ten days later the French government was compelled to sign an armistice. Bismarck insisted that a national assembly be at once elected, competent to conclude a treaty of peace. General elections were arranged for Feb. 8, and the new assembly met at Bordeaux on Feb. 13 to accept the resignation of the government of national defense.

"Government of M. Thiers."—The elections were held in conditions of extraordinary confusion, and their central issue was peace or war. Because the Bonapartists were discredited by Sedan and the Republicans were associated with carrying on the war, the electorate—which mainly wanted peace—turned to Royalists. The national assembly was composed of about 180 Legitimist Royalists and 220 Conservatives, predominantly Orleanist Royalists; 200 Republicans, divided almost equally between moderates and extremists; and about 30 Bonapartists. It thus had a Royalist majority and was by a large majority in favour of concluding peace with Germany. Thiers, on Feb. 17, 1871, was appointed "chief of the executive of the French Republic." He was to work "under the control of the national assembly and with the help of ministers, whom he shall choose and over whom he shall preside." In this way began the "government of M. Thiers" which undertook to conclude peace, liberate France and restore public order.

Treaty of Frankfurt.—On March 1 the assembly affirmed the overthrow of Napoleon III and his dynasty and ratified by 546 votes to 107 the terms of the peace treaty that Thiers and Favre had negotiated with Bismarck. France undertook to pay an indemnity of 5,000,000,000 fr. and to meet the cost of German forces of occupation in its northern provinces until the indemnity had been paid. Two other provisions rankled even more than the indemnity: France gave up Alsace and Lorraine to Germany and agreed that German troops should make a formal triumphal march through Paris. The former provision bred in the next generation of Frenchmen a desire for revenge and for recovery of the lost provinces; the latter contributed, with other factors, to the outbreak of the Paris commune on March 18. The treaty was signed at Frankfurt on May 10.

The Commune (1871).—The commune of Paris was the revolutionary product of the social upheavals of the long siege of Paris, the aftermath of disastrous war and the social discontent bred by Bonapartist dictatorship. It was precipitated by a sense of outraged civic pride when German troops marched down the Champs Élysées and when it became known that the national assembly had decided to move from Bordeaux not to Paris but to Versailles. It seemed that a restoration of the monarchy might be proclaimed by a Royalist assembly from the palace of the kings. Many of the wealthier citizens of the capital had left it, and about 40,000 *évacués* and refugees from the German-occupied provinces poured in. Paris, which had proclaimed the republic on Sept. 4, now tried, under more extremist Republican leadership, to set the pattern of revolutionary action for the whole of France. It appealed to the traditions of 1793, just as on Sept. 4 the moderates had appealed to the traditions of 1830 and 1848. Its example was followed by Lyons, Marseilles and St. Étienne, with fainter responses in Toulouse, Narbonne and Limoges. But it failed, and on May 21 the troops of Versailles entered the city. The merciless repression that followed paved the way for a more conservative republic. Meanwhile, the preliminary tasks, which Thiers undertook to fulfill without prejudging the nature of the new regime, were speedily and ably carried out.

Economic Recovery.—When Thiers in June 1871 floated a loan to pay the first installments of the indemnity, it was oversubscribed two and a half times: a remarkable tribute to the resilience of France and to the firm leadership of Thiers. The second loan a year later for the remaining 3,000,000,000 fr. was oversubscribed 13 times. By getting Bismarck to agree to the earlier withdrawal of troops in proportion to payment of the indemnity, Thiers ensured that France was completely liberated by Sept. 1873, two years sooner than Bismarck had contemplated. His overhaul of French military organization laid the basis for military recovery.

The economic reasons for this remarkable resilience were that these years saw the climax of a phase of expansion that had begun in 1859. Between 1859 and 1869 French imports had increased in value from 1,640,000,000 fr. to 3,153,000,000 fr. and its exports from 2,266,000,000 fr. to 3,075,000,000 fr. Its total tonnage of shipping had increased in the same decade by more than one-third. Its industrial output, especially in the heavy industries and in textiles, had grown fairly steadily. Sedan and the exacting terms of the peace stimulated public spirit and encouraged Frenchmen to work harder and more purposefully. The previous decade of railway building, rising prices and wages and agricultural prosperity laid the basis of a boom in the years 1870–73. During these years the factories were working at full speed; coal and steel output, in spite of the loss of the rich areas of Alsace and Lorraine, were on the upgrade; the index of prices, which had stood at 144 in 1869, stood at 159 in 1873, and wages tended to follow suit. Thiers used these economic opportunities wisely and well before he fell from power on May 24, 1873.

Republicanism Consolidated.—By that time the balance of political forces had changed. Gambetta, after the elections of Feb. 1871, had carried out an intensive campaign of propaganda throughout the French countryside in favour of republicanism. It was he, by pen and spoken word, who taught the French peasant proprietors that they owed their land not to Bonapartism but to republicanism. Of 158 contested by-elections to the national assembly between Feb. 1871 and Sept. 1874, the Republicans won 126. Gambetta co-operated with Thiers to ensure the erection of a conservative republic and founded the new "Opportunist" or moderate section of the Republican party. At the same time the forces of royalism were thrown into disarray. The Legitimists were headed by the comte de Chambord ("Henry V"), grandson of Charles X; the Orleanists by Louis Philippe Albert, comte de Paris, grandson of Louis Philippe. Chambord had no heirs and was 51 in 1871, whereas the comte de Paris already had a son and was only 33. During the government of Thiers three successive attempts at fusion were attempted, but all in vain. The purpose of fusion was an agreement to put Chambord on the throne, to be succeeded on his death by the comte de Paris. Chambord issued a series of ill-timed and stiff-necked manifestos, refusing to accept the tricolour flag and insisting on the white flag of the Bourbons. The growth of moderate republicanism and the obvious hopelessness of royalism ensured support for a conservative republic; and the national assembly, now comprising a more even balance between the two parties, proceeded to draft such a constitution.

Constitution of 1875.—Thiers resigned in May 1873. He was succeeded by Marshal MacMahon, who on Nov. 20 was given the "presidency of the republic" for seven years. As early as Aug. 1871, Thiers had been accorded the title "president of the French republic." So a republic had long been formally accepted in principle. The issue was still whether it should be a conservative republic, so devised as to check the forces of radical democracy and perhaps prepare for a restoration of constitutional monarchy, or whether it should be sufficiently radical to prevent a restoration. Around this issue the debates of the assembly in 1875 mainly revolved. Already the champions of conservatism had won a tactical victory by the appointment of MacMahon as president, and they regarded him as forerunner of a future monarch. Their leader was Albert, duc de Broglie, an astute parliamentarian, who became president of the council of ministers when Thiers fell. He held office for a year with the support of the right-centre and left-centre parties in the assembly.

During the formation and early years of the third republic, France found itself on a downward curve of the economic cycle. A phase of economic depression began in 1873, in striking contrast to the preceding three years of boom. Its deepest impact was on France's chief national industry, farming. Development of railways and the steamship brought grain from the rapidly expanding agriculture of the United States, Canada and Argentina to compete on favourable terms with that grown in the old world. Phylloxera was ravishing the vineyards and cattle disease was ruining French stock. The index of prices fell from 159 in 1873 to 130 in 1879. There were bad harvests in 1878 and 1879. French industry, too, ran into difficulties. The loss of the highly industrialized districts of Alsace and the iron-ore and metallurgical industries of Lorraine began to matter; and in 1878, when the Thomas and Gilchrist methods of smelting phosphorus ore were invented, it was Germany that reaped the benefits. France had lost about 1,500,000 persons, including many of its best miners and metalworkers. In addition, it had lost about 139,000 men killed and another 143,000 disabled in the war, as well as the heavy losses of the Paris commune. Industry was grievously weakened immediately before it suffered the shock of the depression. The remark "How attractive was the Republic under the Empire!" had an economic as well as a political significance.

Against this clouded economic background, the assembly passed the series of constitutional laws which together composed the constitution of the third republic.

The two chief characteristics of the constitution were its basic compromises and its piecemeal nature. Its makers did not set out to formulate general principles or to build an entirely new system. They redefined only those organs of government which the major political parties of the time considered to be in need of overhauling. As they were mostly somewhat conservative parties, they left almost intact whatever they could: for instance, the system of central and local administration, mainly derived from Napoleon I; the judiciary, a blend of former royal and imperial regimes; and the arrangements between church and state. Universal male suffrage, on which the elections of Feb. 1871 had been held, was also preserved.

By the constitutional law of Feb. 25, 1875, legislative power was vested in the national assembly, which consisted of a senate of 300 members (constitutional law of Feb. 24, 1875) and a chamber of deputies. At first 225 senators were elected for a term of nine years (one-third of their number retiring every three years) by electoral colleges representing mainly the municipal councils; the other 75 were nominated for life by the assembly (organic law of Aug. 2, 1875). But by the law of Dec. 9, 1884 (made possible by the constitutional amendment of Aug. 14 of that year), the senate became totally elective, though still on a system of indirect election which gave the preponderance to the large number of rural communes as against the few large towns. The chamber of deputies, elected directly on universal male suffrage for a term of four years, at first rested on the *arrondissements* as single-member constituencies (organic law of Nov. 30, 1875). But in 1885 a system of *scrutin de liste* was established, with the *département* as the constituency and with each elector having as many votes as there were seats ascribed to the *département;* then in 1889 single-member constituencies were restored; in 1919 a system of *scrutin de liste,* combined with a very restricted method of proportional representation, was again tried; but this, too, was abandoned in 1927, when single-member constituencies were again restored. Throughout, a system of second ballot was used. Article 18 of the law of Nov. 1875 laid down that "No one is elected on the first ballot unless he has won (1) an absolute majority of the votes cast; (2) a number of votes equal to a quarter of the electors on the register. At the second ballot a relative majority is sufficient." The interval of a week between the two polls left room for bargaining and shuffling on the part of the parties and their candidates. This device was an advantage in the complex and fluid party system which grew up under the third republic. It prevented an excess of "wasted votes."

Since laws had to be passed by a majority of both the senate and the chamber of deputies, the two houses had nominally equal legislative power. In practice, a ministerial defeat in the chamber was more serious than one in the senate, and only in the last decades of the republic did a ministry feel obliged to resign if it was defeated in the senate alone. Money bills had to originate in the chamber.

The president of the republic, elected by a joint session of the national assembly for a period of seven years and subsequently re-eligible, had the initiative in proposing legislation, concurrently with the members of the assembly. He promulgated laws and ensured their execution. He presided at all state occasions and had the direction of the armed forces, the appointment to all civil

and military offices and the right of pardon but not of amnesty. Ambassadors were accredited to him.

Every act of the president had to be countersigned by a minister, and ministers were "collectively responsible before the chambers for the general policy of the government, and individually for their personal acts." This meant that executive power lay with the body of ministers. No specific provision was made for the office of prime minister, but it gradually established itself as a consequence of the law of March 1873. This law permitted the president to communicate with the assembly only by previous permission to appear before it and speak or by means of messages read by a minister; nor could debate take place in the president's presence. Devised originally to gag Thiers, this arrangement was perpetuated in the constitutional law of July 16, 1875, which determined that the bulk of the president's executive powers should be wielded by the ministers. The "vice-president of the council of ministers" (subsequently known as the president of the council of ministers) became the operative leader of the government.

By the constitutional law of Feb. 25, 1875 (article 5), the president of the republic could, with the agreement of the senate, dissolve the chamber before its four-year mandate had expired. But this power was used only once, by MacMahon in 1877, when it failed in its purpose. Thereafter by custom the chamber acquired immunity from dissolution and security for its full four years of existence. This fact, often lamented by parliamentary reformers of the third republic, weakened the ministry vis-à-vis the assembly, the executive vis-à-vis the legislature. But it is doubtful whether even if used the power of dissolution would have contributed a greater ministerial stability; ministries were weak not only because of constitutional principles but because they consisted of combinations of leaders from the various parties and groups in the assembly, who could neither command the support of a majority nor even be sure of controlling their own supporters.

Party Politics in the 1870s and 1880s.—In the first general elections held under the new constitution, in Feb. 1876, a Republican majority of about two-thirds was returned to the chamber of deputies. Of the 36,000,000 citizens of France, only about 10,000,000 were qualified to vote, and only three-quarters of them actually voted in 1876. More than half this electorate lived by agriculture, a little more than 3,000,000 were employed in industry and about 750,000 were engaged in business and trade. Democracy in France still meant a rural democracy, and political life centred ultimately on the 36,000 communes of the countryside. Gambetta, the most dynamic leader of the Republicans until his death in 1882, conceived a democracy of peasant proprietors and small businessmen.

It was to these new social strata, given political power by universal suffrage and constitutional advantage by the composition and powers of the senate, that the Republicans especially appealed. And although these classes wanted a republic, they wanted the republic to be conservative in bias. By 1879 the Republicans had won a majority in the senate as well as in the chamber; and with the accession of the veteran Republican Jules Grévy to the presidency in that year there began what is known as "the Republic of the Republicans."

Presidents of the Third Republic

1. Adolphe Thiers, provisional, Feb. 1871–May 1873
2. Patrice de MacMahon, May 1873–Jan. 1879
3. Jules Grévy, Jan. 1879–Dec. 1887
4. Sadi Carnot, Dec. 1887–June 1894
5. Jean Casimir-Périer, June 1894–Jan. 1895
6. Félix Faure, Jan. 1895–Feb. 1899
7. Émile Loubet, Feb. 1899–Feb. 1906
8. Armand Fallières, Feb. 1906–Feb. 1913
9. Raymond Poincaré, Feb. 1913–Feb. 1920
10. Paul Deschanel, Feb.–Sept. 1920
11. Alexandre Millerand, Sept. 1920–June 1924
12. Gaston Doumergue, June 1924–June 1931
13. Paul Doumer, June 1931–May 1932
14. Albert Lebrun, May 1932–July 1940

But in this year of its victory the Republican party, hitherto united under the leadership of Gambetta in a common front against both Royalists and Bonapartists, split into two halves. The moderate and conservative wing, led by Gambetta and Jules Ferry, became known as the Opportunists because its aim, as defined by Ferry, was to adopt "a political and parliamentary method which consists in not tackling everything at once, in limiting the scope of reforms and in avoiding disruptive issues." The wing that demanded more rapid reforms and took its stand on Gambetta's Belleville manifesto of 1869 was led by men like Georges Clemenceau and Charles Floquet. It became known as the Radicals and wanted such reforms as a revision of the constitution to make it more broadly democratic, the separation of church and state, the election of judges, a graded income tax and greater local communal self-government.

From 1879 onward, labour organizations were to exercise new influence on French politics. They had been forming in the 1870s, and the economic depression of the later years of that decade made them more active. Socialist congresses were held in Paris in 1876, at Lyons in 1878 and at Marseilles in 1879. At Marseilles it was decided to form a Socialist Labour party. Like the Republicans the Socialists soon split between the more extreme Marxists and the Opportunists, or "Possibilists," led by Paul Brousse. Divisions within the Socialist ranks multiplied during the next 20 years, despite the repeated efforts of Jean Jaurès to unify them. Syndicalist or trade-union organizations had established themselves in French economic and social life and took part in the Socialist congresses. In 1886 the first national congress of trade unions was held at Lyons and decided to set up a national federation of unions. In 1884 trade unions had been legally recognized, and sporadic strikes became an almost permanent feature of French life. The links between organized labour in industry and the Socialist movements in the country and assembly were never strong.

The instability thus induced in the parties of the left had its counterpart among the parties of the right. The failure of successive attempts at fusion on the part of the Royalists left Legitimists separated from Orleanists. The Bonapartists remained a force that could not be neglected during the 1870s: they gained 75 seats in the chamber of 1876. Above all, the issue of clericalism revived to cut across other live issues splintering French public opinion.

The ultramontane clericals expected that a restoration of the monarchy would secure for them that control over policy which was denied them by the Republicans. The church was by now competing openly with the republic in the matter of education and was trying to make France the champion of papal interests both against the new Italian kingdom and against Bismarck's *Kulturkampf* in Germany. The crisis of May–June 1877 was indeed a twofold conflict: between Royalists and Republicans and between clericals and anticlericals. This crisis came about with the so-called *coup d'état du Seize Mai*, when MacMahon, on May 16, 1877, sent to the Republican prime minister, Jules Simon, a letter reproaching him for his conduct of affairs in the chamber; whereupon Simon and his cabinet resigned. A *union des gauches* was forthwith formed in the chamber in protest against MacMahon's action; and in June, when the new prime minister, the duc de Broglie, asked the senate on MacMahon's behalf to dissolve the chamber, the chamber passed a resolution of no confidence in the ministry by 363 votes against 158. On the senate's dissolving the chamber, the 363 deputies of the left presented themselves en bloc to the electorate. Gambetta and Thiers once more cooperated, and when Thiers died (Sept. 3) in the midst of the electoral campaign, Paris turned his funeral into a Republican demonstration. The Republicans won 326 seats and, by the invalidation of about 75 of their opponents' elections—on the grounds that improper official pressure had been used during the polls—raised their strength in the chamber to about 400.

The Republican victory, great enough to check the monarchists' schemes against the constitution, was not great enough to dispel fear of clericalism. Gambetta's chief anxiety in foreign affairs was to win international recognition for the new republic and to remain on good terms with the Italian kingdom. In 1877 he visited King Victor Emmanuel in Rome, but he had scarcely returned to Paris when the king died. A month later Pius IX died, and his successor, Leo XIII, adopted a more conciliatory policy. But the

tradition of hostility between church and republic and the extent of clerical power and influence over education in France combined to make another two decades of strife inevitable. In 1880 decrees were issued disbanding the Jesuits, and two years later Ferry made primary education free, compulsory and secular.

Throughout the formative period of the parliamentary republic, therefore, a mixture of diverse issues split public opinion, and this split was reflected in the multiparty system. Every ministry had to be a coalition of several groups—either a fairly cohesive *union des gauches*, as in the crisis of 1877, or a looser combination of centrist groups, as were most ministries of the 1880s. Any such coalition, being based on only a limited area of agreement, tended to be short-lived and to collapse as soon as one or two marginal elements deserted it. Ministerial instability became the most outstanding and decisive characteristic of the French parliamentary system; and 30 ministries held office during the first two decades of the new constitution.

Governments of the Third Republic

1. Louis Jules Trochu, Sept. 1870–Feb. 1871
2. Eugène Chevandier de Valdrôme, "the Bordeaux government," Sept. 1870–Feb. 1871
3. Adolphe Thiers, Feb. 1871–May 1873
4. Adolphe Thiers, May 1873–Feb. 1875
5. Louis Buffet, March 1875–Feb. 1876
6. Jules Dufaure, Feb.–March 1876
7. Jules Dufaure, March–Dec. 1876
8. Jules Simon, Dec. 1876–May 1877
9. Albert de Broglie, May–Nov. 1877
10. Gaëtan de Grimaudet de Rochebouet, Nov.–Dec. 1877 (10 days)
11. Jules Dufaure, Dec. 1877–Jan. 1879
12. William H. Waddington, Feb.–Dec. 1879
13. Charles de Freycinet, Dec. 1879–Sept. 1880
14. Jules Ferry, Sept. 1880–Nov. 1881
15. Léon Gambetta, Nov. 1881–Jan. 1882
16. Charles de Freycinet, Jan.–July 1882
17. Charles Duclerc, Aug. 1882–Jan. 1883
18. Armand Fallières, Jan.–Feb. 1883
19. Jules Ferry, Feb. 1883–March 1885
20. Henri Brisson, March–Dec. 1885
21. Charles de Freycinet, Jan.–Dec. 1886
22. René Goblet, Dec. 1886–May 1887
23. Maurice Rouvier, May–Nov. 1887
24. Pierre Tirard, Dec. 1887–March 1888
25. Charles Floquet, April 1888–Feb. 1889
26. Pierre Tirard, Feb. 1889–March 1890
27. Charles de Freycinet, March 1890–Feb. 1892
28. Émile Loubet, Feb.–Nov. 1892
29. Alexandre Ribot, Dec. 1892–Jan. 1893
30. Alexandre Ribot, Jan.–April 1893
31. Charles Dupuy, April–Nov. 1893
32. Jean Casimir-Périer, Dec. 1893–May 1894
33. Charles Dupuy, May 1894–Jan. 1895
34. Alexandre Ribot, Jan.–Oct. 1895
35. Léon Bourgeois, Nov. 1895–April 1896
36. Jules Méline, April 1896–June 1898
37. Henri Brisson, June–Oct. 1898
38. Charles Dupuy, Oct. 1898–June 1899
39. René Waldeck-Rousseau, June 1899–May 1902
40. Émile Combes, June 1902–Jan. 1905
41. Maurice Rouvier, Jan. 1905–March 1906
42. Ferdinand Sarrien, March–Oct. 1906
43. Georges Clemenceau, Oct. 1906–July 1909
44. Aristide Briand, July 1909–Nov. 1910
45. Aristide Briand, Nov. 1910–Feb. 1911
46. Ernest Monis, March–June 1911
47. Joseph Caillaux, June 1911–Jan. 1912
48. Raymond Poincaré, Jan. 1912–Jan. 1913
49. Aristide Briand, Jan.–March 1913
50. Louis Barthou, March–Dec. 1913
51. Gaston Doumergue, Dec. 1913–June 1914
52. René Viviani, June–Aug. 1914
53. René Viviani, Aug. 1914–Oct. 1915
54. Aristide Briand, Oct. 1915–Dec. 1916
55. Aristide Briand, Dec. 1916–March 1917
56. Alexandre Ribot, March–Sept. 1917
57. Paul Painlevé, Sept.–Nov. 1917
58. Georges Clemenceau, Nov. 1917–Jan. 1920
59. Alexandre Millerand, Jan.–Sept. 1920
60. Georges Leygues, Sept. 1920–Jan. 1921
61. Aristide Briand, Jan. 1921–Jan. 1922
62. Raymond Poincaré, Jan. 1922–March 1924
63. Raymond Poincaré, March–June 1924
64. Frédéric François-Marsal, June 1924 (5 days)
65. Edouard Herriot, June 1924–April 1925
66. Paul Painlevé, April–Oct. 1925
67. Paul Painlevé, Oct.–Nov. 1925
68. Aristide Briand, Nov. 1925–March 1926
69. Aristide Briand, March–June 1926
70. Aristide Briand, June–July 1926
71. Edouard Herriot, July 1926 (3 days)
72. Raymond Poincaré, July 1926–Nov. 1928
73. Raymond Poincaré, Nov. 1928–July 1929
74. Aristide Briand, July–Oct. 1929
75. André Tardieu, Nov. 1929–Feb. 1930
76. Camille Chautemps, Feb. 1930 (4 days)
77. André Tardieu, March–Dec. 1930
78. Théodore Steeg, Dec. 1930–Jan. 1931
79. Pierre Laval, Jan. 1931–Jan. 1932
80. Pierre Laval, Jan.–Feb. 1932
81. André Tardieu, Feb.–May 1932
82. Edouard Herriot, June–Dec. 1932
83. Joseph Paul-Boncour, Dec. 1932–Jan. 1933
84. Edouard Daladier, Jan.–Oct. 1933
85. Albert Sarraut, Oct.–Nov. 1933
86. Camille Chautemps, Nov. 1933–Jan. 1934
87. Edouard Daladier, Jan.–Feb. 1934 (9 days)
88. Gaston Doumergue, Feb.–Nov. 1934
89. Pierre Étienne Flandin, Nov. 1934–May 1935
90. Ferdinand Bouisson, June 1935 (4 days)
91. Pierre Laval, June 1935–Jan. 1936
92. Albert Sarraut, Jan.–June 1936
93. Léon Blum, June 1936–June 1937
94. Camille Chautemps, June 1937–Jan. 1938
95. Camille Chautemps, Jan.–March 1938
96. Léon Blum, March–April 1938
97. Edouard Daladier, April 1938–March 1940
98. Paul Reynaud, March–June 1940
99. Philippe Pétain, June–July 1940

Colonial Expansion.—A further issue that divided the ranks of the Republicans was colonial expansion. Colonies were associated with the kings and with Bonapartism; a big insurrection in Algeria in 1871 strengthened anticolonial sentiment; and in 1874 the duc de Broglie's government evacuated Tongking. The Radical wing of the Republicans remained opposed to colonial expansion, but the Opportunists, led by Ferry and Gambetta, by 1880 began to favour it. In 1881 the bey of Tunis, Mohammed VI, after a short and inexpensive military campaign, was made to sign the treaty of Bardo which turned his territories into a protectorate of France. By the end of the year the whole of Tunisia was virtually under French control. Ferry's ministry fell under the attacks of the Radicals and the right. But he returned to power between 1883 and 1885 and resumed his forward policy. He strengthened French control in Madagascar; the expeditions of Pierre Savorgnan de Brazza in the Congo basin led to the establishment of French Congo; and in Indochina Tongking was retaken and Annam made a protectorate. Again, despite these remarkable gains, Ferry was swept from office in a tremendous outburst of parliamentary and popular hostility. But overseas expansion went on for the rest of the century, and the French empire in Africa and the far east became, next to the British, the most extensive in the world.

The background to this overseas expansion was economic boom and slump at home. The 20 years before 1873 had been a period of expansion and prosperity interrupted by short, sharp periods of crisis and slump. The 20 years after 1873 were a period of depression interrupted by short periods of sudden prosperity. The first of these periods came in the years 1880–82, when credit expanded, new companies were formed, railways were built and speculators were active. The output of pig iron jumped from 1,400,000 tons in 1877 to 2,069,000 tons in 1883. Agriculture prospered and grain crops were good. But the hectic speculation between 1880 and 1882 was followed by a flutter of bankruptcies and financial crises. The index of prices fell from 133 in 1880 to 122 by 1883 and to 111 by 1890.

Ferry saw in Indochina a new market for French industry and a remedy for trade depression. Great administrators like Paul Doumer, who was governor general of Indochina, built roads and railways and developed economic resources, and Joseph Simon Galliéni strove to overhaul the life of Madagascar as Hubert Lyautey was soon to reorganize Morocco. The more conservative service families found careers in the colonial army and the colonial administrations, while the church found new fields for its missionary

activities. One function of the empire was to ease the pressure of Royalist hostility to the republic at home by opening new opportunities for the service of France overseas.

Boulanger.—By the 1880s the parliamentary republic seemed safe. The constitution was working reasonably well; the party system had taken shape and the Republicans had consolidated their regime; the clerical issue, by no means dead, had almost reached a stalemate; the system of state secular education had been launched; a great new overseas empire had, despite popular hostility, been founded; and French industry and agriculture were on the whole making progress. The state clung to its protectionist and mercantilist traditions and was developing standards of industrial welfare. In 1874 the employment of children under 12 years old in factories had been prohibited, and factory inspectors had been appointed to enforce the law. The tariffs of 1881 cushioned farmers against the worst consequences of agricultural depression. The first big cloud to loom over the republic was the movement of Boulangism.

The Radical Republicans had allied themselves with the right and even with the extreme champions of revenge against Germany in opposition to Ferry's colonial policy. It was Clemenceau, leader of the Radicals, who got Georges Boulanger included in the government in 1886 as "the only Republican general." Boulanger became minister of war and made himself popular both by his energetic execution of measures to reform and "republicanize" the army and by his dashing appearances at military reviews. But a people's army was valued mainly as a weapon of revenge, and Boulanger was given the enthusiastic backing of Paul Déroulède and his League of Patriots. When Bismarck, in his *Reichstag* speech of Jan. 1887, named Boulanger as the greatest obstacle to good relations between France and Germany, popular opinion was left in no doubt: Boulanger became "Général Revanche." He began to demand a revision of the constitution so as to produce a stronger and more directly popular executive. Thrown out of power when the ministry fell in May, he was ready to conspire in order to further his own career. The Wilson scandal gave him his chance.

It was discovered that Daniel Wilson, son-in-law of President Grévy, had conducted a thriving traffic in decorations and honours from the Élysée itself; and the scandal implicated Gen. Jean Thibaudin, former minister of war and military governor of Paris. In the long crisis that ensued both the ministry and the president were forced to resign. The Royalists and Bonapartists began to pay court to Boulanger. He became the focus for all the forces hostile to the parliamentary republic. He was elected on the lists of several constituencies at once and in Jan. 1889 won a resounding triumph by getting elected for Paris itself. A *coup d'état* was staged. It failed mainly because Boulanger lost his nerve at the last moment. The ministry abolished the electoral device of *scrutin de liste* and the system of multiple candidatures which had made his successes possible. The new premier, Pierre Tirard, took action against the League of Patriots and threatened to bring Boulanger to trial before the senate. Boulanger took fright, fled to Brussels on the appropriate date of April 1 and committed suicide on the grave of his mistress 30 months later.

Boulangism was defeated, as MacMahon had been, by the formation of a *union des gauches*, a rally of the parliamentarians to save the republic. The regime was strengthened and its opponents were weakened by the failure of Boulangism. But the root causes, a tendency to parliamentary corruption and to ministerial instability and the failure to reconcile certain classes to the regime, remained. The years of Boulangism were years of falling prices and wages, which induced an atmosphere of economic depression and considerable hardship. It was when such conditions coincided with a political crisis that the republic was most in danger.

Panama Scandal.—In 1889, when the Boulangist crisis reached its climax, the Panama Canal company failed. Eight years earlier the project had been launched for constructing a Panama canal by a company directed by Ferdinand de Lesseps of Suez canal fame. The difficulties of the undertaking had proved enormous, and it had received no official support until the end of 1888. By a succession of loans it had raised 1,040,000,000 fr., and when it went into liquidation the shareholders appealed to the government to safeguard their interests. Lesseps and some of his colleagues were charged with corruption, and although the charges were not proved the Boulangist deputies and their supporters in the country could again raise the cry of corruption in high places.

It was alleged that deputies had been bribed by a Jewish financier, Baron Jacques de Reinach. When Reinach was found dead and another Jewish financier, Cornelius Hertz, who had been blackmailing Reinach, fled to England, a commission of inquiry had to be set up. Clemenceau, who had uncomfortably close associations with Hertz, was denounced as being in the pay of the British foreign office. Proceedings were started against five deputies and five senators, including five ministers or former ministers. Although in the end only a former minister of public works was convicted (on his own confession) and the allegations against Clemenceau rested mainly on forgeries, the whole affair came too soon after the Wilson scandal and the Boulangist scare to be comfortable for the regime. Anti-Semitism, which had been growing since 1885, received fresh impetus. In the elections of 1893 the Radicals collaborated with the Socialists and drew further away from the right-wing Republicans, while Socialist deputies increased in number from 12 to 49.

Labour Organizations to 1902.—Syndicalist organizations had grown faster after trade unions were legalized in 1884. Membership of legally constituted unions was only 140,000 in 1890, but grew to 420,000 by 1895; it reached a total of 589,000 by 1901. In 1892 the *bourses du travail* ("labour exchanges"), which had become local centres for syndicalist activities, formed themselves into the national Fédération. Three years later, in 1895, the trade unions formed the Confédération Générale du Travail (C.G.T.; General Confederation of Labour). In 1902 the Fédération combined with the C.G.T., which henceforth became the national representative of organized labour movements. (*See* also *Trade Unionism*, below.)

The prevalent doctrine of the C.G.T. was direct action; that is, it sought to promote workers' interest not by political action and not by supporting Socialist parties in the assembly but by collective bargaining and use of the favourite revolutionary weapon of the general strike. In 1893 more than 3,000,000 man-days of labour were lost by stoppages. Within its ranks were included a wide variety of revolutionary doctrines, Marxist and anarchist and syndicalist, and there remained few links and often little sympathy between organized labour and the parliamentary Socialist groups. This cleavage weakened the authority of parliament. The 19th century ended with a decade of strikes and the 20th began with another. The social legislation passed around the turn of the century was not far-reaching: a ten-hour factory act in 1900, accompanied by more thorough factory inspection; joint consultative councils of labour and employers to advise the government and to mediate in labour disputes. It was denounced by the revolutionaries of the C.G.T. for whom the class war was an article of faith. These two decades were a period of rising prices and industrial expansion, coinciding with the influx of gold from South Africa. The aim of labour organizations was, partly, to ensure a larger share of the profits of expansion for the workers and to force up wage levels to keep pace with prices; but it was also to propagate revolutionary doctrines among the French working classes. This divergence of ends led to a conflict about means. While parliamentary Socialists like Jean Jaurès, Aristide Briand and Alexandre Millerand preached some reconciliation of classes within the state, the C.G.T. preached the class war. In consequence, material gains were sacrificed for ideological differences.

Dreyfus Case (1894–1906).—It was against this background of mounting social tensions and political controversies that there occurred the most sensational *affaire* of the republic: the Dreyfus case. In 1894 Capt. Alfred Dreyfus, of the staff of army headquarters, was accused of having sold military secrets to Germany. He was condemned, disgraced and sent to Devil's Island. Most Frenchmen accepted the verdict that the young Jewish officer was guilty, until in 1897 his family's efforts to prove his innocence received unexpected support from Lieut. Col. Georges Picquart of the intelligence service. He found strong evidence that the document which had served as the main proof of Dreyfus' guilt had

been forged by a shady artillery officer, Maj. C. F. (Walsin-) Esterhazy. He reported this to the vice-president of the senate, Auguste Scheurer-Kestner, who joined with the Dreyfus family in bringing a formal charge against Esterhazy. The great novelist Émile Zola and the formidable fighter Clemenceau took up their cause.

Esterhazy was duly acquitted by a secret court-martial and hailed as a popular hero. But Zola, in an open letter to the president of the republic headed "J'Accuse," threw down a challenge that no parliamentary government could ignore. He alleged an army conspiracy to condemn Dreyfus despite his innocence. When Zola was tried and condemned, public opinion still showed itself to be against Dreyfus.

It was 1898 before the tide turned. In that year the new Radical minister of war, Godefroy Cavaignac, disclosed in the chamber some of the evidence on which Dreyfus had been condemned. Picquart offered to prove that one of the documents produced did not refer to Dreyfus and that two of the others were false. Col. H. J. Henry, who had been appointed to Picquart's post in the intelligence service and who had been involved in the conspiracy, committed suicide after confessing his own guilt. Esterhazy escaped to England. These events made a retrial inevitable, and now public opinion was wildly excited. The rights and wrongs of Dreyfus as an individual dropped out of sight. Nationalists, clericals and right-wingers tended to be anti-Dreyfusard; Republicans, anticlericals and Socialists tended to be Dreyfusard.

All other events—such as the sudden death of the president of the republic, Félix Faure, in 1899, and the election of Émile Loubet to succeed him—were interpreted as items in the *affaire Dreyfus*. It was only the formation of a new ministry headed by René Waldeck-Rousseau in 1899 that brought the matter to a culmination, for demonstrations and counterdemonstrations were threatening public order.

The new ministry, like its predecessors in the MacMahon and Boulangist crises, was a *union des gauches* for republican defense. It took strong measures, arresting and punishing even Déroulède himself. The retrial of Dreyfus, which began at Rennes in Aug. 1899, attracted world-wide attention. He was again found guilty of "intelligence with the enemy," but "with extenuating circumstances"; and he was shortly after pardoned by President Loubet. It was 1906 before the Rennes verdict was also quashed and Dreyfus was restored to full rights by a resolution of the chamber of deputies.

The reason why the Dreyfus affair was so disruptive in French life must be sought beyond the battle of political forces which filled the stage at the time. The church was a weaker challenge to the republic after the period of *ralliement* encouraged by Pope Leo XIII in 1892, and this weakness showed itself in the relative ease with which, by 1905, church was separated from state. Popular opinion lost interest in it when the issues became so complicated; and the affair played a very small part in the general elections of 1898. There is evidence that the middle-class centre parties were more anxious about the growing threat from the left than about the challenge of the right, and Waldeck-Rousseau undoubtedly helped to split the Socialists when he took Millerand into his ministry. There is a background of economic unrest and social discontent to the Dreyfus case as much as to Boulangism. Moreover, in historical perspective the affair can be seen as one further reason for the slow advance of social reforms in the republic before 1914.

Church and Army.—Conflict between the church and the republic, active in the 1870s, became latent for a short time in the 1890s because of the movement known as the *ralliement*. Beginning in 1890, this movement took clear shape in 1892 when Leo XIII ordered Catholics in France to obey the laws of the republic. It bore fruit in the work of Comte Albert de Mun and a new leniency in the application of the anticlerical legislation. But the bitterness aroused by the Dreyfus case undid most of its benefits. The quarrel entered upon a new phase in 1901 when the formation of free associations was, for the first time, fully allowed in France, but religious congregations could be formed only with special authorization and could be dissolved by decree. This measure was aimed especially at the Assumptionists and the Jesuits. Then Émile Combes, a high dignitary of Freemasonry, who succeeded Waldeck-Rousseau in 1902, suppressed nearly all the congregations and took away their rights to run schools (1904). The conciliatory Leo XIII had died in 1903, and his successor, Pius X, upheld papal claims more inflexibly. The conflict revived quite suddenly with the conjunction of intractable leaders on either side, and separation of church from state was the inevitable result.

Accordingly, in 1904, Combes introduced a bill for the separation of church and state and for ending the concordat. Although he fell from office two months later (Jan. 1905), his successor, Maurice Rouvier, passed the bill into law in Dec. 1905. The republic guaranteed freedom of worship for all but ceased to give any official recognition or subsidy to any form of worship. Church endowments and revenues were to be handed over to new *associations cultuelles*, which would maintain religious services. When the pope refused to countenance this, the state sequestered church property and handed over its funds to public charitable organizations. The separation, effected with more hardship than was either intended or necessary, freed the church itself from state interference.

To Republicans, clericalism and militarism were linked. There was substance in this connection, in that many families produced both priests and soldiers and clung to the traditions of monarchical France. The higher ranks of the army and navy were traditionally held by men of Catholic traditions, and the Dreyfus affair brought this fact to notoriety. To defend French national security by conscription and by heavy military expenditures was also to undermine the republic by placing enormous influence and power in the hands of such men. The problem of how to democratize the French army attracted the attention, in turn, of Gambetta, Clemenceau and Jaurès. The Dreyfus affair showed the strength of antimilitarism, which was bred of the boredom of conscription and of a military life in which no differentiation was made between the peasant and the scholar. The Radicals, intensely patriotic in the days of Gambetta, found themselves becoming antimilitarist. The Socialists, internationalist by doctrine and suspicious of a law of conscription that could permit the call-up of strikers to defeat a strike, were also strongly antimilitarist.

Jaurès, in his book on *L'Armée nouvelle*, later tried to reconcile socialism with a democratic military organization. But a decade before 1914 the left parties were tending to be hostile to a large military establishment, whereas the right—identified with a policy of peace and of internationalism in the 1870s—was emerging as a more aggressively militarist and ultranationalist force in political life. This reversal of attitudes which occurred during the first half of the republic's existence was to be itself reversed again during the second half, when the right became defeatist or even "collaborationist" and the left the parties of "resistance" to fascism.

International Relations (1870–1914).—The counterpart to the maintenance of a strong army and to preparation at first for a war of revenge against Germany and subsequently for self-defense against encirclement by Germany was a system of reliable alliances. Bismarck's aim after his triumphs of 1870 and 1871 was to keep France isolated in Europe and, if possible, embroiled in conflicts with its neighbours. For this reason he favoured a republic as being least likely to find an ally among the monarchies of Europe, and welcomed French colonial expansion as likely to embroil it with Great Britain and Italy. For this reason too he sought alliances himself with Russia, Austria and Italy.

It was, therefore, the inevitable policy for the republic to win recognition for the regime, to settle colonial disputes with Great Britain and Italy and to win allies. Thiers did much to win European recognition for the republic. In 1893 France took the momentous step of entering into a treaty of alliance with Russia. Théophile Delcassé, minister for foreign affairs continuously from June 1898 until June 1905, strengthened the alliance by lavish loans to Russia. He made a commercial treaty with Italy in 1899 and allayed the fears that it had entertained about the French conquest of Tunis. In the same year he settled successfully the Fashoda incident, in which France and Great Britain fell into conflict about the Sudan, by agreeing to a definition of their spheres of influence

there. In 1904 Delcassé crowned his work with the Anglo-French entente. The two countries defined their separate interests in Newfoundland, western Africa, Siam, Egypt and Morocco. Bismarck's plans were thus completely frustrated by 1904; but the price was the division of the European powers into two rival camps, for the triple alliance of Germany, Austria and Italy had been forged by 1882, and the triple entente of France, Russia and Great Britain was completed in 1907 by the agreement between Great Britain and Russia which French diplomacy helped to facilitate. The entente cordiale became the cornerstone of French foreign policy in the west, the alliance with Russia its counterpart in the east.

Once made, the entente was consolidated as much by German aggressiveness as by French diplomacy. When the German emperor William II visited Tangier in March 1905 and Delcassé advocated resistance, he was unsupported by his colleagues and resigned (June). But the fact that the French foreign minister had been forced out of office under German pressure only strengthened the entente. Likewise, the Algeciras conference of 1906, for which Germany pressed, was in effect a victory for France because Germany gained little whereas it was agreed that France and Spain should police the Moroccan ports. By 1912 a French protectorate was formally set up in Morocco, and Great Britain entered into naval agreements whereby France concentrated its main naval forces in the Mediterranean and Great Britain transferred part of its Mediterranean squadron to the North sea. Though Great Britain was not bound by formal alliance to defend France against German attack, these arrangements and the persistence of naval rivalry between Great Britain and Germany made it possible for France to rely on British help if need should arise.

Political Scene in 1914.—The Radical ministry of Clemenceau, which came to power in 1906, set forth a program of reforms. It included provision for old-age pensions, income tax (hitherto not imposed in France), workmen's compensation, an eight-hour working day and governmental control of labour contracts and of the mines. It was the counterpart to the contemporary liberal reforms in England, but it was obstructed at every stage and came to little. The decade before 1914 was a period of great social unrest. At the congress of Amiens in 1906 the C.G.T. formally dissociated the organized labour movement from any political party and so from parliamentary action and affirmed the general strike as the main weapon of revolutionary syndicalism. Strikes and riots in the big towns (Paris, Marseilles, Le Havre, Dunkerque) in 1907–08 spread to the countryside, and there was a strike among the vinegrowers of the south. A strike among post-office workers in 1909 was followed by a call from the C.G.T. for a general strike. It failed, but the strikes split the Socialists from the Radicals and aggravated the already complex working of the multiparty system.

At the beginning of the 20th century it seemed as if the chronic ministerial instability of the republic was diminishing. Of the six ministries of the years 1899–1909, Waldeck-Rousseau's lasted three years, Combes's two and a half and Clemenceau's two and three-quarters. But between the fall of Clemenceau (July 1909) and the outbreak of World War I in 1914, nine ministries followed one another in quick succession, and only one (Briand's first ministry) lasted more than a year.

The main political triumph of the immediately prewar years was the passing of the three-year military service law under the premiership of Raymond Poincaré, who was elected president of the republic in Jan. 1913 and took office in February. In 1905, at the height of antimilitarist feeling engendered by the Dreyfus affair and by the growth of internationalist socialism, the length of compulsory military service had been reduced from three years to two and military expenditure drastically reduced. In 1912–13 Germany and Austria-Hungary increased the size of their armies and the French military authorities, backed by Poincaré and Louis Barthou, felt compelled to restore the three-year period of service. They met with energetic opposition from the Socialists and from most of the Radicals, who won victories in the elections of May 1914 by making opposition to the law one of the main planks in their policy. Only the persistence of the president and the actual outbreak of war in July saved the law from repeal.

As in Great Britain, the prewar years revealed signs of impending crisis in the parliamentary system and a decline of faith in constitutional methods of government. Outbreaks of violence, connected with the syndicalist movement, party conflicts and revolutionary anarchism, were becoming increasingly frequent. Parliamentary governments showed little sign of ability to deal with such developments. National finances were in grave disorder, the system of taxation defective and out-of-date.

Cultural Prestige.—Whatever the shortcomings of the prewar political system, it had the supreme merit of allowing a high degree of freedom to the individual, and this made possible a remarkable flowering of French national genius in nearly every field of the arts and sciences. In literature Anatole France, Zola, Maupassant and Daudet for prose and Verlaine, Mallarmé and Péguy for poetry; in philosophy, Bergson; in science Pasteur, Curie and Berthelot; in music Massenet, Saint-Saëns, Bizet, Franck, Fauré, Debussy and Ravel; in painting Manet, Monet, Renoir, Degas, Cézanne and Gauguin; in the social sciences Georges Sorel, Tarde and Durkheim; on the stage Sarah Bernhardt: these names are some index of the French contribution to European culture made by this era of freedom. Paris retained much of its old role as a fountainhead of European thought and progress. Writers, musicians and artists could find there a large and appreciative public eager to pay them respect. Even the tensions of French national life helped evoke some of the most original and persuasive writings of the period: those of Barrès and Maurras, of Julien Benda and Robert de Jouvenel, of Gide and the young Mauriac. Some of the greatness was to depart after 1918, but before 1914 there was a veritable renaissance.

World War I

The declaration of war by Austria-Hungary on Serbia on July 28, 1914, led to full mobilization by Russia and therefore to a declaration of war by Germany against Russia (Aug. 1). Germany declared war against France two days later and, on the next day, invaded Belgium. This precipitated Great Britain's declaration of war on Germany. Within a week, the two rival systems of alliances were brought into action, and the Anglo-French entente became a formal alliance.

Military Events.—The German plan was to deliver a knockout blow to the heart of France. German armies, advancing in a great hammer sweep through Belgium and northern France, were to envelop Paris. The Belgian army and the British expeditionary force took the first shock of the blow, but the German armies came perilously near to Paris. Only the cool courage of Joseph Joffre and his troops and the enterprise of Galliéni saved the capital. After the decisive battle of the Marne in September both sides dug themselves in, and from the Vosges to the sea an improvised line of defenses became the French frontier. This deadlock on the western front was not much altered until 1917 and not broken until 1918. It meant prolonged occupation of France's northern provinces, much of which country was turned into a battlefield.

The crises of the war in the west were, for France, the checking of the initial German offensive, which was achieved by the end of 1914; the battle for Verdun (Feb.–Aug. 1916); the mutinies and unrest in the French armies (summer 1917); and the checking of Ludendorff's offensive in 1918, which led to ultimate victory under Ferdinand Foch. The battle of Verdun originated in another attempt to knock France out. The German chief of staff, Erich von Falkenhayn, hoped that, with an all-out offensive against so crucial a point as Verdun, he could "bleed France to death" by annihilating its best troops. It was a serious miscalculation to expect that a limited and local action could yield such decisive results, yet he succeeded in smashing several French divisions and inflicting heavier losses than he suffered. But, at heavy cost of life and material, the French held Verdun, and Gen. Philippe Pétain became a national hero. The Franco-British offensive on the Somme, in July 1916, brought some of the fiercest fighting of the war. So, too, did the costly and unsuccessful offensive under Robert Nivelle in the spring of 1917. Disheartened by losses and prolonged strain and by the spread of pacifist feeling, sections of

the French army mutinied. Pétain, as the hero of Verdun, was sent to quell the mutiny, and by severe measures he succeeded. The entry of the United States brought little relief immediately, whereas the withdrawal of Russia from the war, after the October revolution, freed Germany from the burden of major offensives on two fronts. Both events made the battles of 1918 a desperate climax to the whole war.

Before these decisive battles the western powers set up a supreme war council. The French forces, under Pétain, had to defend Paris; the British, under Douglas Haig, had to defend the Channel ports. There was danger that the Germans by striking at the junction of the two forces might split them. At last, in April 1918, Foch was appointed commander in chief of the Allied armies. German offensives failed, and when Foch counterattacked on the Marne, German retreat began. U.S. backing in men, equipment and supplies now became decisive. The simultaneous collapse of Germany's allies in Bulgaria, Turkey and Austria-Hungary forced it to sue for peace. An armistice was signed on Nov. 11, 1918, in Foch's railway carriage in the forest of Compiègne.

France's northern industrial areas had been ravaged by 52 months of unbroken warfare. Towns and mines, factories and farms, were in ruins. About 1,400,000 Frenchmen had been killed and as many again disabled. Direct war expenditure had been about 150,000,000,000 fr. The economic dislocation and human misery caused by the war were incalculable. The war bequeathed to France vast tasks of reconstruction with a depleted labour force, a declining population and a public debt of about 219,000,000,000 fr. On the other hand the invader had been expelled and defeated, and France recovered the rich provinces of Alsace and Lorraine, lost in 1871, so that the menace which had haunted the previous 50 years seemed, for a time, to be removed.

The parliamentary republic, too, seemed to have been vindicated. Parliamentary governments, it was true, had not emerged brilliantly from the early years of the war. France's political leaders had been undistinguished men unworthy of leading a great nation in crisis, and it was to the generals and the millions of common soldiers that the nation had turned in time of need. But there was one exception: Clemenceau, who at the age of 76 had become the real organizer of victory in 1917 and had been mainly responsible for getting Foch made commander in chief. His ministry was formed mostly of nonentities whom he described as "the geese that saved the Capitol." With the simple maxim *Je fais la guerre*, he had ruled almost autocratically and often arbitrarily. But drastic suspensions of normal parliamentary powers and civil liberties were widely accepted as unavoidable in wartime. The *union sacrée* in face of national peril, always more a psychological conception than a political reality, rested on the surrender of virtually dictatorial power to the government. The control of finance by the chambers practically lapsed, save for periodic outcries about extravagant expenditure.

Conference of Paris (1919).—It was appropriate tribute to the part of France in the war that the peace conference should be held in Paris and that Clemenceau should serve as its president. His program, for France, was "restitutions, reparations, guarantees." Restitutions meant recovering the provinces of Alsace and Lorraine. Reparations meant that Germany should contribute to the reconstruction of the devastated areas. Guarantees meant ensuring that Germany should fulfill its obligations and also establishing material and diplomatic guarantees from the Allies for French security. Foch wanted control of the bridgeheads of the Rhine and Clemenceau produced a plan for separating the whole Rhineland from Germany.

By the treaty of Versailles, signed on June 28, 1919, the left bank of the Rhine was demilitarized, along with a zone about 30 mi. E. of the Rhine, and Allied armies were to occupy the left bank and the bridgeheads for a period of 15 years. The amount of reparations to be paid by Germany was to be decided by the Reparations commission. It was a much more flimsy guarantee than France had hoped; and instead of indefinite occupation or separation of the Rhineland, France was given a joint Anglo-American promise of support if it were attacked by Germany. When the U.S. senate refused to ratify the treaty and renounced the U.S. assurances, Great Britain also renounced its assurances.

France was therefore left, in the end, with neither material nor diplomatic guarantees, save the hope of exacting crippling reparations from Germany and the general prospect of "collective security" provided by the covenant of the League of Nations (articles x, xvi, xvii). France entered the postwar years with an acute sense of insecurity and a feeling that it had lost some of the most precious fruits of the victory so dearly bought with French lives.

The remaining material securities had three defects from the French point of view. Germany was to pay reparations only for all damage done to civilians and their property, not for the whole cost of the war. The coal mines of the Saar were ceded to France not permanently, as Clemenceau had asked, but for only 15 years, at the end of which a plebiscite was to be held. Likewise the military occupation of the Rhineland areas was to last for only 15 years. These securities would expire at the very time when France was to need them most.

French enthusiasm for the new League of Nations was, moreover, very restrained. During the discussions of the project Léon Bourgeois had produced a plan to give the League power to enforce military sanctions with an army of its own. This plan had been rejected by Great Britain and by the United States; and even the covenant itself was rejected by the United States, which did not become a member of the League. So the League was, in French eyes, most unlikely to provide the substantial security against war and against defeat in war that France needed. Yet the success of the League would now clearly depend on how far Great Britain and France together could give it leadership. Within or without the League, relations with Great Britain were to remain the crucial problem of French foreign policy after 1919, as they had been in the years before 1914.

The Interwar Period (1919–39)

Postwar Governments.—In parliamentary life, peace brought a reaction against wartime discipline and a reversion to close parliamentary control over the executive. For the general elections of 1919 the method of *scrutin de liste* was revived, in conjunction with a restricted variant of proportional representation which favoured the most highly organized parties. The resulting *chambre bleu horizon* was dominated by ex-servicemen who constituted the conservative Bloc National. Clemenceau, who was attacked for his failure to get better terms in the peace treaties, resigned in Jan. 1920, having held power for more than two years. He was succeeded as premier by Millerand and failed to be elected president of the republic. His overthrow was in part a reassertion of parliamentary power against the man who had himself, before the war, smashed so many ministries.

Paul Deschanel, chosen as president in preference to Clemenceau, had a nervous breakdown in Sept. 1920 and was succeeded by Millerand, whose place as premier was taken by Georges Leygues. Millerand's aim was to be strong with Germany and with the chamber at home. From 1922, when Poincaré became premier, French policy abroad became increasingly intransigent. Chamber, premier and president were agreed on a nationalistic policy toward Germany. Briand had been forced by Millerand to resign, in Jan. 1922, because he showed signs of making concessions to Germany. But Millerand's attempt, after the victory of the Cartel des Gauches in 1924, to reassert the right of president and senate to dissolve the chamber was vigorously resisted by the Cartel, and he was forced to resign. It was almost a repetition of the MacMahon crisis of 1877 and ended similarly. No subsequent president repeated the attempt, and after 1924 the presidency reverted to the pattern of the prewar years.

The policy of the Bloc National was further discredited by the relative failure of its most drastic action against Germany, the occupation of the Ruhr in 1923. Germany was behind in its payment of reparations, and Poincaré decided to "put the bailiffs in," despite British disapproval. But the French troops met with passive resistance by the Germans. The franc suffered from the additional financial burden and from the decline of international confidence that resulted from the French action.

The reaction against this policy was embodied in Aristide Briand.

A man of the left with a fervent and almost mystical belief in internationalism, he came to wield a curious power in the exhausted France of the postwar years. He became the main spokesman of France at Geneva and one of the leading figures in the League as the "apostle of peace," and rivaled the prewar Delcassé in his length of tenure of the ministry of foreign affairs. He was ten times premier of France and, from April 1925 until Jan. 1932 (a few weeks before his death), he was except for one day continuously in charge of French foreign policy. He accepted, as Poincaré would not, the only alternative left to France: wholehearted support for the League, close co-operation with Great Britain and a policy of *rapprochement* with republican Germany. By 1924 foreign policy was in essentials fixed in the pattern that it was to follow, with occasional hesitations, until 1940.

The postwar governments sought separate alliances to shore up the League's provisions for security. France made a military alliance with Belgium in Sept. 1920 and with Poland in Feb. 1921. In the course of the following years it was also to make alliances with the states of the little entente: with Czechoslovakia in 1924, with Rumania in 1926 and eventually with Yugoslavia in 1927. The communist Revolution in Russia had confronted the peacemakers with a new and mysterious terror: and the idea of a *cordon sanitaire* in the east, which should insulate Europe from Bolshevism, coincided with French desires to encircle Germany with a ring of friendly and allied states. It was felt that the new and the augmented states of central and eastern Europe, owing their frontiers to the postwar settlement, would inevitably be opposed to any revision of it and so would be reliable allies against a resurgent Germany.

Economic Aftermath of War.—The economic aftermath of war was, for France, even farther reaching. Its finances had been constantly neglected since 1914, and it had financed the war largely by borrowing at home and abroad. It had relied for revenue chiefly on indirect taxation. Income tax, in a complicated and inadequate form, had been introduced only in 1917. Excessive reliance on short-term loans and unbalanced budgets linked public confidence —and therefore the franc—with governmental prestige at home and national credit abroad. In 1918 the franc stood at half its prewar value. By 1920 real wages fell below the 1911 level, although by the next year they were in general higher. In 1919 there were about 2,000 strikes involving many more than 1,000,000 workers. At the Socialist party congress at Tours in 1920 occurred the split between the adherents of the old second international and those of the new third international, centred upon Moscow. A new French Communist party was formed, and the same split occurred within organized labour, leading to the Communists' founding the Confédération Générale du Travail Unitaire (C.G.T.U.) in rivalry with the C.G.T.

The structure of French industry was greatly changed by the reorganizations and dislocations of wartime production. Heavy industries and mining developed faster than ever before, and postwar France was a much more highly industrialized nation than the France of 1914. Reconstruction meant modernization and the recovery of Alsace and Lorraine augmented both the industrial resources and the industrial manpower of France. The size of units of production and the methods used were different. The silent French revolution of 1914–18 was the displacement of the prewar industrial worker, technically skilled, alertly intelligent and politically individualist, by the operatives of mass production, herded into the big towns and including in their ranks many foreign immigrants. The influx of foreign workers, welcomed because France's manpower was dwindling, went on until by 1931 there were more than 1,500,000 of them in France. Agriculture, prosperous outside the occupied areas in wartime, remained one of France's greatest sources of wealth. Protected fiscally from world depression and gradually adopting more scientific methods, it was still the greatest single industry. But the conflict of interests between farmers, who wanted high tariffs and high prices for food, and industrial wage earners, who—especially in times of inflation—wanted lower tariffs and lower prices for foodstuffs, was now more than ever acute.

Recovery and Crisis (1924–36).—By 1924 the worst problems of the aftermath of war seemed to have been overcome. Most of the devastation had been made good, and newly equipped and modernized factories were producing more goods. The franc, still shaky because of the persistence of unbalanced budgets, had at least been stabilized for a time by Poincaré. The treaties of Locarno (1925) inaugurated the new phase of international conciliation identified with the reign of Briand at the Quai d'Orsay; and the Dawes plan for reparations payments restored allied unity on that issue. Germany became a member of the League in 1926. The Cartel des Gauches, led by Edouard Herriot, gained a large majority in the elections of 1924 and for the next two years Herriot, Paul Painlevé and Briand took turns in ruling France.

The major problem confronting these governments of the left was still the financial problem of inflation and the stability of the franc. The old anticlerical issue raised its head once more when secular education was introduced into Alsace and Lorraine, and the antimilitarist issue recurred in the form of left-wing hostility to military service and advocacy of disarmament. But the fiscal and financial problems were the most intractable. By 1926 the franc fell to 240 to the pound (as against 70 two years before), and the Radicals broke with their Socialist allies in the Cartel and rallied to Poincaré and the Conservatives. The chamber granted Poincaré power to deal with the crisis by decree laws—a power which it had denied both Briand and Joseph Caillaux six months before; and by the law of Aug. 10, 1926, the national assembly, convened at Versailles, modified the constitution to establish a sinking fund. Poincaré succeeded in checking the decline of the franc and restored confidence. By a policy of stringent economy and cheap money, combined with the sinking fund, he inaugurated another three years of relative calm and prosperity.

The great coalition fell apart after the elections of 1928. Poincaré gave up the premiership in 1929 because of ill-health, and the stage was left free for a succession of younger but lesser men such as André Tardieu, Camille Chautemps and Pierre Laval: adept parliamentary politicians and party tacticians who lacked the qualities of statesmanship needed in the gathering storm.

The world economic crisis broke in 1929. Its immediate effects on France, thanks mainly to its relatively well-balanced economy, were less catastrophic than in Germany, Great Britain or the United States. The nation depended less on foreign trade for its prosperity, and not until 1931 was it seriously affected. But in Germany the growing National Socialist party won more than 13,000,000 votes in the German presidential election of 1932. Laval, the French premier from Jan. 1931 to Feb. 1932 (and again from June 1935 to Jan. 1936), countered the economic crisis with a lavish use of decree laws at home and the international crisis by personal visits to Berlin, Washington, Rome, Warsaw and Moscow. He tried to win Italian support as a counterbalance to Hitlerite Germany and opposed League action against Italy when it attacked Ethiopia in violation of the covenant of the League.

It was a period of acute ministerial instability. Between the resignation of Poincaré in 1929 and the formation of the Popular Front government under Léon Blum in June 1936, there were no fewer than 20 ministerial crises. No government could rely on a large majority.

Stavisky Affair.—In the midst of these difficulties, in Jan. 1934, when the effects of the world crisis had at last begun to make themselves more acutely felt in France and unemployment figures were rising, a shady financier, Serge Alexandre Stavisky, whom the police were pursuing, was found dying. It was widely believed that his alleged suicide had been "arranged" by the police, in conspiracy with the premier Chautemps, to prevent revelations of corruption involving politicians, police, judiciary and eminent businessmen. The affair, coming at this moment of social discontent, evoked street demonstrations and riots and rumours of plots to overthrow the regime. Right-wing and paramilitary formations (Action Française, Jeunesses Patriotes, Croix de Feu), which had grown up in France as in most other European countries after the war, staged protests: the left, led by the Communists, staged counterdemonstrations. Riots on Feb. 6, 1934, aroused echoes of earlier Paris revolutions, and within a week a general strike was proclaimed. Edouard Daladier, the alleged "strong man" of the Radicals who

had become premier only a few days before, resigned. It was the first time in the history of the republic that a ministry with support in the assembly had given way before extraparliamentary pressure.

Gaston Doumergue was summoned, as veteran statesman, to form a new government of national union. It comprised all parties in the chamber save the Socialists and Communists. It restored confidence, quelled the disturbances and ruled by decrees. Again, the chamber saved itself by abdicating power, for the emergency, to the executive. But the armed right-wing leagues were not disbanded, and the deflationary policy of the government soon lost it the support of the Radicals.

German Occupation of the Rhineland.—Meanwhile, the flimsy safeguards which France had won from the peace settlement disappeared one by one. The Allied troops left the Rhineland in 1930 (five years before evacuation was due). A plebiscite held in Jan. 1935 in accordance with the treaty returned the Saar to Germany, whereupon Germany announced rearmament, in violation of the treaty. When Hitler occupied the Rhineland on March 7, 1936, denounced its demilitarization and denounced the treaties of Locarno, France did nothing against the aggressor. Thenceforward it was left facing a militant Germany, without faith in former allies (Belgium declared its neutrality in Oct. 1936, in departure from the alliance of 1920) and without any of the guarantees of security so laboriously sought since 1918.

The Popular Front (1936–38).—The elections of April–May 1936 were fought by the Radicals in collaboration with the Socialists and Communists in the Popular Front. The result was a decisive victory for the left, with antifascism replacing anticlericalism as the cement of this new version of the Cartel des Gauches. Although the Communists did not take part in the government formed by Blum, the Socialist leader, the government was a much more broad-based left-wing coalition than any of its predecessors.

With 500,000 unemployed receiving relief and many others out of work, the economic crisis was acute. Since 1919, despite two periods of left-wing rule, only two social measures of importance had been passed by the assembly. One, of 1928 and 1930, provided for social insurance; another, of 1932, set up a system of family allowances. The Popular Front's program included public works, a national grain board, more extensive unemployment relief and old-age pensions, control of the Bank of France by the state, the nationalization of armaments industries and—most controversial of all—a reduction of the working week to 40 hours and a more steeply graded income tax. Faced from the outset with an epidemic of "stay-in" strikes, staged by the extreme left to "push the government," Blum managed to bring the C.G.T. and the employers' representatives together in the Matignon agreement. This recognized collective bargaining contracts, an all-round wage increase ranging from 7% to 15% and the creation of workers' delegations to deal directly with factory managements. Léon Jouhaux, general secretary of the C.G.T., hailed it as "the greatest victory which the working class has won in its whole history." The agreement was confirmed by the Collective Bargaining act (June 1936). The 40-hour week and holidays with pay were also introduced by legislation. Within two years the Popular Front government succeeded in implementing all major points in its electoral program. None of its achievements, except the 40-hour week, was subsequently undone.

In June 1937 Blum gave way to Chautemps, a Radical, and the chamber gave him plenary powers to deal with the financial situation, which had deteriorated under Blum. The gold stocks in the Bank of France had shrunk to a figure below the 50,000,000,000 fr. deemed essential for security. The franc was taken off the gold standard and was devalued. The rise in prices and wages, the expenditure on armaments, a decline in production and a deficit in the trade balance all conspired to create yet another financial crisis.

During 1938 the Popular Front disintegrated. In January Chautemps remodeled his cabinet as a purely Radical ministry, but it was unsupported by the Socialists and Communists and lasted only two months. Its resignation coincided with the annexation of Austria by Hitler. Blum's attempt to establish another Popular Front ministry lasted less than a month. In April Daladier formed a new Radical ministry, which held power when World War II broke out in Sept. 1939.

The Popular Front experiment was not without its successes, but its greatest failure was in the field of foreign policy. Its policy of nonintervention during the Spanish civil war, in which it was backed by Great Britain, and its failure to arrest the progress of Hitler's Germany toward the domination of Europe have been severely criticized. But it is arguable that after the German occupation of the Rhineland in March 1936 no decisive action to stop Hitler without war was practicable.

The latter years of the republic were marked by open conflict between parliamentary forces on the one side and the forces of both fascism and communism on the other. The international tensions were reflected in its internal conflicts. Blum took vigorous action against the right-wing forces: in June 1936 he disbanded the Croix de Feu, Col. François de la Rocque's league (immediately revived as the Parti Social Français, it was again to be declared illegal in Dec. 1937); and in Nov. 1937 he exposed the conspiracy of the Cagoulards or Comité Secret d'Action Révolutionaire (C.S.A.R.) under Eugène Deloncle, which aimed at overthrowing the republic by armed insurrection. Daladier took action against the Communists, defeating the attempt at a general strike in Nov. 1938 and arresting Communist leaders on the outbreak of war. But both fascism and communism were rooted in the recurrent economic crises and social distress of the period. One was to gain strength during the wartime governments at Vichy, the other was to revive with renewed power after the war.

World War II

France in 1938 found itself committed to a small professional army and static defenses—the Maginot line had been built along the Franco-German frontier—rather than to massive forces and mechanization. It maintained a strong fleet, but the air force was small. Given the greater manpower resources of Germany, only complete solidarity with Great Britain could enable France to hold its own, even in defense. Daladier could do no other than follow the lead of Neville Chamberlain, the British prime minister, in making the Munich agreement which dismembered Czechoslovakia in 1938. In March 1939 he likewise followed suit in promising support to Poland if it should become the victim of aggression from Germany. When Germany invaded Poland on Sept. 1, the French declaration of war came five hours after the British.

There followed, until May 1940, the phase known as "the phony war." At the outbreak of war France immediately mobilized all available manpower and manned the Maginot line. After Poland had been overrun by German and Soviet forces and partitioned, France stood waiting for the attack. It did not come for eight months, during which German propaganda seeped into many sections of French opinion and boredom sapped morale. In March 1940 Paul Reynaud succeeded Daladier as premier; the German attack began on May 10, through the Netherlands, Belgium and Luxembourg. Five days later the Germans broke through the defenses of the Meuse and enveloped Sedan. Within two months this defeat led to the collapse of the French armies and to an Italian declaration of war on France. Deficient in armour and aircraft and ill-trained and ill-equipped for a war of fast movement, the French armies could not resist the German armoured divisions and air force. Great Britain could send only ten divisions and inadequate air cover. Reynaud's government fled to Bordeaux in confusion, and on June 16 Reynaud resigned and made way for Marshal Pétain, who favoured coming to terms with Hitler before total collapse.

The Armistice (1940) and the Resistance Movement.—Pétain sought an armistice, and on June 22 it was signed in Marshal Foch's old railway carriage in the forest of Compiègne. Two days later a similar convention was signed with Italy. The French government was left in nominal control of the whole of France and its colonies except Alsace and Lorraine, which were annexed to Germany. But the Germans claimed the "rights of an occupying power" in all areas north and west of a line drawn across France from the Swiss frontier near Geneva to a point east of Tours and then southward to the Spanish frontier at St. Jean-Pied-de-Port.

The country thus fell into two zones, and the line of demarcation remained the limit of German military occupation until Nov. 1942. Paris and the main industrial areas of the north, as well as the Channel and Atlantic coasts, were in German hands. The unoccupied zone was mainly agricultural but included the Mediterranean coast, which gave access to the north African colonies. Germany held more than 2,000,000 French prisoners of war, required the French to pay the costs of occupation and allowed them a small army of 100,000 men and the whole of the powerful French fleet, though this was to be disarmed. The whole arrangement was designed to be a stopgap until Britain had been conquered.

Although France was taken out of the war by the armistice and was to be ruled for the next four years by the governments of Vichy under Marshal Pétain, parts of the French nation continued the fight. Gen. Charles de Gaulle, who had been made undersecretary of state for war by Reynaud, escaped to London and founded the Free French movement. During the second half of 1940 the equatorial colonies of Chad and the Cameroun were led over to the Free French, and General de Gaulle found himself not only leader of a voluntary movement of Frenchmen to continue the war but responsible for administering a large colonial area. Inside France, by the end of 1940, various local movements of resistance had also formed to frustrate the occupying forces. In course of time these movements not only grew but formed links with the Free French. Possession of the fleet and of the north African colonies and the right to administer the unoccupied zone without direct German interference gave Vichy certain foundations for independence.

Vichy Regime.—Although not a member of the government when the armistice was signed, Laval joined it the following day and became the main architect of the Vichy regime. It was he who on July 10, 1940, persuaded the national assembly (summoned at Vichy to ratify the armistice) to grant Pétain authority to promulgate a new constitution (569 votes in favour, 80 against, 18 abstentions), so that Pétain was able, next day, to assume full legislative and executive powers in the "French state" (*État français*). The Vichy governments survived for four years by never promulgating a new constitution. Their policy, and the elements molding policy, changed in tune with the fortunes of the war. When the close collaboration adumbrated by the Montoire meetings of Pétain and Laval with Hitler and Ribbentrop in Oct. 1940 proved impracticable, Laval fell from power in Dec. 1940 and was succeeded by Adm. Jean Darlan. Pétain and Darlan embarked on a period of *attentisme* ("wait and see") in their dealings with Germany. The republican slogan of "Liberty, Equality, Fraternity" was replaced by "Work, Family, Fatherland." Vichy looked to the United States for support and aimed at keeping Germany to the strict terms of the armistice.

In April 1942 Laval returned to power and contrived to convince the Germans that they could get more active collaboration from him. Germany was now engaged in massive war with Russia and with the United States and needed greater security in the west. But six months later the whole basis of Vichy's position was transformed. United States and British forces landed in north Africa, the main units of the French fleet were scuttled by their crews at Toulon, and Germany occupied the whole of France and disbanded the "armistice army" of Vichy.

Henceforth Vichy had no assets with which to bargain, except the cult of loyalty to Pétain and the nimble wittedness of Laval. It became increasingly a tool of German policy and, by March 1944, included extreme collaborators such as Joseph Darnand and the National Socialist Marcel Déat. Darlan was assassinated in Dec. 1942 in Algiers, where he had aligned himself with the Allies.

Etat Français (Vichy Regime)

Chief of State

Philippe Pétain, July 1940–April 1945

Heads of Government

1. Pierre Laval, July–Dec. 1940 (title *vice-président du conseil*)
2. Jean Darlan, Feb. 1941–April 1942 (title *vice-président du conseil*)
3. Pierre Laval, April 1942–April 1945 (title *chef du gouvernement;* from Aug. 1944 at Belfort; from Sept. 1944 at Sigmaringen, Ger.)

Committee of National Liberation.—Meanwhile the Free French movement had also been transformed in character. A French National committee, set up in 1941 under General de Gaulle, came to include spokesmen of various parties and resistance movements. In June 1943 it merged with the north African administration, under Gen. Henri Giraud, heir of Darlan, to form the French Committee of National Liberation. Its authority was enhanced by a provisional consultative assembly in Algiers, representing mainly the resistance movements of metropolitan France. After the Allied invasion of France on June 6, 1944, it moved to France and became the nucleus of a provisional government.

The internal resistance movements grew rapidly in strength and significance as large numbers of young men fled to the hills and open country to escape the German forced-labour laws. Living as outlaws in the *maquis* and aided by the country people and by supplies dropped by aircraft from Great Britain, they harassed German communications and transport in preparation for Anglo-American landings. The French forces of the interior were led by Gen. M. P. J. F. Koenig. The six months preceding D-day was a period of civil war in France, between the men of the *maquis* and the German Gestapo aided by Vichy militias.

Thus the provisional government, based on resistance, took over from a regime in utter collapse immediately after a phase of acute civil strife. As operations against Germany continued for nine months after the liberation of Paris (Aug. 1944), it had to start rebuilding a regime in wartime conditions.

The Fourth Republic

In Sept. 1944 the provisional government was reorganized. It declared Pétain's "French state" abolished, together with all its laws, and announced that "legally the Republic has never ceased to exist." It won formal recognition by the Allies. The elections of Oct. 21, 1945, based on female as well as male suffrage, were not only to return new deputies to the assembly but also to decide whether the constitution of the third republic was to be maintained or not. About 95% of the electorate voted for a new constitution. The constituent assembly contained three major parties almost equal in strength: the Communists, the Socialists and the Mouvement Républicain Populaire (M.R.P.). It had seven months of existence in which to draft a new constitution and submit it to popular referendum. It proclaimed General de Gaulle head of the provisional government, and he embarked on a program of immediate reforms which included the nationalization of credit, electricity and insurance, and reform of the public services and civil service. But in Jan. 1946 he announced suddenly that he would resign. The Socialist Félix Gouin succeeded him.

In May 1946 the draft constitution was rejected in the referendum, and a second constituent assembly was elected to try again. Georges Bidault now headed the ministry. In October the new draft was accepted by 9,120,576 votes against 7,980,333, but nearly one-third of the electorate abstained from voting. The constitution met with energetic criticism from General de Gaulle and his supporters and little enthusiasm from the country in general. It was accepted, like that of 1875, as the form of government that divided Frenchmen least.

The electoral basis of the new regime was very different from that of the old. Women now had a vote. Proportional representation was adopted. The second chamber, now called the council of the republic, was granted very little power over legislation and was only a shadow of the old senate. But in all other major respects the constitution of 1946 was a continuation of the third republic. The centre of gravity of political power still lay in the lower chamber, now called the national assembly and elected for five years instead of four. Ministries were still perforce coalitions of parties and subject to the same bias toward instability.

The president of the republic, with the same tenure and functions as before, was still chosen by the chambers for his most unexceptionable qualities, and in Jan. 1947 the Socialist Vincent Auriol was elected the first president. The system of local administration through the *préfets* and of local elected assemblies remained substantially as before.

The most important differences arose not from the formal con-

stitution itself but from the new balance of social classes and from the new alignment of political parties, which were now more highly disciplined. Postwar conditions in general favoured the agricultural interests as against the industrial workers. Inflation, shortages, a lag of wages behind prices and an endemic black market all tended to improve the standard of living of the countryman and depress that of the industrial wage earner and the salaried and professional classes.

Politically, the most important new factor was the power of the Communist party inside and outside parliament; a development closely connected with the wage earners' plight in a period of rapid price rise and with the role of resistance movements in the period of liberation. From Nov. 1945, when De Gaulle first admitted Communists to the government, they held for nearly two years some key posts in the national economy. This ministerial power was used to "colonize" large areas of industrial administration and management. At the same time, the party gained a strong grip on organized labour through the C.G.T. Throughout the first national assembly it was also the strongest single party, although after May 1947, when Paul Ramadier expelled the Communists from his cabinet, they were deprived of power. They relied increasingly on direct action to harass the government, and strikes were as much a feature of the early years of the fourth republic as of the later years of the third.

In Dec. 1946 Blum formed the only single-party ministry in modern French history. But his Socialist cabinet, designed as a caretaker regime pending election of the president and completion of the new constitution, lasted only six weeks. All subsequent ministries, until 1951, were variations on three-party coalitions of Socialists, Radicals and the Mouvement Républicain Populaire, with the addition of a few Independents and political technicians.

There were ten such coalition cabinets during the life of the first national assembly (Nov. 1946–July 1951), an instability exactly comparable to that of the third republic, though with the same remarkable continuity and recurrence of personnel. The Socialist Jules Moch held an important post in every ministry, including Blum's, and in all ten coalition cabinets foreign affairs remained with either Bidault or Robert Schuman, both of the M.R.P.

These three-party coalitions came to be known as the "third force," because in April 1947 De Gaulle formed the Rassemblement du Peuple Français (R.P.F.), appealing to all forces of discontent with the existing system as well as to fear of communism.

The "third force" governments had to meet a challenge both from the extreme left and from the extreme right but contrived, during 1947–49, to survive great strikes without help from the R.P.F. Trade unionism was further split when the Force Ouvrière, led by the veteran syndicalist Léon Jouhaux, left the Communist-controlled C.G.T.

The plan designed by Jean Monnet to modernize and re-equip French industry within four years made reasonably good progress. Production, both in industry and in agriculture, reached or surpassed the levels of 1939. Aid from the United States assisted economic recovery. But financial instability, inflation and industrial unrest remained acute, and the war in Indochina, waged from the end of 1946 until 1954, put constant strain on resources. The "third force" governments were too unstable and too much preoccupied to tackle these basic problems.

The general elections of June 2, 1951, opened a new phase in parliamentary politics, as the new national assembly was divided into six roughly equal groups: the Communists, the Socialists, the M.R.P., the Radicals and their allies, the Independent Republicans and their allies (the Conservative group), and the R.P.F. The Socialists passed into opposition, and the five ministries which held office between July 1951 and June 1954 moved steadily toward the right. In March 1952 a group of deputies of the R.P.F. seceded from the main body to support the conservative premiership of Antoine Pinay, and in May 1953 De Gaulle formally dissolved the movement as a parliamentary party, while preserving it as a movement outside parliament. This freed the Gaullist deputies to share in government and facilitated the drift toward the right.

When the second president of the fourth republic had to be chosen by parliament at the end of 1953, the parties further discredited themselves by a prolonged deadlock; 13 ballots had to be taken before René Coty was elected on Dec. 23, by 477 votes to 329.

In June 1954 general exasperation gave a unique opportunity to Pierre Mendès-France, who was elected prime minister by the unusual majority of 419 in an assembly of 627. Choosing a ministry drawn mainly from new men of the right-centre and the right, he offered France a "new deal" and undertook to end the war in Indochina within a month before proceeding to tackle the problems of the European Defense Community and economic reforms. His prestige soared when he succeeded in ending the war and in substituting for the E.D.C. treaty, which parliament rejected, the wider project of western European union involving British military commitment in Europe.

Mendès-France was defeated over his Tunisian policy in Feb. 1955, but was succeeded by his former minister of finance, Edgar Faure. Faure successfully concluded, on April 22, the Franco-Tunisian negotiations. In Morocco Mohammed V ben Yussef was restored and on Nov. 6 France proclaimed its resolve "to raise Morocco to the status of an independent state."

In an ill-judged effort to find a more manageable assembly, Faure decided on a snap dissolution. The elections, held on Jan. 2, 1956, produced an even less coherent national assembly and a sequence of left-centre governments no stronger than their predecessors. The assembly contained 150 Communists and 52 followers of Pierre Poujade, while the Gaullists had lost more than 3,000,000 votes and won only 21 seats. Poujadism, attracting more than 2,500,000 votes by its violent denunciations of the parliamentary system, was a symptom of the *malaise* of the nation and the regime. Politics relapsed into fluidity, incoherence and violence.

Mendès-France, the outstanding personality of the left-centre, had to take second place to the Socialist leader Guy Mollet and in May resigned from Mollet's government. By following a broadly conservative policy and a national line over Algeria and (in Nov. 1956) over the Suez expedition, Mollet's ministry survived longer than any government after 1938—for almost 16 months. In Europe it was internationalist and, on March 25, 1957, signed the European Economic Community (Common Market) treaty. But in most other respects it survived only by adopting its opponents' policies.

When Mollet was defeated in May 1957, he was succeeded by similar left-centre coalitions under the Radicals Maurice Bourgès-Maunoury (June) and Félix Gaillard (November). Increasingly, politics were dominated by the failure to end the war in Algeria. Military operations against the rebels, which had continued since Nov. 1954, engaged nearly 500,000 French troops and induced unrest in the army, which had long felt neglected and abused by the civilian politicians in Indochina, Suez and now Algeria. At home the war encouraged inflation, dissipated reserves of foreign exchange and halted the rise in the standard of living. In Feb. 1956 Mollet had given way in Algeria to the "men on the spot"—the French settlers, the army leaders and the right-wing extremists. These forces, combining with elements of discontent in France into the "Algiers Lobby," overthrew Bourgès-Maunoury and Gaillard in turn. On May 13, 1958, when Pierre Pflimlin of the M.R.P. became premier after a ministerial crisis of 28 days, the breaking point was reached. Pflimlin was known to have liberal views about Algeria. Challenged and defied by Generals Raoul Salan and Jacques Massu in Algiers, he was given wide emergency powers by a large majority of the assembly.

The man who now emerged as the rival candidate of the army and the right was General de Gaulle. Although insisting that he sought power only by constitutional means, De Gaulle announced his "readiness to assume the powers of the republic." Pflimlin warned the assembly that France was "threatened by civil war" and resigned. President Coty, similarly convinced, invited De Gaulle to form a government and on May 29 threatened to resign also unless it accepted De Gaulle's return to power. On June 1 the assembly accepted De Gaulle (329–224), and on the following day it granted him full powers for six months and authorized him to reform the constitution. The fourth republic was dead.

The regime, in so many respects a prolongation of the institutions, ideas and even the personalities of the third republic, was overthrown amid widespread contempt and apathy. It had been running down for the previous four years and died of creeping paralysis. Yet it had considerable achievements to its credit. It had held and weakened the threat of communism; it had restored the nation to prosperity after the devastations of 1944; it had gone far toward achieving greater economic unity and co-operation in western Europe. Measured against the vastness of problems during the postwar years its accomplishments were great. But by 1958 the nation was ready for more drastic experiments.

Governments of the Fourth Republic

Presidents

Vincent Auriol, 1947–53
René Coty, 1953–58

Heads of Government

1. Charles de Gaulle, provisional, Sept. 1944–Jan. 1946
2. Félix Gouin, provisional, Jan.–June 1946
3. Georges Bidault, provisional, June–Nov. 1946
4. Léon Blum, Dec. 1946–Jan. 1947
5. Paul Ramadier, Jan.–April 1947
6. Paul Ramadier, May–Nov. 1947
7. Robert Schuman, Nov. 1947–July 1948
8. André Marie, July–Aug. 1948
9. Robert Shuman, Aug.–Sept. 1948 (7 days)
10. Henri Queuille, Sept. 1948–Oct. 1949
11. Georges Bidault, Oct. 1949–June 1950
12. Henri Queuille, June–July 1950 (4 days)
13. René Pleven, July 1950–Feb. 1951
14. Henri Queuille, March–July 1951
15. René Pleven, Aug. 1951–Jan. 1952
16. Edgar Faure, Jan.–Feb. 1952
17. Antoine Pinay, March–Dec. 1952
18. René Mayer, Jan.–May 1953
19. Joseph Laniel, June 1953–June 1954
20. Pierre Mendès-France, June 1954–Feb. 1955
21. Edgar Faure, Feb. 1955–Jan. 1956
22. Guy Mollet, Jan. 1956–May 1957
23. Maurice Bourgès-Maunoury, June–Sept. 1957 (followed by a vacancy of 36 days)
24. Félix Gaillard, Nov. 1957–April 1958
25. Pierre Pflimlin, May 1958 (15 days)

The Fifth Republic

The situation that De Gaulle inherited was acutely dangerous. The European extremists in Algeria and their allies within France had now sufficiently scared public opinion into accepting him back, for yet a second time, as the saviour of France. The forces of the left, reinforced by historic memories of Bonapartism and Boulangism, were preparing to resist military dictatorship by force. Upon him centred the conflicting hopes of the rebels who had opened the door for him and the parliamentarians who invested him with constitutional authority. He brought to his task immense personal prestige, an astute capacity for political leadership and a determination to assert his own will over all the conflicting factions. To sustain his unique position and achieve his aims, he had to refuse subservience to any one group.

De Gaulle chose a cabinet of national unity. It included both Mollet and Pflimlin, and embraced representatives of all parties except the Communists and the Poujadists. It included nine non-parliamentarians, or technicians. Only three were avowed Gaullists, and none were men who had led the insurrection, though Jacques Soustelle became minister of information. In June De Gaulle spoke soothingly to the army leaders in Algeria and to the settlers, but carefully avoided using the key word "integration" to describe his intentions for Algeria. His language was studiously ambiguous.

The Constitution.—The draft constitution was submitted to referendum on Sept. 28, 1958. Out of an electorate of 26,603,464, a total of 22,596,850 (84.9%) went to the polls, and 17,668,790 (79.2% of valid votes) voted in favour of it. In form the constitution departed from the system of *gouvernement d'assemblée* that had prevailed under the third and fourth republics, yet it did not fully adopt the principles of a presidential regime of the U.S. type. The president of the republic and the government chosen by him were allowed greater freedom of action vis-à-vis parliament. But governments were still made "responsible to parliament" and were obliged to resign if the national assembly rejected their program of policy or passed a vote of censure. Parliamentary control was, however, weakened in several ways. A vote of censure required a majority of the whole assembly to be effective. An adverse vote in the senate did not necessitate resignation. The doctrine of separation of powers was introduced by a distinction between the function of lawmaking (the province of parliament) and that of rule making (the province of government), though parliament could authorize a government, for a specified period, to issue ordinances.

The break with the past was less sharp than it appeared. The retention of a bicameral parliament and the reversion, in the electoral law, to single-member constituencies and the second ballot—favourite devices of the third republic—were striking signs of tradition and continuity.

The idea of a separation of powers was further emphasized by the special prerogatives granted to the president of the republic. He was given power to dissolve parliament, appoint a prime minister and address messages to parliament. He might (article 16) assume emergency powers "when the institutions of the Republic, the independence of the nation, the integrity of its territory or the execution of its international commitments are gravely and immediately threatened, and the regular functioning of the constitutional public authorities has been interrupted."

The referendum on the constitution also gave all French overseas territories the opportunity to sever their links with France or to enter into a new French Community. Only Guinea chose total independence: elsewhere votes were overwhelmingly in favour of the new community. In Algeria, where the army remained in power, 79.4% of the electorate went to the polls and 96.5% of valid votes favoured continued links with France (*see* also *Constitution and Government*, below).

Elections, 1958–59.—Elections for the national assembly were held on Nov. 23 and 30, 1958. In metropolitan France the Union pour la Nouvelle République (U.N.R.), a right-wing party led by Michel Debré, who was largely responsible for drafting the constitution, won 188 seats. The swing to the right was also emphasized by great gains for the Conservative Independents (132 seats), and heavy losses by the Socialists (reduced to 40 seats) and the Communists (reduced to 10).

The election to the presidency on Dec. 21 had the foregone conclusion that De Gaulle would be chosen for seven years by a majority (actually it was 78.5%) of the new electoral college. The latter comprised all members of parliament, departmental councils, overseas assemblies and representatives of the municipal councils. In the senatorial elections of April 26, 1959, which reflected the new swing of opinion registered by the municipal elections of March, the U.N.R. lost ground, which the centre parties recovered. Thus the two chambers represented quite different balances of party strengths, with the senate a more accurate mirror of public opinion than the assembly. The fluidity of parties and of opinion had not been destroyed along with the fourth republic. (*See* also *Political Parties and Parliamentary Groups*, below.)

The Regime at Work.—The fifth republic came into operation on Jan. 8, 1959, when De Gaulle assumed presidential functions and appointed a new government. Since June 1958 he had put through, under emergency or transitional powers, about 300 decrees enabling the government to undertake a host of judicial, fiscal, economic and social reforms. Believing that the chronic weakness of the old system had been parliamentary *immobilisme*, but that this sprang, in turn, from deeply entrenched social interests resistant to reform, he stored up this armoury of power. Much of what governments did during the first two years of the new regime rested on this reserve of power and so was independent of parliamentary control. Likewise, much of the sectional resistance and popular outcry against the government was occasioned by its attacks on the interests of privileged groups. But there was substance in the charge that the regime was becoming an excessively bureaucratic and technocratic machine, too easily overriding parliamentary criticism and ignoring public feeling.

This charge was lent still greater substance by early changes within the government itself. De Gaulle chose as premier Debré, who had been minister of justice in his own transitional cabinet. The new ministry reflected party strengths in the assembly in that it was basically a coalition of the right and right-centre (the U.N.R., Conservative Independents and M.R.P.) together with an unusually high proportion of nonparty technicians. But in December the minister of education, a former Socialist, André Boulloche, resigned; in Jan. 1960 the leading Conservative parliamentarian, Pinay, was dismissed from the ministry of finance and economic affairs; and in February Soustelle was likewise dismissed. This progressive elimination of eminent political figures and their replacement by nonparliamentarians (such as Wilfrid Baumgartner, governor of the Bank of France, in place of Pinay) left the government more completely subservient to the will and policy of the president.

In Jan. 1960 the regime was confronted with a resurgence of active resistance from the exasperated extremists of Algiers. On Sept. 16, 1959, De Gaulle had held out the option of eventual self-determination for Algeria within four years after the restoration of peace. To the settlers, some army leaders and the extreme nationalists this seemed a betrayal of their hopes of May 13, 1958. A recurrence of terrorist attacks by Algerians was attributed to De Gaulle's "softer" policy. When in Jan. 1960 he dismissed General Massu for criticizing the government's policy, the Algiers rebels threw up barricades and attempted a new "May 13." But this time the army as a whole remained loyal to De Gaulle, and the revolt was ended within 10 days. It had little support outside the city of Algiers.

The rising had important consequences. De Gaulle's personal prestige was immensely enhanced. On Feb. 3 parliament granted the government special powers for one year; and on April 18 it took power by ordinance to declare by decree a state of emergency for a period of 12 days without getting (as formerly required) a previous affirmative vote of parliament. Although parliament continued to meet in normal session, these further accessions of power to an already strong executive led critics to speak of the coming of the sixth republic.

Meanwhile French influence in international affairs was enhanced by its development of Saharan oil resources and by its tests (four from Feb. 13, 1960, to April 25, 1961) of nuclear devices of its own manufacture. Although these tests involved defying a resolution passed in Nov. 1959 by the UN general assembly, which had requested France not to hold such tests, and the resolution had been supported by 26 Afro-Asian countries, French relations with the non-European peoples were greatly improved by the evolution of the new community set up by the referendum of Sept. 1958. (*See* FRENCH COMMUNITY.) In April 1960 the government signed agreements with Madagascar (later Malagasy) and the Federation of Mali (which soon split into two republics, Senegal and Mali) that both states would, in June, achieve independence while remaining within the community. Mauritania, the Central African Republic, Chad, the Republic of Congo and Gabon gained independence on similar terms. In July 1960 further agreements were made with Dahomey, Ivory Coast, Niger and Upper Volta, on the understanding that agreements of co-operation with France would be made after the achievement of complete independence. The New Community (*Communauté rénovée*) marked the climax of liberal policy toward former colonial peoples.

Throughout 1961 political life in France was overshadowed by the events in Algeria. On April 22 a military revolt broke out in Algiers led by four generals, namely Raoul Salan, Edmond Jouhaud, Maurice Challe and André Zeller. It collapsed four days later. Challe and Zeller surrendered and on May 31 were sentenced to 15 years' imprisonment each; but Salan and Jouhaud went underground to lead the Organisation de l'Armée Secrète (O.A.S. or Secret Army organization), which started a terrorist campaign both in Algeria and in France. In Algeria the O.A.S. aimed at making impossible any cease-fire between the French and the rebel forces. In France it tried to intimidate the supporters of De Gaulle's Algerian policy. An unsuccessful attempt to assassinate De Gaulle, attributed to the O.A.S., took place on Sept. 8, 1961, when the president was traveling by road from Paris to his country house at Colombey-les-Deux-Églises.

The Algerian conflict was finally solved by De Gaulle on March 18, 1962, when the agreements of Évian-les-Bains were concluded with the rebel "provisional government of the Algerian republic." (*See* ALGERIA: *History.*) Salan, the leader of the O.A.S., captured in Algiers on April 20, was sentenced in Paris on May 23 to life imprisonment. Jouhaud, his second in command, had already been arrested in Oran on March 25 and condemned to death on April 13, but this sentence was not carried out (on Nov. 28 he was reprieved by De Gaulle and was given a life sentence). Meanwhile the former premier, Georges Bidault, had gone underground to found the Conseil National de Résistance (C.N.R.) in succession to the O.A.S.

After the achievement of peace in Algeria, Debré resigned on April 14, 1962, having been premier for three years and three months—a record for the French republic. He was succeeded by Georges Pompidou, who had played a discreet but important part in preparing the Évian agreements. On July 3 France recognized the independence of Algeria.

On Aug. 22, 1962, another attempt was made to assassinate De Gaulle while he was on his way from Paris to the Villacoublay air base. This was allegedly organized by partisans of Bidault's C.N.R. (Jean Marie Bastien-Thiry, the ringleader of this attack, was sentenced to death and executed in March 1963.)

Determined to settle as best he could his eventual succession, De Gaulle on Sept. 20 explained to the country his decision that in the future the president of the republic should be elected by universal suffrage and no longer by a college of notables. He at once encountered strong opposition from the parliamentary political parties, with the exception of the U.N.R. and the left-wing Gaullist Union Démocratique de Travail (U.D.T.). Nevertheless, the bill providing for the new method of election of the president was adopted by the government on Oct. 2. De Gaulle addressed a message to parliament which had reassembled the same day. The government announced that the bill would be submitted to a referendum on Oct. 28, but in the night of Oct. 4–5, after a heated 12-hour debate, the national assembly approved a motion of censure by 280 deputies—39 more than required for a majority. Two days later Pompidou's cabinet resigned, and its fall led to the dissolution of the national assembly. After a campaign in which all parties except the U.N.R. and the U.D.T. recommended a "no" vote, the referendum in metropolitan France and French overseas territories gave the following results: 13,150,516 (62.25% of valid votes) answered "yes," 7,974,538 answered "no," and there were 6,490,915 abstentions (23.03% of the registered votes).

De Gaulle had announced before the referendum that he would resign the presidency if he obtained only a weak majority, and the entire opposition had consequently accused him of transforming the referendum on the constitutional question into a plebiscite on his own personality. However, he considered that the result obtained was sufficient to enable him to pursue his task as the "guide" of the French people.

General elections took place on Nov. 18 and 25, 1962. De Gaulle opened the electoral campaign on Nov. 7 with a televised address in which he invited those who voted "yes" in the referendum not to be inconsistent and to send to the national assembly those who approved of a "yes" vote. In the first ballot the two Gaullist parties obtained 31.92% of the valid votes (as compared with 17.5% at the general elections of 1958). The Communists also polled slightly more of the votes cast (21.8% as compared with 18.9% in 1958). The Socialists got slightly less (12.6% as against 15.5%), but the main sufferers were the conservative Independents and, to a lesser degree, the Christian Democrats and the Radicals. Of the 96 deputies elected in the first ballot more than a half were Gaullists. The second ballot was a triumph for Gaullist candidates: out of 482 seats (including 17 from overseas territories) they obtained 234. Together with 18 Independents, 9 Christian Democrats and 3 Radicals who had pledged their support for De Gaulle, the government, for the first time in modern French history, obtained an absolute majority in the national assembly. "Popular front" alliances in many constituencies pro-

duced an increase of Communist (from 10 to 41) and Socialist (from 40 to 67) deputies. The number of conservative Independents was considerably reduced (from 132 to 17) while there were 38 Christian Democratic affiliates of the M.R.P. (instead of 57) and 25 Radicals (instead of 35).

De Gaulle's press conferences and decisions during 1963, 1964 and 1965 gave him the opportunity to define or reaffirm the main outlines of his foreign policy. On Jan. 14, 1963, he clearly indicated that France refused to welcome Great Britain into the European Economic community. On Jan. 22, he and the German chancellor, Konrad Adenauer, signed a treaty of co-operation in Paris; but in October, when Ludwig Erhard succeeded Adenauer, Franco-German co-operation received a setback, because the Bonn government differed at first from Paris on agricultural policy and on relations with Great Britain.

The French government recognized the People's Republic of China on Jan. 27, 1964: at his press conference on Jan. 31, De Gaulle affirmed that China could not be left out of the eventual settlement of Asian affairs.

De Gaulle visited Mexico in March and then other Latin-American republics in Sept. and Oct. 1964. On Feb. 4, 1965, he called for a five-power Geneva conference (including the People's Republic of China) to reform the United Nations, "reverting to prudence and to the Charter"; *i.e.*, to the hegemony of the five permanent members of the Security Council, each being armed with the right of veto. At the same time he also proposed a return to the gold standard in international monetary relations.

(D. Tn.; X.)

VI. POPULATION

The population of France in 1962 was 46,520,271 with an annual increase of about 0.9%. This figure represented an increase of 6,500,000 over that given by the census of 1946 and of 4,000,000 over that of 1954. The growth following World War II had thus more than compensated for losses sustained during the war years. The postwar yearly increment also contrasted with the regular decrease of the immediate prewar period and was substantially higher than increments of the previous century.

A principal cause for such a population increase in this period was the generous financial assistance given by the state to encourage larger families, in the form of maternity allowances, family bonuses and medical facilities. Minor reasons were the influx of French citizens from former overseas territories and a liberal policy over the admission of refugees from central Europe.

The population of France (including Corsica) at the beginning of the 19th century was just under 27,500,000. Despite the losses of the Napoleonic Wars and the cession of territory after 1814, it had risen in 1821 to approximately 30,500,000 and, in 1861, to 37,500,000, assisted in this latter year by the acquisition of Savoy and Nice. But the proportionate increase lagged considerably behind that of some European countries, particularly the United Kingdom. By 1876, however, following the loss of Alsace-Lorraine, the population had fallen to just under 37,000,000. During the first two decades of the 20th century it tended to stabilize itself around 39,000,000, though World War I, in which French losses were equivalent to 1 in 31 or 10% of the young and middle-aged groups, was a factor in checking any increase. By 1936 figures had reached a prewar maximum of 41,907,000. Thereafter, partly because of economic deterioration with a resulting decreasing marriage and birth rate, and of the later losses during World War II, figures began slowly to decline until in 1946 the total was 39,848,182. The census of 1954 showed a recovery to 42,777,174 with a density of 201 per square mile. Since then the rise in population has been regular.

The number of resident foreigners in France after 1918 was always large, deriving principally from the entry of refugee Russians, Poles, Germans, Italians and Spaniards. Many of these and their offspring eventually became French nationals. In 1936 their total reached a peak of nearly 2,500,000, but had fallen in 1954 to just under 1,500,000, the reduction being explained mainly by naturalization. After World War II refugees from eastern European countries and Spanish immigrants predominated. The number of resident foreigners in the early 1960s was estimated at around 2,000,000. Of these, Spaniards formed by far the largest single national group.

Deaths exceeded births fairly frequently, and even during the period of peace (1920–38) this occurred in no fewer than five years. Then, a falling marriage rate (383,000 in 1922 compared

France: Area and Population

Départements	Area in sq.mi.	1954 census	1962 census
Ain	2,249	311,941	327,146
Aisne	2,868	487,068	512,920
Allier	2,850	372,689	380,221
Alpes-Maritimes	1,659	515,484	618,265
Ardèche	2,145	249,077	248,516
Ardennes	2,028	280,490	300,247
Ariège	1,893	140,010	137,192
Aube	2,327	240,797	255,099
Aude	2,449	268,254	269,782
Aveyron	3,386	292,727	290,442
Bas-Rhin	1,851	707,934	770,150
Basses-Alpes	2,698	84,335	91,843
Basses-Pyrénées	2,978	420,019	466,038
Bouches-du-Rhône	2,026	1,048,762	1,248,355
Calvados	2,198	442,991	480,686
Cantal	2,231	177,065	172,977
Charente	2,306	313,638	327,658
Charente-Maritime	2,792	447,973	470,897
Cher	2,820	284,376	293,514
Corrèze	2,273	242,798	237,926
Corse	3,368	246,995	275,465
Côte-d'Or	3,393	356,839	387,869
Côtes-du-Nord	2,787	503,178	501,923
Creuse	2,164	172,702	163,515
Deux-Sèvres	2,338	312,842	321,118
Dordogne	3,561	377,870	375,455
Doubs	2,031	327,187	384,881
Drôme	2,533	275,280	304,227
Eure	2,331	332,514	361,904
Eure-et-Loir	2,293	261,035	277,546
Finistère	2,714	727,847	749,558
Gard	2,271	396,747	435,482
Gers	2,429	185,111	182,264
Gironde	4,141	896,517	935,448
Haute-Garonne	2,458	525,669	594,633
Haute-Loire	1,931	215,577	211,036
Haute-Marne	2,416	197,147	208,446
Hautes-Alpes	2,179	85,067	87,436
Haute-Saône	2,075	209,303	208,440
Haute-Savoie	1,775	293,852	329,230
Hautes-Pyrénées	1,751	203,544	211,433
Haute-Vienne	2,145	324,429	332,514
Haut-Rhin	1,363	509,647	547,920
Hérault	2,403	471,429	516,658
Ille-et-Vilaine	2,700	586,812	614,268
Indre	2,666	247,436	251,432
Indre-et-Loire	2,378	364,706	395,210
Isère	3,180	626,116	729,789
Jura	1,952	220,202	225,682
Landes	3,615	248,943	260,495
Loire	1,853	654,482	696,348
Loire-Atlantique	2,695	733,575	803,372
Loiret	2,630	360,523	389,854
Loir-et-Cher	2,480	239,824	250,741
Lot	2,018	147,754	149,929
Lot-et-Garonne	2,079	265,549	275,028
Lozère	2,000	82,391	81,868
Maine-et-Loire	2,787	518,241	556,272
Manche	2,476	446,860	446,878
Marne	3,168	415,141	442,155
Mayenne	2,012	251,522	250,030
Meurthe-et-Moselle	2,039	607,022	678,078
Meuse	2,410	207,106	215,985
Morbihan	2,738	520,978	530,833
Moselle	2,414	769,388	919,412
Nièvre	2,659	240,078	245,921
Nord	2,229	2,008,545	2,293,112
Oise	2,273	435,308	481,289
Orne	2,372	274,862	280,549
Pas-de-Calais	2,607	1,276,833	1,366,282
Puy-de-Dôme	3,095	481,380	508,928
Pyrénées-Orientales	1,600	230,285	251,231
Rhône	1,104	966,782	1,116,664
Saône-et-Loire	3,331	511,182	535,772
Sarthe	2,411	420,393	443,019
Savoie	2,389	252,192	266,678
Seine*	185	5,154,834	5,646,446
Seine-et-Marne	2,290	453,438	524,486
Seine-et-Oise*	2,185	1,708,791	2,298,931
Seine-Maritime	2,449	941,684	1,035,844
Somme	2,424	464,153	488,225
Tarn	2,232	308,197	319,560
Tarn-et-Garonne	1,441	172,379	175,847
Var	2,325	413,012	469,557
Vaucluse	1,381	268,318	303,536
Vendée	2,709	395,641	408,928
Vienne	2,720	319,208	331,619
Vosges	2,279	372,523	380,676
Yonne	2,881	266,410	269,826
Territory			
Belfort	235	99,427	109,371
Total	212,973	42,777,174	46,520,271

*By a reorganization initiated in 1964 these *départements* were to be abolished and six new ones plus the Ville de Paris created in their place (see *Administration and Social Conditions*, below).

ECONOMIC REGIONS AND DÉPARTEMENTS OF FRANCE

with 274,000 in 1938) restricted births (760,000 and 612,000, respectively), while deaths remained fairly constant at around 650,000. But an influx of foreigners tended to redress the balance. Between 1850 and 1930 it was calculated that net immigration contributed 3,500,000 new inhabitants, compared with a natural increase of 2,000,000. In the period 1946–60 figures were reversed, however. Indeed, France, with fewer marriages than the United Kingdom, had in some years a higher birth rate, though this decreased from 21.2 per thousand in 1948 to around 18 in the late 1950s. On the other hand infant mortality also declined considerably (55.9 per thousand births in 1948 compared with 27.4 in 1960) and the over-all death rate was slightly lower at 11.4 per thousand. Despite this substantial increase of births over deaths France in age structure remained one of the "oldest" countries with the proportion of adults of above 40 being about 43% of the population.

Towns.—The population of the urban areas was progressively increasing because of a pronounced drift from the countryside. The populations of the ten chief cities in 1962 (census) were: Paris 2,779,935; Marseilles 783,738; Lyons 524,834; Nice 278,714; Toulouse 254,791; Bordeaux 246,186; Nantes 234,747; Strasbourg 225,964; St. Étienne 200,528; Lille 191,863.

VII. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution and Government.—The constitution of the fifth republic (1958), as shown by its drafting, often vague and ambiguous and lacking the precision and comprehensiveness of its predecessors, was a compromise between a presidential and a parliamentary system of government. Its intent was to give less additional power to the executive than General de Gaulle (who became president) probably wished. Nevertheless, he interpreted, wherever possible, its provisions to the advantage of the presidential authority. A strong republican tradition, built up during about 70 years, was in theory, and more so in practice, seriously modified after 1958.

Prevailing circumstances and the prestige and personality of De Gaulle himself combined during the first years of the fifth republic to transform the traditional passive president into an effective political leader, exercising far more executive power than the new constitution in itself granted.

The president of the fifth republic was first chosen for seven years by an electoral college of parliament, departmental councils and overseas assemblies, and the delegates of municipal councils, whereas formerly he was the nominee of parliament. By a referendum of Oct. 28, 1962, the method was altered to election by popular mandate. As under the fourth republic he appoints the premier and members of the government. He presides over the council of ministers and other official bodies and promulgates legislation which he can ask parliament to reconsider. He may dissolve the national assembly (and did so in Nov. 1962) after consultations with the premier and presidents of the two chambers, but not during the year following a general election. This power of dissolution (vested under the third republic in the president and senate, but never exercised after 1877, and seriously qualified under the fourth republic) imposed, in the hands of a strong president, a discipline on the chambers in that irresponsible government defeats might no longer entail a mere change or reshuffling of ministers without the unwelcome ordeal of an appeal to the electorate. The president is also given the right, by a controversial article, to declare a state of emergency when a serious threat jeopardizes the security of the state, and then to take appropriate steps, after consultation with the premier, presidents of the chambers and constitutional council. This power has inevitably been criticized as opening the door to a possible *coup d'état*. The president can also, on the initiative of the government, appeal by referendum to the country on certain subjects while parliament is sitting, though apparently the actual voting can only be taken when it is not. (De Gaulle did so April 8, 1961, over the independence of Algeria, and Oct. 28, 1962, to alter the method of electing French presidents.)

The 1958 constitution sought to give more power to the government than that possessed by those of the third and fourth republics, and the relations with the legislature are defined in detail. Members of the government cannot have a seat in parliament. The government (which decides and directs national policy) and members of parliament can initiate legislation, but the scope and opportunity of the latter, and their power to frustrate the executive's proposals, have been drastically restricted. The government controls the parliamentary timetable, has priority for its own bills and can curtail the members' opportunities for amendments, divisions and questions. In financial legislation its power has been strengthened by the authority to legislate by decree in the event of parliamentary delay. The administration's authority to enact delegated legislation, which did, of course, exist under the third and fourth republics but was exceptionally invoked, has been strengthened. It now includes spheres outside those defined expressly in the constitution as within parliament's competence (as well as these latter if parliament's agreement is given).

The responsibility of the government to parliament is ensured by an article which requires the premier after appointment to submit his program and general policy to a vote of confidence. The assembly (but not the senate to which the government is not responsible) can defeat a government by a vote of censure (absolute majority of members) or refuse a vote of confidence by tabling and passing a countering vote of censure. Though the position of the premier and his colleagues is now constitutionally strengthened vis à vis parliament, in effect the president (though not responsible to the chamber) has arrogated to himself the authority for deciding and directing policy, domestic, foreign and within the French Community, and for the general shaping of legislation. The cabinet under the chairmanship of the premier and the larger council of ministers became increasingly the agents for implementing presidential policy and decisions. Specialized committees under presidential direction decided the lines of action in a growing number of spheres. The president thus became the effective head of government as well as chief of state. Inevitably there was parliamentary opposition from the left against this concentration of power, but support of the right and a prevailing sentiment of antiparliamentarianism gave De Gaulle's authoritarian regime time to consolidate, chiefly by economic successes.

The two chambers of the French republic, the national assembly (directly elected) and the council of the republic under the previous regime and later called the senate (indirectly elected), are retained in the constitution of the fifth republic. The power of the senate

was increased, though it still remained the junior partner of the legislature. The 1946 constitution had placed a decisive authority with the assembly, and attempted to make the upper house a mere *chambre de réflexion*. As the years passed, however, the council of the republic had rebelled with some success against this passive role. In 1954 it succeeded, for example, in gaining the right to initiate legislation and, in the event of disagreement with the senior chamber, that of negotiating a joint text. Since then any bills (except financial or organic) can originate in either chamber. In the case of disagreement after two readings in each (or, if the government judges the matter one of urgency, after a single reading) the premier can submit the bill to a committee of the two assemblies. The resulting text with any amendments acceptable to the government is then put before parliament. Should the committee or either chamber reject the bill, the government, if it so desires, can in the last resort request a further reading and, when disagreement persists, ask the national assembly to vote on the committee's version or its own with or without the senate's amendments. Financial or organic legislation is initiated in the national assembly, but if that body has not given it a first reading within 40 days the government can place it before the senate. Should the two chambers fail to reach a decision within 70 days the government may enact its proposals by ordinance.

The 1958 constitution re-created, sometimes with certain changes, various bodies which existed under the fourth republic. The constitutional council is given a somewhat more important function than its predecessor. It is composed of nine nominated members with former presidents of the republic as ex-officio members, and the president in office as its chairman. Its duties are to supervise the elections to the presidency, disputed parliamentary elections and referendums. It examines the constitutionality of organic laws and the rules of parliamentary procedure and may be consulted on other legislation, international agreements, or disputes between the government and parliament. It acts as an advisory body to the president of the republic on the question of his assuming emergency powers and on the measures he proposes to take. A higher council of the judiciary advises the government on certain judicial appointments, acts as a disciplinary court for judges, and must be consulted on petitions to the president for commutation of the death penalty, but is no longer responsible for the general organization of courts of law (now in the hands of the ministry of justice). A high court of justice (numbering 20, and elected in equal numbers by the two legislative chambers) is retained, before which the president of the republic can be indicted for high treason and ministers for violations of the penal code. Another body mentioned in the constitution is the council of state, whose chief functions are to act as expert adviser to the government on the drafting of legislation, and as the highest tribunal of administrative law. An economic and social council advises the government on the latter's request about pertinent legislation or problems and also studies these within the French Community. The assembly of the former French union has been replaced by various bodies of this community.

A revision of the constitution (except provisions dealing with the community) must first be voted by the two chambers and then confirmed by a referendum, or, should the president so decide, by a three-fifths majority of both chambers sitting in congress. Revision of the organs of community can be carried out by ordinary legislation.

Electoral Law and Representation.—The 1958 constitution gave the government the power to pass an electoral law by ordinance, though parliament retained the right to revise it or vote a new one. The system for its first two national assemblies (of which 465 deputies were from metropolitan France) was the single-member system with two ballots. An absolute majority was required for the first, and failing this a relative majority at the second, for metropolitan France and the overseas *départements*. In most overseas territories a single ballot was used and, in Algeria (which had attained independence by the election, Nov. 1962) party lists whose members were elected by a relative majority were used. There was universal suffrage of adults over 21. Candidates (elected for five years) had to possess French nationality and to have attained the age of 23. They were required to nominate a substitute in the event of inability to take their seats, but if they resigned a by-election was necessary.

The outcome of the 1958 election, the first to be held since 1936 under a single-member constituency system with two ballots, resulted in a considerable discrepancy between party representation and party polling, to the advantage of the Gaullists. The second election (Nov. 1962) increased the gains of the Gaullists, and to a lesser degree of the Socialists and Communists (who formed local alliances at the second ballot), at the expense of the independent right and the M.R.P.

The upper house (in 1962 reduced to 274 senators through Algerian independence) was, as under the third and fourth republics, elected indirectly by an electoral college of members of parliament, local departmental and municipal councilors (with some slight variations in the overseas territories). Election in most metropolitan and overseas *départements* and in the overseas territories was by a majority system with two ballots (absolute in the first voting, relative in the second). In seven metropolitan *départements*, electing five or more senators, a proportional system was used. Six senators representing French residents abroad were nominated. Senators are elected for nine years with one-third retiring every three years. They must have attained the age of 35. The senate was partially renewed in Sept. 1962, after full elections in 1958. Its new composition was 83 Independents, 51 Radicals, 52 Socialists, 35 M.R.P., 32 Gaullists, 14 Communists and 6 unattached. (For France d'Outre-mer [France overseas] *see* FRENCH COMMUNITY.)

2. Political Parties and Parliamentary Groups.—With the exception of the Socialist and Communist parties, political parties and groupings in France are not well-organized national bodies, nor are local organizations and their policies closely linked or controlled by central executives. Successful candidates, especially those of the centre parties, show an individual independence and place more importance on the demands of their own constituents than upon party allegiance. Loose and temporary coalitions, either for fighting an election or to press a joint policy, are common. The individualism and parochialism of the French elector exercises a further pull toward disunity. Thus, within the broad divisions, right, centre and left, there exist many shades of opinion, each one conscious of the regional interests that it must satisfy. As a result governments were formerly based on coalitions of ill-disciplined parties and their life was short (on the average, 8½ months for the third republic and 6½ for the fourth).

The numerical strength of elements within the national assembly elected in Nov. 1958 revealed a decline in the power of some of the older parties and the elimination of several more recently created movements. An example of the latter was the short-lived tax resistance movement represented by the Poujadist party (Union et Fraternité Française, founded in 1953) which polled 52 seats in 1956 but only 1 in 1958. The principal groups after the 1962 elections (in a national assembly of 482 members, 11 of them independents) were as follows:

Gaullists (*Union pour la Nouvelle République*).—The chief electoral success in 1958 was gained by this group, who were the supporters of De Gaulle, though he himself discountenanced the use of his name. De Gaulle and his adherents had, in July 1946, officially founded the Union Gaulliste. With the retirement of De Gaulle from political life on the creation of the fourth republic, this body became the Rassemblement du Peuple Français (R.P.F.), a movement rather than a party, whose objectives were to press for a stronger executive and to oppose Communism. The June 17, 1951, elections for the national assembly resulted in the R.P.F. emerging as the strongest single party (121 seats out of 627), but the group disintegrated into two main elements in 1953. One, the Groupe des Républicains Sociaux, with 21 deputies, survived as an effective remnant of purer Gaullism. It formed the nucleus of heterogeneous elements from the right and centre who, for various reasons, rallied behind De Gaulle in support of a new regime under the title of Union pour la Nouvelle République. In the national assembly elected in Nov. 1958 the U.N.R. held 188 seats and had the support of about 12 affiliated deputies. The

hostility of certain elements and individuals within it toward De Gaulle's liberal Algerian policy threatened to undermine its cohesion. On De Gaulle's challenge to, and dissolution of, the assembly, it rallied firmly and successfully behind him. In Nov. 1962, the group increased its numbers to 229, with whom were affiliated 20 conservative Independent Republicans. With the overseas elections completed in Dec. 1962 the group's deputies numbered 233.

Conservatives.—French conservatives described themselves before World War I as left republicans and after World War II as independent republicans. Before 1939 the major conservative party had been the Alliance Démocratique (founded in 1901) whose representatives adhered to several groups in the assembly. Its policy of appeasing Germany brought it into disrepute, and its members after World War II reappeared at first in two parliamentary parties, the Républicains Indépendants and the Parti Républicain de la Liberté. Both sought to revive the constitutional structure and parliamentary practice of the third republic and were opposed to *dirigisme* (economic planning and control) and nationalization. In 1951 the two parties merged in the national assembly and numbered 51 members, rising to 81 in 1956. Associated with them was the Peasant party of 14 members in this latter year. A coalition, Independants et Paysans d'Action Sociale (I.P.A.S.), *i.e.*, right-wing independents and the peasants, numbered 132 in 1958. The 1962 elections brought disunion to the group on the question of supporting De Gaulle, and their numbers (including those affiliated to the Gaullists) fell to 36. The right retained the traditional attitudes of opposition to state control in industry and championship of the small farmer, wine producer and other private concerns. It advocated a nationalist foreign policy and was antagonistic to the dissolution of the French union. It gave support to De Gaulle until 1962, though certain members had some qualifications on his progressive policies and authoritarian procedures.

Radicals.—The Radical party, embodying the oldest republican tradition in French politics, the spirit of the Jacobins and Republicans of 1848, was represented in the 1962 assembly by the Rassemblement Démocratique. Its strength of 39 (with allies and affiliated deputies) in 1962 testified to the parliamentary decline of this once powerful party. Radical policy of the 19th century was based on universal suffrage, separation of church and state, compulsory secular education and liberty of the press. It represented a mixture of practical common sense and idealism, reflecting the conflicting desires of the small property owner brought up in the ideals of the French Revolution. By the 20th century the title of the party (Parti Républicain Radical et Radical-Socialiste) was something of a misnomer; it was radical only in its anticlericalism but, as a defender of private property, opposed socialism.

The influence of the Radical party began to decline in the 1930s, when the Socialists became its great rival. Yet until 1940 it usually joined in the government. After World War II, it suffered from the association of its leaders with the policy of appeasement and with the *débâcle* of 1940, and also for its preference of the third republic. A revival in Radical strength in 1948 led the party to form with its allies the Rassemblement des Gauches Républicains (R.G.R.). The Radicals joined with the M.R.P. and the Socialists in various "third force" administrations. The Radicals' insistence on liberal economic principles antagonistic to the *dirigisme* of the M.R.P. and Socialists finally broke up the "third force" alliance. From 1955 dissensions split the ranks of the group, and all its various elements suffered severely in the 1958 elections, but it recovered slightly in 1962.

Mouvement Républicain Populaire (M.R.P.).—This party, formed after World War II, had its origin in resistance groups, prewar Christian trade unions and the small Catholic Parti Démocrate Populaire. During the first postwar years, when it secured considerable electoral success, it supported De Gaulle. The M.R.P. drew its support from the proletariat and lower-grade office workers of more religious inclination; it also had some support from the Roman Catholic bourgeois and the peasants in more Catholic areas. It differed, however, from the Socialists, with whom it had much in common on social and economic questions, over the state subsidization of Catholic schools. It diverged also from the Radicals on this same religious issue and in its acceptance of economic *dirigisme* and nationalization. The initial success of the M.R.P. was blunted by the rise of the Gaullists. In 1951 its representation fell from 164 to 94 and declined in 1956 to 83. In the 1958 national assembly the M.R.P. and affiliates numbered 57, and gave general but cautious support to De Gaulle. After the 1962 elections the party formed the core of the Centre Démocratique, with a total of 55 members.

Socialists.—The French Socialist party was formed in 1905, aiming to transform capitalist society into a communist association in accordance with Marxist doctrine. In 1920 the left wing seceded to form the Communist party. The moderate Socialists then tended to ally themselves with their neighbours on the right, the Radicals, until in 1933 a majority element forced the party to conclude a pact for united action with the Communists. In 1936 the Socialists, with 146 seats, became the strongest single party. Later they entered into coalition governments with the Radicals.

During World War II the party took an active part in the resistance. After a brief postwar period of influence, during which they preferred the parties on their right to the Communists as allies, the Socialists began to lose a certain amount of working-class support to the Communists. Because of the operation of the electoral law in 1951, however, their parliamentary representation increased to 107 (from 101 in 1946). In 1956 the party obtained only 94 seats. In Sept. 1958 a minority broke away, because of official party tolerance of De Gaulle and opposition to the Communists. At the elections of that year the official party, Section Française de l'Internationale Ouvrière (S.F.I.O.), secured 40 seats and the splinter group (Parti Socialiste Unifié [P.S.U.]) none. But the Socialists became, with the Communists, the chief opponents of De Gaulle in Nov. 1962 and, in second ballot alliances with the latter, increased their strength to 66.

Communists.—The party was founded in Dec. 1920 after the Socialist congress at Tours by delegates who voted for affiliation with the newly constituted third international of Moscow. It secured only a small representation until 1936 when it returned 72 deputies. In 1936 the party supported but did not join the Popular Front government of Blum. It attacked the later "Munich" policy of Daladier, but defended the Soviet-German pact of Aug. 1939. Because of opposition to the war after the Soviet invasion of Poland, the party was suppressed by decree on Sept. 26, 1939. After the Franco-German armistice the Communists for a time supported a policy of collaboration with Germany. When the latter declared war on the U.S.S.R. the Communists entered the resistance movement and gained many supporters by their effective action and propaganda.

The Communists finally joined De Gaulle's wartime administration. After the liberation they secured enough seats to make them the most powerful single group (190 Communists and fellow travelers were elected in 1946). But subservience to the U.S.S.R. aroused the opposition of other parties, and disruptive economic tactics lost them support. A new electoral law of 1951 also curtailed their parliamentary representation. Nevertheless, the party consistently polled (though its membership decreased) more votes than any other single one during postwar elections. In 1958 its representation was reduced to 10, again because of the operation of the electoral law, though it polled at the first ballots 3,882,204 (18.9%) votes. The Communist party (Parti Communiste Française [P.C.F.]) recovered to 41 members in Nov. 1962, when it entered into local second ballot alliances with the Socialists at the general elections.

3. Local Administration.—French local government is by no means well developed, and much of its work is carried out by representatives of the central authorities. Though efforts were made immediately after World War II by local bodies to obtain a greater independence, and though the constitution of the fourth republic promised greater local autonomy, little progress was made to this end. The post-World War II system remained largely a legacy of the *ancien régime* and of the Revolution. It suited the habits of a people preferring local state-paid officials to the unpaid services of elected representatives.

Before the reforms instituted in 1964 there were 89 *départements* and 1 territory, and within them about 300 *arrondissements* and 38,000 *communes*. To administer the growing Paris region better two *départements*, Seine and Seine-et-Oise, were divided into Ville de Paris and six other new *départements* (Seine-Saint-Denis, Hauts-de-Seine, Val-de-Marne, Val-d'Oise, Essonne and Yvelines), each with around 600,000 inhabitants.

The *préfet*, created in 1800 and responsible to the minister of the interior, administered the national legislation of most central government departments. After 1945 this so greatly increased that local civil servants often dealt directly with their parent bodies, and many advisory commissions were created. The *préfet* was assisted by a *conseil de préfecture* (appointive) and by *sous-préfets* in the *arrondissements*. He also controlled the administration of finance, police, highways, etc. A consultative elected *conseil général* voted on resolutions approved by him, and discussed his budget and regulations. It entrusted its detailed work to an executive committee. In the communes was a municipal council which elected a mayor as its chief administrator who substantially acted for the *préfet* and the local representatives of the central ministries.

In March 1964 various decrees initiated an attempt to improve the cohesion of departmental administration, by then inadequate to cope with the complexity and scope of national legislation. The traditional responsibility of the *préfet* to administer national legislation (except military, judicial and certain fiscal and educational matters) was reaffirmed. His duties were divided into those of police, finance and the supervision of local communities, health and social welfare and economic affairs. His own professional advisers were greatly increased and the multitude of consultative commissions reduced. Moreover, the local heads of central ministries were specifically placed under him, though he could delegate his authority to them.

Regional economic planning was judged more efficient than departmental, so the *départements* were grouped to correspond with the 21 existing economic areas of the national plan: Nord (regional headquarters: Lille); Picardie (Amiens); Champagne (Châlons-sur-Marne); Lorraine (Metz); Alsace (Strasbourg); Bourgogne (Dijon); Franche-Comté (Besançon); Rhône-Alpes (Lyons); Côte d'Azur, Provence, Corse (Marseilles); Languedoc (Montpellier); Midi-Pyrénées (Toulouse); Aquitaine (Bordeaux); Poitou-Charentes (Poitiers); Pays de la Loire (Nantes); Bretagne (Rennes); Basse-Normandie (Caen); Haute-Normandie (Rouen); Centre (Orléans); Auvergne (Clermont-Ferrand); Limousin (Limoges); Région Parisienne (Paris). Except in the Région Parisienne (*see* PARIS), a regional *préfet* was placed over each group. He exercised normal prefectorial duties in the *département* with the regional capital, and was responsible to the premier for implementing the government's economic plans, collating and submitting regional information and offering proposals on investment. He also inherited the function of the *inspecteur général de l'administration en mission extraordinaire (Igame)* created in 1947 to assume civil control of groups of *départements* in serious emergency.

The decrees established a regional advisory economic council of representatives from the *conseils généraux*, mayors, chambers of commerce, industry, agriculture and of employers, professional and labour unions, etc. A second body was an administrative committee of senior officials seconded from the central administration, and finally an interdepartmental conference of *préfets* and civil servants. The decrees claimed to introduce a decentralization necessary in a progressive state. In effect they strengthened the power of the central authority at the expense of local government bodies. But they also protected more effectively regional interests within the overall development.

4. Taxation.—During the *ancien régime* the sovereign was supposed to seek the agreement of the estates-general for such taxes as he wished to levy, each of which was alleged to meet particular circumstances. As the royal power strengthened and the need of the central administration for regular financial resources increased, taxes became permanent, and were often levied without the consent of parliament. A considerable discrimination characterized the choice of *contribuables*, and extensive corruption marked the collection of taxes.

The Revolution attempted to establish the principle of direct taxation without distinction according to the value of lands, rents and movable estate. But under the Directory and empire indirect taxation began to reappear. During the 19th and 20th centuries there was a growing tendency to prefer the raising of revenue by a multiplication of indirect taxes rather than by direct. Direct taxes were the *contribution personelle, contribution mobilière, patente* (licences) and door and window tax.

Income tax was progressively introduced into France during World War I. A law of Dec. 26, 1914, established a general income tax. A second, July 31, 1917, replaced the older direct taxes mentioned above (which were allotted as a source of revenue to the *départements* and communes) by a number of scheduled taxes applying at different rates to various categories of income, according to their origin. A decree of Dec. 9, 1948, introduced two additional taxes: a *taxe proportionelle* applying at a flat rate according to the different incomes (wages, dividends, business profits, etc.) of the taxpayer classified by schedules, and a *surtaxe progressive* according to his total income.

By the late 1950s there was an increasing demand for a simplification of the system, for a more equitable distribution and a lessening of the fiscal burden. The economic progress and policy of France under the fifth republic assisted the promotion of this demand, which resulted in major fiscal reforms under a law of Dec. 28, 1959. This was to be progressively applied and was designed to simplify and modernize the old system, and also to lessen the fiscal burdens of all classes as well as to secure a fairer incidence. The law of 1959 was based on the principle that each economic transaction should be only subject to a single tax. The basis of this tax was to be broad, but its weight moderate. It aimed at equitable distribution, the promotion of economic expansion, a system more in harmony with those of other European countries and the provision of relief for family needs. It was hoped also that it would eliminate substantially tax evasion and fraud.

Thus the proportional tax and the progressive surtax were amalgamated into a single progressive tax on personal revenue. A temporary complementary tax (8% in 1961), with allowance in some cases, was imposed on incomes other than from salaries, pensions, dividends; *e.g.*, on revenues from property and professional, industrial, commercial and agricultural sources. Nevertheless, these income classes still benefited even allowing for the 5% increase in the new single levy, for the new single tax plus this complementary tax was substantially lower than the total of the two previous taxes to which the nonwage-earning groups had been subjected. On the other hand wage earners benefited from an increase in the basic exempt figure of salaries, pensions and life annuities, which was raised from 15% to 20%. In addition, special consideration was given to the lowest wage earner who, when married and with two children, for example, could escape taxation if his net revenue was less than 1,000 fr. a month. Similarly, households with only one wage earner were totally exempt from taxation on any allocations to which they were entitled, and income from employment which fell below the guaranteed professional minimum salary was also freed. Reliefs for the family man (increasing with the number of children) continued, and were a complementary measure to the system of family allowances.

By the 1959 legislation, as an incentive to investment, only a single imposition was now to be levied on revenue from movable estate at a rate depending on the class of investment (24% from shares and 12% from bonds). Specially favourable treatment was granted to revenue derived from state funds and investment societies. This income also enjoyed relief for children. Reliefs in the form of deductible expenses, in addition to the general one granted to family men with dependents, were also revised and curtailed. Property owners, for example, were given some additional relief by an increase in the deductible expenses spent on new constructions, on the maintenance, insurance, etc., of their property, and also by a basic sum which was nontaxable. Death duties, already much lower than in the United Kingdom, were also reduced by the new legislation. Deductions were also granted for super-

annuation, social service contributions and professional expenses, and special reliefs granted on life assurance payments. For companies, public and private, there was a general tax of 50% on profits with, in some special cases, qualifying provisions, but those cooperating in programs for national (Monnet plan) or regional development were allowed a rebate on new capital subscribed before Dec. 1961. Capital gains were also taxable unless reinvested within three years in either the business or specific securities.

Indirect taxation, which contributed 60% of revenue from taxation in 1962 (*cf.* 71.3% in 1952), was chiefly raised by duties on business turnover (added value tax and additional local tax at the retail stage) of articles within the production sector, and a tax on service performed. There was also a profusion of taxes, both national and sometimes local, on such commodities as wine, coffee, tea, meat, gasoline, certain agricultural products, on transactions requiring stamp duties, on the transport of goods, and on entertainment. Naturally the turnover tax passed on eventually to the consumer. As luxury goods were the most heavily taxed, the higher income groups who could afford them were the larger contributors. But proportionately the lower income groups suffered more, for the turnover tax and tax on services performed fell upon a wide class of essential commodities.

In reality the new system of taxation achieved only partially its aim of redressing the former inequality in distribution. It brought some relief to the lower income groups and to the highest, particularly those with small families. For other categories, especially those nonsalaried earners of middle incomes, the financial advantages gained through an amalgamation in taxes were offset by the suppression of many deductions which could formerly be claimed. In its endeavour to stimulate initiative in private business, and promote savings and investment and land ownership, the reform did achieve some progress.

5. Trade Unionism.—The *loi Le Chapelier* of 1791, which forbade the combination of workers in pursuit of their common interests, was abrogated in 1884, when the *loi Waldeck-Rousseau* legalized, with certain restrictions, the formation of trade unions. Later acts of 1901 and 1920 removed these legislative restrictions on associations and it was the latter which finally conferred on them a full legal personality. Labour organizations had existed more or less as secret associations since the beginning of the 19th century and the early years of trade union development were characterized by a syndicalism often of a revolutionary nature. The Association Internationale des Travailleurs, created in 1864 (before legalization), numbered about 300,000 members by 1870. Despite repressive measures, there were about 135 *chambres syndicales* in France by 1876, when the first workers' congress was held in Paris. Following the passage of the *loi Waldeck-Rousseau* two workers' associations were set up, the Fédération Nationale des Syndicats (heir to the former Association Internationale des Travailleurs) and the Fédération des Bourses du Travail. In 1895 the Confédération Générale du Travail (C.G.T.) was formed from an amalgamation of these two bodies, though it was not until 1902 that a centralized constitution was created. In these early years two schools of opinion fought for control. The syndicalists rejected the idea that working-class aims could be attained by the parliamentary process of persuasion and held that strike action and violence were indispensable to bring about the social revolution. The reformists, on the other hand, maintained that labour reforms should be by constitutional action. Some desired collaboration with the Socialist party in the chamber of deputies; others sought to repudiate any political connections and to concentrate solely on economic demands.

In 1906, at the congress of Amiens, the revolutionaries gained the day by forcing through a resolution, known as the charter of Amiens, which rejected dependence on any political party or doctrine and endorsed the opinion that the best results for the working classes could only be obtained by direct action, by means of the general strike. About the same time the C.G.T. as a body began in addition to assume a pacifist and international character.

From 1914 the unions (then 1,000,000 members strong) accepted the supremacy of the constitutional authority and sought legislation for a better standard of living and of working conditions. It was the outbreak of World War I, the "ordained opportunity" for revolutionary action, that had the effect of depriving the revolutionaries of the control of labour. Under the influence of Léon Jouhaux (*q.v.*) and the reformists, who had suffered defeat in 1906, the C.G.T. decided to co-operate with the government. With the advent of the Russian Revolution, however, there emerged an important minority both in the C.G.T. and in the Socialist party (with which that body had then allied itself) which adopted an antiwar policy and desired affiliation with the Moscow Trades Union International (the Profintern). The collaboration of the C.G.T. with the government was, however, confirmed in 1918 by the formulation of the C.G.T. "minimum program." This statement repudiated revolutionary tactics, renounced the use of the general strike and supported the League of Nations; in return it demanded more comprehensive rights for trade unions than those granted by the *loi Waldeck-Rousseau*, the acceptance of collective contracts and the constitution of a national economic council and regional councils on which there should be trade-union representation. It further urged that monopolies should be taken over by public state boards or cooperatives representing the producer and the consumer and that individual enterprise should be regulated, as regards conditions of work and profits, by the state. As the government made no immediate response, the C.G.T. created in 1919 its own national economic council. In 1925 the Herriot government officially adopted the idea of a national economic council, adding representatives of the employers to the existing unofficial one.

The elements sympathetic to communism remained strong, however, and their tactics led in 1921 to the exclusion by the C.G.T. of all affiliated organizations which were under revolutionary influence. The latter thereupon formed themselves into a new confederation, the Confédération Générale du Travail Unitaire (C.G.T.U.), which was affiliated to the Soviet-sponsored Profintern. Before this split the C.G.T. had attained a peak figure of about 2,500,000 members; but this was reduced considerably during the year 1920 by the economic difficulties and resulting ineffective strikes, which disappointed the hopes of the workers. Until 1936 (in which year the C.G.T. and the C.G.T.U. fused) the membership of both confederations fluctuated but on the whole increased, that of the C.G.T. being then around 1,123,000 and that of the C.G.T.U. less than 500,000.

The first strongholds of trade unions were in the Nord and Pas-de-Calais *départements* and in and around the large towns, and the movement emphasized organization around local labour bodies known as *bourses du travail*, and their associations at *département* level. Recruitment was, however, hampered by the hostility of the big industrial concerns, which often introduced a rival paternalism in the shape of various benefits for their workers; and secondly by the spirit of individualism prevalent in the widespread small-scale industry of France, which made the organization of its employees very difficult. The employers also in 1919 formed a protective confederation, now the Conseil National du Patronat Français. The C.G.T. drew its principal strength from government employees (civil servants, post office officials, railway men, schoolteachers, local government officials and workers in government establishments such as arsenals, dockyards, etc.), from the miners and from the employees of public utility industries. The C.G.T.U. members were mostly railway men, builders and metalworkers, particularly from the Paris and northern areas. As well as these two bodies, there existed the Confédération Française des Travailleurs Chrétiens (C.F.T.C.), founded in 1920 and based upon Catholic social and anti-Marxist principles. By 1937 this body claimed about 500,000 members, principally drawn from the clerical and distributive workers and women employees in business or factories. Though the C.F.T.C. rejected the theory of class warfare, it nevertheless collaborated occasionally in strikes with the C.G.T. In 1964 it changed its name to Confédération Française Démocratique du Travail (C.F.D.T.) (*see* below).

The C.G.T. itself, despite the losses in membership after World War I, continued to exercise considerable influence among the workers. The spirit of "reformism" prompted it to seek reforms through parliamentary pressure, and it became increasingly the

ally of the Socialist party. In industrial disputes the local unions tended to use the good offices of the ministry of labour, of the *préfets* and of other public bodies. The old institution of the *conseils de prud'hommes*, composed of elected representatives of employers and workers, was used also for the settlement of local disputes between employers and individual workers; and there was increasingly frequent resort to the expedient of mixed committees of workers and employers for the consideration of many other labour questions. In 1934, amplifying its "minimum program" of 1918, the C.G.T. called for the nationalization of credit and banking and of the key industries. It demanded also the 40-hour week, collective contracts and other concessions to labour. Many points of this program were incorporated in the platform of the Rassemblement Populaire of 1935, a coalition of left political parties which led to the formation of the Popular Front government in 1936. In 1936 also, after the alliance of the Socialist and Communist parties, the C.G.T. and the dissident C.G.T.U. were amalgamated. The new union, which was to last until 1939, had about 5,000,000 members; and, through co-operation with the Popular Front administration, gained by the Matignon agreement with the employers' confederation many concessions for labour; *e.g.*, wage increases, 40-hour week, paid holidays, the right of creating the offices of shop stewards, the principle of collective bargaining and compulsory arbitration on labour disputes. On the outbreak of World War II in Sept. 1939, Communists within the C.G.T. came under attack both from the government and from the non-Communist majority of the federal bureau of the confederation; and within the month those who approved the action of the U.S.S.R. in invading Poland were expelled from the various unions. The Communist party itself, outlawed by the decree of Sept. 26, 1939, sought to continue its activity under the legal cover of the unions.

The German occupation of northern France and control of the Vichy government resulted in the replacement of the central confederations, both of labour and employers, by corporate institutions. The individual federations and departmental unions themselves, however, were finally allowed to continue, and a *Charte du Travail* established "professional families," prohibited strikes and lockouts, and sought to eliminate class warfare. The ranks of the C.G.T. were now split into three groups: a very small proportion became wholehearted collaborationists, embracing the social principles of National Socialism; the Belin group (around the Vichy minister of labour René Belin), though accepting the new regime, advocated the independence of trade unions from political activity and adhered to the labour policies of the former Popular Front; and finally a third group, led by Jouhaux, organized some kind of underground resistance. Meanwhile, the Communist element was able to snipe effectively at the officially sanctioned federations and at the *Charte du Travail* permitted them by their German overlord. When the Germans attacked the U.S.S.R., Communist policy was appropriately changed. Before that event it had consisted solely of conquering the syndicates in order to ensure a liaison with the labour masses, which meant opposition to all the former leaders of the C.G.T. who had demanded the expulsion of the Communists in Sept. 1939; the indiscriminate attack against all reformist elements was then abandoned, and the creation of a *front unique*, excluding only those acquiescent to the existing regime, was preached on the basis of the *Charte d'Unité*, adopted at the Toulouse conference. But a syndical medium was required to mask the true political orientation of the campaign (in which the party acted, indeed, as a secret French government allied to the U.S.S.R.), so as not to alienate workers distrustful of Communist doctrines. Hence the creation of *comités populaires*, which were in effect local Communist cells but could appeal to the worker with an authority wider than the sectarian political one.

Meanwhile the strength of the resisting reformist elements of the unions was growing and in the south there was created the Mouvement Ouvrier Français, an alliance of the C.G.T. and the former C.F.T.C., which began to work in close collaboration with the Gaullist resistance movement. Its activities were, however, far more cautious and less direct than those of the Communists. By the time of the liberation, then, the Communists had not only acquired among the workers a far greater prestige as being the effective architects of the resistance movement but had also succeeded in securing a dominating foothold in many of the labour organizations, particularly those of the C.G.T.

Two aims then influenced the policy of the C.G.T.: to take the lead in voicing the inevitable demands of labour for higher wages, despite the opposition of the government; and on the other hand, as it was almost the official labour organization of the Communist party, to support the policy of a government in which Communists were participating.

In Feb. 1945 *comités d'entreprise* (works committees) associated the unions with management. Serious industrial unrest was, however, provoked initially by certain autonomous unions. At the first postwar congress in April 1946 representatives of individual syndicates and unions had complained that the confederal body was attempting to impose too rigid a supervision upon the component parts and to dictate a policy of a Communist nature. Within the ranks of the C.G.T. there existed increasingly rebellious elements which demanded independence of action and sometimes broke off into splinter groups to form autonomous unions. These later linked themselves together as the Confédération Nationale du Travail (C.N.T.).

At the same time the number of strikes continued to grow, despite the partial concessions granted by the administration. Then some leaders, including Jouhaux, who in Nov. 1947 had shown their desire to break away from Communist policy, created the Confédération Générale du Travail-Force Ouvrière (C.G.T.-F.O.) This body held its first conference in April 1948, when it numbered a total of 30 departmental unions and 35 federations, with a probable aggregate membership of about 1,000,000.

The C.G.T. itself emerged from these strikes weakened in membership and in prestige. For a time, at the beginning of 1948, its policy was to avoid any serious agitation, to attract members of the Force Ouvrière and other splinter groups back to the fold and to restore the morale of its own disheartened followers. However, it soon became clear that the rival unions could not hope to outdo its propaganda, backed by better organization and greater funds, by its control of the key industries of engineering, mining, building, etc., and by the Communist party's wholehearted support. Thenceforth the C.G.T. became self-avowedly synonymous with the Communist party; its chief policy was to hamper the economic and military revival of France and western Europe by opposition to the European Recovery program, to western European union and to the Atlantic pact.

Only between 20% and 25% of the employed population belonged to trade unions and their financial resources were somewhat limited. The C.G.T. remained the largest, best organized, most energetic and effective confederation, claiming around 1,700,000 members. Its main strength was among the miners, the workers in heavy industries and the dockers. The dissident Force Ouvrière probably numbered about 700,000 members, its strength being among the civil servants and clerical workers and including a big minority in the railways and textiles and a smaller one in engineering (it was weak in the mining industry and among the dockers). Though it had no official connection with the Socialist party, it was in fact its labour parallel. The C.F.T.C. increased its numbers in the 1960s, and by Nov. 1964, when it became the C.F.D.T., it probably had about 1,000,000 members. The vote to "secularize" the organization, by omitting any specific reference to Christianity in its name or charter, was passed with a 70% majority; a minority group, led by Joseph Sauty and claiming to represent about 150,000 members, broke away from the union and formed the "C.F.T.C.–Sauty."

A fourth powerful confederation was the Confédération Générale d'Agriculture (C.G.A.), which, taking the place of the Corporation Paysanne (founded under the Vichy regime and dissolved after the liberation), became the sole peasant organization.

A fifth and much smaller organization was the Confédération Générale des Cadres (about 200,000), created after the liberation to safeguard the interests of senior staffs (such as foremen) and of the more qualified workers (technicians, etc.).

Finally there were the autonomous unions linked in a national

federation, mostly small groups in separate factories and the important Fédération de l'Éducation Nationale. These were established in some cases by former members of the C.G.T. who had left that body before the split in Dec. 1947, chiefly because they objected to the increasing discipline imposed by the central authority (also, sometimes, because they disliked the Communist nature of the movement). In 1965 the total number of subscribing union members was about 3,500,000 or only 30% of France's wage-earners. But many more workers voted, as entitled, in the elections of members to the social and economic organizations on which the unions had the right of representation. (*See* Labour [Trade] Union; Industrial Relations.)

6. Employment and Wages.—The active population of France in the early 1960s was nearly 20,000,000 of whom about 13,000,000 were directly earning salary or wages. The latter figure was broadly divided into about 6,000,000 in industry, 3,000,000 in the professions, civil service and domestic employment, 1,400,000 in commerce, 1,300,000 in agriculture, around 1,000,000 in transport and 500,000 in fuel and power. State employed workers (including about 800,000 civil servants) numbered nearly 3,000,000, chiefly engaged in the nationalized industries of coal, steel, electricity and transport. Unemployment was never a very serious problem in France (*e.g.,* under 20,000 were assisted in Jan. 1964).

The worker was by the early 1960s well protected by various social security systems against illness, accident, etc. Unemployed persons enjoyed the family benefits scheme and were also eligible for old-age benefits. There was no distinction made between French and foreign workers, provided the latter were domiciled in France. France had also reciprocal agreements on social security with a number of other countries. The legal working week constituted 40 hours. Additional work was paid at 25% over the basic rate for a first extra eight hours and 50% for subsequent hours. A national minimum wage was fixed for various zones of the country and was periodically adjusted according to the cost of living. In industry the highest pay belonged to employees of the nationalized industries (miners, steelworkers, railway men), automobile workers, banking and printing. Wages declined for those employed in textiles, clothing, agriculture, timber and furniture. The wages of employed people with at least two children, were, however, substantially increased by a scale of family allowances. In addition a single salary allowance was payable in certain circumstances to households with only one earned income source.

Claims for higher wages were frequent, but the policy of the fifth republic was marked by a determined effort to keep down prices of essential commodities rather than concede wage increases (prices, however, by 1964, had risen more than 30% since 1958). The unions, though traditionally against De Gaulle's authoritarian attitude and disliking his attempts to peg wages, were at first relatively quiescent. In 1963 workers in the nationalized industries (particularly mining) struck over the failure of wages to rise commensurately with prices and a compromise agreement was reached. Both Christian and Socialist unions allied themselves with the Communists, and brought closer the threat of a general strike.

In the matter of labour agreements, as in other relevant social and economic subjects, the worker was represented through his union delegates on a higher committee of collective agreements. He also had a voice through them on the boards of the nationalized industries and on the works committees of private enterprises, but claims for wages were presented by shop stewards. Collective agreements (which included a variety of other subjects besides wage scales) could in certain circumstances be extended by the government to cover all concerns within the relevant branch of the industry and of the area. A further type of agreement was the collective contract between the management and labour of the bigger enterprises; *e.g.,* in the iron, steel and automobile industries.

Collective agreements on wages, etc., are generally concluded between either a national or regional organization of employers and the corresponding level of the trade union within a particular industry. Some collective agreements may be extended by the government to cover the entire industry. Collective contracts can also be signed between the management and workers of a single enterprise.

It is compulsory by law to submit labour disputes to a joint conciliation board of representatives of employers and labour. An additional procedure is one of mediation instituted by either party or by the government, whereby the mediator investigates the dispute and makes recommendations.

Trade unions are represented on the economic council, the higher committee of collective agreements, and at regional levels on such bodies as employment advisory committees and social services. They have a voice in running the nationalized industries. Works committees exist in all sizable enterprises. But employers remained fundamentally antagonistic to the demands of organized labour, preferring the voluntary paternalism, deeply rooted in the French social structure, which itself had initiated such features as family allowances and health and service benefits.

7. Housing.—During World War II about 1,500,000 French homes, 750,000 farms and 10,000 industrial concerns were destroyed or damaged. Extensive areas of almost total destruction existed in such cities as Le Havre, Caen, Brest, Saint-Nazaire, Boulogne and Marseilles. The capacity for the manufacture of building materials was seriously impaired, and machinery was insufficient. A rising population, including, in the 1960s, repatriates from Algeria, and plans for modernization and re-equipment combined to give a high priority to building.

Before World War II the erection of dwellings had fallen to 56,000 (1938). In 1947 only 12,200 were constructed and in 1948, 40,720; ten years later the figure had reached 320,000, while for the mid-1960s a target of 500,000 new dwellings a year was set. Legislation to encourage building comprised the granting of special loans, premiums, moderate rentals, housing allowances and tax reliefs. Schemes for the erection of homes by private business to supplement the state program were encouraged. The construction of large blocks of flats was also financed in many urban areas from the local benefits funds of the family allowances agencies, one of whose tasks was to promote family welfare. A feature of development was integrated urban units of modern flats. Some devastated city areas (*e.g.,* Le Havre) were entirely rebuilt in an impressive manner.

To combat overpopulation in existing big cities and depopulation in certain other areas, new industries were encouraged to migrate. Government assistance to enterprises to reconvert and decentralize and encouragement to labour to go to such places was offered in the form of loans, tax reliefs and reductions of interest rates.

8. Social Security and Welfare Services.—The beginnings of social security were introduced in the early 20th century by legislation to safeguard the worker and compensate him for accidents. Some tentative steps to provide for the unemployed were taken in 1905, when the state first subsidized for that purpose the funds of trade unions; and in 1914 a national unemployment fund was created, through which contributions were granted to relief organized by many county and municipal councils. Meanwhile, the unofficial organizations, supported mainly by private subscription, were the chief sources of protection against sickness, old age and unemployment. Family allowances, which had been given by certain firms in the 19th century, were adopted by the state for its employees during World War I, and later pensions were added.

The question of social insurance came to the forefront after 1918, but a comprehensive measure was delayed by the unwillingness of the government and the assembly to incur the necessary expenditure. Finally, in 1930, a law was enacted which introduced an additional degree of social assistance. Insurance was made compulsory for many employed persons and extended to all in 1946. Benefits for sickness, maternity and death were paid out of departmental funds or out of those of trade unions, mutual aid associations and employers' institutions. Old-age and disability benefits came from national or private funds. The scheme was financed by contributions from the insured and the employer.

Despite this measure, social insurance before 1939 remained piecemeal, limited in scope, inadequate in its benefits and largely left to local bodies whose efficiency varied considerably. Thus, until the end of World War II the majority of French labour was very much at the mercy of the fluctuations of the economic situation. After 1945 the problem of extension, co-ordination and uniformity in the somewhat haphazard system was quickly tackled. The burden of health and social welfare increased public expenditure substantially after 1945. By 1963 it represented 9.1% of total expenditure. During the 1960s about 34,000,000 people were covered by social security services, membership being obligatory for all employed persons. Self-employed are required to join an old-age pension scheme. Funds are provided by contributions from workers and employers (of whom the state is the largest), for family and accident benefits, and for social insurance from employers (13.5%) and employed (6%). In each *département* a *caisse* (run by a private elected body of candidates put forward by the trade unions) administers the services for sickness, maternity and industrial injury benefits. Regional *caisses* look after old-age and disablement pensions. A national body, the *caisse nationale*, provides an equalization fund. Family allowances, first officially and partially introduced in 1918 to check a decline in population, are dealt with by a separate organization.

The main benefits are for sickness (80% expenses or more), old age (40% of wage at 65), disability and family. There are several kinds of family allowances: prenatal and maternity; housing (on need for larger domicile); for two or more dependent children. Grants are also made by the social security services to public health and social welfare institutions and for research, etc., into medical and social problems. The ministry of labour and social security is responsible for the general policy on social security services. Within the ministry is a social security division entrusted with their efficient running. A special supervisory corps acts as a permanent liaison between the central authority and the regional offices and agencies.

Local agencies manage the application of social security legislation. They are of two kinds. One type, primary social security agencies, collects contributions, pays sickness and maternity benefits and those payable for industrial injuries. In each region, also, is a co-ordinating regional social security agency and a regional agency for old-age pensions. A second category comprises family allowance agencies which collect contributions and pay family benefits. At the apex of the system is the national social security agency. All these agencies are made up of representatives of employed and employers.

Benefits consist of the reimbursement of all medical and dental expenses including general and specialized treatment, hospital fees and the payment of allowances to compensate the insured for loss of earnings. The individual can choose his own doctor, hospital or clinic. Expenses are reimbursed as incurred, and approval for treatment is only required where heavy expenditure is involved such as a long stay in the hospital or serious surgical operations. If a private hospital or clinic is chosen it must be on the approved list of the social security agency. Except in cases of industrial injuries and treatment in state hospitals or approved private hospitals, the social security scheme prefers that the insured should pay his bills and then claim for reimbursement. Apart from more serious operations and prolonged treatment the insured must usually bear 20% of the cost. Scales of medical fees have been agreed upon by representatives of doctors and dentists and of the agencies, but excess payments are often demanded and borne by the patient.

The older state hospitals besides being improved are supplemented by specialized clinics and centres built by the regional security agencies or by the national social security agency from their funds; *e.g.*, tuberculosis, babies', prophylactic and traumatological clinics and centres. In addition to sickness and injuries benefits are maternity benefits (besides a maternity grant). These comprise full repayment of all expenses due to pregnancy and a daily allowance up to six weeks before and eight weeks after confinement. Invalidity benefits are also paid at various scales until receipt of old-age pension.

9. The Legal System.—French law is largely codified and was based on the Code Napoléon (*q.v.*) and on the codes *de procédure civile, de commerce, d'instruction criminelle* and *de procédure pénale*, by which it was followed. This body of law (1804–10) was, of course, supplemented and altered by much statutory law and decree, and there came into being also a certain proportion of judge-made law. French legal tribunals rely, however, in the main upon the codified law. In 1958 the *code d'instruction criminelle* was abrogated and the *code pénal* revised and made more comprehensive. Many changes were inspired by more advanced principles of social rehabilitation.

Judicial power is independent of others, and the fifth republic's constitution stipulates that the president of the republic, assisted by the higher council of the judiciary, is the guarantor of the independence of the judicial authorities.

Judicial organization had become increasingly inadequate to cope with modern social conditions. In 1958 reforms introduced the first major changes in the administration of justice since Napoleon, and affected chiefly the civil courts and the penal code. There are now four types of courts: civil for civil disputes between private persons; penal for infringements of the law; professional for disputes in occupational activities; and administrative for differences between private individuals and public bodies. A further reform created a Centre National d'Études Judiciaires, to train the higher ranks of the judiciary.

For civil cases there are 455 courts of first instance and 172 higher ones (*de grande instance*). The former deal with actions up to a certain maximum value. They also have competence in the spheres of labour, forestry, rural and electoral disputes. One or more judges preside but one judgment is given by the senior (*juge directeur*) and in some cases there is the right of appeal against his decisions. The higher civil courts deal with more serious actions, and also act as courts of appeal. Attached to them may be a juvenile court. Appeals can also be made to the 27 *cours d'appel* (with an appeal chamber for juveniles). The final court of appeal in civil as well as criminal cases is the *cour de cassation*.

Criminal jurisdiction is exercised by three types of tribunals. Police courts (*tribunaux de police*) deal with minor offenses and can inflict a maximum of two months' imprisonment or a fine of 2,000 fr. Courts of correction (*tribunaux correctionnels*) with three judges but no jury try more serious offenses (*délits*) with a maximum prison sentence of five years and fines from 2,000 fr. upward. Serious offenses (*crimes*) are judged in courts of assize in each *département*. These consist of a judge and two assessors, and a jury of nine, who combine in giving a verdict. An appeal can be made only on a point of law or procedure to the *cour de cassation*, which may order a retrial. The lower courts of appeal are for criminal cases tried in tribunals below courts of assize and their verdicts also are subject to appeal to the *cour de cassation*, which may refer the case to another court of appeal. They are divided into chambers dealing with different types of cases.

The administrative courts are empowered to settle suits between individuals and public bodies. Appeals against their decisions can be made to the highest administrative court, the council of state. This tribunal is also one of first instance, particularly in the matter of appeals against government decrees and challengeable executive action. Where there is doubt upon the respective competences of the administrative and the civil or criminal courts, the question is submitted to a *tribunal des conflits*, a joint body drawn in equal numbers from the *cour de cassation* and the council of state.

Special courts deal with disputes arising out of occupational activities: *conseils de prud'hommes* (courts of labour arbitration, consisting of representatives of workers and employers to deal with labour differences); courts of commerce; professional courts; and a court of accounts. (For the high court of justice and the higher council of the judiciary [two courts set up by the constitution] see *Constitution and Government*, above. *See* also FRENCH LAW.)

10. The Police.—The ministry of the interior, through the *préfets* of the *départements*, and in the new Ville de Paris area

through the *préfet de police*, is responsible for public security and the administration of police bodies. In a state of emergency the regional *préfets* are responsible to the minister. The duties of the French police cover public health, licensing, passports and identity documentation, fire service, civil defense, inspection of works premises, etc. There is a close association between police and judicial authorities. There are two classes of police, the administrative and judicial, though some officials, *e.g.*, *préfets* and mayors, and higher officers, *e.g.*, *commissaires de police*, may belong to both.

Broadly speaking the function of the administrative police is to prevent breaches of the law and public order, or threats to national security. Thus, most of the municipal police are administrative and perform the usual routine duties of crime prevention. The judicial police (divided in the largest cities into specialist sections) concentrate on the investigation of crime and collection of evidence for prosecution. There are, however, repressive services of the judicial policy such as *brigades territoriales* in the Paris area for tackling serious violence, while the administrative police in other areas have attached to them *brigades mobiles* for criminal investigation.

The Sûreté Nationale, immediately under the ministry of the interior, is the central police authority for the whole country. It exercises a general supervision over the municipal police forces, and a more active direction of the judicial police outside the Paris area. It is also responsible for the security of the state (frontier control, supervision of foreigners, antisabotage and counterespionage precautions). At *département* level the chief police executive is the *préfet* and below him the mayors or municipal councils in larger communes.

The former Préfecture de Police, which was responsible for Paris and the Seine *département*, underwent some change because of territorial reorganization (see *Local Administration* above). Previously it had been an autonomous body responsible to the ministry of the interior, and run on a local budget (heavily subsidized by the government). It has now lost its municipal and departmental constitution, and has become a state-paid force. Its *préfet de police* retained his former powers, exercising them within the Ville de Paris and also the three new *départements* (with some overlap) into which the former Seine *département* was split. He was also given the same powers in event of emergency as the regional *préfets* over this area, and the former *département* of Seine-et-Oise, together with that of the Seine-et-Marne. (*See* Paris.)

In addition to the above classes of police there are the *gendarmerie* (about 64,000) which, though part of the army, exercises police duties under the minister of the interior; departmental *compagnies de securité* (for special duties); the *police sanitaire* (health); and the *garde champêtre* (rural duties).

Criminal procedure in France, which dates back in some of its aspects to the *ancien régime*, was somewhat modified by the reforms of 1958. Proceedings are begun by a preliminary inquiry before an investigating officer of the judiciary (*juge d'instruction*). Before this the judicial police can hold an official inquiry on which an indictment is prepared or the suspect is released. During this inquiry the accused may be in custody. In court itself the presiding judge interrogates the accused (who cannot refuse to give evidence) and witnesses. In the *cour d'assise* (the only one with a jury) summing up is embodied in a series of questions put to the jury by the presiding judge who, with his two assistants and with the jury of nine, decide upon the verdict and sentence (a verdict of at least 8 out of 12, with those undecided counting in favour of the accused, is necessary for a conviction).

In certain sentences judges have been given a wide latitude to determine the nature of their execution; *e.g.*, detention and employment in public works outside prison; daily out-of-prison work; conditional freedom, probation, etc. The treatment of juvenile offenders is also based on more progressive principles.

11. Education.—The early history of education in France was, in the main, a conflict between religious and secular teaching. (*See* Education, History of.)

In the mid-20th century the educational system remained highly centralized. Primary, secondary, lower grade technical and university education were administered by the ministry of national education, assisted by a supreme council with deliberative, administrative and judiciary functions, and by a consultative committee. Advanced technical education was mostly under this ministry but some special institutions came under others (*e.g.*, agriculture, public works). A department known as the Haut Commissariat à la Jeunesse et au Sport, controlled by the ministry of national education and the *présidence du conseil*, was created in 1958 for youth and sport.

The country (with Corsica) is, however, divided for the purpose of the local administration of education into 20 academic districts: viz., Paris, Caen, Lille, Nancy, Strasbourg, Besançon, Dijon, Lyons, Clermont-Ferrand, Grenoble, Aix, Montpellier, Toulouse, Bordeaux, Poitiers, Rennes, Nantes, Orléans, Reims and Rouen. Each, with its university centre, is administered by a rector appointed by the ministry and advised by a local academic council. The rector has control over all types of instruction, though for primary the *préfet* of the *département* is responsible for certain routine matters. Under the rectors are inspectors, some of whom are usually in charge of a particular subdivision (*département* or *arrondissement*) of the academic district. Another body of inspectors is responsible to and reports to the ministry itself. Within each *département* is also a consultative and advisory council, headed by the *préfet*, and composed of officials and teachers.

Schools are divided into three broad categories. The *premier degré* comprises *écoles maternelles et enfantines* (nurseries and kindergartens) for children under 6, elementary schools (until 14) and *cours complémentaires*. The latter, for pupils of 11 to 17, are really secondary modern (high school) continuation departments whose curriculum is linked up with the nonclassical studies of the *lycées*, to which the advanced third of the pupils goes after four years. The *deuxième degré*, or secondary with primary and advanced stages, includes the *lycées* and technical and professional institutions. Higher education is offered by the 20 state-controlled universities, supplemented by institutions for advanced study (such as the Collège de France, and the École Polytechnique), by the *écoles normales* (teacher training colleges), by numerous technical colleges and since 1958 by colleges attached to university faculties. In addition there are a few free Catholic institutes devoted principally to theology, law and the humanities.

Little local control or individual freedom was allowed in matters of syllabus or teaching methods, which were almost entirely laid down by the ministry and closely supervised by the inspectors. The system was failing to keep pace with postwar France, and in 1959 a major reform aimed at progressively modernizing its somewhat narrow academic approach. This reform in the early 1960s was still largely in an experimental phase, and handicapped by lack of schools and staff as well as opposition from parents and employers. By 1967 compulsory education was to be raised from 14 to 16. An "observation-orientation" cycle in 1961 was introduced to assess the aptitudes of 11-plus pupils distributed in different courses of instruction. Guidance committees were created in 1964 to express opinions. At 15 a second cycle of secondary instruction of four types could begin: an extended general one (leading to a *baccalauréat* and higher education), a short general one with some vocational training and an extended or short technical one (leading to a *brevet*). Higher education suffers badly from overcrowding, especially in Paris, which in the early 1960s took about one-third of all students. Rates of failure at the *licence* (degree) are high (roughly 72%). Decentralization of universities was designed to solve these problems, to emphasize practical work in small classes rather than formal lectures.

Private schools are mainly religious, and particularly popular in the strongly Roman Catholic regions. Since 1959 they may be either integrated or associated by contract with the state system; the state then subsidizes them to varying degrees, and exercises control over them by regular inspection.

In the early 1960s pupils in educational establishments numbered about 10,000,000. State nursery schools and kindergartens were attended by about 1,100,000; private, by about 165,000. State elementary schools gave instruction to around 5,500,000 (including 477,000 attending complementary classes of a secondary

modern type of education called *collèges d'enseignement général*) and private to about 1,000,000. State secondary schools were attended by 816,000 and technical, commercial, etc., by 978,000. Private secondary and technical, etc., pupils numbered 480,000 and 450,000. Students attending universities and advanced educational institutions exceeded 237,000. State grammar and technical school attendance was substantially increased during the 1960s. By 1964 about 9,000,000 pupils were receiving state education and 1,700,000 private education. (*See* also UNIVERSITIES.)

12. Defense.—The French army from the middle ages onward was formed at first by mercenaries and later by conscripts. Conscription was extended to practically the whole of the male population by Napoleon, and a system of military service, with extension on the reserve list, has existed practically ever since.

Naval power was largely developed under Richelieu and strengthened by J. B. Colbert, stimulated by the discovery of the new world and the increased importance attached to maritime strength. After the Franco-German War (1870) construction lagged and from 1918 financial difficulties hampered the building of capital ships. The fleet was chiefly manned by volunteers or selected conscripts, mostly Bretons.

The French air force came into existence in 1909 and a directorate of military aviation was established within the war ministry in 1912. From 1919 to 1928 responsibility for the air force was shared by several ministries. In 1928 an air ministry was created which assumed control of the existing military, naval and colonial arms. (*See* ARMY; MILITARY AFFAIRS [ARTICLES ON]; NAVAL AFFAIRS [ARTICLES ON]; AIR FORCES.)

Toward the end of World War II the reconstruction of French armed forces, particularly of the army, was pushed forward. By the end of 1945 land forces in Europe and overseas numbered around 700,000. Military service was fixed at one year, and in 1950 at 18 months. As a result of the Algerian war every Frenchman between 18 and 45 became liable to national service, and to military service for 17 years. He was also liable for civil defense up to the age of 60. Between 20 and 25 he had to serve a period of 18 months armed service, but by decree this could be lengthened up to 30 months, with duty usually, in the case of the army (after four months of basic training), in Algeria. After the end of the Algerian war, national service was reduced, in 1963, to 16 months.

Under the constitution the president of the republic is head of the armed forces, and presides over the more important councils for national defense. To the president of the council of ministers (also minister of defense) he delegates the duty of co-ordinating all aspects of defense throughout the French Community. Under the minister of defense is the minister of the armed forces, now a high civil servant responsible for all aspects of military policy. The former secretaries of the departments of war, air and navy are subordinate to this minister. They also are civil servants (delegated by the government) and control the administrative side while service chiefs are in charge of other aspects. This attempt to separate the purely administrative matters from the more military has resulted in a certain friction. Various bodies assist the president and minister. The principal are the top-level Conseil Supérieur de la Défense Nationale presided over by the president of the republic, and the Comité de la Défense Nationale under the president of the council in his capacity as defense minister. The former Secrétariat Permanent de la Défense Nationale was replaced by an *état-major*, whose head is, after the president, the chief military authority and responsible for advising the government on military policy.

In addition there is a chiefs of staff committee, headed by a chief of general staff of the armed forces, with the duty of co-ordinating the various services and advising on interservice problems; it is directly responsible to the minister of the armed forces. The minister of the interior is entrusted with civil defense, while the minister of economic affairs co-ordinates the production and utilization of resources. France is committed to the defense of western Europe through membership of the North Atlantic Treaty organization (*q.v.*).

Army.—France is divided into nine military regions (Paris, Lille, Rennes, Bordeaux, Toulouse, Metz, Dijon, Lyons and Marseilles). There are also various overseas commands within the French Community. Following Algerian independence, plans to build a nuclear striking force and create various divisions equipped and organized in the most modern way were accelerated.

The total strength of the army at the mid-1960s was 415,000. Home units of the regular army were supplemented by the *gendarmerie*, a separate branch for domestic service, numbering about 64,000. The army comprised six divisions (two in Germany) and a number of brigades and regiments organized on a regional basis. Officer-cadets, after basic training, were given instruction in the various schools for each arm. Staff officers' training was given at the École d'État-Major and the École Supérieur de Guerre.

Air Force.—The air force is divided into five major commands: strategic air command (Mirage IV aircraft able to carry 50–60 kiloton atomic bombs); air defense command; tactical air command (with NATO); light aircraft command for observation, support and evacuation; and air transport command. There are miscellaneous units for liaison, training, etc. Four metropolitan air regions exist: northeast, northwest, southwest and southeast France. There are overseas commands in the French Community. Personnel numbered about 125,000 at the mid-1960s.

Navy.—The French navy was slowly becoming smaller because of lack of finances to carry out projected replacements and additions. In 1965 the navy included: 3 aircraft carriers, 1 helicopter carrier, 2 antiaircraft cruisers, 1 experimental guided missile ship, 60 destroyers and frigates, 22 submarines, 102 minesweepers and 233 other smaller craft. There is also a naval air arm (*aéronavale*) with fighter, fighter-bomber and reconnaissance planes and helicopters.

France is divided into three *préfets maritimes:* Cherbourg, Brest and Toulon. These, together with Lorient, are the main naval bases.

The personnel, numbering about 72,500, were recruited from juvenile entries, at 14½, 15½ or 17 years of age, as volunteers for three to five years service; volunteers at 18 years of age prior to national service, for 18 months enlistment; selected conscripts at 21 years of age, and *inscrits maritimes* (fishermen and merchant seamen) for the same period. (J. D. L.; X.)

VIII. THE ECONOMY

The development of the French economy has owed much to France's geographical endowment of a favourable world situation, easy internal communications, a temperate maritime climate, and extensive tracts of fertile soil, although its mineral resources, with the notable exception of iron ore, are not large.

From the nuclear areas of agricultural occupation in prehistoric and Roman Gaul on tracts of fertile and light, more easily cultivated soils, agricultural colonization made great advances from the 11th to the 14th centuries. Under the leadership of lay and ecclesiastical lords, with monasteries playing a very important role in some areas, and in response to the pressure provided by a growing population, a massive extension of the cultivated area was effected by forest clearing and marsh drainage. At the same time trade revived, especially in the north, and in its wake grew craft industries, in particular textiles. By the beginning of the 14th century the population within the extent of modern France probably exceeded 23,000,000, a figure not reached again for several centuries and almost as high as at the time of the Revolution. More village sites were occupied than in the 20th century. During the succeeding centuries the countryside was ravaged by war and plague, there was widespread depopulation and much cultivated land reverted to waste. Although recovery came slowly, interrupted by internal religious wars, it made progress in the 17th century under the enlightened and vigorous direction of the great ministers, notably J. B. Colbert and Maximilien de Béthune, duc de Sully, of the increasingly powerful and centralized state. Among other agricultural improvements, new crops were introduced and extended, and a renewed attack was made upon the marshlands with the help of Dutch engineers. Richelieu and

Colbert established and developed the French navy and pursued a vigorous policy of colonial expansion and development of overseas trade, and Colbert did much to stimulate French manufactures and improve internal communications. The construction of arterial roads fostered internal trade as well as political centralization, and at the same time the navigable waterways provided by France's great rivers were improved and interconnected.

The chief industries of France in the 17th and 18th centuries, providing its chief exports, were manufactures of textiles from flax, hemp and wool, and under royal patronage the silk industry had become important after its introduction at Lyons, Tours and elsewhere in the 15th century. But religious intolerance deprived France of some of its most valuable craftsmen, the Huguenots, and after the time of Colbert (1661–83) the later policy of Louis XIV and Louis XV in endeavouring to continue overseas expansion and at the same time win territorial extensions in Europe proved too great a burden to allow France to resist the challenge of Britain; by 1763 most of the French possessions abroad and its conquests in Europe had been lost. Internally the country had been crippled by excessive taxation of the bourgeois and peasant classes. Although the introduction of maize (corn) reduced the fallow area in Aquitaine from the 17th century, the wasteful system of fallow was only slowly being replaced by root and other fodder crops in the north before the Revolution.

The Revolution and the wars that followed delayed France's adoption of the technical inventions that were being made in Britain, and the country's meagre endowment with coal, the material basis that counted so much in the earlier phases of the development of modern industry, caused industrialization to be further retarded. Big changes in France's economy took place during the 19th century, but there was never such a degree of transformation as makes the term Industrial Revolution appropriate to describe what happened in Great Britain or, later, in Germany. Lacking coal, France played a leading role, however, in the development of hydroelectric power.

Industrial development has contributed to urbanization, but only a little more than half the nation have become urban dwellers and there are few towns that are the creations of modern industry. Among 30 French conurbations with more than 100,000 inhabitants, not more than six can be described as essentially industrial in their basis. Rather has the growth of industry enlarged provincial towns at the expense of the surrounding countryside. Although the handicrafts that were formerly widespread over the countryside have declined, in many districts local small-scale industries have persisted sufficiently through the phase of concentration into steam-driven urban factories to experience resuscitation with the use of electric power.

The Franco-German War of 1870 left France maimed by the loss of two of its richest provinces and a considerable war indemnity had to be faced. A policy of stronger protection was introduced and attention was increasingly focused upon the development of the French colonial empire. World War I created another setback to economic progress. In 1919 the country faced serious problems through heavy loss of manpower, the devastation of its northern and eastern provinces and heavy war debts incurred to its allies. But Alsace-Lorraine was recovered, which gave France practically the whole of Europe's major iron ore field, and for a time the country was able to supplement meagre supplies of coal with those of the Saar. Although the strength of its agriculture, the existence of much small-scale industry and its lesser reliance upon international trade helped France to resist the severe economic depression that hit the western world in the late 1920s, its economy was severely shaken, and it was neither politically nor economically in any condition to face the German onslaught of 1940. After 1945 France began planned reorganization of agriculture and industry. Considerable progress was made in the development of water resources by multipurpose projects, and communications were improved, while the heavy industry of the northeastern districts was closely integrated with that of the neighbouring countries and the whole economy geared to a wider area of western Europe within the Common Market organization of the European Economic Community (*see* ECONOMIC UNION).

Persisting peasant farming and a limited development of large-scale organization in industrial production, with much manufacturing still carried on by small units, are indicative of the less advanced economy of France as compared with some other western countries. This is reflected in the smaller proportion of the working population who are employed in service occupations, only one-third as compared with one-half or more in Great Britain and the U.S.

A. PRODUCTION

1. Agriculture.—To a far greater extent than Great Britain or West Germany, France is still an agricultural country—about 23% of its workers were engaged in agriculture in the early 1960s, and the townsfolk are largely maintained by home-grown foods. The favourable climate, relief and soils all contribute to the extensive farmlands and to the variety of produce grown. Before the 19th century, agriculture had almost completed its colonization of the good land and subsequently only small areas have been added to this, chiefly by further drainage works to reclaim marshland and by the extension of irrigation in Mediterranean France. There has been a big modern reduction, however, in the area of *lande*, wasteland previously used only for rough grazing. From 20% of the total area of France in 1789, its extent has been reduced to less than 10% in the mid-20th century. During the 19th century French agriculture became more commercialized and geographically specialized. As communications were improved, local self-sufficiency became less necessary and various localities could dispense with the production of crops for which their particular conditions were unfavourable and could concentrate instead upon types of farming for which they were more suited. In combination with the competition increasingly exerted by alternative sources of supply overseas, this has led to the decline and virtual disappearance of some traditional crops and the severe contraction of the areas occupied by others. It has also led to increased emphasis upon livestock farming, especially in highland districts and in some lowland areas of poorer soils or damper climate. The area under the plow has decreased in favour of permanent grass, and on the reduced arable acreage, fodder crops have extended at the expense of cereals grown for human food. But the swing has not been so pronounced as in Britain, and nearly 40% of France is still under the plow, with half of this area remaining faithful to two traditional crops, wheat and the vine.

The existence of a land-owning peasantry, occupying a large share of France's farmland, dates from long before the French Revolution. The policy of both the Revolutionary and Napoleonic regimes was to establish the peasant freeholder as the backbone of the nation. Laws of inheritance required the subdivision of estates among the sons.

Agriculture continued to be heavily protected by tariffs, and the peasant was relieved of too heavy a burden of taxation. Although large numbers of the farm population have been drained away into urban employment since about 1870 and war losses have created serious manpower problems, France remains fundamentally a nation of peasants. Their innate conservatism, the state policy of protection and the fragmentation of the land in small holdings have militated against improvements along the lines of mechanization and other forms of capitalization. Peasant proprietorship accounts for about two-thirds of the surface of France. Most of the country is divided among small cultivators operating family farms. Holdings of less than 25 ac. (10 ha.) occupy more than one-quarter of France and the majority of holdings are less than 100 ac. (40 ha.). Larger farms are commonest on the rich soils of the *limon*-covered limestone platforms round Paris, where they developed before the Revolution and were the vehicle for the introduction of commercial organization and improved techniques. Here *fermage* (tenant farming with money rent) is characteristic. It was not until a considerable time after the Revolution that the system of share tenancy (*métayage*) that was formerly widespread south of the Loire river and in the poorer agricultural districts was much reduced. The unspecialized polyculture and archaic methods that accompanied this form of tenure gave way only slowly. Progress

was also hampered, especially in the eastern districts, by the fragmentation of holdings into scattered plots, a relic of open-field practice and equal division of the inheritance among co-heirs. In the 20th century *remembrement*, the consolidation of unprofitable holdings, made some progress helped by legislation in the early 1960s, and inheritance laws were modified in 1961. Agricultural co-operation among small holders developed considerably after the 1880s, especially in some areas highly specialized upon dairying or viticulture.

Crops.—Except in some highland districts, the climate of France is admirably suited to the cultivation of wheat, which remains the mainstay of arable farming over large areas of the country. Wheat is especially important in the Paris basin, on the *limon*-covered chalk and limestone country of Picardy, the Île-de-France and Beauce, but it is a very widespread crop throughout the lowlands of France. In areas of poor acid soil where rye was formerly the bread crop, for example in the Massif Central where the district name for some of the western tracts of plateau is Ségalas (rye-lands), wheat has largely replaced it since communications were improved, allowing lime and other fertilizers to be brought in to improve the soil. In this way, and under the stimulus of a growing population and a rising standard of living, the area under wheat increased considerably during the mid-19th century. Although it has dropped back as less favourable terrains were turned over to grass and other fodder crops, a trend that has continued, wheat still occupies half the arable area, and a larger national crop is obtained from the reduced acreage.

Other cereals are grown mainly for fodder, though malting barley is grown in Alsace and Burgundy for the breweries of the north-east, where beer is the popular drink. Oats and barley rank after wheat in acreage. Rye and buckwheat, the traditional crops of the poor areas, have been largely ousted, but maize (corn) is an important crop in the lowlands of the Rhône-Saône valley and of Aquitaine, with their warmer but still moist summers. Its cultivation spread rapidly from the 17th century, as it became associated with wheat in the biennial rotation practised in the Midi.

The potato, another crop from America, was slower in becoming important, but after the Napoleonic Wars it rapidly made headway, especially in the uplands and other poor soil areas, where it has proved an invaluable addition to the local economy and peasant diet. Root crops and green fodder crops have not only replaced the fallow of the old open-field system that persisted over large areas well into the 19th century, but have also gained ground at the expense of grain crops. Sugar beet is especially important. It has enjoyed a privileged position ever since it was introduced in the time of Napoleon during the exigencies of the British blockade, and it is strongly entrenched with wheat in the crop rotation practised in the tracts of better soils in the Paris basin. It presents the government with a serious problem of overproduction, and the taxpayer has to bear the burden on behalf of the growers. The crop would provide sugar in quantities that exceed France's needs and much is converted by the state into alcohol.

Among the minor crops of France are some lingering survivals of cultures that were once extensively practised. Among these hemp has almost disappeared, but flax cultivation is still carried on to a small extent along some valley floors in the northeast. The mulberry tree, formerly widely grown in the valleys of the Cévennes and other highlands that flank the Rhône valley, is now neglected. The cultivation terraces are no longer maintained and the dying trees are not replaced. The olive, always strictly confined by climate to the Mediterranean fringe, has there lost ground to other crops and the remaining patches of olive culture are no longer important. Rice, on the other hand, is a new crop, introduced during World War II in the Camargue district of the Rhône delta near Arles, and rapidly extended there on the bottom lands. Tobacco is a subsidized crop grown on a limited scale in several parts of France under government regulations. Hops are locally important on the Rhine flood plain in Alsace and various oilseeds, including sunflower, are among other minor crops.

Orchards are widespread features of the French countryside, where they often mark villages and farmsteads. Almonds are extensively grown in Mediterranean France and some other parts of the Midi, walnuts are a special crop near Grenoble, and the cider apple is ubiquitous in Normandy and Brittany, where cider takes the place of wine as the popular drink.

In several districts market gardening is intensively pursued, under the stimulus of local urban markets as along the valley floors near Paris and in the valley of the Somme, or in response to special advantages of climate. The mild littoral zone of Brittany, the reclaimed Marais Poitevin and the middle Loire valley are intensively cultivated tracts of market gardens, producing *primeurs* (early vegetables). On the irrigated lands in the lower part of the Rhône valley east of Avignon and in Roussillon advantage is taken of the generally mild winter and long growing season to produce a succession of high-value salad crops in the shelter of cypress and cane windbreaks. Flower culture is a special feature of some other districts in Provence, either for cut flowers round Hyères and along the Esterel coast or for perfume, as around Grasse.

Viticulture.—Like wheat, the vine retains a major place in French agriculture. Although Italy has a larger area under vineyards, France is the most important wine-producing country and by far the largest exporter of high-quality wine. The vine is less widespread in France than it was in the closed economy of the middle ages, and it is no longer grown in the northernmost parts of the country or at the high altitudes in the valleys of the Alps and Pyrenees. After considerable extension about the mid-19th century, in spite of trouble with mildew, viticulture received a rude shock when the vineyards throughout France were ravaged by phylloxera (*q.v.*). In 40 years from 1874 the area of vineyards was reduced from 6,200,000 ac. (2,500,000 ha.) to 3,700,000 ac. (1,500,000 ha.), after which the area remained relatively stable. From about 1888 the French vineyards have been entirely reconstituted with American rootstocks, on to which the French vines are grafted, but the vine has never effectively reappeared in some areas where the local economy has been reoriented along new lines.

Bas Languedoc, where a virtual monoculture reigns, produces nearly half the national output of wine by bulk. Here the small holders, organized in co-operative syndicates that process and market the wine, are concerned with the mass production of *vin ordinaire*. The trade in export wines, concentrating upon high-quality products rather than upon bulk, is derived from a number of favoured localities where viticulture is intensively pursued, for the most part by colonies of small holders, although there are some large estates. Their *vignobles* make the districts around the Gironde estuary (the Bordelais), the Côte-d'Or (Burgundy) and other parts of the Rhône valley, the flanks of the middle Loire valley in Anjou and Touraine, the foothills of the Vosges in Alsace and the escarpment of the Ile-de-France about Reims and Épernay deservedly famous. The last is a small area, situated on the northern margin of vine-growing, where the large-scale champagne industry grew up after 1820, when a process that had been developed locally in the previous century by the monks of Hautvillers was exploited commercially. Parts of Aquitaine, notably the Charente country (cognac) and Armagnac, are important for brandy, and Languedoc is an important producer of vermouth and liqueur wines. The modern industry, since its recovery from the phylloxera disaster, has faced recurrent crises of overproduction. The problem has never been effectively solved by the government and vine growing in France is still overdeveloped in relation to its markets, especially for *vin ordinaire*. Large additional quantities of inferior-quality wine are imported from Algeria, especially through Sète. Much surplus French wine is purchased by the state and goes to make industrial alcohol (*see* WINE).

Livestock.—Since the mid-19th century French farming has become increasingly concerned with livestock, as urban markets for meat and dairy products have grown and the development of communications has freed districts where conditions are less favourable for corn growing to concentrate upon pastoral farming. Cattle especially have increased greatly in numbers (which in the early 1960s totaled more than 20,000,000) and their quality has been much improved. Upland districts are extensively engaged in rearing store animals and in dairying, and on the seasonal summer pastures of the mountain areas cheese production is a leading feature of the economy. In lowland areas dairying or fattening is carried on

either in association with predominantly pastoral farming in maritime districts of the west and on clayey soils elsewhere or on arable farms with stall feeding. Away from close proximity to urban markets, dairy farming is concerned with the production of butter or cheese and several localities in France give their names to cheeses of high repute. In some districts of specialized dairy farming, the co-operative organization of the industry is highly developed, as in the Charente area in western France and the Bessin district in Normandy. In the southern half of France oxen are still widely used as draft animals.

Meantime, while the number of cattle has been increasing, that of sheep has suffered a drastic reduction from 33,000,000 in about 1850 to fewer than 10,000,000 in the mid-1960s. Disappearance of fallow, reduction of the area of heath and rough grazing and the competition of foreign wool have all contributed to this. Sheep are now kept for fat-lamb production rather than for wool, and in the southern Alps are now maintained on the irrigated valley meadows rather than by transhumance between the Mediterranean lowlands and the high mountains. Over a greatly extended area of the southwest of the Massif Central, and beyond its borders, sheep are kept to provide milk for the Roquefort cheese industry. The lambskins are the basis of an important glove industry at Millau.

Pig keeping and poultry and egg production are widespread, usually as adjuncts of other farming rather than as specialized enterprises, but in some districts of small holdings they are more highly developed. Horse rearing, although generally much less important than formerly, is still a characteristic feature of some districts, such as Brittany and Perche.

2. Fisheries.—With its long Atlantic coast line and numerous harbours, France has an important fishing industry, though it is much less important than that of Great Britain. In modern times the industry has become increasingly concentrated at a few specially equipped ports, and four of these—Boulogne, Lorient (Kéroman), Dieppe, and La Rochelle—account for half the total catch, which mainly consists of cod, herring, sardine, mackerel and tunny. Among them Boulogne is by far the largest. From there and other Channel ports, notably Fécamp and Dieppe, herring fishing is an especially important activity, but trawling for cod and other demersal fish is also carried on. Fishing is a mainstay of the economy in the densely populated coastal zone (l'Armor) of Brittany, where half the fishermen of France live, engaging in seasonal fishing in association with the family working of a small holding. Although Lorient and St. Malo have large trawling fleets, the seasonal fishing for sardine and tunny from numerous ports of the south coast is especially important and canning is a typical activity of these ports, especially at Concarneau and Douarnenez. Inshore fishing along the north coast of Brittany is chiefly for mackerel. La Rochelle, with its outport La Pallice, is the main fishing port south of the Loire estuary, and is chiefly concerned with distant trawling. Oyster culture in silted estuaries and lagoons along the Biscay coast is a noteworthy activity and several places have considerable catches of lobsters and other crustaceans. Fishing is relatively unimportant along the Mediterranean coast but tunny, anchovy, etc., are fished from Marseilles and other ports and fishing is also carried on in the lagoons of Languedoc.

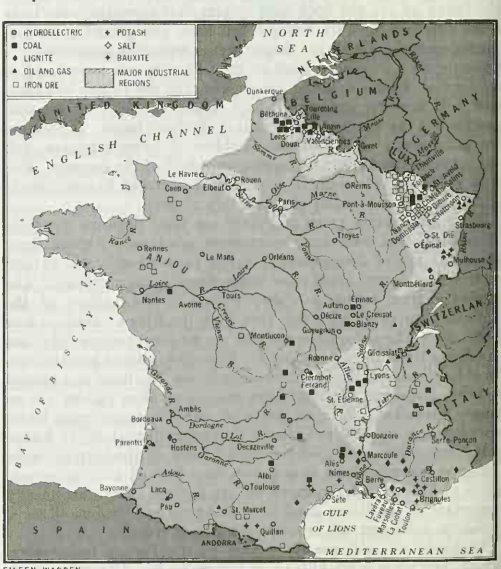
3. Forestry.—About one-fifth of France is forested, a much higher proportion than in Great Britain, and a considerably larger area than at the beginning of the 19th century, by which time the destruction of the natural forest by man and his grazing animals had reached its maximum in France. Subsequently a considerable measure of afforestation has developed plantations of conifers as an important national resource. About 13% of the forests belongs to the state, another 25% is owned by communes and the remaining forest cover is in private ownership.

Woodland is very widespread in France, with fragments of the natural mixed deciduous woodland persisting in the lowlands outside the Mediterranean area. The old forest economy has greatly declined since the supersession of timber for shipbuilding and many other purposes and of charcoal for smelting. The chestnut woods, formerly so important in the economy of some upland areas, especially in the Massif Central, have been ravaged by disease and are no longer maintained. Above the zone of deciduous woodland, in the mountain areas of the Alps, Jura, Vosges and Pyrenees, are valuable coniferous forests. These extend up to about 4,000 ft. (1,200 m.) in the Vosges and Jura, and to 6,000 or 7,000 ft. (1,800–2,000 m.) in the High Alps and Pyrenees. Afforestation with conifers has also made considerable progress in parts of the Massif Central (*e.g.*, the Cévennes and Haut Limousin), Champagne and the Sologne, but above all in the Landes (*q.v.*), where the sandy wastes have been transformed since 1857 by draining and planting of maritime pine. The forests of the Landes, covering more than 2,100,000 ac. (800,000 ha.), yield large quantities of resin and timber for pit props, railway sleepers and telegraph poles.

The evergreen vegetation of the Mediterranean area is distinctive in its species. Here the original woodland of holm oak was long ago replaced by scrub (often dominated by kermes oak) on the tracts of uncultivated land that occupy the limestone hills. Besides these areas of *garrigues* there are extensive woodlands of Aleppo pine in Provence that yield much resin, but they suffer greatly from the ravages of fire. On the crystalline massifs of the Maures and Esterel are cork-oak forests, but the product is not of very high quality.

4. Industry and Mining.—Large-scale industry was late in developing in France, and the evolution from small workshop and domestic industries, widely scattered over the country and often in rural settings, to concentrated, urban, factory industry is far less advanced in France than in Britain or Germany. Manufacturing processes such as charcoal smelting of iron ore and hand spinning and weaving of textiles persisted on a considerable scale in France long after they had been superseded in Britain by coke smelting and the use of steam-driven machines. The slowness and incompleteness of the change has been the result largely of France's lack of coal, although the existence of a large supply of cheap rural labour and the conservatism of small employers and craftsmen and the strength of their resistance to large-scale organization have undoubtedly contributed. Although a late but considerable development has been made by large-scale organization and heavy industry, French industrial production tends to emphasize the lighter branches of manufacture and to be concerned with high-quality textiles and luxury articles.

It was not until the French railway system was substantially completed in the 1860s that there was a marked increase in the



EILEEN WARREN

PRINCIPAL INDUSTRIAL AND MINERAL LOCATIONS

rate of industrial expansion. Subsequently the loss in 1871 of iron ore fields in Lorraine and of the textile industries of Alsace dealt a severe blow, but stimulated development in neighbouring areas that remained French. Again in World War I, enemy occupation and the heavy warfare waged in the frontier provinces that were the chief seats of industrial concentration entailed widespread destruction of collieries and manufacturing plants, but afterward prepared the way for modernization of equipment. During the German occupation after 1940 the country was denuded on a large scale both of labour and materials, and industry was geared to the production of essential war equipment. After World War II, coal, gas, electricity and petroleum were nationalized, and industrial recovery supported by substantial U.S. aid was inaugurated by the Monnet plan, adopted in 1947, for the modernization of equipment, the improvement of transport and the development of material resources by massive capital investment in factories and public works, including construction of power stations, irrigation works, roads and bridges, and the electrification of railways. The Monnet plan was concerned first with the modernization of basic sectors of the economy and the second plan from 1954 concentrated upon achieving a more balanced economy and upon increasing productivity. Although progress was seriously handicapped by labour unrest and political tension, France's industrial output was substantially increased. The Schuman plan for the integration of the coal and steel production of western Europe came into operation with the establishment of the European Coal and Steel Community (*q.v.*), which became fully effective in 1953, and was a decisive step toward the establishment of the Common Market by the treaty of Rome in 1957. After 1957 the third French modernization plan placed emphasis upon the balance of French trade with the rest of the world, combating inflation, filling gaps left by the earlier development plans, and correcting the disequilibrium between the metropolis and the provinces. There is a great deal more far-reaching state intervention in the detailed control of the economy in France than in most western countries. This is reflected both in the scale of direct public ownership and in the extensive system of controls, affecting prices, investment, currency and foreign trade. The fourth economic and social development plan, 1962–65, envisaged annual increases in the gross national product, the creation of 1,000,000 new jobs and improved living standards.

Industrial Areas.—France has four major areas of industrial concentration, but large parts of the country show a wide diffusion of industry or small pockets of concentration near power sites and ports. The most important industrial area is near the northeastern frontier on and around France's major coal field. This area, favoured by a long tradition of manufacturing industry, especially in textiles, and by a highly developed system of communications and proximity to ports, as well as by supplies of power, is concerned especially with metallurgical and textile industries. In Lorraine and Alsace industry is also well developed, with district specialization in steel and engineering industries in the Moselle valley on the Lorraine iron ore field, and in textile manufacture in the plain of Alsace and on the west side of the Vosges. Paris itself is a third major industrial concentration. As late as 1870, of 100,000 persons in Paris who were classed as *fabricants*, no fewer than 62,000 worked alone or with a single assistant. This type of small-scale organization persists in the inner *arrondissements* of Paris, while factory industry has developed in the outer zone of the enlarged city. There are still thousands of small rooms and little workshops in the old quarters that turn out expensive goods, such as fashion clothing, jewelry and a multitude of small luxury articles. Along the Seine valley below central Paris are large automobile, aircraft, other engineering and chemical works, and on the north and northeast sides of Paris, where railways and canals converge to use the Saint-Denis gap in the girdle of hills, locomotive and other engineering works, chemical industries and a host of lighter industries have congregated. Lyons is the centre of a fourth industrial area, which includes the Saint-Étienne coal field and spreads considerable distances up the valleys of the Massif Central and the Alps. Using hydroelectric power from the High Alps, textile industries are especially important there, but there are also specialized metalworking industries on the Saint-Étienne coal field.

Coal.—France has only one sizable coal field, in the extreme northeast of the country in the *départements* of Nord and Pas-de-Calais. This coal field produces half the national output, but most of the coal is deeply buried and the coal field was hardly developed before 1850. Of earlier importance were the pockets of coal preserved among the older rocks of the Massif Central, especially along its eastern margin, but France, which was producing less than 1,000,000 (metric) tons of coal at the end of the Napoleonic Wars, had increased this amount to only 2,000,000 tons by 1830 and 5,000,000 by 1850. From this time the northern coal field was penetrated and mining spread westward toward Béthune at increasing depths in the following decades. French coal production increased to 41,000,000 tons by 1913, when an additional 20,000,000 tons were imported. Subsequently production was increased by the early 1960s to about 55,000,000 tons, with an additional 2,000,000 tons of lignite (chiefly from Fuveau, behind Marseilles). Reserves are estimated at about 10,000,000,000 tons, of which 207,000,000 tons are reckoned to be suitable for making metallurgical coke. Since the nationalization of coal mines in 1944 to 1946, the modernization of pits has enabled the French coal industry to become technically very efficient, with the highest output per man shift underground in Europe. The labour force of more than 200,000 workers includes considerable numbers of foreign immigrants, especially from Poland.

The northeastern coal field of France is continued across the Belgian frontier into the Sambre-Meuse valley. The French portion, which was first worked in the frontier districts near Valenciennes and Anzin, extends westward for 60 mi. (100 km.) as a narrow belt, from 3–10 mi. (5–16 km.) wide, to beyond Béthune, and may be connected at great depth with the Kent (Eng.) coal field. In the western portion of the developed field the coal is buried at depths of more than 3,000 ft. (900 m.) under the chalk of the Artois anticline. Although there are numerous seams, they have been greatly affected by folding and faulting, so that they are thin, steeply tilted and frequently interrupted, and mining is difficult and costly. The coal varies greatly in type, but there is a dearth of coking coal, and this particular deficiency is the more serious in view of France's possession, in Lorraine, of the largest iron ore field of Europe. France's smelting industries have had to depend to a large extent upon imported fuel. Barren strata divide the northeastern coal field into western and eastern sections, round Lens and Valenciennes respectively. Apart from the output of gas and other distillation products, there is an important manufacture of briquettes and other patent fuels at many of the mines and especially at Aniche.

The extension of the Saar coal field into the French *département* of Moselle, where the coal is deeply buried, was vigorously developed for the needs of the Lorraine industry in the period between World Wars I and II. From only a little more than 1,000,000 tons in 1900, output had increased twelvefold by mid-20th century, chiefly from pits round Forbach and Saint-Avold.

The other small, scattered coal fields of France, chiefly in the Massif Central, with limited resources that in most cases have now been severely depleted, account for the remaining quarter of France's production. The largest of these minor coal fields is the elongated basin of Saint-Étienne in the *département* of Loire, which is noteworthy for its high-quality gas and coking coals. Production has declined considerably since its maximum at the beginning of the 20th century. Farther north the similar synclinal basin of Le Creusot is worked on a diminishing scale at Blanzy, and there is also a little production still farther north from the Autun-Épinac field, which also produces oil shale. The Alès coal field, at the foot of the Cévennes in the *département* of Gard, produces a small amount of high-quality coal, and on the western side of the massif are other small coal fields in the basins of the Lot (round Décazeville) and Tarn (Carmaux-Albi) rivers. A major line of faulting that traverses the massif from north to south is also accompanied by a string of coal pockets, most important in the north at Décize and Commentry. There are other small pockets of coal, including anthracite, among the heavily folded sedimentary

rocks of the French Alps, on both sides of the central crystalline massifs.

Electricity.—In the northeast of France and in the Paris area, French electric power stations use coal or blast-furnace gas. In the southern half of the country the great water resources of the Alps, Jura, Pyrenees and Massif Central have increasingly been harnessed to provide hydroelectric power since the first station was established in the French Alps in the 1880s. Under the post-World War II economic development plans, hydroelectric power production has been greatly expanded and has overtaken the production of thermal electricity in France. Developments include some major projects involving the construction of great barrages; *e.g.*, at Génissiat on the Rhône below Geneva, at Donzère-Mondragon on the Rhône above Montélimar, at Serre-Ponçon on the Durance river, at Castillon on the Verdon river and on the upper Dordogne and Truyère. Generating plants are especially numerous along the Isère and its tributaries in the northern part of the French Alps, whence most of the power generated is transmitted for use in the Lyons industrial area, but metallurgical and chemical industries have been drawn to locations in the Alps. The power stations in the heart of France on the Truyère, Dordogne, Vienne and Creuse rivers play a major role in supplying electricity to the French electricity grid. The central Pyrenees, in the upper basins of the Garonne and the Adour and its tributaries, also contribute large quantities of power. Whereas in 1938 France's consumption of electricity amounted to 20,000,000,000 kw.hr., by 1963 it had risen to 88,800,000,000 kw.hr. Tidal energy has been harnessed on the Rance river in Brittany, and the application of nuclear energy has also been undertaken. France's first nuclear power station is located at Marcoule (Gard) in the lower valley of the Rhône, and two other stations near Chinon (Indre-et-Loire) were opened in 1961 and 1962.

Oil and Gas.—Mineral oil has long been known at Pechelbronn in Alsace and lubricating oil was being made there by 1870. Some development of this small oil field took place during the early part of the 20th century and accounted for France's output of 70,000 metric tons of oil in 1938. Since then explorations in southwestern France have yielded much more important results and oil fields have been developed from 1949 at Lacq, near Pau in the western Pyrenees, and from 1954 at Parentis in the Landes, bringing France's production to 2,500,000 tons in 1962. This falls far short of its growing needs and a great development of oil refining has been taking place at some of the chief ports, notably at the mouth of the Seine and on the Étang de Berre near Marseilles. France's refining capacity, about 8,000,000 tons in 1938, exceeded 40,000,000 tons in the early 1960s.

The group of refineries at the mouth of the Seine (Port Jerôme, Gonfreville, Petit-Couronne, Gravenchon), connected with Paris by pipeline as well as by river transport, imports crude oil through Le Havre. Lavéra, at the entrance to the Étang de Berre, has been developed as a great oil port. It is an annex of Marseilles, and the oil is refined at La Mède and Shell-Berre as well as at Lavéra itself. From these refineries there is pipeline connection with the Rhine at Karlsruhe in West Germany. Crude oil accounts for two-thirds (by bulk) of imports at both Le Havre and Marseilles, and Marseilles is now as important as the older refining area of the lower Seine. Other refining centres of lesser importance are Dunkerque, the Gironde (Bordeaux, Ambès, Pauillac), Donges near Nantes and Frontignan near Sète.

In 1939 natural gas was discovered at Saint-Marcet, near Saint-Gaudens, in the Pyrenees and more recently another field at Lacq has been opened up. The fuel is piped in great quantities to Bordeaux, Toulouse and Pau. France had, by the 1960s, invested heavily in the prospecting for and the development of Saharan oil, gas and hydrocarbon deposits.

Iron and Steel.—Iron ore is of widespread occurrence in France, and metalworking industries, using pig iron made by smelting with charcoal, were pursued in many districts before the 19th century. Long after charcoal furnaces for smelting iron ore had gone out of use in England they continued to increase in number in France. In 1840 there were more than 400 in action and it is estimated that they accounted for more than half the country's pig iron output. Since then the French iron and steel industry has become much more concentrated upon the country's major ore field in Lorraine and near the major coal field in the northeast. France's reserves of iron ore are estimated at 6,730,000,000 (metric) tons, with a content of 2,200,000,000 tons of metal. The Lorraine ore is low grade and, although the first concession to work the field dates from 1845, not until after the field was partitioned between France and Germany in 1871, with Germany claiming the easily accessible outcrop portion, did any major development take place. This followed upon the invention by Thomas and Gilchrist of the process of smelting phosphoric ore in a Bessemer furnace with a basic lining (*see* CONVERTER STEEL), which made Lorraine ore available for steelmaking. In the 30 years before World War I the ore field was rapidly developed on both sides of the frontier and after 1919 the whole field, apart from a small northward extension into Luxembourg, came under unified French control. Ten years later French ore production reached 51,000,000 tons. Although it had dropped by 1938 to 33,000,000 tons it has increased again and exceeded 66,000,000 tons in the early 1960s.

The ironstone, known as minette, outcrops at the base of the great escarpment (Côte de Moselle) that flanks the Moselle valley on its western side, and it dips very gently westward under the limestone of the Briey plateau. An anticlinal structure, crossing the Moselle valley about Pont-à-Mousson, interrupts the southward extension of the ore field, but there is an outlying area in the Nancy basin, dissected by the Moselle and Meurthe rivers.

Although low grade, with an iron content of only a little more than 30%, the ore is exceedingly cheap to work. Nearly 40% is extracted from adits or shallow shafts. The ore occurs in thick beds and working faces are never less than seven feet thick, and it dips only slightly and is little disturbed by faults, so that large-scale mechanical methods of extraction can be employed. Moreover, in the largest, most productive part of the field, the ore is calcareous and self-fluxing.

Other ore fields in Normandy near Caen and farther south, in Anjou north of the Loire estuary and some small, scattered ore bodies of high-grade hematite in the Pyrenees, account for about 8% of French ore production, but the ironstones in the Jurassic and lower Cretaceous rocks, whose outcrops were the scenes of charcoal smelting industries, and the Coal Measure ores of the Massif Central are now inconsiderable. The surviving metalworking industries in these areas depend upon raw material from Lorraine or upon scrap metal and have become highly specialized.

From Lorraine a large surplus of ore, about 40% of the total, is exported to Belgium and Luxembourg and to the Saar, but a large-scale iron and steel industry has been developed in northeastern France. By the early 1960s France's steel production exceeded 17,000,000 tons annually. The Monnet plan achieved major technical improvements in ore mining, ore preparation in crushing and sintering plants to achieve fuel economy, coking, electricity generation by use of blast-furnace gas, and in iron and steel production itself, where modernization of plant rather than expansion of productive capacity has been the primary objective. The major problem is still lack of coking coal, of which more than half the nation's requirement is based on imports. Saar and Lorraine coal, the nearest to hand, must be mixed with other coal for coke manufacture, but improved technique allows a much greater proportion of local coal to be used. Lorraine has always depended heavily upon Ruhr coke and the canalization of the Moselle river from Thionville to Coblenz in the 1960s would reduce freight costs and facilitate the effective integration of the iron and steel industry within the framework of the European Economic Community. Hitherto most of the traffic to and from steelworks and mines in Lorraine was carried by rail.

The iron- and steelworks are found along the Moselle valley and the tributary valleys of the Fentsch and Orne, with subsidiary concentrations in the Longwy area in the north and the Nancy area in the south. The emphasis is upon primary metallurgy. With successive stages of processing, Lorraine's share of the national production of iron products diminishes—from nine-tenths of the ore to four-fifths of the pig iron, two-thirds of the crude steel, and little more than half of the finished steel. Lorraine's own

steel industry uses little scrap and is largely concerned with making steel from local pig iron by the basic Bessemer process.

The northeastern coal field, which produces more than 20% of French steel, is concerned with steelmaking rather than with iron smelting and uses much pig iron from Lorraine and scrap. It is located on the coal field, chiefly along the canalized Escaut (Scheldt) in the Valenciennes district and in the Douai-Lens district, and off the coal field in the Sambre valley southeast of Valenciennes and on the Aire canal. Situated between the ore field and the coal field, there are other important steelworks in the Meuse valley above the frontier town of Givet.

On the coal fields of central France about 8% of the total output of French steel is made, almost all in electric open-hearth furnaces that turn out steels of special quality. The electrometallurgical industries of the Alps and Pyrenees, located near hydroelectric stations that provide cheap power, are also concerned with special steels and use pig iron and scrap that are brought from other districts. There are also a few other coastal steelworks that use imported materials; *e.g.*, on the Loire estuary and at Boucau near Bayonne. About one-third of the Normandy ore output is smelted near Caen, the rest being shipped away by the canalized Orne river.

Nonferrous Metals.—Apart from iron, France has few ore resources of importance, but bauxite is an exception. Bauxite, the ore of aluminum, takes its name from Les Baux, near Arles, where it was first exploited in 1822. The chief workings now are farther east in the *département* of Var, especially in the Brignoles district, and there are other workings in Languedoc. The annual production amounts to more than 2,000,000 tons. There are scattered deposits of zinc, lead and copper ores in the crystalline rocks of the highlands and mountains, but they have never been of much importance. Recently uranium ore has been worked at Gueugnon and elsewhere in the Massif Central.

Chemicals.—France lacked many of the natural advantages possessed by Britain and Germany for the development of heavy chemical industries. Deficiency in an important raw material, coal, was a great drawback, but there has been some development of coal distillation products, especially on the northeastern coal field. The salt deposits that occur in the Triassic rocks of Lorraine provide the basis of chemical industries at Dombasle, Château-Salins and Dieuze, and France possesses an important deposit of potash in the plain of Alsace, north of Mulhouse. There are other salt deposits on the edge of the Jura in Franche-Comté, and there is still production of salt by the traditional method of brine evaporation at places along the Mediterranean coast. Basic slag is a by-product of the iron-smelting works of Lorraine, and large quantities of fertilizers are made at port locations with phosphate rock imported from north Africa. France's extensive outcrops of limestone and chalk make possible a large production of lime and cement, the chief works being related to sites favourably placed for transport and access to major centres of demand. The developed hydroelectric power resources of the Alps and Pyrenees have proved an important asset for some chemical industries that are heavily dependent upon cheap power for high temperatures, notably calcium carbide, cyanamide and nitrogen compounds. A petrochemical industry has appeared in association with the oil-refining ports, and the development of natural gas at Lacq yields considerable quantities of sulfur as a by-product. In the 1950s France made great advances in chemical production, which nearly trebled between 1953 and 1960.

Engineering.—Although supplies of iron and of electric energy are plentiful, France's lagging coal output has restricted the development of metallurgical and engineering industries, and France exports 40% of its iron ore production and about 25% of its output of crude steel. Moreover, except for aluminum ore, France depends largely upon imported supplies of nonferrous metals. Much specialized machinery is imported, but engineering industries, mainly composed of small firms, employ about 680,000 workers and cover a wide range of branches.

Most of the heavy engineering, including railway engineering, is carried on near the coal fields and steel-producing districts of the north and east, but there are several outlying centres. Armament industries have sought locations away from the eastern frontier and are found especially on the coal fields of central France. Electrical engineering, a growing industry that provides valuable exports, is centred upon Paris and to a lesser extent upon Lyons. Shipbuilding, which has never been a major industry of France, is carried on chiefly on the estuaries of the Loire (Saint-Nazaire) and Seine (Le Havre, Hartleur and Le Trait near Rouen) and at Dunkerque, with minor centres on the Gironde below Bordeaux and on the Mediterranean coast near Marseilles (Port de Bouc and La Ciotat) and Toulon (La Seyne). The Loire estuary is also the chief centre of marine engineering, but much ship equipment is made at inland works.

The manufacture of motor vehicles, which is chiefly carried on by a few large and well-known firms, is a major industrial activity of greater Paris, where Renault, Simca and Citroën have large works. There are some other important centres, such as Montbéliard, Le Mans and Rennes. In 1962 the French automobile industry produced more than 1,200,000 cars and 230,500 vans and trucks, a large proportion of them being manufactured for export. The French aircraft industry has always been a leader in technological advancement and employed about 85,000 workers in the early 1960s. A number of aircraft were exported, notably the Caravelle airliner.

Textile Manufactures.—At the beginning of the 19th century linen and woolen industries were widespread and most French peasant women spun either flax or wool. Silk manufacture was more concentrated in the Rhône valley, but it was not an urban industry. The cotton industry was already well established in some districts in the north, especially in the Rouen district, round Lille and in southern Alsace.

The cotton industry was the first to experience large-scale factory organization and it has become the most concentrated in urban factories. After the loss of Alsace in 1871 many French manufacturers migrated to the French side of the Vosges and established new centres of the industry at Saint-Dié and Épinal. The chief cotton manufacturing areas are the lower Seine district, the Lille district and Alsace-Lorraine. The basin of Roanne in the Massif Central also has an important weaving industry. Le Havre is the great importing port for raw cotton.

The French woolen industry was maintained by home-produced wool until the late 19th century, thanks to a great expansion in the home production of fine merino wool, but subsequently Australian wool, imported chiefly through Dunkerque, has assumed an increasing share of the provenance of the industry. The manufacture of woolen textiles is more widely dispersed than the other major textile industries, but individual centres show a high degree of product specialization; *e.g.*, flannels at Reims, blankets at Orléans. The Roubaix-Tourcoing area, near the Belgian frontier, is the chief worsted manufacturing district.

The linen industry, although it has declined considerably since the beginning of the 20th century, is still widespread in the old areas of its establishment. Round Lille, the Lys valley in Flanders now produces more than 90% of French linen goods. It no longer uses much home-grown flax, but it is still in part a cottage industry. A modern jute industry has developed to a modest scale, chiefly at Dunkerque and in the Somme valley.

First introduced with mulberry cultivation and sericulture in the 15th century from Italy under royal patronage, the silk industry never recovered at Tours from the persecution of its Huguenot craftsmen. But it remained important in and around Lyons, and until the mid-19th century the valleys of the highlands that flank the Rhône valley provided most of its raw material. After the opening of the Suez canal, however, raw silk from the east began to compete seriously and has almost entirely supplanted home-produced material. At the beginning of the 20th century much of the industry, though organized from Lyons, was still an activity of small workshops and homes in the surrounding countryside, and this type of small-scale organization has persisted side by side with the development of factories. The increasing use of hydroelectric power has facilitated the dispersion of the industry. After World War II there was increased use of mixed fabrics and of rayon and synthetic substitutes. Mulhouse in southern Alsace is a noteworthy outlying centre of the silk industry.

Alongside factory organization, much textile manufacture is still carried on in small workshops and even in cottages, and the textile industries are widely scattered over France. There are four major concentrations, however: on the northeastern coal field, around Lille, producing chiefly cotton, but also linen, woolen, synthetic and mixed fabrics; on the lower Seine, round Rouen, chiefly concerned with cotton but with important representation of woolen textiles at Elbeuf; on both sides of the Vosges in Alsace and Lorraine, in the districts of Mulhouse and Saint-Dié–Épinal, producing cotton goods and especially calico; and the Lyons region, the great area for the manufacture of silk and man-made substitutes. Alike in different localities within these provinces, and in the scattered centres of textile manufacture that are found elsewhere in France, there is a great deal of local specialization upon particular products. Old-established industries have survived in specialized form; *e.g.*, the hosiery and knitwear industry of Troyes, the manufacture of ribbon and elastic web in the Saint-Étienne district and carpet manufacture at several places. Domestic textile industries such as lacemaking remain a feature of the local economy in some districts of France.

Among other minor industries sugar refining in the beet-growing areas of the northeast, alcohol distilling from beet and wine, milling of oilseeds and manufacture of vegetable-oil products, especially at Marseilles, rubber manufacture at Clermont-Ferrand and Montluçon and widespread manufacture of plastics, with an especially important development in the Jura and at Quillan in the Pyrenean foothills, deserve special mention. (Ar. E. S.)

The Fashion Industry.—The importance to the national economy of the French fashion industry as a whole cannot be overestimated; it is in effect, taken in its widest sense, one of the country's best foreign currency earners. It can be said that the hub of the vast, eclectic but at the same time interdependent aggregate of industries that come under the heading of fashion is the *Haute Couture*. Taken in its restricted meaning of the sale of models to private and wholesale clients, the *Haute Couture* is on the wane; it is however the prestige symbol around which the fashion industry as a whole revolves. By the early 1960s annual exports of luxury and high-grade fashion merchandise including, besides true *Haute Couture*, fabrics, perfumes, jewelry, lingerie, furs and fashion accessories, exceeded 800,000,000 fr. in value. The *Haute Couture* share was only approximately 10% and although more than 30 houses are listed as ranking *Haute Couture*, only 5 or 6 can be called creator houses.

Export trade by the *Haute Couture* divides approximately into half to the Americas (with a heavy percentage of wholesale business with the U.S.) and half to Europe and the middle east. A further analysis of the business done shows that approximately 60% of trade is with wholesale houses (manufacturers and retailers) and 40% with private clients. France is still the *Haute Couture*'s best client.

So important as a key industry is the *Haute Couture* that an *Aide à la Couture* subsidy was granted by the government in 1949 with the provision that only a 10% quota of foreign fabrics could be used by houses benefiting by the subsidy. In line with the general policy of subsidy cutting, the *Aide à la Couture* was abolished in 1960 with the result that the importation and use by the *Couture* of foreign fabrics has increased. Leading countries exporting fabrics to France are Italy, Switzerland, the U.K., Germany and the U.S.

Mention must also be made of the *Haute Couture* ready-to-wear business which grew up after World War II and groups six major houses under the name of *Prêt-à-Porter Création*. The main markets are the Scandinavian countries and Canada. (P. W. He.)

Tourism.—Receipts from the large tourist industry constitute an important resource contributing toward France's balance of payments with foreign countries. After Paris, the chief tourist area is the French Riviera. There the enormous expansion of the tourist industry after the early 19th century produced large resort and residential towns such as Nice and Cannes, and the area along the coast is highly urbanized with villas and hotels. There too is Monte Carlo in the independent principality of Monaco. A similar but more modest development of fashionable winter resorts has taken place at the western end of the Pyrenees, with Biarritz. Centres of winter sports are also becoming increasingly important in the northern Alps and in the central Pyrenees, but both at seaside and mountain tourist centres the mass influx of summer visitors in most cases far exceeds the winter trade.

Spas still remain as fashionable health resorts, visited chiefly by the French themselves. The most frequented are in the Massif Central, especially Vichy, La Bourboule and Mont Dore, but Vittel in the east and many others in the Pyrenees and Alps are also popular. The magnificent mountain scenery has been made accessible to tourists by modern motor roads and old market and spa towns in the mountains are developing as centres for motorists.

Admission receipts from places of special tourist interest show the outstanding importance of those in Paris itself and its neighbourhood (notably Versailles and Fontainebleau), followed by Lourdes in the Pyrenees, but the abbey of Mont St. Michel in western Normandy, the Loire châteaux and the historic monuments of the Midi also attract crowds of sight-seers. (Ar. E. S.)

B. Trade and Finance

1. Foreign Trade.—Because of a largely self-sufficient agriculture and only moderately developed industries France had little need during the 19th century to import large quantities of raw materials. Its industrial revolution was on a relatively small scale. Moreover, the country was not by tradition a great mercantile nation. During a century of internal political vicissitudes French economy remained remarkably stable, but also relatively static. The chief industrial activity was in textiles, which accounted for nearly one-third of imports and one-half of exports, until an increasing industrialization and colonial expansion under the third republic gave France a greater and more varied interest in world trade. Commercial policy, except for a period under Napoleon III, was strongly protectionist and, behind a high tariff, some attempt was made to develop backward industries toward the end of the century. Within trade agreements a most-favoured-nation clause was often inserted by which France extended to the signatory any tariff reduction granted to a third country in return for a similar concession. After 1875 a customary yearly favourable trade balance became, with rare exceptions, an adverse one.

By the beginning of the 20th century a more diversified industry was requiring more imports of fuel, machinery, tools and metal goods. Exports had become more varied with the products of heavy industries, iron, steel, machinery and chemicals becoming increasingly important. In pre-World War I years, however, there was invariably an adverse balance of visible trade of around 10%, which was compensated for by invisible exports and advantageous trade with overseas possessions.

After World War I the modernization of the northern industrial areas and the recovery of Alsace-Lorraine assisted the production of textiles, steel and machinery. There was some concentration of French industry and commerce into larger units, but at the same time small-scale concerns were also multiplying. A decline in the external value of the franc, and an increased exploitation of overseas possessions, contributed to assist exports. Between 1920 and 1929 these were averaging around one-third more (in terms of 1913 gold value) than in pre-1914 years. In addition, the volume of imports was kept down. Thus an advantageous balance in total overseas trade was usually struck before 1928. But the credit side was also assisted by considerable invisible contributions from tourism, foreign banking and insurance. In later years these assets usually offset a visible adverse trade balance.

During that period the commercial policy of France became at first more protectionist. The most-favoured-nation clause in existing commercial treaties was denounced, the general tariff raised, and trading relations settled by reciprocal advantages and bargaining. By 1927, however, France was obliged to return to the most-favoured-nation principle and a stabilized system of tariffs, and to abandon reciprocity.

In 1930 there was a general decline in exports, partly because of the high prices of products which France's adherence to the gold standard (abandoned by many other nations) entailed. To protect its agriculture and industry, and to improve the balance of

payments, France adopted a policy of quotas and denounced the most-favoured-nation clause. Though this move did limit imports, it failed to benefit exports because of retaliatory measures, and it also brought an increase in the cost of living.

The devaluation of the franc in 1936 did little to remedy the adverse visible trade balance. In 1937, even when world trade was reviving, the gold value of French exports was 29% of that in 1929, and a year later exports were only paying for about 66% of imports. Imports consisted chiefly of raw materials (coal, other fuels, cotton, wool), of food and drink, and of manufactured goods (machinery, metal goods and chemicals). In exports manufactured goods (textiles, chemical products and highly fabricated metal articles) held the lead, followed by raw materials (chiefly iron ore). Productivity was falling rapidly during the 1930s, partly because of labour troubles and also deficiencies in the French economic structure with its preponderance of small-scale firms and its excessive bureaucratic controls. The larger steel, metal and chemical enterprises, sheltered within the protected sector, fared better than the smaller.

Between 1930 and 1938 the gross national product had fallen by one-sixth and industrial production by almost two-thirds. Exports were averaging 30% less than imports. By the outbreak of World War II industrial and agricultural output barely exceeded the 1914 level. Capital investment was precariously low. France was indeed living on the accumulated wealth of former years. Moreover, the theory that economic self-sufficiency was possible persisted in some quarters, and there was little official determination to introduce the basic reorganization necessary for an obsolescent industry, an out-of-date agriculture and a wasteful distributive system.

Under the Vichy regime industrial production, particularly in textiles and chemicals, continued to sink. French trade was strictly controlled by Germany, and its volume with overseas countries dropped to a very low level. By the end of World War II, a major part of the traditional world markets had been lost and the value of invisible exports seriously impaired.

After the liberation the nationalization of certain industries (coal, gas and electricity, banking and insurance) was introduced. The modernization and re-equipment of industry was undertaken under the Monnet plan to increase productivity. Though the targets set were by no means achieved by 1952, industrial production had increased 20% over that in 1931, but agriculture was failing to keep the country self-supporting. Foreign trade in the decade following World War II showed yearly a considerable but decreasing over-all deficit ($1,527,000,000 in 1946 compared with $179,000,000 in 1954), in particular with the United States, Germany and the sterling area. France's trade with its overseas territories was, however, improving. By 1954 it amounted to 31% of total external trade compared with 15% in 1929. The balance with these territories (a deficit in 1938) had become a substantial surplus even by 1949. Invisible assets were also beginning to increase once more.

Until 1948 France, like most other European countries, had tried to protect its own industries by a system of quotas rather than tariffs. After the formation of the Organization for European Economic Co-operation (O.E.E.C.) in 1948 this policy was progressively superseded by one of liberalization of exchanges, with a lowering of customs tariffs. But, while France supported programs for the integration of resources and trade such as coal and steel (Schuman plan) and agriculture (Pflimlin plan), tariffs were still retained to protect trade with the French union.

Even up to 1958 France was living beyond its means. Its financial resources were still being drained by overseas wars and handicapped by a failure to undertake a basic economic and fiscal reorganization and tariff reform. After late 1958 a trade recovery began to take place, due to the devaluation of the franc, a check on domestic prices and a wage freeze, and the Common Market. Gross national production in the early 1960s was annually increasing by about 5.5%; restrictions were removed from nearly all industrial imports and the few remaining were mostly designed to protect domestic agriculture; trade and payment balances were favourable, and satisfactory reserves of gold and foreign exchange had been accumulated.

Principal foreign trading partners were the U.S., the U.K., Italy, the Netherlands and Switzerland, with all of whom a surplus was obtained, and the Federal Republic of Germany with whom there was a slight deficit. With most countries of the franc zone the balance of trade was favourable. Overall, in 1964 France imported 49,700,000,000 fr. of goods and exported 44,400,000,000. Invisible exports, particularly tourism, substantially reduced the gap.

General Pattern of Imports and Exports After World War II.— Essential to French economic recovery were the restoration and expansion of foreign trade which had declined to negligible proportions under the German occupation. A primary necessity was the immediate acquisition of capital equipment and raw materials for the rehabilitation of the country's basic industries and its communications. Imports initially, therefore, concentrated on such essentials as coal and oil; iron, steel and cement; machinery and rolling stock; and, in view of an impaired agriculture, food. Exports naturally failed by a considerable margin to balance imports.

After the immediate post-World War II years French output began to play its part in supplying the home market, thus cutting down many types of imports, and even providing a surplus for export. But a substantial deficit in the balance of payments persisted until 1957 when it amounted to 491,000,000,000 fr.

However, domestic annual production of fuel and power had slowly increased by the early 1960s; *e.g.*, coal was more than 60,000,000 tons and electrical output exceeded 63,000,000 kw.hr. Though France still had to import coal and other fuels, it was estimated that by the mid-1960s there would be complete self-sufficiency in these sectors. Similarly the rehabilitation of the iron, steel and nonferrous industries and of engineering not only cut down initial postwar imports in these fields, but resulted in the increasing export of motor vehicles, railway equipment, aircraft, electronic and radio equipment, turbines, etc.

Industries such as textiles and hosiery which had been handicapped by the war years and, moreover, whose plants were out-of-date, were gradually modernized and began to supply an increasing quota toward domestic consumption. The chemical industry also recovered its productive capacity and began to contribute a growing proportion toward the nation's exports. Agriculture, which during the mid-1950s was failing to satisfy home demand, had by the early 1960s, as a result of improved organization and more scientific methods, become a net exporter of more products. Imports from abroad were largely raw materials (wool, cotton, rubber, wood pulp), industrial equipment, nonferrous metals and some foodstuffs. Exports were the traditional ones of wine, spirits, agricultural produce and luxury goods, which were also supplemented by an increasing range of finished steel and electrical products, machinery, and railway and shipping equipment. During the early 1960s exports exceeded imports; from the mid-1960s there was an increasing visible adverse deficit (about 5% in 1964).

2. National Finance.—National finance suffered not only from the effect of disastrous wars, but also from an inefficient fiscal system, from ineffective application of tax regulations and from the reluctance of the nation to accept additional impositions. Thus, an increasing resort was made to balancing budgetary deficits, which prevailed with rare exceptions, by borrowing. This contributed to a progressive inflation, and between 1914 and 1939 the annual depreciation of the franc averaged 8%. By 1960 it was calculated to have lost 99.5% of its 1914 value.

In post-World War II years prices continued to mount, with a corresponding successful agitation by labour for increased wages. Financial recovery was also hampered by expenditure necessary for economic rehabilitation, by rearmament programs, a costly war (until 1954) in Indochina, hostilities in north Africa, and a lack of confidence on the part of both domestic and foreign investors in the future of the national economy. Liberal contributions of economic and military assistance from the United States did something to alleviate the position, but these came to an end in the mid-1950s. By 1958 foreign exchange and gold reserves were almost exhausted. The bank rate stood at 5%. Budgetary deficits regularly exceeded 600,000,000,000 fr., with a record 1,050,000,000,000 fr. in 1957.

The struggle against inflation and rising prices continued until 1959, when the devaluation of the franc in 1958 began to assist financial recovery. A regime of financial austerity was also imposed, with cuts in subsidies and expenditure and with increased taxation. The new commercial policy of liberalization also began to make its influence felt. Large amounts of French "flight" capital began to be repatriated. Foreign capital was also being invested more freely. By the early 1960s public and private investment had increased considerably and a relative stability of prices and wages was attained. The improvement in finances enabled France to repay its debt to the International Monetary fund at the end of 1960. Progress continued, and five years later gold and foreign currency reserves reached just over $5,000,000,000 (exceeded only by the United States and West Germany), of which 74% was in gold. A policy of converting dollar reserves into gold was then begun. Further external debt repayments were made.

The budgets of 1959 and 1960 established an improving financial position. Those of the early 1960s aimed at monetary stability and expansion particularly in the spheres of essential state development as envisaged by a planned economy. For 1965 a balanced budget was presented for the first time in decades.

3. Banking and Currency.—On Jan. 1, 1960, the *nouveau franc* ("new franc"), or *franc lourd* ("heavy franc"), equaling 100 old francs, came into circulation. A devaluation of 14.9% at home and 17.55% abroad had previously taken place toward the end of 1958. Note circulation was increasing and in the first quarter of 1965 approached 58,000,000,000 fr.

The state bank is the Banque de France (*q.v.*), founded in 1800; it possesses the sole right to issue bank notes. In 1945 the Banque de France and four of the larger joint-stock banks, the Crédit Lyonnais, the Société Générale, the Comptoir National d'Escompte and Banque Nationale pour le Commerce et l'Industrie, were nationalized. In addition to the national banks and the national post office *caisses d'épargne*, which carry the major part of French savings, there are a number of independent deposit banks in the provinces. (J. D. L.)

C. Transport and Communications

1. Roads.—The Romans used and developed the ancient routes of Gaul, including the Greek trade routes that linked Marseilles and other Mediterranean trading posts with their hinterland. As developed under Agrippa, the Roman road system had as its main feature the great south-north axis along the Rhône-Saône valley toward the Rhine frontier, with transverse offshoots to the Atlantic and Channel coasts and across the Alps. The Roman towns that were the nodes of this road system have in most cases become the provincial towns of modern France, but Paris had no great nodality in Roman times. Lugdunum (Lyons) was the major route centre of Gaul, and in the north Durocortorum (Reims) was much more important than Lutetia (Paris).

Throughout the middle ages the Roman road system in its decay had to serve the needs of internal transport in France. There was no further significant advance until the 17th century, by which time the political unification of the country allowed a national route system to be conceived, with the primary object of connecting the frontier provinces and regional cities with Paris. Under Henry IV, Sully reorganized and centralized the road and bridge service, and under Colbert a great development of roads was achieved, focusing upon Paris. There were few nonradial roads, however, and it was only later, during the 18th century, that attention was directed to establishing cross connections and to linking ports and hinterlands. By the time of the Revolution 12,000 mi. (nearly 20,000 km.) of new roads had been built, exciting the admiration of travelers such as Arthur Young (*q.v.*), and Paris was no longer the only road focus. Apart from the direct benefits to trade, this developed road system greatly facilitated extension of the French language in the frontier provinces and the general decline of local patois and it encouraged internal migration on a greatly extended scale.

Under Napoleon, new mountain roads were built in and across the Alps, but it was not until the latter part of the 19th century that France's fine system of trunk roads was supplemented by much improvement of local country roads. An act of 1836 prepared the way for this improvement, and by the time of the advent of the automobile France was equipped with an extremely close mesh of well-maintained roads. By the early 1960s there were more than 50,000 mi. (80,000 km.) of *routes nationales*, about 170,000 mi. (275,000 km.) of *routes départementales* and *routes communales*, and the *chemins ordinaires* totaled more than 200,000 mi. (300,000 km.). In 1963 there were 216 mi. (348 km.) of *autoroute* (motorway) and more was planned or under construction. The chief project, the *autoroute du sud*, would eventually link Paris with Marseilles. There is a dense network of bus services knitting together the countryside and local service centres in the provincial towns.

2. Railways.—Although a 13-mi. (21 km.) line of railway to use horse traction for moving coal from the coalfield at Saint-Étienne along the Furens valley to the Loire river at Andrézieux was opened as early as 1827, the first railway built for steam locomotion was that connecting Saint-Étienne with Lyons (1832). Ten years later France's railways had reached a total length of only 350 mi. (565 km.), but in 1842 legislation was enacted which outlined the development of a trunk railway system. The main lines, built before 1870, linked Paris with the Belgian frontier, Le Havre, Strasbourg, Lyons and Marseilles (1856), Bordeaux and the Spanish frontier in the southwest. The most important lines not centred upon Paris were those connecting the Mediterranean with the Rhône by Lyons and Mulhouse, and the Mediterranean with the Atlantic, from Marseilles through the gate of Carcassonne and Toulouse to Bordeaux. By 1870 a total of 10,830 mi. (17,430 km.) had been constructed.

The earliest railways provided for internal connections between Paris and the provinces, and only later were links established with Italy, by the Mont Cenis tunnel opened in 1869, and Spain, by the western and eastern ends of the Pyrenees in 1864 and 1878. Other railways across the Pyrenees were not built until 1928 (via the Somport) and 1929 (via Puymorens). Until late in the 19th century large areas of France were left without railways and cross links were seriously deficient. During the 30 years before World War I, however, much railway construction was carried out, and the network became close, so that in the 1960s France had 23,941 mi. (38,530 km.) of railway, the second highest ratio of mileage to population in Europe. The Massif Central, however, has tended to remain a *pôle repulsif* in the French route system, skirted rather than traversed by both main roads and railways.

In the automobile age many branch railways have become redundant, and many uneconomic lines have been abandoned. In 1938 the French railways were nationalized as the Société Nationale des Chemins de Fer Français (S.N.C.F.) and the system was divided into six main regions, Nord, Est, Ouest, Sud-Est, Sud-Ouest and Mediterranée. The railway system is closely integrated with state road transport, both long and short distance, and the railways provide extensive road transport services for goods and passengers.

Electrification, first begun on the Paris suburban lines in 1901, was subsequently extended to long distance lines, especially after World War II. The Monnet plan of 1947 included provisions for main line electrification, and considerable progress was made with the electrification of the main Paris-Lyons-Marseilles line. By 1963 there were 4,770 mi. (7,675 km.) of electrified track. (*See* also Railway.)

3. Navigable Waterways.—Although France has several great rivers, their navigation is hampered by their irregular regimes. The Seine and other rivers of the northeastern quadrant of the country are most favoured, both in respect of regimes and gradients, and with their canal links the waterways of this part of the country account for more than 85% of internal water-borne traffic.

In the 17th century, when little had been done to improve or interconnect the natural waterways, the Loire was most important. From the 17th century a number of projects to connect the great rivers across the watersheds were carried out, beginning with the establishment of links between the Seine and Loire (Briare and

Orléans canals of 1642 and 1692), between the Mediterranean sea and the Garonne (Canal du Midi, 1681) and between the Deule and Scarpe in Flanders (1693). During the 18th century important additional links were provided in central and northeastern France. The second quarter of the 19th century saw a great extension of canals for the transport of heavy commodities such as coal. Difficult portions of the great rivers were bypassed by means of lateral canals and the link canals were multiplied. The length of canals increased between 1814 and 1860 from 820 to 3,000 mi. (1,320 to more than 4,800 km.). The principal subsequent additions have been the Marne-Saône canal (1879) and the Canal de l'Est (1882). After World War II the canalization of the Moselle was planned to provide an effective water connection between Lorraine and the Ruhr, and the navigation of the Rhône was greatly improved by means of the lateral canal from Donzère to Mondragon.

The role of the French waterways is chiefly to transport coal, coal products and building materials. These account for two-thirds of the total traffic, agricultural products, fertilizers and mineral oil being the other main cargoes carried. The Seine below Paris is outstanding in tonnage of traffic, most of it passing upstream from Rouen to Paris. Paris is France's largest inland port, followed by Strasbourg on the Rhine waterway. Movement of heavy goods by water is also important in Flanders and Dunkerque's water connections with its hinterland are highly developed.

France has nominally about 9,500 mi. (15,300 km.) of waterways (6,200 mi. [10,000 km.] of navigable rivers and 3,300 mi. [5,300 km.] of canals) but not more than 5,300 mi. (about 8,500 km.) are in regular use.

4. Shipping.—The French mercantile marine amounts to about 4,500,000 tons of shipping, but does not carry more than half of France's sea-borne trade. Marseilles accounts for one-quarter of the tonnage of imports and nearly one-third of that of exports. As an importing port Marseilles is closely followed by Le Havre, but the latter is much less important for exports. Rouen and Dunkerque rank third and fourth for imports. After Marseilles, Dunkerque, Le Havre, Bordeaux and Rouen are the chief exporting ports. The Atlantic ports on the estuaries of the Loire, the Charente and the Gironde (Nantes, La Rochelle and Bordeaux) flourished greatly as participants in the rich colonial trade of the 17th and 18th centuries but, in spite of their development as outports, they are relatively far less important now. Brest and Toulon are primarily naval bases, and Calais, Dieppe and Cherbourg passenger ports, but Marseilles leads among French ports for passenger as well as cargo traffic.

5. Air Transport.—France's air communications, connecting it with other European countries, the French community and the Americas, are chiefly in the hands of a state enterprise, Air France, which by the early 1960s was carrying most of the air traffic, totalling about 6,000,000,000 passenger-km. and 168,000,000 net metric ton-km. of freight and mail annually. Le Bourget and Orly (Paris) are the major airports, followed by Marseilles and Toulouse.

6. Post and Telecommunications.—In the later middle ages both the king and the University of Paris operated postal services in France. In 1576 the royal post was placed at the service of the general public. François Michel Le Tellier, marquis de Louvois, established a *fermier des postes* and in 1719 the university postal services were fused with those of the royal post. Under the Revolution a centralized postal system was created. Since 1878 the postal service has incorporated a telegraph service, and since 1889 a telephone service. These are now under the direction of the ministry of posts and telecommunications (P. et T., formerly P.T.T.).

Radio and television are conducted by the Office de Radiodiffusion-Télévision Française (O.R.T.F.), a state public service reorganized in 1964 with a greater degree of autonomy than the former R.T.F.

See also references under "France" in the Index. (AR. E. S.)

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FRANCES, SAINT, of Rome (Francesca Romana) (1384–1440), founder of the Benedictine Oblates, asked to become a nun at the age of 11, but her parents married her to Lorenzo de' Ponziani when she was 13. The knowledge that Vanozza, wife of Lorenzo's elder brother, had also wished to become a nun made a close bond between the two women, and together they drew up a rule of life. As they neglected none of their wifely duties, their husbands approved of their devoting to the sick and poor of Rome the time they would otherwise have spent in social life. Rome was the centre of fierce civil strife as this was the period of the Great Schism, in the course of which the Ponziani became impoverished. Frances continued to live in a corner of her ruined palace, sharing her last resources with the suffering people. With her husband's approval she founded in 1425 the Oblates of Mary, known since 1433 as the Oblate Congregation of Tor de' Specchi (or, commonly, Oblates of St. Frances of Rome), a community affiliated to the Olivetan Benedictines. After Lorenzo's death in 1426 she became its superior. She died on March 9, 1440.

A devoted wife and mother, St. Frances succeeded in reconciling the claims of God, her husband and family, and her neighbour so perfectly that the Romans canonized her in their hearts long before her official canonization in 1608. Her feast day is March 9.

See I. Hernaman, *St. Frances of Rome* (1931). (Mv. M.)

FRANCESCA, PIERO DELLA (PIERO DEI FRANCESCHI) (*c.* 1420–1492), Italian painter, one of the great masters of the Quattrocento, was born at Borgo San Sepolcro (Sansepolcro) in Umbria between 1410 and 1420, probably nearer 1420. Throughout his life he retained a deep affection for his native place and spent much of his time there, although he worked in Florence, Arezzo, Ferrara, Rome and Urbino. The earliest record, Sept. 7, 1439, describes him as working in Florence with Domenico Veneziano—whether as pupil or partner is not clear—on frescoes in S. Egidio (Sta. Maria Nuova). These have almost entirely disappeared, so that nothing is known of the style of either at this date. During the 15th century Borgo San Sepolcro was dominated by Sienese art, and the "Baptism of Christ" (National gallery, London)—usually accepted as one of Piero's earliest works—shows marked affinities with Sienese painters like Stefano di Giovanni Sassetta. Probably his Florentine experience was decisive in the formation of Piero's style, for his strong mathematical bent enabled him to extend the researches into perspective of the Florentines Filippo Brunelleschi and Paolo Uccello. G. Vasari lays great stress on his mathematical abilities, and the intellectual climate of Florence in the first half of the 15th century was particularly favourable to a scientific and geometrical art. Nevertheless, Piero was back in Borgo by 1442. On Jan. 11, 1445, the Company of the Misericordia of Borgo commissioned an altarpiece (now in the Pinacoteca there) to be completed within three years. In fact this work, in which his style is fully developed, may not have been finished before 1462. Certainly the polyptych contains a representation of San Bernardino, who was not canonized until 1450.

About 1449–50 Piero painted in Ferrara some frescoes, now lost, which contributed much to the development of the Ferrarese school, and in 1451 he signed and dated the fresco of "Sigismondo Malatesta before St. Sigismund" in S. Francesco at Rimini. This was formerly regarded as his earliest datable work but cleaning revealed a signature and the date 1450 on a "St. Jerome" in Berlin, a crude work which is not an adequate prelude to the "Sigismondo" or to Piero's greatest achievement, the fresco cycle of the "Legend of the True Cross" in S. Francesco at Arezzo, painted between 1452 and *c.* 1459 (certainly completed before 1466). These severely geometrical compositions show Piero at the height of his powers. Now among the most famous of 15th-century frescoes, they were virtually unknown until late in the 19th century, when their pale colour and austere forms brought them back into favour among circles stressing the importance of aesthetic elements in wall decoration. It is precisely their inhuman calm, their lack of Florentine vigour, which led to four centuries of neglect but which is the essence of their attraction to modern sensibility. About this time Piero painted the "Resurrection" fresco in the Palazzo Comunale at Borgo, which combines these qualities with an awe-struck dramatic sense. Critics as disparate as Vasari and Aldous Huxley have considered it his masterpiece.

Other works of this period of classical maturity include the diptych portraits of Federigo da Montefeltro, duke of Urbino, and Battista Sforza, his duchess (Uffizi, Florence). These are usually dated before 1466 on the inconclusive evidence of a poem by Ferabò of that year, but *c.* 1472 would seem to be more in accordance with the marked Flemish influence characteristic of Piero's later works. During 1459–60 he seems to have been working in Rome in the Vatican, but nothing survives, though a "St. Luke" in Sta. Maria Maggiore is not very convincingly ascribed to him. In the 1460s and 1470s Piero was frequently in Urbino and—perhaps partly on account of a lack of pictures ascribable to him—it has been suggested that he was in some way connected with the building of the palace there, perhaps the finest example of Italian architecture of its date. It is certainly imbued with the calm harmony of Piero's mathematical art, but the available evidence does not seem to justify more than a tentative connection. An altarpiece for S. Agostino in Borgo San Sepolcro, commissioned in 1454, was apparently completed in 1469. This picture, dismembered and partly lost, was reconstructed by M. Meiss from extant parts in the National gallery, London, the Frick collection, New York city, and the Poldi-Pezzoli museum, Milan; the subsequent rediscovery of a "St. Augustine" in Lisbon confirmed Meiss's original reconstruction. During the 1470s Piero probably had both Signorelli and Perugino as pupils and he painted the large "Madonna and Saints, with Federigo da Montefeltro" (Brera, Milan) and the "Senigallia Madonna" (Urbino). It has been suggested that the head and hands of Federigo in the "Brera Madonna" were added by the Spaniard Pedro Berruguete, but this is a very controversial point. The "Nativity" (National gallery, London) is probably Piero's last known work and his later years were taken up with mathematics. Of his two treatises, *De perspectiva pingendi*, on perspective, and *De quinque corporibus regularibus*, on the five regular bodies, the latter was written after 1482. There is a tradition that he was blind in his last years, but, even so, there is a long gap between the "Brera Madonna" of *c.* 1475 and the "Nativity," perhaps slightly later, and his death at Borgo on Oct. 12, 1492.

BY COURTESY OF THE NATIONAL GALLERY, LONDON

DETAIL FROM THE "BAPTISM OF CHRIST," ONE OF PIERO'S EARLIEST WORKS IN THE NATIONAL GALLERY, LONDON

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FRANCESCHINI, BALDASSARE (1611–1689), Italian painter of the Florentine school, called Il Volterrano from his native Volterra, was the son of a sculptor. At a very early age he started as an assistant to his father and then studied under the Florentine painter Matteo Rosselli. From 1652 to 1660 he was employed on paintings in the cupola of the Niccolini chapel in S. Croce, Florence, which constitute his most noted performance. Among his best oil paintings of large scale is the "St. John the Evangelist" in the church of S. Chiara at Volterra. One of his last works was the fresco of the cupola of the Annunziata, Florence, which occupied him for two years around 1683. Franceschini died at Volterra on Jan. 6, 1689.

FRANCESCHINI, MARCANTONIO (1648–1729), Italian painter, a leading artist of the Bolognese school of his time, was born in Bologna on April 5, 1648. His masters were G. M. Galli da Bibiena and Carlo Cignani (*qq.v.*). He worked in Genoa, Modena and Rome as well as in Bologna. He was made director of the Accademia Clementina in Bologna in 1721. Franceschini was the last important representative of the tradition of the Carracci, the works of Lodovico Carracci and Francesco Albani being the main sources of his style. His figures, brushwork and colouring are unimaginative and unoriginal but he had a gift for skilfully arranging an elaborate composition and considerable talent as a decorator. His paintings in both oils and fresco are very numerous, though little known; the most famous, which was done for the church of Corpus Domini, Bologna (1687–94), were unfortunately destroyed during World War II. He died in Bologna on Dec. 24, 1729. (M. W. L. K.)

FRANCESCO DI GIORGIO (FRANCESCO MAURIZIO DI GIORGIO MARTINI [OR DI MARTINO]) (1439–1501), a versatile Italian painter, sculptor and architect of the Sienese school, was baptized in Siena on Sept. 23, 1439. Early works were manuscript illuminations, furniture panels, and two monumental altarpieces in the Siena gallery. By 1477 he was in the service of Federigo da Montefeltro, duke of Urbino; there he produced a series of brilliant bronze reliefs, probably participated in the design and decoration of parts of the great palace of Urbino, and built 136 military fortresses. His architectural masterpiece is S. Maria del Calcinaio, Cortona (1484). Later masterpieces are four brilliant bronze figures for the high altar of Siena cathedral. He also probably returned to painting after many years. His book on architecture discusses city planning and military architecture, and anticipates some of the architectural theories of the high Renaissance. He was remarkably versatile, a kind of Sienese Leonardo da Vinci, who combined the bold investigation of the Renaissance with the conservative lyricism of the Sienese school.

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FRANCHE-COMTÉ, a territory divided from 1790 between the *départements* of Jura, Doubs and Haute-Saône in eastern France, but historically important as the Free Countship of Burgundy (Ger. *Freigrafschaft Burgund*). Bounded on the north by Lorraine, on the east by Alsace and by Switzerland, on the south by Bresse and Bugey and on the west by the duchy of Burgundy, it embraced the greater part of the Jura range of mountains and most of the adjacent low ground toward the Saône river.

Occupied from the 4th century B.C. by the Celtic tribe of the Sequani, whose principal settlement was Vesontio (Besançon), the country was romanized after Julius Caesar's conquest of Gaul (52 B.C.). Overrun by the Burgundians in the second half of the 5th century A.D., it was annexed by the Franks in 534. After the vicissitudes of Burgundy in Merovingian times, Charlemagne divided Cisjurane Burgundy (between the Saône and the Jura) into five *pagi* or countships, Ajoie, Portois, Varais, Amaous and Escuens, leaving at the same time considerable authority to the archbishop of Besançon. On the partition of the Frankish empire in 843 the country was assigned to the Middle Frankish kingdom, Lotharingia (*see* LORRAINE).

When Lotharingia had been broken up, a new kingdom of Burgundy emerged in 888 (*see* BURGUNDY). Its kings, however, had very little control over the local counts in Cisjurane Burgundy, where effective authority passed more and more into the hands of the counts of Salins. After a period of instability in the 10th century, the house of Salins emerged as the real rulers of the country. After the kingdom of Burgundy had passed to the Holy Roman emperor Conrad II in 1032 (*see* further ARLES, KINGDOM OF), the counts played some part in the disputes between the emperors or German kings and the popes. Then, in 1127, the new count, Raynald III, refused to do homage to the German king Lothair III (later emperor as Lothair II). Lothair then tried to set Conrad of Zähringen up in Raynald's place, but after ten years of conflict Raynald was victorious. Thereafter he was the *franc-comte* ("free count"; Ger. *Freigraf*), and his territory became known as the Franche-Comté (*comté*, now masculine, being formerly a feminine noun in French).

The emperor Frederick I Barbarossa, of the newly royal dynasty of Hohenstaufen, married Raynald's heiress Beatrix in 1156, hoping that the possession of the countship would strengthen his influence in Germany. The countship, however, passed on Beatrix's death to her third son, Otto I (d. 1200), then to his daughter Beatrix and to her husband, Otto II (d. 1234) of the house of Meran. Their son Otto III was succeeded in 1248 by his sister Alix, whose husband, Hugues, of the house of Mâcon, was descended from a brother of Raynald III.

During these years of female succession and dynastic change, French influence gradually supplanted German. Cluniac and then Cistercian monasteries were founded in the mountains, and roads were repaired to connect the commercial centres of Champagne and Flanders with northern Italy. The towns prospered, and many of them received charters.

Otto IV (d. 1303), who succeeded his mother, Alix, in 1279 and married Mahaut (Maud or Matilda) of Artois in 1285, found himself not only subjected to grave pressure by the German kings but also heavily indebted. To raise money, he signed two treaties with Philip IV of France (1291 and 1295). Under these his daughter Joan (d. 1322) was married to the comte de Poitiers, later Philip V of France, and the government of the Franche-Comté was transferred to the French. Baronial resistance, led by Jean de Chalon-Arlay, was put down and French *baillis* took the administration over. Philip V, however, left no male heir, so that on his death (1322) the countship remained in his widow's hands. Their elder daughter, Joan of France (d. 1335) was married in 1330 to Eudes IV, duke of Burgundy. Thus when Eudes died (1349), his grandson and successor, Philip of Rouvre, was both count and duke. At Philip's death in 1361, however, countship and duchy were separated, the countship passing to Margaret of France (a younger daughter of Philip V and Otto IV's daughter Joan), widow of Louis of Nevers, count of Flanders. She died in 1382, her son Louis of Male in 1384. The latter's daughter Margaret of Flanders then brought the countship to Philip (*q.v.*) the Bold, duke of Burgundy, to whom she had been married in 1369. (*See* also ARTOIS; BURGUNDY; FLANDERS, COUNTY OF.)

Philip the Bold and his successors gave the Franche-Comté an organized political and administrative system. A council and a *parlement* were established at Dole, which also became the usual meeting place for the estates of the Franche-Comté; baronial dissidence was finally broken and the territory divided between three *bailliages*, Amont (Gray), Aval (Salins) and Dole, themselves subdivided into *chatellenies;* and regulations were made for the economic exploitation of the country's salt.

After the death of Charles the Bold in 1477, his heiress, Mary, married the Austrian archduke Maximilian I of Habsburg (later Holy Roman emperor), thus disappointing French hopes that she would marry Louis XI's son Charles, the future Charles VIII of France. The treaty of Arras (1482), however, ceded the Franche-Comté to Charles on his betrothal to Mary's daughter Margaret of Austria. When he broke this engagement, he had to retrocede the Franche-Comté to Austria (treaty of Senlis, 1493).

For the next 185 years the Franche-Comté was a Habsburg possession. When the future emperor Charles V succeeded his father (Mary's son Philip the Handsome) as count in 1506, his aunt Margaret, now dowager duchess of Savoy, took over the government of the Burgundian inheritance for him. He retained her as regent of it after his majority (1515), and in 1522 she arranged the treaty of St. Jean-de-Losne with France, which ensured the neutrality of the Franche-Comté in the wars between the Habsburgs and the last French kings of the Valois line. The ensuing prosperity of the country, enhanced by industrial development, can be judged by the splendid Renaissance architecture of its towns. Civil disturbances, however, came with the Reformation, when bands of Protestants entered from Germany and Switzerland. Montbéliard, an enclave belonging to Württemberg, was a centre of Protestantism within the predominantly Catholic Franche-Comté.

The Franche-Comté passed to the Spanish Habsburgs with the rest of the Burgundian inheritance (*i.e.*, the Netherlands) through Charles V's partition of his dominions. Under Philip II of Spain, a forceful repression of the Protestants took place, and Henry IV of France, in his war against Philip, violated the Franche-Comté's neutrality. From 1598 to 1635 peace was maintained. The fact, however, that the country was a geographical link in the Spanish Habsburgs' encirclement of France made the French want to annex it. In Louis XIII's war against Spain it was invaded and ravaged annually from 1636 to 1639; but in 1648, though the Franco-Spanish war went on, the Franche-Comté, as a fief of the Holy Roman empire held by Spain, was included in the peace of Westphalia.

Conquered in 1668 by the great Condé in the War of Devolution but retroceded to Spain by the peace of Aix-la-Chapelle (Aachen), the Franche-Comté was finally conquered for France by Condé in 1674, in the last of the so-called Dutch Wars, the annexation being recognized by the peace of Nijmegen (1678).

The Franc-Comtois had violently opposed the French invaders, against whom Lacuzon (Claude Prost, 1607–81) had achieved outstanding feats of warfare, and pro-Spanish feeling lasted till the 18th century. Louis XIV transferred the *parlement* to the former imperial city of Besançon, which he made the capital of his new province and the seat of faculties later to become a university. Vauban was entrusted with the fortification of the frontier. The 18th century saw a revival of vine growing, an increasing exploitation of timber, the establishment of metallurgical and textile industries in the north and the introduction of clock- and watchmaking. In 1790, with the rest of France, the Franche-Comté was broken up into *départements*.

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FRANCHET D'ESPERÈY, LOUIS FÉLIX FRANÇOIS (1856–1942), marshal of France, one of the best French military leaders of World War I, perhaps the finest in high command, was born on May 25, 1856, at Mostaganem (Algeria). Physically and spiritually tough, he was brilliantly self-confident. In all his early career—starting when in 1874 he entered the military school of St. Cyr as the sixth of 413—the one reproach in a senior's report was that he "might be more modest." Much of his prewar service was in Algeria and Tunisia. The keenest of soldiers, he yet took what leave he could get and used his ample means for world travel. At the outbreak of World War I he was commanding the I corps at Lille. He so distinguished himself by the way in which he held his retreating troops together, and at Guise, that on the eve of the battle of the Marne he was promoted to command the 5th army. In March 1916 he was raised to the command of the eastern army group. In December he was transferred to the command of the northern army group. His group won the victory of Malmaison in Oct. 1917 but suffered a tremendous blow on the Chemin des Dames in May 1918. When in June he went to take command of the polyglot allied armies in Macedonia he was thus somewhat under a cloud. His victory in that theatre (Sept. 15–29, 1918) was decisive and drove Bulgaria out of the war. There followed an amazing thrust to the Danube, the collapse of demoralized German divisions hurried from Russia and the surrender of Hungary.

Franchet d'Espèrey remained two years in command, with headquarters in Istanbul, and inevitably became involved in Franco-British differences. In Feb. 1921 he was created marshal of France. His activity continued, even after he was crippled in a car accident while exploring the layout of a road to link Tunisia and Morocco, just before his 77th birthday. In Nov. 1934 he was elected a member of the Académie Française. He died at Albi (Tarn) on July 8, 1942. In Oct. 1947 his remains were placed in the Invalides in Paris, near those of Napoleon.

See Paul Azan, *Franchet d'Espèrey* (1949). (C. B. FA.)

FRANCIA (FRANCESCO DI MARCO DI GIACOMO RAIBOLINI) (*c.* 1450–1517?), the major Bolognese painter of the late 15th century. He was born, according to G. Vasari, in Bologna in 1450 and died there on Jan. 5, 1517 (or perhaps 1518, as Vasari says). He was trained as a goldsmith and entered the goldsmiths' guild in Bologna in 1482; later he became famous as an engraver of dies and nielli and was master of the mint under the Bentivoglio and also under Pope Julius II after the expulsion of the Bentivoglio. As a painter he was much influenced by the Ferrarese (*e.g.*, Cossa and Ercole de' Roberti) and was closely associated with Lorenzo Costa, but his later works clearly show the influence of Perugino and Raphael. He seems to have begun painting by 1486, but the earliest dated work by him is the "Felicini Madonna" of 1494 in the Pinacoteca, Bologna. A Madonna in the National gallery in London, once thought to have been composed in 1490 or 1492, is now regarded as a forgery. There is also a certain amount of doubt about his exact relationship with Raphael. Formerly it was said that Raphael wrote to Francia on Sept. 5, 1508, in the most polite terms extolling the devotional quality of his madonnas; while Francia was said to have addressed an enthusiastic sonnet beginning "Non son Zeusi, nè Apelle . . ." to Raphael. Both these documents appear for the first time in C. Malvasia's *Felsina pittrice*, a notoriously unreliable source; nor has anyone been able to discover the original documents. Vasari speaks of letters passing between the two, and it would have been easy to supply the want of them. It is, however, clear that Francia was acquainted with Raphael's works, and later opinion has not excluded the possibility that Malvasia was substantially correct. According to Vasari, Raphael was indirectly the cause of Francia's death, for the "St. Cecilia" so impressed him on its arrival in Bologna that he died of depression at his own inferiority.

An altarpiece from the church of S. Frediano, Lucca, now in London, is one of his last works and clearly shows the Perugino-Raphael influence on his later style. There are many works by him (including two silver paxes) in the Pinacoteca, Bologna, and in the churches there and in many other European and American galleries.

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FRANCIA, JOSÉ GASPAR RODRÍGUEZ (*c.* 1766–1840), "El Supremo," dictator of Paraguay, was born in Asunción about 1766, probably the son of a Brazilian coffee grower. He studied at the university of Córdoba in Argentina and obtained there the degrees of master of philosophy and doctor of theology. Relinquishing his intention of taking holy orders, he studied law and practised in Asunción, where he acquired a reputation for ability, energy and integrity. Under the colonial government he filled several important posts, and when independence was declared in 1811, he became secretary to the national junta, exerting an influence far out of proportion to his position. In 1813, when a duumvirate replaced the national congress, Francia and Fulgencio Yegros, a gaucho, were chosen to fill the office. In 1814 he secured his election as dictator for three years, and in 1817 obtained the dictatorship for life. In his administration was found a strange mixture of farsighted statesmanship and petty despotism. Aware of his precarious position among powerful neighbours, he pursued a policy of strict isolation; realizing that he must make the country self-supporting, he carefully fostered internal industries. He banned foreign commerce; usurped the national revenues; organized and equipped an army; and introduced modern methods of agriculture. Imbued with the principles of the French Revolution, he abolished the Inquisition, suppressed the college of theology, swept away tithes and deprived the aristocracy of their social and political privileges. While practising republican simplicity in his private life, he exacted imperial deference wherever he went, isolated himself in the most stringent manner and punished with Draconian severity the slightest violation of his assumed prerogatives or hint of conspiracy against him. He died in Asunción on Sept. 20, 1840. (W. B. P.)

FRANCIABIGIO (1482–1525), Florentine painter, best known for his portraiture, was probably born in Milan. His real

name was Francesco di Cristofano. His father was a Milanese weaver, settled in Florence. According to Giorgio Vasari, Franciabigio when young worked in the company of Andrea del Sarto. He studied under Mariotto Albertinelli for a few months, and he was devoted to the study of perspective. One of his early works is the Madonna del Pozzo in the Uffizi gallery, Florence, which was for some time ascribed to Raphael. In the Atrium of the Annunziata in Florence he painted in 1513 the "Marriage of the Virgin," as a portion of a series wherein Andrea del Sarto was chiefly concerned. When the friars uncovered this work before it was quite finished, Franciabigio was so incensed that, seizing a mason's hammer, he struck at the head of the Virgin, and some other heads; and the fresco, which would otherwise be his masterpiece in that method, was mutilated.

At the Chiostro dello Scalzo, in another series of frescoes in which Andrea was likewise employed, he executed in 1518–19 the "Departure of John the Baptist for the Desert," and the "Meeting of the Baptist With Jesus"; and, at the Medici palace at Poggio a Caiano, in 1521, the "Triumph of Cicero."

Franciabigio was a first-rate portrait painter. The Dresden gallery contains one of his masterpieces, the "Bath of Bathsheba" (1523).

FRANCIS, SAINT, OF ASSISI (GIOVANNI FRANCESCO BERNARDONE) (1181/82–1226), founder of the Franciscans (*q.v.*) and principal patron of Italy (with St. Catherine of Siena), was born at Assisi in Umbria, the son of Pietro di Bernardone, cloth merchant, and the lady Pica, perhaps of noble lineage. Nothing certain is known of the family background. Francis learned to read and write Latin at the school near the church of St. George and later acquired some knowledge of the French language and literature, especially of the troubadours. His youth does not seem to have been marked by serious moral lapses but by a general spirit of worldliness which made him a recognized leader of the young men of the town.

In 1202 he took part in a war between Assisi and Perugia, was held prisoner for almost a year and on his release fell seriously ill. Setting out once more to join the forces of Walter of Brienne, he had a vision at Spoleto that bade him return to Assisi. He began to give himself to solitude and prayer.

Several other episodes make up what is called his conversion: a vision of Christ while he prayed in a grotto near Assisi; an experience of poverty during a pilgrimage to Rome, where, in rags, he mingled with the beggars before St. Peter's and begged alms; the incident where he not only gave alms to a leper (he had always felt a deep repugnance for lepers) but also kissed his hand. One day at the ruined chapel of S. Damiano outside the gate of Assisi, he heard the crucifix above the altar command him: "Go, Francis, and repair my house which, as you see, is well-nigh in ruins." Taking this literally, he hurried home, gathered much of the cloth in his father's shop and rode off to Foligno, where he sold both cloth and horse. He then tried to give the money to the priest at S. Damiano. Angered, his father first kept him at home and later cited him before the civil authorities. When Francis refused to answer the summons, his father called him before the bishop. Before any accusations were made, Francis "without a word peeled off his garments even down to his breeches and restored them to his father." Covered only by a hair shirt, he said: "Until now I have called you my father on earth. But henceforth I can truly say: Our Father Who art in heaven." The astonished bishop gave him a cloak, and Francis went off to the woods of Mt. Subasio.

Francis had renounced material goods and family ties to embrace a life of poverty. He repaired the church of S. Damiano, restored a chapel dedicated to St. Peter the Apostle and then the now famous chapel of St. Mary of the Angels, the Porziuncola, on the plain below Assisi. There on the feast of St. Matthias, Feb. 24, 1208 (1209?), he heard at Mass the mission of Christ to the apostles: "Do not possess gold, nor silver, nor money in your purses: Nor scrip for your journey, nor two coats, nor shoes, nor a staff; for the workman is worthy of his meat. And into whatsoever city or town you shall enter, inquire who in it is worthy, and there abide till you go thence" (Matt. x, 9–11). Although a layman, he began to preach to the townspeople. Disciples joined him, and for them he composed a simple rule of life. In 1209 (1210?), when the group numbered 12, they went to Rome and obtained the approval of Innocent III for the rule (*see* FRANCISCANS for further development of the order).

This early rule, which has not survived, set as the aim of the new life, "To follow the teachings of our Lord Jesus Christ and to walk in his footsteps." Probably no one in history has ever set himself so seriously as did Francis to imitate the life of Christ and to carry out so literally Christ's work in Christ's own way. This is the key to the character and spirit of St. Francis. To neglect this point is to show an unbalanced portrait of the saint as a lover of nature, a social worker, an itinerant preacher, a lover of poverty. Certainly the love of poverty is part of his spirit, and his contemporaries celebrated the "holy nuptials of Francis with Lady Poverty"; *e.g.*, in the fresco of Giotto at Assisi and in the allegorical prose-poem, the *Sacrum commercium* (Eng. trans., *The Lady Poverty,* by Montgomery Carmichael [1901], or *The Converse of Francis and His Sons With Holy Poverty,* by Canon Rawnsley [1904]). However, it was not mere external poverty he sought, but the total denial of self (as in Phil. ii, 7).

He considered all nature as the mirror of God and as so many steps to God. He called all creatures his "brothers" and "sisters," and in his "Canticle of Creatures" (less properly called the "Praises of Creatures," "Canticle of the Sun," etc.) he referred to "brother Sun" and "sister Moon," the wind and water and even "sister Death." His long and painful illnesses were nicknamed his sisters, and he begged pardon of "brother Ass the body" for having unduly burdened him with his penances. Above all, his deep sense of brotherhood under God embraced his fellow men, for "he considered himself no friend of Christ if he did not cherish those for whom Christ died."

The Franciscan order spread from Umbria through Tuscany, the Marches and other regions of Italy. In 1212 Francis began his second order for nuns, giving the habit to a noble lady of Assisi, later known as St. Clare (Clara) of Assisi (*q.v.*). For those who could not leave their families and homes he eventually (*c.* 1221) formed the Third Order of Brothers and Sisters of Penance, a lay fraternity which, without withdrawing from the world or taking religious vows, would carry out the principles of Franciscan life (*see* TERTIARIES).

As the friars became more numerous, the order extended outside Italy. In the late spring of 1212 Francis set out for the Holy Land but was shipwrecked on the east coast of the Adriatic and had to return. A year or two later sickness forced him to abandon a journey to the Moors in Spain. In 1217 he proposed to go to France, but Cardinal Ugolino (later Pope Gregory IX) advised that he was needed to direct the order in Italy. He did go to Egypt, where the crusaders were besieging Damietta, in 1219. With Brother Illuminato he went into the camp of the Saracens and preached to the sultan, who, impressed, gave him permission (it is said) to visit the holy places in Palestine.

News of disturbances among the friars in Italy forced Francis to return there. To remedy the situation he appointed Peter Catani as his vicar to handle practical affairs; after Peter's early death in 1221 he chose Elias of Cortona (*q.v.*). He asked Pope Honorius III for legislation introducing a year of probation (novitiate) for new friars, and set about amplifying and revising the rule. After the rule was approved by Honorius III in final form on Nov. 29, 1223, Francis tended to withdraw more and more from external affairs. In the summer of 1224 he went to the mountain retreat of La Verna to celebrate the feast of the Assumption of Our Lady (Aug. 15) and to prepare for St. Michael's day (Sept. 29) by a 40-day fast. There he prayed that he might know how best to please God; opening the Gospels for the answer, three times he came upon references to the Passion of Christ. As he prayed one morning, about the time of the feast of the Exaltation of the Cross (Sept. 14), suddenly he beheld a figure coming toward him from the heights of heaven.

St. Bonaventura wrote:

> As it stood above him, he saw that it was a man and yet a Seraph with six wings; his arms were extended and his feet conjoined, and his body was fixed to a cross. Two wings were raised above his head, two were

extended as in flight, and two covered the whole body. The face was beautiful beyond all earthly beauty, and it smiled gently upon Francis. Conflicting emotions filled his heart, for though the vision brought great joy, the sight of the suffering and crucified figure stirred him to deepest sorrow. Pondering what this vision might mean, he finally understood that by God's providence he would be made like to the crucified Christ not by a bodily martyrdom but by conformity in mind and heart. Then as the vision disappeared, it left not only a greater ardor of love in the inner man, but no less marvelously marked him outwardly with the Stigmata of the Crucified.

Francis took the greatest care to hide those wounds in his lifetime. After the death of Francis, Brother Elias announced the stigmata to the order by a circular letter. Later Brother Leo, confessor and intimate companion of the saint, who left a written testimony of the event, said that in death Francis seemed like one just taken down from the cross. (*See* also STIGMATIZATION.)

Francis lived two years longer, in constant pain and almost totally blind (he had contracted an eye disease in the east). Medical treatment at Rieti was unsuccessful, and after a stay at Siena he was brought back to Assisi, where he died at Porziuncola on Oct. 3, 1226. He was buried temporarily in the church of St. George at Assisi. Francis was canonized on July 16, 1228, by Gregory IX; his feast day is Oct. 4. In 1230 his body was transferred to the lower church of the basilica being erected by Elias at the west end of the city.

The works of St. Francis, consisting of the rule (in two redactions), his testament, spiritual admonitions, prayers and letters, were first edited by Luke Wadding (1623). There are critical editions by Leonard Lemmens (1904) and by H. Boehmer (1904); and English translations by Paschal Robinson (1906), Countess de Ware (1907), James Meyer (1952) and others.

BIBLIOGRAPHY.—The chief sources on the life of St. Francis and the beginnings of the order are (1) two *Lives* by Thomas of Celano, with his treatise on the miracles following Francis' death (1229, 1245–47, 1250–53, respectively), Eng. trans. by A. G. Ferrers Howell (1908) and critical Latin edition by the Quaracchi Franciscans, *Analecta Franciscana,* tome x (1926–41); (2) the *Life* or "Legend" by St. Bonaventure (1260–62), written at the request of the general chapter of Narbonne to compress the tomes of Celano. The legend, the work of a theologian, interprets the life of St. Francis in terms of mystical theology (critical edition, *Analecta Franciscana,* x, pp. 557–652).

Other writings important for the spirit of St. Francis rather than for the facts of his life are the *Mirror of Perfection* and the so-called *Legend of the Three Companions.* The former is from the 14th century; the latter is a misnomer, and the text as published is something of a puzzle (Eng. trans. of both, 1904 *et seq.*).

The *Fioretti* or *Little Flowers of St. Francis* (some nine or ten English versions and innumerable editions) is a treasure of 14th-century popular literature. While it breathes the spirit of St. Francis, it must be used cautiously as a historical source (*see* the Italian edition of R. Pratesi, 1958; and the Eng. trans. with excellent notes of R. Brown, 1958). The interdependence of these and other sources and their historical value made up the so-called Franciscan Question, which went out of vogue somewhat after 1940. *Cf.* J. H. R. Moorman, *The Sources for the Life of St. Francis of Assisi* (1940); and the review of M. Bihl in *Archivum Franciscanum Historicum,* 39:3–37, 279–287 (1946).

See also biographies by J. Jørgensen (1907; Eng. trans. by T. O'Conor Sloane, 1912; 3rd ed., 1955); Fr. Cuthbert (1912; later ed., 1956); O. Englebert (Eng. ed. and trans. by E. Hutton, 1950); G. K. Chesterton (1924; later ed., 1957). (I. C. BY.)

FRANCIS, SAINT, OF PAOLA (1416–1507), founder of the Minim Friars and patron of Italian seamen, was born of humble parents in Paola, Italy, on March 27, 1416. Devoted to his saintly namesake of Assisi, to whom he ascribed his eye cure in infancy, Francis spent his 13th year with nearby Franciscan friars in San Marco. At the age of 14 he began a hermit's life of prayer and penance near Paola. Around 1435, like-minded men joined him to form his first friary of Hermits of St. Francis of Assisi, which he renamed in 1492 Ordo Minimorum (Order of the Least) in contrast to the Franciscans or Ordo Fratrum Minorum (Order of Lesser Brethren). Besides poverty, chastity and obedience, Minim Friars vowed to observe a perpetual fasting diet without meat, eggs or dairy products. After papal approval in 1474, they spread to other parts of Italy. By 1506, when Pope Julius II approved the definitive Minim rule, France, Spain, Germany and Bohemia had friaries, and Francis had established a second order for nuns and a third order for married people in the world. Hoping for a miraculous cure, Louis XI, king of France, induced Pope Sixtus IV to send Francis to him. Arriving in 1483, Francis instead persuaded Louis to make his peace with God. Successive monarchs built monasteries for the saint, keeping him in France until his death at Plessis-les-Tours, April 2, 1507. Famous for miracles and prophecy, Francis was canonized in 1519; his feast is April 2. His relics were disinterred and burned by Huguenots in 1562. *See* also FRANCISCANS: *Minims.*

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints,* vol. ii, pp. 10–13 (1956); B. Bauer, *Saints of the Missal,* vol. i, pp. 153–156 (1958). (A. B. WR.)

FRANCIS, SAINT, OF SALES (FRANÇOIS DE SALES) (1567–1622), bishop of Geneva, refuted the error prevalent in his day that spiritual perfection was impossible for those living in the world. Born Aug. 21, 1567, in the castle of Sales at Thorens in Savoy, he was the eldest son of the Boisy family. His education began at La Roche and Annecy, continued at the Jesuit college of Clermont in Paris (1580–88) and was completed at Padua by theological study and the acquisition of the doctorate in law (1591). After a brief practice of law he turned to the ecclesiastical state and was ordained priest at Annecy (1593).

Missionary activity leading to the conversion of the Chablais from Calvinism to Roman Catholicism occupied the years from 1594 to 1598. Appointed coadjutor to the bishop of Geneva (1599) by Pope Clement VIII, Francis was consecrated bishop of that see on Dec. 8, 1602.

Diocesan organization and reform, plus continued efforts against Calvinism, marked Francis' episcopal administration. In teaching that perfection was easy and possible for all, he was especially effective as author, spiritual director and preacher. In 1610, through Jeanne Françoise Frémiot, the widowed baronne de Chantal, he founded a religious order for women, the Visitation of Holy Mary (*see* CHANTAL, SAINT JANE FRANCES DE). Francis died at Lyons on Dec. 28, 1622. His beatification (1661) and canonization (1665) took place under Pope Alexander VII. The title of doctor of the church was conferred on him by Pius IX (1877), and he was named the heavenly patron of all writers by Pius XI (1923). His feast day is Jan. 29.

Various religious congregations, both of men and women, taking him as their patron have followed his principles of spirituality.

St. Francis' writings—which include controversies against the Calvinists, works on spirituality, letters, sermons and documents on diocesan administration—resulted in most part from his activity in the ministry. A 26-volume critical edition was issued under the auspices of the Sisters of the Visitation of Annecy (1892–1932). The following have been translated into English: *The Controversies; The Treatise on the Love of God; Spiritual Conferences;* selections from the letters, by H. B. Mackey; and, in several versions, *The Introduction of a Devout Life,* which is recognized as a classic on spirituality.

BIBLIOGRAPHY.—*See* the biographies in English by H. Burton (1926) and E. Sanders (1928). V. Brassio, E. Morganti and M. St. Durica list other works from 1623 to 1955 in *Opere e scritti riguardanti San Francesco Di Sales* (1956). (E. J. CY.)

FRANCIS I (1708–1765), Holy Roman emperor from 1745, also duke of Lorraine, as Francis Stephen, from 1729 to 1736 and grand duke of Tuscany from 1737, was born on Dec. 8, 1708, at Nancy, the second son of Leopold, duke of Lorraine, and Elisabeth Charlotte d'Orléans. As his elder brother, Clement, had died, he succeeded his father as duke in 1729. From 1723, however, he had been brought up at the Viennese court of the Holy Roman emperor Charles VI, because of his dynasty's close connection with the Austrian Habsburgs. His marriage to Charles VI's heiress Maria Theresa (*q.v.*) took place on Feb. 12, 1736, but Charles had consented to it only on condition that Francis would make the sacrifice required by the French in order to end the War of the Polish Succession (*q.v.*): namely the cession of his duchy to Stanislaw Leszczynski, for whom the French had failed to secure Poland. In compensation, Francis was given the reversion of the grand duchy of Tuscany, where in July 1737 he succeeded the childless Giovan Gastone, last of the Medici grand dukes. These arrangements were finally ratified in the treaty of Vienna of 1738.

When Maria Theresa became mistress of all the Habsburg in-

heritance on Charles VI's death (Oct. 20, 1740), she immediately appointed her husband co-regent; but, easygoing as he was, Francis made no use of the possibilities thus presented to him, though he was not lacking in ability. His desire to win military laurels remained unfulfilled, since Maria Theresa, apprehensive for her beloved husband's life, was astute enough to disregard his repeated demands to be allowed to defend her inheritance at the head of the army. Having weathered the storm in the War of the Austrian Succession (*q.v.*), Maria Theresa had the triumph of seeing Francis elected emperor on Sept. 13, 1745. Yet even as emperor Francis remained entirely overshadowed by the great personality of his wife. Only in financial and economic matters did he wield strong influence. On the other hand he is still remembered for his cultural interests—numismatics, the natural sciences, the arts and horticulture—thanks to the collections founded by him and the layout of the park at Schönbrunn. His sudden death at Innsbruck on Aug. 18, 1765, was a severe blow to Maria Theresa.

(Fr. Wr.)

FRANCIS II (1768–1835), Holy Roman emperor from 1792 to 1806 and, as Francis I, emperor of Austria from 1804 to 1835, was born in Florence on Feb. 12, 1768, son of the then grand duke of Tuscany and later emperor Leopold II, and of Maria Luisa, daughter of Charles III of Spain. Educated in Vienna from 1784 as heir to the throne, he succeeded his father on March 1, 1792, in both the Habsburg states and in the empire. Still immature, he was forced to deal with the difficult problems raised by the French Revolution and its world-wide repercussions. Napoleon's armies marched three times into the heart of Austria (1796, 1805, 1809). Twice Francis was forced to flee his capital, and the third time he was threatened with dethronement. The final victory over Napoleon, in which Austria played a leading role (1813–15), was followed by a long sequel of revolts and attempted revolts caused by the liberal and national movements in various parts of Europe, against which the emperor backed fully the conservative system of his chancellor, Metternich (*q.v.*).

The emperor Joseph II had disliked his nephew's dry and unimaginative outlook, but had had to acknowledge his application, a sense of duty, sound common sense and feeling for justice. These qualities characterized Francis as ruler, together with a certain timidity, a lack of flair for essentials and a sometimes petty officiousness. All this was combined with a precocious, rigid desire to impose his authority, which was based on belief in the divine right of kings but contrasted strangely with his natural modesty and affability.

Francis grew up to be pathologically afraid of revolution, hostile to all popular movements and anxious to supervise them with stringent police regulations. The exigencies of the struggle against France, especially in the heroic year 1809, forced him to agree to the arming of the whole people under pressure from his advisers. Yet there was no inner bond between the emperor and, for instance, the peasant patriots of the Tirol who, out of mere dynastic sentiment, made great sacrifices for his person. This lack of sympathy, as well as the bad conscience of an absolute ruler who did not wish to admit his lack of real power, may explain Francis' hesitant, indeed disingenuous attitude to Andreas Hofer and his group; it certainly contributed to the tragic end of the Tirolese revolt.

The same predispositions explain also Francis' attitude to other important problems, such as that of the crown of the Holy Roman empire, which he was the last to wear. He preferred his Austrian dominions to his position in the rest of Germany; in 1804 he elevated Austria to an empire in order to oppose Napoleon's French empire, and he would have liked to drive a political bargain with the crown of the old empire. In this, however, he was forestalled and had to abdicate in 1806. After the war of liberation (1813–15) he was easily persuaded by the court military party of the value of a more compact state with easily defensible frontiers. Hence he opposed the return to Austria of the upper Rhine, though the original Habsburg lands lay there, and he refused to revive the former empire in Germany though this went against the traditions of his house. His policy in Italy was motivated both by Austria's claim to predominance over the Appennine peninsula and by dynastic considerations, namely the restoration of the Habsburg rulers in northern and central Italy. He despised Napoleon as an upstart, yet for reasons of state did not dare to refuse him the hand of his daughter Marie Louise.

Francis preferred administration to politics. He thwarted all attempts to limit him to the issuing of directives and continued to interfere personally in administrative measures down to the smallest details. His aversion to oral discussion often delayed urgent and important decisions. By 1814 Metternich had forced through the limitation of the overburdened council of state to legislative affairs and had created the conference of ministers as an independent executive authority; but Francis himself often ignored the newly established order.

In general Francis followed Joseph II's system as modified by his father, but in his last years he deviated from the strict Josephine state supervision of church matters, under pressure from the Catholic-Romantic group at court (Clement Hofbauer, Friedrich Schlegel, Adam Müller), which was furthered by the impressions that he brought back from a visit to Rome (1819) and by the effect of a serious illness in 1826. Francis charged his successor, Ferdinand, in his two political testaments of Feb. 28, 1835, to adjust the relations of church and state according to the wishes of the papacy but otherwise not to alter the principles on which the state rested. The emperor's long reign brought little happiness to his states. He died in Vienna on March 2, 1835.

He had been married four times: in 1788 to Elizabeth of Württemberg (d. 1790); in 1790 to Maria Theresa of Naples-Sicily (d. 1807); in 1808 to Maria Ludovica of Modena-Este (d. 1816); and in 1816 to Caroline Augusta of Bavaria (d. 1873). His second wife, also a grandchild of the empress Maria Theresa and Francis I, was the mother of his 12 children, including the heir, Ferdinand; Napoleon's consort, Marie Louise; and Francis Charles, father of Francis Joseph. His third wife took an active interest in Austria's fight against Napoleon; his fourth championed the movement for ecclesiastical "restoration." *See* also references under "Francis II" in the Index volume.

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(Fr. Hu.)

FRANCIS I (1494–1547), king of France from 1515, was born at Cognac on Sept. 12, 1494, the son of Charles de Valois-Orléans, comte d'Angoulême, and Louise of Savoy. On the accession of Louis XII in 1498, Francis became heir presumptive and was given the duchy of Valois. He was tutored by Pierre de Rohan, sire de Gié, and, after Gié's disgrace in 1503, by Artus Gouffier, sieur de Boissy. On May 18, 1514, he was married to Claude, daughter of Louis XII and heiress of the duchy of Brittany (she died in 1524); and on Jan. 1, 1515, he succeeded to the crown of France.

Francis I's reign was an exceptionally spectacular one: the progress of royal absolutism, the Italian campaigns, the flowering of humanism, literature and art, all assured the glory of a prince whom a particularly careful education had polished. To his contemporaries and to immediate posterity he was *le grand roi François*.

In the early years of the reign the government was chiefly in the hands of Louise of Savoy and the chancellor Antoine Duprat. During the reign Anne de Montmorency rose to favour; and other royal favourites were Philippe Chabot and, in the last years of the reign, the marshal Claude d'Annebaut and François, cardinal de Tournon. Francis I's most influential mistress was Anne de Pisseleu, duchesse d'Étampes, who supplanted Françoise de Foix, comtesse de Châteaubriant, about 1526 and remained *maitresse en titre* until the end of the reign.

Rival of Charles V.—On his accession Francis resumed the Italian policy of his father-in-law, Louis XII. In 1515 he led an expedition to conquer Milan and by his victory at Marignano won the reputation of the most glorious and powerful prince in Europe. It was followed by the concordat of Bologna (1516) with Pope

Leo X. Encouraged by success, Francis sought election as Holy Roman emperor in 1519, but Charles V was elected instead, thanks to the financial help of Jakob Fugger. At the Field of Cloth of Gold (*q.v.*), in 1520, Francis failed to win the support of Henry VIII of England for the next round of his struggle against Charles V. France lost Milan in 1522 and, Charles, duc de Bourbon (*q.v.*) and constable of France, fled to join the emperor's service in 1523. In July 1524 he besieged Marseilles at the head of imperial troops. In retaliation, French troops entered Italy again, but they were defeated at Pavia (Feb. 24, 1525), where Francis was taken prisoner. "Of all things," he wrote to his mother, "nothing remains to me but honour and life, which is safe"—the authentic version of the legendary phrase "All is lost save honour." In captivity in Madrid (where he arrived on July 20, 1525), Francis was forced to sign the treaty of Madrid (Jan. 14, 1526) in which he not only renounced his suzerainty over Flanders, Artois and Tournai and his claims to Milan, Naples, Genoa and Asti, but also ceded the duchy of Burgundy to Charles V and agreed to restore the duc de Bourbon to his lands and titles. He had, however, no intention of executing this treaty, which served only to procure his release from Spain (March 17, 1526). Back in France, he formed the League of Cognac with Venice, Pope Clement VII and Francesco Sforza against Charles (May 22, 1526). When his subsequent expedition to Italy had proved a failure, Francis agreed to the peace of Cambrai or Ladies' peace (so called because Louise of Savoy and Margaret of Austria had negotiated it), under which Charles V renounced his claim to the duchy of Burgundy. This peace was ratified on Aug. 3, 1529; and next year Francis married Eleanor of Austria, Charles V's sister. For his last two wars against Charles (1536–38 and 1542–44) Francis allied himself with the Protestant princes in Germany and also with the Turks, who were threatening Hungary.

Ruler.—Francis I considerably strengthened royal authority: without his achievement in this sphere the absolute monarchy of Louis XIV could never have evolved. As part of his program, Francis strove to keep all the magnates of France in dependence on himself and did not shrink from prosecuting the most dubious lawsuits against those who seemed to him to be dangerous, such as the constable de Bourbon and the financier Jacques de Semblançay. He also exerted himself to strengthen the administrative machinery of government. Under him the *conseil du roi* gradually began to specialize, allotting some days to financial affairs, some to judicial questions, etc.; and he entrusted much work to royal secretaries detached from the *conseil du roi*, who thus became the forerunners of the future secretaries of state. The *trésor de l'épargne* was established in 1523 to bring the collection of taxes under the central government's control. For the legal system, Francis reorganized the jurisdictions of the *parlements* and of the courts for *bailliages* and *sénéchaussées* and also, in the ordinance of Villers-Cotterets (1539), asserted the rights of royal over ecclesiastical tribunals and prescribed the use of the French language in all legal procedure.

Largely because his policies required heavy expenditure, Francis was driven to multiply the number of public offices offered for sale. Thanks to this, the rich *bourgeoisie* took an increasing part in public affairs and was able to improve its position against the nobility.

Patron of Arts and Letters.—Francis I was pre-eminently the king of the French Renaissance. His well-known generosity was exercised chiefly on behalf of artists and humanists, whose company he especially enjoyed at least in the first 20 years of his reign. He attracted to France and installed at Fontainebleau a large number of Italian painters and sculptors, who worked at the decoration of the château, among them Benvenuto Cellini and Francesco Primaticcio; and Leonardo da Vinci spent his last years at Amboise. The châteaux of Chambord, Villers-Cotterets, St. Germain-en-Laye and Madrid in Neuilly (destroyed in 1793) were Francis I's creations.

The support that Francis gave to humanists was of great importance. Founder of the Collège de France in 1530, at the request of Guillaume Budé, he made sure that the *lecteurs royaux* —in Hebrew, in Greek, in Latin and, after 1539, in medicine and in mathematics—should be completely independent of the reactionary Sorbonne. Francis indeed never ceased to encourage humanists, though after 1534 he became more cautious with them.

Catholic.—Up to 1534 the king's good will had extended not only to the humanists but also to the group of men led by Guillaume Briçonnet, bishop of Meaux, and Jacques Lefèvre d'Étaples, who sought to bring about a reform within the Catholic Church. In this Francis was encouraged by his sister Margaret of Angoulême (*see* MARGUERITE D'ANGOULÊME), by the brothers Du Bellay and by the duchesse d'Étampes, but the boldness of the Lutherans, who became more and more numerous after 1526, forced Francis to come down against all the reformers. The "affair of the Placards" (Oct. 1534), when grossly offensive broadsides against Catholicism were posted on walls throughout Paris and other towns, led to severe repression, though the preface of John Calvin's *Institutes of the Christian Religion* (1536) shows that the Reformers went on hoping for toleration from Francis. During the last years of his reign, under the guidance of the cardinal de Tournon the king issued a series of edicts against the Reformed religion and the Sorbonne published two lists of proscribed books (1542 and 1544). Two acts of persecution are notorious: the massacre of the Waldenses (*q.v.*) in 1545 and the execution of 14 people at Meaux (and the scholar Étienne Dolet in Paris) in 1546.

Historians and contemporaries have often underlined the discrepancy between Francis' persecution of the Reformed religion within his kingdom and his allying himself with the German Protestants and with the Turks. A readiness to distinguish temporal from spiritual matters, however, was part of the Gallican tradition, and Henry IV, Richelieu and Mazarin were to follow the example that Francis consciously set.

Succession.—Francis I died at Rambouillet on March 31, 1547. By his first marriage he had had seven children: Louise (1515–17); Charlotte (1516–24); Francis, dauphin and, on his mother's death, heir to Brittany (1518–36); Henry (1519–59), at first duc d'Orléans, then dauphin from 1536 and finally king in succession to his father; Madeleine (1520–37), who married James V of Scotland in 1537; Charles (1522–45), at first duc d'Angoulême, then duc d'Orléans; and Margaret (1523–74), who married Emmanuel Philibert, duke of Savoy, in 1559.

See also references under "Francis I" in the Index volume.

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(Ro. M.)

FRANCIS II (1544–1560), king of France from 1559, was born at Fontainebleau on Jan. 19, 1544, the eldest son of Henry II and Catherine de Médicis. In April 1558 he was married to Mary Stuart, queen of Scotland. On his father's death he became king of France (July 10, 1559). A sickly and weak-willed young man, Francis was the tool of his consort's uncles François, duc de Guise, and Charles, cardinal de Lorraine (*see* GUISE, HOUSE OF). To break the power of the Guises, Louis de Bourbon, prince de Condé, planned the so-called *tumulte d'Amboise* (March 1560), an abortive *coup d'état*, in which some Huguenot gentlemen surrounded the château of Amboise and tried to seize the king's person. The failure of this strengthened the Guises, whom Catherine de Médicis then tried to counterbalance by securing the appointment of the conciliatory Michel de L'Hospital (*q.v.*) as chancellor. The king's death, at Orléans on Dec. 5, 1560, ended the Guises' dominion and saved Condé, who had been sentenced to death for high treason.

See L. Romier, *La Conjuration d'Amboise* (1923); A. Buisson, *Michel de l'Hospital* (1960).

FRANCIS I (1777–1830), king of the Two Sicilies from 1825, was born at Naples on Aug. 14, 1777, the son of Ferdinand I (*q.v.*) and Maria Carolina. He was married first, in 1797, to the Austrian

archduchess Maria Clementina, daughter of the Holy Roman emperor Leopold II; secondly, in 1802, to the infanta Isabella, daughter of Charles IV of Spain.

As a youth Francis showed an inclination to liberalism, particularly during the Neapolitan court's exile in Sicily. There Lord William Bentinck, the British minister, made Ferdinand appoint Francis as *vicario* or regent when the constitution of 1812 was to be introduced. In July 1820, moreover, Francis sympathized with the rising of the Carbonari (*q.v.*), which, he thought, would win popular support for the monarchy. In these circumstances Ferdinand again nominated him his *vicario;* and when Ferdinand's treacherous conduct during the congress of Laibach alarmed the Neapolitan patriots, Francis wanted to renew his oath to the constitution and to let the government send two armies to stop the Austrian invasion. The success of the reaction, however, together with his own more recent experiences, completely changed his attitude.

Succeeding to the throne on Ferdinand's death (Jan. 4, 1825), Francis departed altogether from liberalism and showed himself even more cowardly, dissembling and reactionary than his father had been. He ordered the disbanding of the national guard and wanted to recruit a Swiss corps to guard his court; and he asked for the Austrian forces, which had been garrisoning the kingdom since 1820–21, to remain there till March 1827. A revolutionary outbreak in the Cilento (1828) was repressed with atrocious savagery by Guglielmo del Carretto, to whom the king then gave the title *marchese*. Francis died at Naples on Nov. 8, 1830.

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FRANCIS II (1836–1894), king of the Two Sicilies from 1859 to his deposition in 1860, the last of the Bourbons of Naples, was born on Jan. 16, 1836, the only son of Ferdinand II (*q.v.*) by his first consort, Maria Cristina of Savoy. Timid and suspicious by nature, Francis was brought up on strict moral and religious principles that made him even more scrupulous, so that his uncles, his stepmother, Maria Theresa, and his wife, the beautiful, vivacious and intelligent Maria Sophia (1841–1925), duchess in Bavaria, to whom he was married early in 1859, could easily overrule him in state and family councils. His father's death (May 22, 1859) brought Francis to the throne at the critical moment when Sardinia-Piedmont and France were at war with Austria (*see* Italian Independence, Wars of). From Piedmont, Cavour sent certain proposals (drawn up by Neapolitan exiles): Francis II was invited to intervene in the war against Austria and, when the war ended, to set up a liberal regime in his kingdom; in return, he might be granted some territory at the expense of the papal states. Francis flatly rejected these proposals. When his Swiss guard, hitherto the mainstay of his dynasty, mutinied and had to be disbanded, his anxiety increased. His prime minister and minister of war, Carlo Filangieri, then advised him to make an alliance with France and to grant his kingdom a constitution of the Napoleonic type, but Francis opposed this plan, which also found little support in France.

The invasion of Sicily by Giuseppe Garibaldi and his Thousand in May 1860 thoroughly alarmed Francis, who became convinced that the western powers, together with Piedmont, were resolved to bring the Bourbon kingdom to an end. Even so it was decided to request the diplomatic intervention of the French emperor Napoleon III. Napoleon advised Francis to grant the Neapolitans a constitution, to make Sicily autonomous and to ally himself with Piedmont. Following this advice, Francis capitulated on June 25, 1860: the constitution of 1848 was brought back into force; freedom of the press was granted; preparations for elections were made; and a new government was formed under Antonio Spinelli and Liborio Romano. It was too late, however, to save the monarchy. Garibaldi had crossed the Straits of Messina and was advancing on Naples. From the Bourbon camp itself many deserted—even the king's uncle, Leopoldo, conte di Siracusa, went over to the liberals. On Sept. 6 the court left Naples and took refuge in Gaeta, where Francis offered his last, obstinate resistance, first to Garibaldi's forces, who defeated the Bourbon troops on the Volturno river (Oct. 1–2), then to the Piedmontese, who were besieging Gaeta by Nov. 6. Meanwhile, by the plebiscite of Oct. 21–22, Francis had been deposed from his kingdom. On the fall of Gaeta (Feb. 13, 1861), Francis retired to Rome as the guest of Pope Pius IX. His hopes of recovering his throne were encouraged for a few years by troubles in southern Italy. When Rome also fell (1870), he settled in Paris. Much of his later life was spent in travel. Francis died at the spa at Arco, in Trentino, on Dec. 27, 1894.

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FRANCIS II (1435–1488), duke of Brittany from 1458, was born on June 23, 1435, the son of Richard, comte d'Étampes, and Marguerite d'Orléans. He succeeded his uncle, Arthur III, on Dec. 26, 1458. His policy was the maintenance of Breton independence against encroachment by the king of France. Francis joined the League of the Public Weal against Louis XI in 1465; invaded Normandy in 1467 on behalf of the dispossessed Charles de France (Louis XI's brother), who had taken refuge in Brittany; and allied himself with Edward IV of England in 1468. Forced to sign the treaty of Ancenis with France (1468), he allied himself again with Edward in 1475, but again had to come to terms with France at Senlis when Edward did so at Picquigny. When Louis XI had bought from the house of Penthièvre its rights to the duchy of Brittany (1480), Francis made yet another treaty with Edward, whereby his eldest daughter, Anne (*see* Anne of Brittany, queen of France), was to marry the prince of Wales (1481).

Pierre Landais, the duke's chief counselor, provoked the hatred of the Breton nobles by his persecution of the chancellor Guillaume Chauvin, who died in prison (1481). With support from Anne of Beaujeu, regent of France from 1483, the nobles had Landais hanged (1485), but when Anne sent French troops into Brittany (1487) they rallied to the duke. The Bretons, however, were defeated at St. Aubin-du-Cormier on July 28, 1488, and on Aug. 19 Francis signed the treaty of Verger in which he undertook to contract marriages for his daughters Anne and Isabelle only with the French king's permission. Francis died at Couëron on Sept. 9, 1488.

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FRANCIS of Meyronnes (Lat. Franciscus de Mayronis) (d. *c.* 1328), Provençal Franciscan philosopher, known to the scholastics as *doctor illuminatus* or *acutus*, was a pupil of Duns Scotus, whose doctrine of *formalitates* he applied even to the Trinity. According to Francis, ideas belong to God's substance; variations in the intensity of qualities, rather than qualities themselves, mark off individuals. The new kinetic theory of *vis impressa* and that of the revolution of the earth are mentioned in his works. He advocated a universal temporal monarchy headed by the pope; and upheld the doctrine of the Immaculate Conception. In addition to theological and political treatises, he wrote commentaries on Porphyry's *Isagoge*, Aristotle's *Categories* and *Physics* and Peter Lombard's *Sentences*. (L. M.-Po.)

FRANCIS, JAMES BICHENO (1815–1892), U.S. civil engineer best known for his development of the mixed-flow or Francis turbine, was born in Southleigh, Eng., May 18, 1815. He left school at the age of 14 to assist his father on hydraulic works connected with a small railway in Wales. In 1833 Francis moved to the United States where he was employed in construction of the Stonington (Conn.) railway under the supervision of G. W. Whistler. Francis later followed Whistler when the latter joined

a group known as "Proprietors of the Locks and Canals on the Merrimack River" at Lowell, Mass. At the age of 22 Francis became chief engineer of the company, engaged first in locomotive design, then in the erection of cotton mills, and finally in management of water-power facilities at Lowell. For 40 years he looked after the company's water-power interests and acted as consulting engineer to factories using the power; he contributed greatly to the rise of Lowell as an industrial city.

Among technical matters to which Francis gave his attention were timber preservation, the testing and design of cast-iron girders and the design of fire protection systems. In addition to his development of the Francis turbine, he is probably best known for his formulas for the flow of water over weirs and his many other hydraulic studies. He was widely consulted on engineering projects; one of them took him as far as Minnesota. An original member and onetime president of both the Boston and American societies of civil engineers, he wrote more than 200 technical papers and, although unschooled, became known as one of the most scientific in outlook of the civil engineers of his day. He died at Lowell on Sept. 18, 1892. (W. E. Hd.)

FRANCIS, SIR PHILIP (1740–1818), English politician and pamphleteer, the supposed author of the *Letters of Junius* and the chief antagonist of Warren Hastings, was born in Dublin on Oct. 22, 1740, the son of a clergyman. He was educated at a Dublin free school and at St. Paul's school, London. In 1756, on leaving school, he was appointed to a junior clerkship in the secretary of state's office by Henry Fox (afterward Lord Holland), his father's patron. He was secretary to Gen. Edward Bligh in the expedition against Cherbourg (1758), and in the same capacity he accompanied the earl of Kinnoul on his special embassy to the Portuguese court in 1760. Francis was promoted to a principal clerkship in the war office in 1762. That year he married Elizabeth Macrabie, the daughter of a London merchant. In 1763 the constitutional questions arising out of the arrest of John Wilkes began to be sharply argued. It was natural that Francis, who had been in the habit of writing to the newspapers, should eagerly take part in the controversy, though his position as a civil servant made it necessary that his own contributions be carefully disguised. His chief title to fame as a writer is his supposed authorship of the *Letters of Junius*, which appeared between Jan. 1769 and Jan. 1772 (*see* Junius).

Francis left the war office in March 1772. In June 1773 Lord North appointed him a member of the newly constituted supreme council of Fort William, Calcutta, at a salary of £10,000 a year. No completely satisfying reason for this spectacular promotion has yet been given. With his colleagues George Monson and Sir John Clavering he reached Bengal in Oct. 1774, and a long and bitter struggle with Warren Hastings, the governor general, began. These three formed a majority in the council and consistently opposed Hastings, overruling his policies and accusing him of corruption. The deaths of Monson (1776) and Clavering (1777) re-established Hastings' independence, but further disputes culminated in a duel between him and Francis (1780) in which the latter was wounded. Francis returned to England in 1781, having failed to realize his ambition to wrest the governor generalship from his rival. Tireless in the publication of anonymous pamphlets, he won the support of public opinion, turning it against Hastings; and he was the moving spirit in Hastings' impeachment.

Francis entered the house of commons for Yarmouth, Isle of Wight, in 1784, and subsequently sat for Bletchingley (1790–96) and Appleby (1802–07). A follower of Charles James Fox, he became a convert to parliamentary reform and was one of the founders of the Society of the Friends of the People in 1792. The acquittal of Hastings in 1795 was a bitter blow, and in 1796 Francis lost his seat at the general election. Even though he had dissipated the bulk of his fortune in parliamentary election expenses, Francis declined the governorship of the Cape, with its salary of £10,000 a year and substantial patronage, when the Whigs came into power in 1806. He also declined a peerage at the same time because he was refused the governor generalship of Bengal, the lifelong object of his ambition: "the only reparation that can be offered me for all my sufferings in that country." Deeply mortified though he was, he did accept a knighthood. After his retirement from parliament in 1807 he lived in comparative privacy. He died in London on Dec. 23, 1818.

Francis was a man of vast ability, but rancorous, unforgiving and prone to malignity. Between him and Hastings there existed not merely a personal vendetta but also a real conflict of principles as to how the territorial acquisitions of the East India company should be governed. The "permanent settlement" of Bengal (the work of Marquess Cornwallis and Sir John Shore, afterward Lord Teignmouth) embodied Francis' doctrines on Indian land revenue. He also stood for a policy of nonintervention in the politics of the Indian "country powers"—a policy which, under Shore, brought the company to the verge of disaster before its reversal by the earl of Mornington (later Marquess Wellesley) in 1798.

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(A. Al.)

FRANCISCANS (Friars Minor; Ordo Fratrum Minorum; O.F.M.; in England called Grey Friars), an order of mendicant friars founded by St. Francis (*q.v.*) of Assisi. Francis heard the call to a life of poverty and preaching of penance (1209), and soon was joined by his first followers. He gave them a short and simple rule of evangelical maxims (the so-called "primitive rule") and in 1210 went with them, 11 others besides himself, to Rome, where he received oral authorization from Innocent III. The brethren, who had no possessions of any kind and whose only centre was the little church, the Porziuncola, at Assisi, preached and worked at first in Umbria and then, as numbers grew, in the rest of Italy and abroad.

The character and message of Francis precipitated, so to say, a form of life that was already in the air in northern and central Italy, and recruits came in great numbers. For a time there were no fixed residences, but the brotherhood met each year in chapter at Assisi. In 1219, as a result of appeals and controversies, "ministers" for different regions were appointed and certain canonical ordinances were imposed by the pope. Francis himself renounced the official headship in 1220, but at the request of the general chapter composed a rule (the "second rule") which was found too strict and never applied. Unwillingly, with the aid of Cesarius of Speyer, he composed a third version (the "approved rule" or *Regula bullata*), which received papal confirmation when Honorius III gave formal approval of the order on Nov. 29, 1223. Finally, in 1226, Francis wrote his testament, in which he reaffirmed his deepest convictions as to poverty, the renunciation of all papal privileges and the sacrosanctity of the rule, understood literally. Francis, it seems clear, had originally no intention of founding an order. He had heard the call to follow Christ in evangelical poverty and simplicity, and he accepted this life as one to be shared with all—with his followers, with St. Clare and her sisters, and with all men and women of good will. He explicitly asserted the novelty of his brotherhood and his unwillingness to follow monastic precedent. When followers came in hundreds, neither he nor they could bring themselves either to insist fully upon or to renounce absolutely the primitive idea with Francis as its only accredited exponent. This inner conflict between the spiritual intuition of a saint, and the practical necessities of a large and miscellaneous body of men, remained unresolved for the first four centuries of the order's history and remains a problem of religious history.

Constitution.—When Francis died in 1226 the number of his friars was already great, but the rule gave no more than the skeleton of an organization, in which Francis and his vicar-general, Elias (*q.v.*) of Cortona, had had an almost monarchic position. In the years that followed there was a double tension: that of transforming a brotherhood of spiritual endeavour into a fully articulated and disciplined religious order, and that of translating the soaring vision of St. Francis into a body of doctrine that could be preached to and practised by a multitude of ordinary mortals. It was indeed the basic problem of Christianity focused upon a small body of medieval men.

The former process was at first delayed and later hastened by the autocratic and in some ways retrograde behaviour of Elias,

who was himself neither learned nor in orders. Subsequently, under the generalate (1240–44) of Haymo of Faversham, an Englishman, the general chapter was used as a legislative body to sanction an elaborate constitution, based in part upon that of the Dominicans (Friars Preachers). The convents, each under a guardian, were grouped in regional provinces under ministers provincial, and the provinces under a minister general. Provincial and general chapters (the latter no longer an assembly of all the friars) were held triennially, and a system of education similar to that of the Dominicans was introduced. Friars not in orders were excluded from holding office, and gradually came to form a separate class. Meanwhile the pull of circumstances and the entry into the order of university masters and their pupils assisted in transforming a brotherhood of unlettered preachers of the Christian message into an order of highly trained clerical theologians. In two respects, however, the Friars Minor stood apart from the Friars Preachers: they remained nearer in heart and spirit to the common people, and the order was governed by its superiors rather than by elected committees (*see* also DOMINICANS: *History*).

The second of the two processes alluded to above was a longer and more difficult one, in which the victories of moderate men and practical statesmen were often counterbalanced by a lowering of ideals and by the harsh treatment meted out to those who might well seem to have preserved more faithfully the purity of their founder's ideal. In the process of change the papacy played a leading part; the friars were a valuable militia for the church; and the curia, if appealed to on a question of law, could answer only in legal terms. The testament of Francis was soon (1230) declared to have no canonical force, and a succession of bulls reduced Francis' vision of poverty into a legal status in which the exigencies of the rule were preserved in word, but eluded, partly by the use of a third party to stand between the benefactor and these who in fact enjoyed the benefaction, and partly by the legal fiction of vesting the ownership of all property in the Holy See.

These decisions were not unchallenged, and a division showed itself between those who were familiar with the life and teaching of the founder and those, especially from countries beyond the Alps, who wished to see the order attain a maximum of freedom to pursue its work of learning and teaching. Something of an equilibrium was reached in the generalate (1257–74) of St. Bonaventura, who has sometimes been called the second founder of the order. By his life of St. Francis, his commentary on the rule and the constitutions promulgated under him at Narbonne (1260), as well as by his firm government and saintly personality, Bonaventura provided the framework and the inspiration for an interpretation of the message of St. Francis and a version of the Franciscan life that has remained ever since official and central in the order.

Meanwhile the friars had spread far and wide in Europe, while bands of missionaries had penetrated Syria and Africa. Simultaneously, the friars' houses in university towns such as Paris and Oxford were transformed into schools of theology which rapidly became the most celebrated in Europe, and both attracted and produced many of the greatest masters of the golden age of scholasticism. At Paris Alexander of Hales, Bonaventura, John Pecham and Matthew of Aquasparta, and at Oxford Adam Marsh, Thomas of York, Duns Scotus and William of Ockham, maintained the succession of genius for a century. After 50 years the contemporary controversies over Aristotelian philosophy brought the Dominicans and Franciscans into collision, and thenceforward the two orders were consistently and often bitterly opposed on all matters that were not part of the traditional faith.

Reform Movements.—*Spirituals and Conventuals.*—With the death of Bonaventura the internal dissensions of the order flamed up anew. The mantle of the first companions of Francis and the *zelanti* (zealots) was assumed by a school that gradually acquired the name of Spirituals, standing for the literal observance of the rule and testament, and the renunciation of papal dispensations. Opposed to them were the Conventuals, who stood for a less austere community life adapted to the exigencies of study and preaching. Among the 13th- and 14th-century leaders of the Spirituals were Pietro Giovanni Olivi, Angelo of Clareno and Ubertino of Casale, and among their followers were those who formed for future generations in literature and in art—in the *Fioretti* ("Little Flowers"), the *Speculum perfectionis* ("Mirror of Perfection") and the poems of Jacopone da Todi—the romantic image of Francis and his first friars that has become part of the medieval legacy of beauty.

Yet the victory in law and practice was ensured to the Conventuals by the climate of the age, the fortunes of the other orders of friars, the needs of the faithful and the patronage of the papacy. Their advantages were increased by the extreme and ultimately rebellious and heretical opinions and conduct of many of the Spirituals. For a long time, however, the moral and what may be called the aesthetic superiority lay with the Spirituals, and their ultimate catastrophe is one of the tragedies of medieval history. After many vicissitudes, the controversy on poverty within the order, as also the claim of the Spirituals to form communities following their conception of the Franciscan life, was settled in 1322–23 in favour of the Conventuals by John XXII. His harsh treatment of dissidents led to a temporary schism in the order and the departure into rebellion and heresy of the extremists known as the Fraticelli. Within a few decades, however, calamities of another sort had changed the face of the church. Both discipline and observance had suffered in the Conventual party during the strife, and the Minors felt also the disastrous effects of the great plague and the Great Schism, not to mention the nominalist movement in the schools, which had issued from their midst.

In the latter part of the 14th century the friars, and in particular the Franciscans, who were ubiquitous because of their great numbers and their active mendicancy, lost much of the esteem and popularity of earlier times. They became the target of satirists and reformers in every country, as readers of Boccaccio, Langland and Chaucer well know. Their theologians, already adepts in the subtleties of Scotus, were deeply infected with Nominalism (*q.v.*) and as "Duns' men" (whence "dunces") they were regarded in the 16th century with distaste and hostility by Erasmus and the humanists in general.

Observants.—Throughout the 14th century a series of zealous reformers, the direct spiritual successors of Angelo and Ubertino, had initiated groups of friars of austere life existing apart from the main body of Conventuals. At last a clear separation was effected. A group of French and Burgundian friaries, vowed to the literal observance of the rule, were put by the Council of Constance in 1415 under a vicar-general who owed obedience to the minister general alone. These were known as Observants. Though several attempts were made by the papacy to align the whole order under the Observants' standard, the outcome was in fact a complete separation in 1517, when they became a separate religious order. Before that, the Observants under the leadership of St. Bernardino of Siena, St. John of Capistrano and St. James of the March had spread far and wide over Europe. They were introduced into England in 1482, and gained a name for strict discipline. The leading spirit of the Observants in early days was St. John (*q.v.*) of Capistrano, a preacher and wonder-worker of unparalleled genius and zeal, who died shortly after the victory over the Turks at Belgrade which was largely due to his inspiration. In Spain the great reforming statesman Cardinal Jimenez was an Observant. The English Observants as a body opposed both the royal divorce and the royal supremacy of Henry VIII, and were driven to death, prison and exile.

Between the Observants and the Conventuals a number of splinter groups came into existence, of which the "half-reform," a compromise sponsored (1430) by Martin V, was the most notable. Finally, in 1517 Leo X erected the Observants into an autonomous order, to which for a short time the Conventuals were subordinated. They spread widely and themselves gave birth to stricter groups, notably that of the Alcantarines or Discalced Friars Minor in Spain and Portugal, the work of St. Peter of Alcantara, remarkable for their extreme austerity.

Capuchins.—Meanwhile another important movement of reform had taken place that added an eremitical element to the literal interpretation of the rule. These friars, known as Capuchins (from their pointed cowl, *capuche*), were founded by Matteo da Bascio in 1525 and received papal confirmation and separate govern-

ment under a vicar-general in 1535. Their constitutions prescribed absolute poverty, both corporate and personal, and great austerity of life. The Capuchins had a rough passage through the 16th century. They were harassed by the Conventuals and forbidden by the papacy to extend outside Italy. The defection (1542) to Protestantism of their second general, Bernardino Ochino, all but ruined them, and their leaders were not men of great ability. Nevertheless they increased rapidly, and by 1571 counted 17,000 brothers in Italy alone. In the following centuries, when allowed to expand freely, they reached a maximum of 33,000 in 1750. They played almost as important a part as the Jesuits in the later stages of the Counter-Reformation, appealing to the lower orders and to the country people as well as to courts and castles. Among notable Capuchins were St. Lawrence of Brindisi, a papal diplomatist; Ange de Joyeuse, a leader in the wars of religion; Père Joseph du Tremblay, the "gray eminence"; Benet Canfield, the English mystical writer; St. Fidelis of Sigmaringen; and Marco Cristofori of Aviana, who played a part in the victory over the Turks in 1683–88 similar to that of St. John of Capistrano two centuries earlier. In England a group staffed the chapels for the Catholic queens Henrietta Maria and Catherine of Braganza. They were active in missionary and social work all over the world, notably in America and Ireland.

After the French Revolution.—The Franciscans suffered, though not so severely as the endowed orders, in the French Revolution and the subsequent liberal and secularizing epoch; they have always been most numerous in the Latin lands, and on the missions they were never reduced to nonentity. They revived with the religious revival of the early 19th century and again spread widely; during the mid-19th century years they developed their activities in every missionary field of the old and new worlds. Since the 16th century the order had consisted of three main branches, but whereas the Capuchins were undivided, and the Conventuals had absorbed their largest offshoot (the so-called "improved Conventuals") in the 17th century, the Observants had consisted from early days of the Observants proper, the Reformed Observants, the Recollects, the Discalced and other smaller splinters. These were all united by Leo XIII in 1897 with new constitutions under a single minister general.

The Franciscans therefore form not one but three orders: the Conventuals (O.F.M. Conv.), the smallest group; the Observants (O.F.M.), the largest by far; and the Capuchins (O.F.M. Cap.). In 1960 the Observants had 37 provinces, including 5 in the United States, with many friars of German origin; the Conventuals 21 provinces, including 3 in the United States; the Capuchins 45 provinces and other lesser groups, of which half are in Italy.

Five popes have been Franciscans: Nicholas IV; Sixtus IV; the two intensely dynamic 16th-century popes Julius II and Sixtus V; and Clement XIV, who suppressed the Jesuits. There have been numerous historians of the order since the Reformation, including the Irish friar Luke Wadding (1588–1657). In modern times the foundation (1879) of the College of St. Bonaventura at Quarrachi near Florence led to the establishment of a school of editors of the works of Bonaventura, Peter Lombard, Alexander of Hales, etc. A number of learned periodicals also have appeared, such as the *Analecta Franciscana*, the *Achivium Franciscanum historicum*, the *Antonianum* and the *Franziskanische Studien*, to say nothing of more popular productions in all languages.

Among Franciscan scholars may be mentioned P. M. Oliger, the historian of St. Francis, and A. Gemelli (d. 1959), founder and rector of the University of the Sacred Heart at Milan, both Observants. Among social workers may be mentioned Theobald Mathew (d. 1856), the Irish "apostle of temperance," and his contemporary Theodosius Florentini (d. 1865), the great Swiss philanthropist. In theology, the Franciscans have always taken St. Bonaventura and Duns Scotus as guides, and from the latter they received the legacy of propagating the doctrine of the Immaculate Conception. In the middle ages they introduced the Christmas crib, and since the 17th century they have popularized the devotion of the Way of the Cross, the indulgences of which they still distribute. In the 14th century the Franciscans were the first to establish funds to grant interest-free loans to the poor.

The Observant habit is a dark brown tunic with rope girdle and round hood and sandals over bare feet; they wear a large tonsure. Conventuals wear a black tunic with white cord; a large, double, pointed hood; biretta, and shoes. The Capuchin habit is a coarse brown tunic with cord, pointed cowl, sandals and beard.

The Franciscan Aim.—The widespread modern predilection for St. Francis, the intensive work done by historians of every tongue on Franciscan origins, and the selection of the saint and his first followers as figures of ideal beauty and simplicity, heralds of the modern love of nature and of animals, have perhaps led many writers to a certain neglect of perspective. They have examined the original documents, have traced what seemed to them to be a decline from the original ideal, and have noted the lamentable divisions in the order in the late 13th century. As a consequence, those unfamiliar with the history of the church throughout the centuries have perhaps failed to appreciate the immense scope and the beneficent achievement of the Franciscans among the poor, the unfortunate and the heathen throughout the world from the time of St. Francis onward. They have been for centuries, and still are, by far the most numerous body of religious in the Roman Catholic Church, and in part at least their absence from the forefront of the world's stage is due to their fidelity to the message of simplicity and poverty which they have received from their founder.

Second Order.—The Second Order of St. Francis, known also as the Poor Ladies, Clarisses or Poor Clares, was founded at Assisi by St. Clare (*q.v.*), a daughter of a noble family of the town. She took the veil at the hands of St. Francis in the Porziuncola on March 18, 1212, and together with her sister Agnes and others was lodged by him in the church of San Damiano, where she was joined by relatives and friends and became abbess in 1216. Francis gave her only verbal counsel and a short "way of life," and the first rule, an austere monastic directory, was imposed by Cardinal Ugolino (later Gregory IX) in 1218–19. This was later modified to the second rule by Innocent IV in 1247. But Clare fought hard for union with the Friars Minor and the observance of full Franciscan poverty, and a third rule, largely that of St. Francis and embodying her wishes, was approved by Pope Innocent IV only two days before her death; the papal letter was found when her tomb was opened in 1893. Long before this papal act the Poor Ladies had founded convents in north Italy and beyond the Alps, and they continued to be very numerous until the Reformation, despite the severity of their rule.

The Second Order did not escape its share in the tribulations of the friars. Convents existed following each of the three rules, and a fourth became current in France. In 1263 Urban IV at the instigation of St. Bonaventura united all the Clares under the slightly mitigated (second) rule of 1247, but several reforms in the direction of primitive austerity took place. The Colettines, named after their founder, St. Colette (*q.v.*) of Corbie, represented one such (1417), the Conceptionists in Spain another (1489). In 1538 the Clare-Capuchinesses were founded in Italy; and finally the Clares of Strict Observance (Alcantarines) also in Italy, originated in 1630. The first and third of these multiplied greatly, particularly in France and Spain, respectively. All save the last-named still exist.

The Poor Clares have always ranked among the most austere and penitential of the religious orders, and in the 20th century they share with the Carmelites (*q.v.*) a reputation for the strict observance of a dedicated contemplative life. Despite (or perhaps because of) the severity of its rule, the order has always counted among its members, especially in France and Germany, many women of royal, noble and gentle families, and has never decayed. It remains flourishing in the mid-20th century, with more than 650 convents, chiefly in Spain and Italy but also throughout the world, including North and South America. Among the many saints, besides the foundress, her sister Agnes and St. Colette, may be mentioned St. Catherine of Bologna.

The Poor Clares' habit is brown, with cord girdle and black veil, and they go barefoot except for wearing sandals out of doors.

Third Order.—The Third Order of St. Francis, for men and women living in the world, was no more than a formalization of the

message of St. Francis, who himself wrote a letter "to all Christians." Perhaps as early as 1221 brethren and sisters "of penance" (*i.e.*, pledged to a devout life) were in existence; certainly the Third Order was known as such in 1230. It met a need in the growing urban population of Europe that had hitherto been satisfied by semiorthodox associations and sects. Its members were distinguished by an exact observance of all the fasts and other precepts of the church, by a refusal to bear arms or to take oaths save in specified circumstances. Christopher Columbus and Isabella I were members of this order. The constitutions of the order for those in the world were revised and mitigated by Leo XIII in 1883, and by the 1960s there were more than 4,000,000 Franciscan "Tertiaries," both men and women, many of them given to works of charity and social service.

Early in Franciscan history there arose a "regular" Third Order of communities under vow. The male branch was all but extinguished at the Reformation and later during the French Revolution, but witnessed a revival after the mid-19th century, with numerous congregations, particularly in Holland and German-speaking countries, with derivatives in North America. Congregations of Franciscan women Tertiaries are numerous all over the Catholic world. Both men and women are devoted to teaching, nursing and the auxiliary missionary activities. A revised rule and constitutions were given them by Pius XI in 1927.

Minims.—The Minims (*Ordo Minimorum*) were founded by St. Francis (*q.v.*) of Paola in southern Italy about 1435, at first as a group of hermits. They were neither a reform of nor a revolt from the Franciscans, with whom they have never had organic connection. They were a separate institute, deriving their inspiration from St. Francis of Assisi, particularly in his encouragement of simplicity and the eremitical life. Their name, intended to set them below the Friars Minor, was a token of humility, and they received from their founder a life of the most austere penance, with emphasis on silence and on abstinence from all foodstuffs save bread, vegetables, fruit and oil. The order received papal approval in 1474 and spread rapidly in the 16th century, particularly in Italy, France, Spain and the new world, and has survived to the present day in Italy. The habit of the Minims is a wide-sleeved black or natural wool tunic, with cord girdle, and a cape with hood. The order is governed by a corrector general. *See* Monasticism; Orders and Congregations, Religious; *see also* references under "Franciscans" in the Index volume.

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FRANCISCO MORAZÁN, department in the highlands of central Honduras. Area 3,068 sq.mi. Pop. (1961) 283,607. About half of the inhabitants live in the *districto central*, which includes Tegucigalpa (*q.v.*), the national and departmental capital. The many fertile highland valleys and basins are important agriculturally, producing poultry, corn, beans, potatoes, cotton, harvested forage grasses, cattle and swine. Mountain forests cover about 34% of the department. Gold and silver are mined. Industries include foodstuffs, beverages, textiles, cigarettes, soap, glass, china and other clay products, matches, shoes and other leather goods, and furniture. The department was called Tegucigalpa until 1943 when it was renamed in honour of the president of the Central American federation. (C. F. J.)

FRANCIS FERDINAND (1863–1914), Austrian archduke whose assassination was the immediate cause of World War I, was born in Graz on Dec. 18, 1863, the eldest son of the archduke Charles Louis, brother of Francis Joseph.

The death of the heir apparent, the archduke Rudolf, on Jan. 30, 1889, made Francis Ferdinand next in succession to the throne after his father, who died in 1896. To enlarge his knowledge he embarked in 1892 on a one-year cruise round the world. A severe lung complaint forced him, beginning in 1895, to spend several years in the south under medical supervision. During this period his younger brother Otto (father of the future emperor Charles I) was regarded as likely to succeed to the throne. This made Francis Ferdinand a deeply embittered man, full of contempt for the high society of Vienna. Through his desire to marry Sophie, Gräfin Chotek (1868–1914), a lady in waiting, he came into sharp conflict with the emperor and with the court. Only after he had renounced his future children's rights to the throne was the morganatic marriage allowed (July 1, 1900).

Francis Ferdinand's military interests centred chiefly on the navy. In foreign affairs he considered the estrangement from Russia to be disastrous and tried, without endangering the alliance with Germany, to restore Austro-Russian understanding. At home he had a clear eye for the difficulties that were bound to develop through the reckless policy of magyarization pursued by the Hungarians against the Slavs in their half of the dual monarchy. At first he thought of a "triadic" reorganization of the monarchy, with the Slavs as the third force beside the Germans and the Hungarians. Later, however, he formed the plan of enforcing universal suffrage in Hungary before eventually receiving the crown of that kingdom, so as to secure the rights of the southern Slavs. These plans were based not on any preference for the Slavs but rather on the realization that any nationalistic policy pursued by one section of the population would endanger the multinational state of Austria. His relationship with Francis Joseph I was exacerbated by his continuous pressure on the emperor, who more and more left things to take care of themselves but sharply resented any interference with his prerogative.

From 1906 onward Francis Ferdinand's influence in military matters grew (*see* Conrad von Hötzendorf, Franz), and in 1913 he became inspector general of the army. Though he thought out his plans carefully, it is doubtful whether the irascible, temperamental prince, whose harshness roused fear rather than affection, could have mastered the problems that he would have had to face as emperor. On a visit to Bosnia-Hercegovina, he and his wife were assassinated by the Serbian student Gavrilo Princip on June 28, 1914, at Sarajevo.

See R. Kiszling, *Erzherzog Franz Ferdinand von Österreich-Este* (1953). (K. O. v. A.)

FRANCIS JOSEPH I (1830–1916), emperor of Austria from 1848 and, by virtue of coronation, apostolic king of Hungary from 1867, was born on Aug. 18, 1830, at Schönbrunn, the eldest son of the archduke Francis Charles and the princess Sophia, daughter of King Maximilian I Joseph of Bavaria. As his uncle Ferdinand I was childless, Francis Joseph was educated as his heir presumptive, particular attention being paid to military training. In spring 1848 he served with the Austrian forces in the fighting in Italy. When revolution spread to the capitals of the Austrian empire, he was proclaimed emperor of Austria at Olmütz (Olomouc) on Dec. 2, 1848, after the abdication of the emperor Ferdinand, his father's rights to the throne being passed over. Hopes of a revival of monarchist sentiments were raised by his radiant youthful appearance.

First Decade of the Reign.—Together with his prime minister, Felix, prince zu Schwarzenberg (*q.v.*), the young monarch set out to reconquer his countries. In order to quell the Hungarian rebellion he had to accept Russian help in 1849 (*see* Hungary: *History*). Schwarzenberg, the most capable statesman under Francis Joseph, combined clear understanding with the gift of propounding and executing his plans in such a way as to spare as much as possible the young emperor's strongly developed *amour-propre*. During this period Karl, Graf Grünne, adjutant general to the emperor, was also very influential; up to 1859 he was responsible for a good many calamitous decisions. In external affairs Schwarzenberg achieved a powerful position for Austria; in particular, with the Olmütz convention of Nov. 1850, he won a clear triumph over the Prussian challenge to Austrian predominance in Germany. In home affairs, however, his harsh rule and the formation of an intolerant police apparatus evoked a latent mood of rebellion. Matters became worse after 1851, when the promise of a constitution, given in 1849 under the pressure of the revolutionary troubles, was withdrawn. The consequences of this withdrawal had long aftereffects and explain the permanent distrust of Francis Joseph's rule on the part of the Liberals. In 1853 the people's discontent made itself felt in an attempt on the emperor's life in Vienna and in a riot in Milan.

On April 24, 1854, Francis Joseph contracted a marriage of love with Elizabeth, daughter of Maximilian, duke of Bavaria. The marriage produced a son and three daughters. The exceptionally beautiful and high-spirited empress succeeded in arousing popular enthusiasm, especially among the Hungarians, but brought much unrest into the emperor's life. Contemptuous of all ceremony, she was irritated by the stiff ritual of the Viennese court. Her manner deepened the gulf between herself and the Austrian high aristocracy, who for a long time also viewed Francis Joseph with disapproval.

After Schwarzenberg's death (1852) Francis Joseph took a greater part in politics. His minister, Karl Ferdinand, Graf Buol-Schauenstein, had not the abilities to impart to the emperor the necessary firmness and to restrain him from ill-considered steps. Austria's mistaken policy during the Crimean War originated largely with the emperor, who could not make up his mind between gratitude to Russia for the help given in 1849 and the advantage the monarchy might derive from siding with Great Britain and France. The deployment of Austrian armies in Galicia compelled the Russians to station troops there and created in Russia an atmosphere of ill will toward Austria that lasted up to World War I. Furthermore, the mobilization unsettled the finances of the country without providing Austria with reliable friends in the west.

Years of War.—In 1859 there began, with the war against Sardinia-Piedmont and France (*see* ITALIAN INDEPENDENCE, WARS OF), the series of unfortunate wars which seriously shook Austria's military reputation in the world. Under Grünne's influence, Francis Joseph entrusted the high command to the quartermaster general, Franz Gyulay. When Gyulay proved incapable, Francis Joseph himself took over the supreme command, but he could not prevent the defeat of Solferino (June 24, 1859). Although some German states (Prussia and Bavaria) were prepared to rush to Austria's aid, Francis Joseph concluded the peace of Villafranca (July 11, 1859), by which Austria lost Lombardy.

The mood of crisis prevailing after the defeat caused Francis Joseph to pay renewed attention to the constitutional question. There ensued a period of constitutional experiments that kept internal political life in a permanent state of crisis up to 1867. The federalistic October diploma (Oct. 20, 1860) was followed by the centralistic February patent (Feb. 26, 1861), which met with the approval of the Germans but evoked hostility among the Hungarians and the Croats. The possibilities of ruling centrally with the help of the German Austrians were quickly exhausted, as it became plain that Austria's claim to be the leading German power was no longer accepted by Prussia. The attempt of Anton von Schmerling to restore the validity of this claim at the meeting of the German princes in Frankfurt (Aug. 17–Sept. 1, 1863) miscarried because Bismarck managed to persuade William I of Prussia to stay away from the conference. The Austro-Prussian comradeship-in-arms in the war against Denmark (1864) appeared to confirm the dyarchy of the two leading German powers, but the struggle for predominance became apparent from the spring of 1865 onward. Nevertheless Francis Joseph, anticipating the result of this struggle, appointed as prime minister the conservative Richard, Graf Belcredi, whose constitutional plans were well known. Whereas Schmerling had advocated a centralist policy, Belcredi was an extreme federalist who wanted to establish the Austrian empire on the basis of the historic political rights of all the nationalities of the monarchy. Consequently he suspended the centralistic February constitution in Sept. 1865.

In the middle of the constitutional reorganization the Seven Weeks' War (*q.v.*) against Prussia and Italy broke out in 1866. Belcredi had been notified of its imminence by the emperor only after he had assumed office. Moreover, the decision as to predominance in Italy and Germany had virtually been taken before the beginning of the war, for Francis Joseph, before the outbreak of hostilities, had given an undertaking to the French emperor Napoleon III that he would cede Venetia to Italy. Nor did the new cabinet have any ideas as to how, in case of a victory over Prussia, the German confederation was to be constituted. The annihilating defeat at Königgrätz (July 3, 1866) meant the final departure of Austria from the German body politic.

Hungarian Compromise.—In domestic affairs Francis Joseph now went the way of least resistance. Belcredi had admittedly succeeded in preserving law and order in the threatened Bohemian provinces, but Belcredi's course of conciliating the Slavs was not pursued further. On the contrary, a settlement was sought with the Hungarians, who had become restless during the war. Friedrich, Graf von Beust, the new prime minister (until 1866 prime minister of Saxony), was not well enough acquainted with Austrian conditions and therefore terminated the constitutional conflict by a settlement in the Hungarians' favour—the *Ausgleich* or Compromise of 1867. This was renewable every ten years, and no consideration was given to the rights of national minorities which had remained loyal to the imperial house. Austria was now divided into two halves, each with a strong Slav minority which was granted no part in running the state and was, in the Hungarian half, in fact increasingly abandoned to magyarization. The settlement became a cancer in the body of the monarchy. (*See* AUSTRIA, EMPIRE OF.)

In spite of great temptations Francis Joseph did not want to jeopardize the newly gained constitutional stability, and therefore forwent the revenge on Prussia which Napoleon III and Beust suggested on the occasion of the Franco-German War (1870–71).

Failure of Foreign Policy in the 1870s.—Francis Joseph was now chiefly concerned with safeguarding peace. In 1872 he concluded the *Dreikaiserbund* or League of the Three Emperors with the German and Russian emperors. The international exhibition in Vienna (1873) raised the severely diminished reputation of Austria-Hungary. The new trend in Austrian foreign policy was inaugurated by the emperor's visit to Dalmatia in 1875, during which Prince Nicholas of Montenegro met him and professed his devotion to Austria. At the same time the seemingly imminent dissolution of European Turkey gave Austria an opportunity to become the guardian of law and order in the Balkans, in accordance with age-old tradition. This new policy, however, soon foundered. The ruthless policy of magyarization carried out by the Hungarians increasingly alienated the Serbs from Austria, for which they had at first had great sympathy. The Austro-Hungarian foreign minister at the time, Gyula Andrássy, himself a Hungarian, resisted an active policy in the Balkans lest any strengthening of the Slav element in the lands of the Hungarian crown should prejudice the special position of the Magyars. And finally, Austria came into collision with Russia, which exploited the situation to pose more and more forcefully as the protecting power of the Balkan Slavs. The failure to develop a sound Balkan policy in 1875 had consequences fatal for Austria. Francis Joseph recognized, it is true, the harmful results of a foreign policy increasingly dictated by Hungarian interests, but he let things slide without objection. In 1876 he reached an agreement with the Russian emperor Alexander II at Reichstadt on a delimitation of their respective spheres of interest in the Balkans; but this accord was of short duration. At the congress of Berlin (*q.v.*) in 1878 Andrássy obtained the assent of the great powers to Austria's occupation of Bosnia-Hercegovina, but this success was achieved at a great price. The Balkan Slavs from then onward looked on Austria-Hungary as the enemy, and Austria's friendship with Russia was broken for good. In 1879 a defensive and offensive alliance with Germany was concluded.

Problem of Nationalities, 1870–1914.—Henceforth until 1914 Austria-Hungary stood under the pressure of hostile Pan-Slav propaganda from both Russia and Serbia. This propaganda was bound to threaten the very existence of an empire more than one-third of whose inhabitants were Slavs. Hungarian policy prevented a satisfactory solution in the eastern half. In the western half the Czech question (*see* BOHEMIA), which had been in abeyance since Belcredi's dismissal, now became a vital issue. Nor did Francis Joseph fail to understand this. The memorandum which he caused Karl Sigmund, Graf von Hohenthal, to produce on the internal situation of the monarchy (1870) paid particular attention to conditions in Bohemia. Hohenthal (who on Feb. 7, 1871, became prime minister of the western half of the empire) attempted, in the so-called "fundamental articles," to enlarge the

privileges of the countries of the Bohemian crown, on the pattern of the Hungarian compromise, but his attempt generally to give the Slavs of the monarchy a greater measure of political freedom was dropped by Francis Joseph as soon as the first difficulties appeared. The situation in Bohemia remained practically unchanged. In this matter also Francis Joseph allowed Andrássy and Beust to dissuade him from what really was his opinion. On Oct. 30, 1871, Hohenthal had to resign. The fact that Francis Joseph never fulfilled his promise (given in 1867 and in 1871) to have himself crowned in Prague with the crown of St. Wenceslas was particularly resented by the Czechs because he did have himself crowned amid great pomp with the Hungarian crown of St. Stephen at Pressburg on June 8, 1867. Francis Joseph proved too weak to make his sounder judgment prevail against both Germans and Hungarians.

The result was the growth of radicalism among the Slavs, both in Croatia and, especially, in Bohemia. There the leadership of the national opposition passed from the Conservatives, who, despite all hostility, felt loyal to the emperor, into the hands of the radical "Young Czechs," who already disavowed the unity of the Habsburg monarchy. After a two-year state of emergency in Prague, Francis Joseph in Oct. 1895 appointed Kasimir, Graf Badeni, a Pole, to be prime minister of the western half of the empire, in a last attempt to satisfy the Czechs. But when Badeni sponsored a language decree (April 1897) giving Czech and German equal status as official languages, a storm of German nationalist indignation arose and Badeni, despite his initial successes, was dropped by the emperor (Nov. 1897). The consequence was a renewed accentuation of the national differences, which became decisive in the internal politics of the Danube monarchy.

The emperor, perplexed and irresolute, allowed things to drift. To the national differences of Germans, Magyars and Slavs there were added also, after 1900, the irredentist aspirations of the Italian-speaking minority in South Tirol. The two chambers of parliament in Vienna became the scenes of savage nationalistic vituperation in which the emperor himself was not spared. Envy of Hungary's special position perpetuated the discontent of the other nationalities, but the Hungarians showed no gratitude for it, raising their demands from decade to decade, whenever the *Ausgleich* had to be negotiated afresh. They sharpened the always latent conflict with the other nationalities by their persistent refusal to grant them rights similar to those enjoyed by themselves. The Hungarians encountered insuperable opposition from the emperor only when they attacked the unity of the army, but they succeeded in prohibiting the playing of the emperor's anthem in the lands of the Hungarian kingdom and drove obstruction to the point of refusing the lawful contingent of recruits from 1903 until 1912.

From 1882 onward external policy was determined by the triple alliance with Germany and Italy. This alliance, too, was under strain after 1900, not only because of the question of South Tirol but also because of the differences between Austria and Italy in Balkan affairs, especially over Albania. In home affairs Francis Joseph once more seized the initiative in 1906, when he took up the proposal of the Christian Social People's party and introduced universal suffrage in the western half of the empire, regarding it as a counterpoise to the forces of nationalism. This was one of the few matters on which he agreed with his heir presumptive, the archduke Francis Ferdinand (*q.v.*), whom he otherwise contrived to exclude from all participation in major political decisions.

Bosnian Crisis and World War I.—The year 1908, the 60th of his reign, brought heavy burdens for Francis Joseph. On Aug. 12, Edward VII of England visited him at Ischl with the purpose of inducing him to abandon his alliance with Germany. The emperor declined. When in October the occupation of Bosnia-Hercegovina was transformed into definite annexation by an ill-considered step of the new foreign minister, Aloys, Graf Aehrenthal, Austria was confronted with a new array of enemies. Not only were Serbia and Russia angry, but Austria also lost much good standing with the western powers. In these circumstances the fact that the German emperor William II and all the rulers of the German empire were present at Francis Joseph's jubilee (Dec. 2) served to demonstrate the solidarity of Germany with Austria-Hungary, while simultaneously student riots in Vienna, Prague and Graz provided the sombre background of the perturbed internal situation.

With the Bosnian crisis a new era of Austrian external policy seemed to be inaugurated. Franz Conrad von Hötzendorf, the chief of the general staff, and his military associates worked for a preventive war against Italy or against Serbia. In 1908 and again at the outbreak of the Italo-Turkish War in 1911, they advised an attack on Italy; and in 1912, at the outbreak of the Balkan War, against Serbia. Aehrenthal, who had correctly assessed the danger of this policy and therefore had fallen out with Conrad and indeed had brought about Conrad's dismissal in 1911, died in 1912. His successor, the easygoing and frivolous Leopold, Graf Berchthold, became enamoured of Conrad's ideas, and Conrad was recalled in 1912.

On June 28, 1914, Francis Ferdinand and his wife were murdered at Sarajevo by the Serbian student Gavrilo Princip. On July 21 Berchthold persuaded the aged emperor to sign the disastrous ultimatum to Serbia, which led to World War I (*q.v.*). Francis Joseph, deliberately misled by Berchthold, was not clear about the gravity of his decision. The war filled his last years with anguish. In 1915, true to his ingrained indecision, he could not make up his mind to bribe Italy to enter into the war on Austria's side by ceding the Italian-speaking parts of South Tirol. Thereafter his empire was involved along its entire eastern and southern borders in a life-and-death struggle for survival. On Nov. 21, 1916, the tired emperor died at Schönbrunn.

Personal Character and Achievement.—In the 68 years of his reign Francis Joseph regarded himself primarily as the chief of the house of Habsburg-Lorraine. His most important decisions were often determined by dynastic and military rather than by political considerations. The bitterest griefs that he had to sustain came to him in his own family. The series of tragedies began on June 19, 1867, when his brother Maximilian, emperor of Mexico, was shot in Queretaro at the orders of Benito Juárez. Francis Joseph's only son and heir to the throne, the archduke Rudolf, committed suicide in the hunting lodge of Mayerling on Jan. 30, 1889. The empress Elizabeth was murdered on Sept. 10, 1898, in Geneva by an anarchist. Francis Ferdinand's morganatic marriage in 1910 deeply hurt the dynastic pride of the emperor. The assassination of Francis Ferdinand and his wife was the beginning of the end of the monarchy. If the prestige of the dynasty remained intact after all these blows of fate, it was chiefly due to Francis Joseph. Lonely and old, he found a refuge in his universally respected friendship with the actress Katharina Schratt. Francis Joseph always remained the emperor, even in the circle of his family. His demeanour in public was one of inimitable dignity. His memory remained astonishing, even in his old age.

In his thoughts and actions Francis Joseph was an absolute ruler who did not know what to do with the modern institutions of parliamentary government or with the nationalist tendencies of his time. He regarded them as emanations of insubordination, and his military turn of mind confirmed him in this view. He therefore saw nothing dishonourable in breaking his various constitutional and coronation promises; in fact, he had no understanding of the indignation thus provoked. While he managed in his later years to bear personal disparagement with great dignity, he sharply rebuked, right up to the end, every attack on the unity of the army, which in his political thinking was the only reliable pillar of the state and the unifying link of the monarchy. Proceeding from such conceptions, the emperor was incapable of harmonizing the modern views of the state with the nationalistic movements among his peoples or with the peculiar structure of his empire. This explains his usual expedient of shelving urgent problems, which eventually sharpened the differences so dangerously that, in the end, only his own person, respected by everyone in spite of all hostility, kept the empire together. Francis Joseph became the symbol of his empire; he was the emperor of his era.

Francis Joseph's love of peace and proverbial devotion to duty, the many misfortunes of his life and, not least, his generosity

where help was needed, ultimately brought him the admiration of his peoples. His reign, in particular the long period of peace after 1866, formed the face of his capital, Vienna. While he himself did not indulge in any artistic inclinations and was gifted with little understanding of art, his capitals, Budapest, Prague and Vienna, assumed a cosmopolitan character that they owed to a large extent to the emperor.

There are editions of Francis Joseph's letters to his mother by F. Schnürer (1930) and to Katharina Schratt by J. Bourgoing (1951). *See* also references under "Francis Joseph I" in the Index volume.

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FRANCIUM, the heaviest of the alkali elements, is highly unstable, existing only in short-lived radioactive forms. Francium (symbol Fr, atomic number 87) occurs in uranium ores as actinium K, one of the decay products of uranium-235. As early as 1914, S. Meyer, V. F. Hess and F. Paneth observed that actinium 227, which disintegrates chiefly by emission of beta particles (electrons), sometimes emits an alpha particle (helium nucleus) instead. The emission of the alpha particle must produce atoms of element 87 with mass number 223.

In 1939 Marguerite Perey, of the Curie laboratory in Paris, isolated the daughter product, actinium K (francium), and studied its properties. She is credited with the discovery of the element, which she named francium in honour of France. Actinium K (symbol AcK) has a half life of only 21 min. for the emission of beta particles. It is produced from actinium in only 1.2% of the disintegrations of the parent element. AcK in turn exhibits branching decay since in about 1 disintegration in 10,000 it decays by alpha particle emission.

Several isotopes of francium have been produced artificially. Fr^{221} is a member of the U^{233} disintegration series. Isotopes with mass numbers 212 and 217 through 222 have been identified among the radioactive products observed when targets of thorium or uranium are bombarded in high-energy cyclotrons. All of these isotopes are more unstable than AcK. Francium cannot be isolated in visible or weighable amounts.

The chemistry of francium can be studied only by tracer methods. In all respects its behaviour is that to be expected of an alkali element filling a place just below cesium in the periodic chart of the elements. It can be coprecipitated with alkali perchlorates, chloroplatinates or silicotungstates. It is not coprecipitated with insoluble hydroxides, carbonates, sulfides or fluoride precipitates. Adsorption on cation exchange resin is a useful method of isolation.

See M. Perey, *Le Journal de physique et le radium,* vol. 10, p. 435 (1939); E. K. Hyde, *Journal of Chemical Education,* vol. 36, pp. 15–21 (1959). (E. K. H.)

FRANCK, CÉSAR AUGUSTE JEAN GUILLAUME HUBERT (1822–1890), Belgian (naturalized French) composer and organist, one of the most important post-Wagnerian figures, who exerted a wide influence on the composers of his time, was born at Liège on Dec. 10, 1822. Though claims of equal validity were made for his ancestry of German, Flemish or Walloon roots, he spent almost his entire life in France, where his style was developed. He studied at the Liège conservatory in his youth and in 1835 went to Paris, where he studied composition with Anton Reicha, entering the Paris conservatory in 1837 as a pupil of P. J. G. Zimmermann for piano, of François Benoist for organ and of A. A. S. Leborne for composition. His first compositions, *Trois Trios Concertants* (1841–42), were followed by the cantata *Ruth* (1845). He was appointed organist in 1851 at St. Jean–St. François in Paris and in 1858 at Ste. Clotilde, holding this post until his death. While professor of the organ at the Paris conservatory (1872), he became a greatly admired *chef d'école,* his pupils including Vincent d'Indy, Ernest Chausson, Charles Bordes, Henri Duparc and Augusta Holmès, the French-born composer of Irish extraction to whom he was greatly attracted.

Basing his style on the contrapuntal technique of Bach and the chromatic harmony of Wagner's *Tristan,* he established the cyclic form in composition in which a cell-like theme is repeated throughout the movements of a sonata or symphony in different guises. This principle became the basis of the teaching of D'Indy, who enlarged upon it at the Schola Cantorum, founded in 1894. In 1879 Franck completed *Les Béatitudes* and in 1888 his Symphony in D minor (first performed in Paris, Feb. 17, 1889). Franck's best works were written in the latter part of his life and include, besides the Symphony, the Piano Quintet (1879), the String Quartet (1889), *Les Djinns* (1884) and the *Variations symphoniques* (1885) for piano and orchestra, the Sonata for piano and violin (1886) and the symphonic poems *Les Éolides* (1876) and *Le Chasseur Maudit* (1882). Among his organ works are the *Six Pièces* (1862), the *Trois Pièces* (1878) and the *Trois Chorals* (1890). The finest of his works for solo piano are the *Prélude, choral et fugue* (1884) and the *Prélude, aria et finale* (1887). Though his style, making a strong romantic appeal, deeply affected his pupils, his influence faded with the first decade of the 20th century. The best of his own works continued, however, to be widely played and were rightly held to display the more powerful features of the later French romantic style. He died in Paris on Nov. 8, 1890.

See Léon Vallas, *César Franck,* Eng. trans. by H. J. Foss (1951); Maurice Kunel, *César Franck inconnu* (1958). (F. E. G.)

FRANCK, JAMES (1882–1964), German-born physicist who received the Nobel prize for physics in 1925 with Gustav Hertz, was born in Hamburg on Aug. 26, 1882. He studied in the universities of Heidelberg and Berlin and became head of a department in the Kaiser Wilhelm Institute of Physical Chemistry at Berlin-Dahlem and later (1920) professor of physics at Göttingen. In 1935 he was appointed professor in Johns Hopkins university, Baltimore, and in 1938 professor of physical chemistry at The University of Chicago, eventually becoming a citizen of the United States. His researches lay in the fields of photochemistry and atomic physics and include determinations from molecular band spectra of the energy levels of the dissociation of molecules. He was awarded the Nobel prize for researches on the changes of energy occurring on the collision of atoms with electrons, from which it appeared that an electron must have a certain minimum energy (measured in volts as ionization potential) in order to ionize an atom and that this potential varied for the different gases. This result gave experimental proof to the fundamental assumptions of Niels Bohr's theory of the atom, namely, that an atom can take up internal energy only in such discrete amounts as transform it from one stationary state to another stationary state. He died May 21, 1964, in Göttingen. (D. McK.)

FRANCK, SEBASTIAN (*c.* 1499–*c.* 1542), German humanist and spiritualist, was born at Donauwörth. After studying at Ingolstadt (1515) and at the Dominican college at Heidelberg, where Martin Bucer was among his fellow students, he was appointed to a cure in the diocese of Augsburg. About 1525, however, he went over to the Lutheran party at Nürnberg, gave up his cure and became a preacher. His earliest work (1528), a German translation of the first part of the *Diallage,* or *Conciliatio locorum scripturae,* by Andreas Althamer, shows Franck as a good Lutheran, this work being directed against Anabaptists and Sacramentarians. But in 1529 Franck produced a free version of the violently anticlerical (and to that degree anti-Lutheran) pamphlet *Supplycacyon of the Beggers* by Simon Fish, and a tract in which he demanded church discipline for drunkards. He was apparently disappointed by the moral results of the Reformation. At Nürnberg he seems to have met the disciples of Hans Denck and other Anabaptists, but he soon denounced Anabaptism as dogmatic and narrow. In 1530 he was at Strasbourg, at that time, as Nürnberg had formerly been, a centre of the spiritual movement, and there he grew intimate with Kaspar von Schwenckfeld (*q.v.*) and was revealed as a fierce enemy of all kinds of dogma. After the publication of his most important work, the *Chronica: Zeitbuch und Geschichtbibel* (1531), he was driven from Strasbourg by the authorities, after a short imprisonment. He then tried to make a living as a soap boiler at Esslingen, moving in 1533 to Ulm, where he lived as a printer till 1539, when he was forced to leave. He died after 1541 at Basel.

Franck combined the humanist's passion for freedom with the mystic's devotion to the religion of the spirit. He was suspicious as to the meaning of the "word," and regarded the Bible as a "sealed book" full of contradictions—in fact, a series of allegories merely hinting at the hidden eternal word. Controversies over dogma are meaningless and the sacraments playthings for the early church, which was not yet truly led by the spirit. In his historical writings Franck proves himself a complete skeptic regarding the meaning of history. His original intention seems to have been to demonstrate the ways of God in history, but in the end he found no realm of truth left but the inner life of a few mystics, who may be found among heathen as well as Christians and whom necessarily the world regards as heretics. Luther hated Franck not as a heretic but as a man who played with everything and did not believe or even wish to believe anything, but modern research has discovered in him a skilful writer and one of the most modern thinkers of his century.

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FRANCKE, AUGUST HERMANN (1663–1727), German pietist and educator, founder of the "ragged school," was born on March 22, 1663, at Lübeck. He studied at Erfurt and at Kiel, where he came under the influence of the pietist Christian Kortholt (1633–94), then at Leipzig where he graduated and where, in 1685, he became a *Privatdozent*. A year later he founded the Collegium Philobiblicum for the systematic study of the Bible, philologically and practically. Interdicted from preaching at Erfurt and Dresden, he found a place in the new University of Halle, first as professor of Greek and oriental languages, and then as professor of theology. There he continued to teach and preach for the next 36 years, until his death on June 8, 1727, and Halle became a centre of pietism.

At Halle in 1695 Francke instituted the "ragged school," supported by public charity. In 1698 there were 100 orphans under his charge to be clothed and fed, besides 500 children who were taught as day scholars. In succeeding years other institutions, including a dispensary and publishing house, were added. The schools grew in importance and are still known as the *Franckeschen Stiftungen*.

See the biographies by H. E. F. Guericke (1827; Eng. trans., 1837) and G. Kramer, 2 vol. (1880–82).

FRANCKE, MEISTER, German painter of altarpieces, was active in Hamburg during the first half of the 15th century. His name occurs in a contract with the travelers to England, dated 1424, in which the artist undertakes to paint an altarpiece for a chapel in the church of St. John at Hamburg. Nine separate portions of this work are now in the museum at Hamburg. Two represent scenes from the life of Thomas of Canterbury, and seven scenes from the life of Christ, including a fragment of "The Crucifixion." Besides these, few pictures can be ascribed to him with certainty. One of these is the "Christ as the Man of Sorrows" in the museum at Leipzig, an early work, and another is a later representation of the same subject in the museum at Hamburg. Meister Francke's style, though doubtless the product of the art of his time, is that of a strong personality, and all attempts to relate it to other schools have failed. With feeling for the decorative value of colour and for two-dimensional design, he combined a realistic rendering of detail and a somewhat exaggerated expression of emotions. To judge from numerous altarpieces in the north of Germany, which recall his style, his influence must have been widespread.

FRANCKEN. A number of Flemish painters of this name cultivated their art in Antwerp, Belg., during the 16th and 17th centuries. Several of them were related and some bore the same Christian name in succession. Hence, there is unavoidable confusion in the subsequent classification of paintings not widely differing in style or execution. Frans Francken the first, finding a rival in Frans Francken the second, described himself as "the elder," in contradistinction to his son, who signed himself "the younger." But when Frans the second was threatened with competition from Frans the third, he called himself "the elder," while Frans the third called himself "the younger." It is possible, though not by any means easy, to sift the works of these artists. The family stems from NICHOLAS OF HERENTHALS (*c.* 1535–96), an artist, none of whose works has survived.

HIERONYMUS (JEROM) FRANCKEN (1542–1610), the eldest son of Nicholas, studied under Frans Floris. In 1566 Hieronymus was one of the masters employed to decorate the palace of Fontainebleau, and in 1574 he obtained the appointment of court painter from Henry III. In 1603, when Karel van Mander wrote his biography of Flemish artists, Hieronymus was still in Paris. Among his earliest works was a "Nativity" in the Dresden museum, executed in co-operation with Floris. Another of his important works is the "Abdication of Charles V" in the Amsterdam museum. Equally interesting is a "Portrait of a Falconer," dated 1558, in the Brunswick gallery, Germany.

FRANS FRANCKEN the first (*c.* 1542–1616), was the second son of Nicholas of Herenthals. He matriculated at Antwerp in 1567, and died in that city in 1616. He, too, studied under Floris. Several of his pictures are in the museum of Antwerp; another, dated 1597, in the Dresden museum represents "Christ on the Road to Golgotha."

AMBROSIUS FRANCKEN (1544–1618), the third son of Nicholas of Herenthals, left more specimens of his skill than Hieronymus or Frans the first. He started as a partner of Hieronymus at Fontainebleau, then returned to Antwerp, where he passed for his guild in 1573. He died at Antwerp on Oct. 16, 1618. His best works are the "Miracle of the Loaves and Fishes" and the "Martyrdom of St. Crispin," both in the Antwerp museum.

Frans Francken the first trained three sons to his profession, the eldest of whom, though he practised as a master of guild at Antwerp from 1600 to 1610, left no trace of his labours.

HIERONYMUS (JEROM) FRANCKEN (1578–1623), the second son of Frans the first, took service with his uncle Ambrosius. He was born in Antwerp on Sept. 12, 1578, passed for his guild in 1607, and in 1620 produced a curious picture of "Horatius Cocles Defending the Sublician Bridge," which is in the Antwerp museum.

FRANS FRANCKEN the second (1581–1642), the third son of Frans the first, signed his pictures until his father's death in 1616 "the younger" and after 1630 "the elder." He was born on May 6, 1581, in Antwerp. In 1605 he entered the guild, of which he subsequently became president. He died in Antwerp on May 6, 1642. His earliest composition is the "Crucifixion," in the Belvedere at Vienna, dated 1606. His compositions include "Adoration of the Virgin" (1616) in the gallery of Amsterdam, "Woman Taken in Adultery" (1628) in Dresden, "Seven Works of Charity" (1630) at Munich, "Prodigal Son" (1633) at the Louvre.

FRANS FRANCKEN the third (1607–67), the son of Frans the second, passed in the Antwerp guild in 1639 and died at Antwerp on Aug. 21, 1667. His practice was chiefly confined to adding figures to the architectural landscape pieces of other artists. He often introduced the figures into the works of Pieter Neefs the younger.

FRANCO, FRANCISCO (1892–), Spanish soldier and statesman, head of state after the civil war of 1936–39, was born at El Ferrol on Dec. 4, 1892, the second of five children of Nicolas Franco and Pilar Bahamonde. His father was a paymaster in the navy attached to the base at El Ferrol; his mother also came of a naval family. He entered the military academy at Toledo in 1907 and was commissioned in 1910. He volunteered for service in Morocco where he served with gallantry and rising prestige for about 15 years. Promotion was rapid and he was the youngest brigadier in the army, at the age of 32, having been wounded and awarded the military medal. He founded in 1920, and later commanded, the first battalion of the Spanish foreign legion. In 1923 he married Carmen Polo, the daughter of a prosperous merchant of Oviedo. They had one child, a daughter.

Franco came much into the public eye in 1925 with the suppression of Abd-el-Krim's revolt. His spectacular landing at Alhucemas effectively ended the long-drawn-out Riff War. In 1928 he commanded the military academy at Saragossa, under the dictatorship of Primo de Rivera. This was summarily suppressed by the newly founded republic in 1931. Franco was posted to reserve and

later to the comparatively insignificant command of the Balearics. He was prominent in suppressing the Asturian miners' uprising in 1934. He was appointed chief of the general staff in 1935 by the centrist administration of Alcalá Zamora.

Franco's successive periods of power and impotence during the troubled years of the Spanish republic corresponded with its pendulum swings from moderate democratic processes to the extremes of demagogy. His last efforts at collaboration terminated with the popular front election of Feb. 1936. His appeal to the government to declare a state of emergency in the face of an anarchical situation was refused and his appointment as commander of troops in the Canary Islands amounted to exile.

The next five months of mounting tension culminated in the military rising of July 17–18. On July 18 Franco issued a manifesto in its favour in Las Palmas, flew to Tetuán and was immediately in control of Spanish Morocco. The rising in Madrid and various provincial capitals had failed and by the end of July Spain was roughly divided into two halves—the nationalists holding the north and west and the republicans the south and east (except for Seville, Córdoba and the area round Cádiz). Assassination, accidental death and imprisonment had cut off various nationalist leaders, leaving Franco in the south and Gen. Emilio Mola in the north as the outstanding figures. This dualism ended with the decree of Sept. 29, 1936, issued by the insurgents' junta of national defense, nominating Franco as head of state and supreme commander, with Mola (who was killed in an air crash nine months later) in command of the army of the north. By September Franco was at the outskirts of Madrid: he was entrenched there for the next three years. Gradual conquest of province after province and the consolidation of what was to evolve as a new regime ended with the unconditional surrender of the republican leaders in the field in March 1939.

Franco emerged as the unchallenged dictator of the new Spain. He had successfully merged the various subsidiary nationalist groups: monarchists, Falangists, Carlists and the army were now all in one movement under his leadership. No opposition or criticism of this was to be tolerated: repression was severe, revenge often ousting justice.

The necessity of repairing the ravages of civil strife enjoined on Franco a policy of neutrality at the outbreak of World War II. The *Caudillo* ("leader"), as he was now called, made no secret, however, of his belief in an Axis victory and moved toward closer ties with the Axis so long as this seemed a possibility. When Italy entered the war "neutrality" changed to "nonbelligerence," and in June 1941 Franco sent "volunteers" to fight with the Germans on the eastern front. He managed to bring his policy round full circle as the fortunes of war changed and German pressure on him lessened. By Oct. 1943 he was again a "strict neutral"; in due course the Germans were expelled from Tangier, wolfram supplies were cut and the "volunteers" on the eastern front withdrawn. Such measures did not, however, succeed in reconciling him to the victorious forces; mainly under Soviet pressure their attack on Franco, initiated at Potsdam, reached its peak on Dec. 13, 1946, when the general assembly of the United Nations recommended to its members that they withdraw their ambassadors from Spain—a motion falling far short of Soviet demands.

This moral isolation of Franco succeeded only in consolidating his power in the country. By 1947 a formal constitution had been devised, proclaiming Spain as a monarchy but specifically naming Franco as head of state with the power to name his successor "as king or regent" at a time of his choosing. At this point, as always, Franco showed discernment in his choice of ministers, constantly balancing the latent oppositions and tensions within the movement. The course of world events and the growing Soviet threat impressed on the western powers the necessity of reversing the United Nations verdict of 1946 and diplomatic normality was restored in 1950.

With the election of Gen. Dwight D. Eisenhower as president of the United States in 1952, U.S. policy regarding Spain worked toward a military alliance. Franco agreed in 1953 to the establishment of U.S. air force bases in Spain on lease, in exchange for a substantial loan, mainly expendable on military equipment. In the same year a concordat with the Vatican was established replacing that which had been abolished by the republic. The effect was to put church and state in close interdependence. In a message to the *Cortes* Franco stated that for Catholic nations questions of faith were primary obligations for the state. These pacts on the material and moral planes bore witness to the stability of his regime: neither the U.S. state department nor the Vatican would have so engaged themselves with anything less than an established power. By 1956 growing nationalism in Morocco and the granting of independence by the French to those parts of the country for which they were responsible forced Franco reluctantly to abandon the Spanish protectorate there. This he did with good grace and considerable ceremony. Spanish rights in the bases of Ceuta and Melilla and the continued possesssion of the Ifni region were guaranteed, not without seeds of future dissension. Franco consolidated his anti-Soviet position in 1957, reaffirming the Iberian bloc after talks with António de Oliveira Salazar of Portugal, and reviewing the international situation with John Foster Dulles, the U.S. secretary of state, in December. Franco explained and defended Spain's international commitments as an anti-Communist power in his end-of-the-year message to the nation. Isolation had changed into collaboration—expressed in Spain's entry into the United Nations and later to the Organization for European Economic Cooperation (O.E.E.C.). The new situation was confirmed by President Eisenhower's visit to Franco in Dec. 1959. The joint communiqué after this meeting "registered satisfactory progress in the realization of economic agreements for defense made in 1953 founded in the recognition of the necessity of the strength of both countries to reach their common objective of world peace and stability." After the breakdown of the Paris summit conference (May 1960), President Eisenhower expressed the view, in a message to Franco, that this experience of failure would serve to strengthen the bonds which united the U.S. and Spain.

Meanwhile, in internal affairs, Franco had promulgated (May 1958) his principles of the national movement, synthesizing the fundamental laws of the regime. While maintaining an absolute ban on opposition and criticism of the regime in any form, Franco brought a conciliatory note into his speech at the dedication (April 1959) of the memorial to the dead of the civil war at the Valle de los Caídos and in his declaration that Spain had its door wide open for the return of political exiles and refugees. Franco had an interview with the Spanish pretender, Don Juan, in March 1960, described in a vague official communiqué as having "examined themes of importance for the national life." The pretender's son Don Juan Carlos was clearly being educated for kingship in the undefined future. Simultaneously the Falangist syndicate was being educated for an undefined political future foreshadowed by Franco in his speech to the first syndical congress (March 1961) where the necessity of some form of dialogue in political life was emphasized.

Spain's new international commitments brought with them a reversal of Franco's original economic policy with its attendant corruption. A measure of prosperity resulted from this change. In July 1961 General Franco celebrated the 25th anniversary of the uprising which brought him to power with the most elaborate of all the parades with which he had annually celebrated this event.

In July 1962 he brought about numerous cabinet changes and also appointed Capt. Gen. Agustín Muñoz Grandes, chief of the general staff, as deputy premier and thus his apparent successor.

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FRANCO-GERMAN WAR (1870–71). This conflict, sometimes called the Franco-Prussian War, began with a declaration of war by France against Prussia on July 19, 1870, and ended with the treaty of Frankfurt signed on May 10, 1871. Hostilities, however, lasted for only six months, and after the battle of Sedan (Aug. 31–Sept. 2) German victory was virtually assured. The defeat of the French emperor Napoleon III and the triumph of Bismarck's design to establish the domination of the Hohenzollern kingdom of Prussia over Germany had far-reaching consequences

not only for their two countries but for the whole future of Europe.

The Hohenzollern Candidature for Spain.—The immediate occasion for the war, though not its basic cause, was the candidature of Prince Leopold of Hohenzollern-Sigmaringen for the vacant throne of Spain, from which Queen Isabella II had been deposed in Sept. 1868. The military politician Juan Prim, who then took charge, sought a successor from among the ruling families of Europe. In May 1869 Otto von Bismarck (*q.v.*), the Prussian chancellor, sent to Spain two emissaries whose task it was to promote the choice of a Hohenzollern. When Prim first approached Leopold in Sept. 1869 he met with refusal. He sought the aid of Bismarck and, through him, the help of King William I of Prussia in persuading Leopold to agree. On June 19, 1870, Leopold was at last persuaded. Two days later he gained from the hesitant William, as head of the Hohenzollern family, formal permission to accept the Spanish throne.

On July 2 a rumour of this *fait accompli*, so surreptitiously prepared, appeared in a Paris newspaper. It caused immediate outcry in press and parliament against a project which, by placing a German king in Madrid, would weaken French security. William I, apprised of the strong reaction in France which he had always feared, tried to withdraw. Bismarck, who was encouraging the Prussian press in a violent campaign against France, was now resolved to maneuver the French into taking some fatal step, so that France would be the aggressor if war broke out. He was plunged into despair when he learned on July 12 that, under pressure from William, Leopold's candidature had been withdrawn.

The Ems Telegram.—French diplomatic arrogance and intransigence, however, played into Bismarck's hands. The French ambassador, Vincent Benedetti, was instructed to secure from William an assurance that he would never again allow Leopold to be a candidate for the Spanish throne. The king, who was then at Ems, said on July 13 that he could never give such a promise, and a member of his diplomatic staff sent a telegram to Bismarck, in Berlin, describing the incident. It was this famous Ems telegram, edited and published by Bismarck in a way calculated to infuriate France into declaring war, that undid William's placatory gestures. In both countries public opinion was already so excited and so ready to take offense that little was needed to touch off popular clamour for war. Neither government, egged on by its military leaders, was anxious to avoid war, though personally both Napoleon and William were irresolute. On July 14 Earl Granville, the British foreign secretary, appealed to France and Prussia to make use of his country's friendly offices to avoid war. It was too late: that day the French government ordered mobilization, and the next day Prussia followed suit. On July 20, the day after France's declaration of war, Bavaria, Württemberg and Baden undertook to fight on Prussia's side.

The Origins of the Conflict.—The dispute over the Hohenzollern candidature was, clearly, little more than an excuse for an open trial of strength between France and Germany. War could have been avoided if both had wished to avoid it and might not have happened had either wanted to prevent it. The substance of French anxieties about Spain disappeared once Leopold's candidature had been withdrawn. Each government had ends which it believed would be achieved by a war at that moment; and each was convinced that it would win. In such purposes and beliefs the true origins of the war must be sought.

Napoleon III, committed to a policy of grandeur by his name and his promises, but failing in health and in clarity of mind, was confronted with increasing opposition at home and a series of recent rebuffs abroad. Prussia's victory over Austria in the Seven Weeks' War of 1866 had caught him completely by surprise, and it led to the formation of the North German confederation headed by Prussia. By the conventions of the diplomacy of "balance of power" so great an increase of Prussian power required some equivalent increase in French strength. Napoleon's efforts to secure such compensatory gains, at the expense first of Bavaria, Luxembourg and Prussia, then of Belgium and Luxembourg, were rejected by Bismarck but used to scare Bavaria, Württemberg and Baden into secret alliances with Prussia. Napoleon's second proposal, moreover, was published, undated, in the *Times* (London) of July 25, 1870, as a useful piece of Bismarckian propaganda.

Napoleon's Italian policy had been no more successful. He had forfeited any gratitude that Italian patriots might have felt for his aid in defeating Austria and gaining Lombardy in 1859 by his hasty signing of peace with Austria at Villafranca, in which he agreed to leave Venetia under Austrian control (*see* ITALIAN INDEPENDENCE, WARS OF). When Austria gave up Venetia in 1866, Italy clearly owed this concession more to the victory of Prussia than to Napoleon's mediation. In Nov. 1867 he still further alienated Italian support by intervening to preserve the temporal power of the papacy. If his Italian policy had faltered and failed, his Mexican expedition was a disaster. Having backed, by force, the installation in 1863 of the Austrian archduke Maximilian (*q.v.*) as emperor of Mexico, he had to yield to United States pressure to withdraw his troops (1866–67). Thereupon Maximilian's government fell and Maximilian himself was executed.

This restless foreign policy was prompted partly by Napoleon's desire to win the approval of different factions within France: prestige in Europe would please the nationalists; support for the Italian Risorgimento would please the liberals; support of the pope and of Maximilian would please the Catholics. Since successive failures to achieve any of these ends alienated each faction in turn, his position at home became increasingly critical by 1869. The one assuredly popular policy was to defy Bismarck: to humiliate Prussia seemed the only way to recover his waning prestige. His wife, the empress Eugénie (*q.v.*), strongly encouraged such a course. His military advisers were convinced that the reorganization of the army, which they had undertaken after the Prussian defeat of Austria in 1866, had made it more than the equal of the German armies. Much faith was pinned on the new breech-loading rifle, the chassepot, with which the whole army was now equipped, and the recently invented mitrailleuse, an early machine gun. The French generals, blinded by national pride, were confident of victory.

Bismarck, on the other hand, saw in the whole situation in Europe, and especially in the febrile policies of Napoleon, an opportunity to complete the schemes which he had cherished since he first became premier of Prussia in 1862: the hegemony of Prussia in a united Germany, but with Germany sufficiently limited in extent to be capable of being effectively united under Prussian control. The formation of the North German confederation, excluding Austria and the mainly Catholic southern German states, had been one big step in this direction. It became increasingly apparent that the next step must involve excluding French influence from Germany, as he had already eliminated Austrian. French policy, at every turn, played into his hands. Its one dramatically brilliant success, in persuading William to get Leopold's candidature withdrawn, he had to reverse equally dramatically and brilliantly by his publication of the Ems telegram.

The complete success of this maneuver can be explained only by a further important element in the whole situation. Neither the second empire in France nor the Hohenzollern monarchy in Prussia was a democracy, though each had parliamentary institutions. Public opinion and political parties, subject to waves of the cruder mass emotions of anger, fear and hatred, were much affected by a highly nationalistic press. The events of the 1860s had built up a war fever which in each country was readily directed against the other. Bismarck relied on these conditions to precipitate the war which, at least by 1870, he desired. The Prussian generals, too, were well prepared for war, and as in France the group of professional soldiers close to the throne played its part in making war inevitable.

The German Victory.—The contrast between the process of mobilization in each country, from July 14 onward, betokened ill for France. In Germany skilful planning and transport organization delivered three armies (about 380,000 men) to the forward zone within 18 days. In France great confusion reigned. Units reaching the front lacked supplies and transport, while many others were late in arriving. On July 28, when Napoleon joined the army at Metz, 14 days after mobilization had begun and 9 days after war had been declared, not a single corps was in condition to take the field. This initial inefficiency offset France's qualitative advantages of a higher proportion of professional troops and better small

arms. Germany, on the other hand, not only had superiority of numbers—for to Prussia's army were added those of the other states of the North German confederation (including Saxony and Hesse) and those of the three southern states outside it (Bavaria, Württemberg and Baden)—but also was superior in artillery. Good organization and greater mobility enabled the chief of the German general staff, Gen. H. K. B. von Moltke (*q.v.*), to reflect his superiority of numbers in most engagements of the war.

The first major engagement of the rival armies was at the battle of Wörth on Aug. 6, 1870. The German 3rd army under the crown prince Frederick of Prussia, victorious in its Aug. 4 surprise attack near Wissembourg, enveloped and defeated the flank of the French right wing under Marshal de MacMahon (*q.v.*). But although French losses included about 7,000 men killed and wounded and 4,000 taken prisoner, German losses numbered more than 10,000 men killed and wounded. MacMahon retreated westward. The main German forces, sweeping south of Metz, ran into the main French forces just west of Metz. The result was two blundering and indecisive battles, at Vionville (Aug. 16) and at Gravelotte (Aug. 18). The Germans had a three-to-two superiority in numbers, but lost more heavily than the French. The chief German gain was a strategic one—that the French retreated behind the defenses of Metz and stayed there, under Marshal A. F. Bazaine (*q.v.*). This brought with it a moral advantage—it was the French who had had to retreat to base, in considerable disorganization.

On the Marne, at Châlons, MacMahon had meanwhile assembled an improvised army of four corps. The German armies were also reorganized to meet the new situation. A force of 175,000 under the crown prince Frederick (*see* FREDERICK III, German emperor) was formed to invest Metz and keep Bazaine bottled up there. An army of the Meuse, of 240,000 men under the Saxon crown prince Albert (*see* ALBERT, king of Saxony), was directed to advance on Paris. On Aug. 22 it began to advance to Châlons. MacMahon's plan was to move to Reims, where he could act against the flank of a direct advance toward Paris and could also be near enough to join up with Bazaine if opportunity arose. But on Aug. 22 a dispatch from Bazaine was received, from which MacMahon inferred that he was about to break out of Metz. Politically it seemed necessary to go to his aid. MacMahon, therefore, ordered the ill-fated march to the Meuse and, under pressure from Paris, persisted in it even when he foresaw defeat. By Aug. 31 his forces were hemmed in by encircling German armies around Sedan. From the surrounding heights deadly artillery fire poured down on them. Trapped against the Belgian frontier, the French lost 17,000 men and were compelled to surrender on Sept. 2. About 104,000 officers and men were taken prisoner, including both Napoleon III and MacMahon. German losses numbered 460 officers and 8,500 men. Since Bazaine's army was still shut up in Metz, the result of the war was virtually decided by a campaign of only five weeks.

Yet if Sedan meant the fall of Napoleon III and losses on a scale large enough to preclude a French victory, it was by no means the end of the Franco-German War. The conflict was prolonged for another five months, against desperate odds, by the government of national defense which assumed power in Paris on Sept. 4, 1870, and proclaimed the deposition of the emperor and the establishment of the third French republic. If German victory at Sedan was the supreme example of the Prussian *Blitzkrieg*, the stubborn resistance put up by Léon Gambetta (*q.v.*) and his raw levies of patriots foreshadowed the lengthy national wars of attrition of the 20th century.

The next objective of the German command was inevitable. Paris must fall. By Sept. 19 the German armies began to invest the city. Jules Favre (*q.v.*), sent by the government of national defense to discover Bismarck's terms, broke off negotiations. Apart from the fervour of resistance shown in the capital, the Germans found the very extent of their victory an embarrassment. Thousands of prisoners had to be transported to Germany and looked after, lines of communication were greatly lengthened, and the German forces needed overhaul after their losses. The precisely run German machine was ill-fitted to deal with the irregular, improvised forces which Gambetta called up from the French countryside. A war of indefinite commitments and widely dispersed action was far from being what Bismarck wanted. Bazaine did not capitulate at Metz until Oct. 27, and meanwhile the Germans resorted to savage reprisals to combat the spread of guerrilla warfare in France. On Nov. 9 the Germans were driven out of Orléans, which they had taken a month before, but they regained it in early December. The French, however, recaptured Amiens. Four months after Sedan, the Germans had still not taken or even bombarded Paris.

Moltke felt ready to begin the attack on the capital by Dec. 27, and on Jan. 5, 1871, pressed on from bombardment of the forts to that of the city itself. On Jan. 19 the defenders began a massive sortie with a force of 90,000 men against the German lines before Versailles. It failed, and four days later Jules Favre went to Versailles to negotiate an armistice. Elsewhere Gambetta's heroic efforts to save Paris had all failed. A large force under Gen. C. D. S. Bourbaki (*q.v.*), driven back to the Swiss frontier, crossed it on Feb. 2 and was disarmed by the Swiss.

The Armistice and the Treaty of Frankfurt.—On Jan. 28 a three-week armistice was signed. In the interval general elections were to be held to elect a national assembly, to meet in Bordeaux and make peace. On Feb. 17 Adolphe Thiers (*q.v.*) was appointed chief of the executive power, commissioned to conclude peace. The preliminaries were signed on Feb. 26 and ratified by the assembly on March 1. On March 18, however, occurred the revolt of the Commune (*q.v.*) of Paris, and for nearly two more months Frenchmen fought Frenchmen in the capital, with the German armies standing by. The treaty of Frankfurt was not completed until May 10 and was ratified on May 23.

The terms of the armistice and the subsequent peace treaty were severe. They were designed to keep France weak for years to come. Germany annexed Alsace and German Lorraine with Metz (*see* ALSACE-LORRAINE). France kept Belfort, which had not surrendered until Feb. 17, and undertook to pay an indemnity of 5,000,000,000 fr. ($1,000,000,000) and to meet the costs of German occupation of the northern provinces until the indemnity had been paid. Paris itself was not occupied, but suffered the civic humiliation of a German triumphal march down the Champs-Elysées. The real triumph for Bismarck was that on Jan. 18, 1871, in the palace of Versailles, William of Prussia was proclaimed German emperor. Prussian domination of Germany (including the southern states) was now ensured.

The Results of the War.—The consequences of the war, only partially embodied in the peace which ended it, were in part dictated by the victors and in part quite incidental. The decisive military defeat of France and the completion of German unity under Prussia were Bismarck's intentions and achievements. So was the annexation of Alsace-Lorraine, though he later pretended to have agreed to it only under military pressure. The substitution of the third republic for the second empire in France and the bitter interlude of civil war that preceded it were not of his seeking or making, though he welcomed a republican France insofar as it was less likely to find friends among the monarchies of Europe.

Several other consequences were by-products of the new balance of power created by the replacement of French by German hegemony in Europe. The temporal power of the papacy, maintained since 1867 only by Napoleon's troops, survived the second empire by only 16 days. The French withdrew, Italian troops entered Rome on Sept. 20, 1870, and Italy's unification was completed shortly before Germany's. A plebiscite held in Rome on Oct. 2 declared for union with the kingdom of Italy.

In the same month the Russian government, seizing the magic moment, announced to the world that it would no longer regard itself as bound by the naval clauses of the treaty of Paris that had ended the Crimean War in 1856. The emperor Alexander II claimed the right, denied by that treaty, to build naval or military establishments on the shores of the Black sea. Great Britain and Prussia joined in denouncing this repudiation, but nothing was done to make Russia retract it. A fresh cause of future Anglo-Russian distrust was created.

The war had other, less measurable, long-term consequences. The wars of the period 1859–71, culminating in the unification of Italy and Germany, produced a great displacement of power and a

resettlement of Europe comparable to those achieved by the congress of Vienna in 1815 and by the treaties of 1919 at the end of World War I. The older diplomatic conventions, underlying the concert of Europe and involving a balance of power, had been defied and destroyed. War between major powers had been used repeatedly as a deliberate method of political reconstruction. To a degree unknown since 1815 international politics were now openly dominated by threats of violence; governments of great powers were dedicated to war as an effective instrument of national policy, not to preserving a public law of Europe. In the new atmosphere of sustained fear and tension, peace could be preserved only by subtle manipulation of the balance of power and systems of rival alliances: a situation which bred the crisis of 1914. Like the settlement of 1815, that of 1871 inaugurated a period of more than 40 years during which there was no war between the major powers. But it was not a peace born of organized stability: only a lull, born of rival tensions. *See* further EUROPE: *History;* FRANCE: *History;* GERMANY: *History;* and references under "Franco-German War" in the Index volume.

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FRANÇOIS, JEAN CHARLES (1717–1769), French etcher and engraver, one of the inventors of the crayon method in engraving, was born at Nancy. He studied art under Claude Charles at Nancy. He experimented in copper engraving, working at Dijon and Lyons where he published in 1740 the *Principes de dessein faciles,* with descriptions of a new process imitating the effect of crayon drawings in engraving. He later perfected this process and in 1758 he received a pension from the king. His most important work is the series of portraits for Saverien's *Histoire des Philosophes modernes* (1761–69). François's work is not artistic. Its importance is due to his claim of having introduced the crayon method. He stated in a letter addressed to Saverien (1760) that he made experiments in the method in 1740; and the fact that he attained recognition from the French Royal Academy in 1757 seems to substantiate his statement. Two other engravers claimed the honour of the discovery, Gilles Demarteau and L. M. Bonnet. *See* also STIPPLE AND CRAYON ENGRAVING.

FRANCOLIN, any of numerous partridges abundant in Africa and southern Eurasia, particularly the genus *Francolinus* with about 35 species and many races. One of the francolins, *F. francolinus,* is called the black partridge, from the dark plumage of the male. It ranges west to Cyprus and is about 13 in. long. The browner female lays six to ten eggs in a well-concealed nest on the ground. The double-spurred francolin (*F. bicalcaratus*) is well known, as are *F. africanus, F. shelleyi, F. coqui* and *F. squamatus,* all of which are widely distributed in Africa. The bare-throated partridge or red-necked francolin (*Pternistes afer*) and three allied species are common over Africa. Closely related is *Anurophasis monorthonyx,* of alpine grasslands high on the Oranje mountains of New Guinea. *See* also PARTRIDGE. (G. F. SS.; X.)

FRANCONIA (Ger. FRANKEN) was one of the five duchies constituting the East Frankish kingdom and subsequently the German kingdom, the other four being Saxony, Lotharingia (Lorraine), Swabia and Bavaria. It comprised some territory to the west of Mainz, Worms and Speyer and extended eastward along the Main river as far as the Fichtelgebirge; in the north it originally included Hesse, and in the south it adjoined Swabia and Bavaria. From the end of the 7th century A.D. onward this country was conquered and settled by the Franks; *c.* 720 it became a royal demesne, after the Merovingians had overthrown the ducal dynasty. Ecclesiastically, Franconia was divided among the bishoprics of Mainz, Worms, Speyer, Würzburg and, from 1007, Bamberg; the bishopric of Eichstätt, moreover, in the 8th and 9th centuries, was partly in Franconia, partly in Bavaria.

After the division of the Carolingian empire under the treaty of Verdun (843), Franconia became the nucleus of the East Frankish kingdom, until under the Ottonian emperors the centre of gravity shifted to Saxony (*see* GERMANY: *History*). The dukedom of the Conradine family (*see* CONRAD, German kings: *Conrad I;* and EBERHARD) did not last long and had disappeared by 939; as Franconia had always been a royal demesne, no strong ducal power grew up there.

The country very soon split into West or Rhenish Franconia and East Franconia. The greater part of Rhenish Franconia fell to the Palatinate or to the various Rhenish bishoprics, and a number of free imperial cities also grew up in the region. One of the most influential families of Rhenish Franconia were the Salians, who in 1024 obtained the German kingship in the person of Conrad II.

The old name of the country eventually survived only in East Franconia, and the title of duke of Franconia was in 1116 bestowed by the emperor Henry V on Conrad of Hohenstaufen. The latter's son Frederick called himself duke of Rothenburg, but toward the end of the 12th century this title too disappears. The influence of the church was always very strong in Franconia. In 1168 the bishop of Würzburg was even granted the title of duke by the emperor Frederick I, and his successors in the see of Würzburg kept this title until the secularization of the bishopric in 1802.

A great number of small territories ruled by spiritual and temporal lords developed in Franconia, particularly after the interregnum of 1254–73. In 1340 these territories combined in a first "League for the Preservation of Peace" (*Landfriedensbund*), a forerunner of one of the "imperial circles" into which Germany was to be organized in 1500 and 1512.

After the Napoleonic Wars, Franconia was divided mainly between the kingdoms of Bavaria and Württemberg and the grand duchy of Baden. Even the old name of the country vanished for some time until in 1837 King Louis I of Bavaria instituted the three provinces of Upper, Middle and Lower Franconia.

Rhenish Franconia is now divided between the *Länder* Hesse and Rhineland-Palatinate in the Federal Republic of Germany, while East Franconia forms part of the *Länder* Bavaria and Baden-Württemberg.

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FRANCO-PRUSSIAN WAR: *see* FRANCO-GERMAN WAR.

FRANCS-ARCHERS represent the first attempt at the formation of regular infantry in France. They were created by Charles VII's ordinance of Montils-les-Tours on Aug. 28, 1448, which prescribed that in each parish an archer should be chosen from among those of the people (neither nobles nor ecclesiastics) who were most apt in the use of arms; this archer was to be exempt from the taille and certain obligations (hence *franc,* "free"), to practise shooting with the bow on Sundays and feast days and to hold himself ready to march fully equipped at the first signal. Even under Charles VII, however, the *francs-archers,* numbering about 8,000, never gave complete satisfaction, and during the succeeding reigns the institution languished. It finally disappeared in the middle of the 16th century.

FRANK, ILYA MIKHAILOVICH (1908–), Russian physicist awarded the 1958 Nobel prize for physics jointly with P. A. Cerenkov and I. E. Tamm, "for the discovery and interpretation of the Cerenkov effect," was born in 1908. Cerenkov's discovery, made in 1934, was concerned with the light emitted by charged particles traveling at very high speed. Study of this effect resulted in the discovery of methods for detecting and measuring the velocity of high-speed particles. Frank, together with the noted Russian physicist I. E. Tamm, provided a theoretical interpretation of the Cerenkov effect in 1937. This work is of the greatest importance for research in nuclear physics and for

the study of cosmic rays. Frank's work includes collaboration with Cerenkov and Tamm in research on electron radiation, for which all were awarded the Stalin prize in 1946. Frank also specialized in the study of gamma ray quanta and the problem of neutron fluxes. He was made a member of the Academy of Sciences of the U.S.S.R. in 1946. (W. J. Bp.)

FRANK, JAKOB (*c.* 1726–1791), founder of the Jewish Zoharist, or Frankist, sect, was born in Berezanka (near Husiatyn) or Korolowka (near Niezlawka), both in Galicia, about 1726. His real name was Leibowicz. While wandering in the Balkans he became associated with the followers of the pseudo-Messiah Sabbatai Zebi (*q.v.*) and with the Philipovtsy sectaries. An uneducated visionary and charlatan, Frank appealed to the mystics who awaited the reincarnation of Sabbatai, and about 1751 he revealed himself as the Messiah-God. In 1755 he formed in Poland an antinomian (the term describing the view that certain elect persons are exempt from moral law) sect that abandoned Judaism for a cabalistic gnostic "higher Torah." The members called themselves Zoharists, after the *Zohar*, the chief Cabalistic writing. Their practices, including orgiastic rites, led to a ban by the Brody Jewish community in 1756. Protected by Roman Catholic authorities (who saw in the Zoharists a means of converting the Jews) as "trinitarians" and "anti-Talmudists," the Zoharists debated publicly with rabbis. They were partly responsible, thus, for Talmud burning and ritual murder accusations. In 1757 Frank fled to the Balkans and Turkey and (perhaps for the second time) became a Muslim. The sect returned to Poland in 1759 under royal protection, and over 1,000 were baptized under church pressure; others followed. They all retained their sectarian cohesiveness, however, which led to Frank's imprisonment by the Inquisition in 1760.

Freed by the Russians in 1773, Frank moved to Brno (Moravia) and in 1786 settled in Offenbach. His followers, baptized and unbaptized, in many countries, supported him in style. With age, Frank's delusions of grandeur increased. He died on Dec. 10, 1791, and was succeeded by his daughter Ewa (d. 1816). The sect deteriorated rapidly, though remnants survived probably till late in the 19th century, certainly till the middle of it.

Descendants of the baptized were absorbed by the Catholic population. Many were prominent in Polish life, and some were anti-Semites. Frankists were active in libertarian and Polish nationalist movements, particularly the 1831 revolt. A few were involved in the French Revolution. The nonbaptized die-hards, restricted to family underground groups, participated in the revolutions of 1848. Several families emigrated to the U.S.

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FRANKEL, ZACHARIAS (1801–1875), German rabbi, scholar and theologian, was born in Prague on Sept. 30, 1801. He received a thorough Talmudic training, as well as an intensive classical education at the University of Budapest. After serving as rabbi in several German communities, he was called in 1854 to the presidency of the newly organized Jewish Theological seminary at Breslau, which became the most important modern institution for the training of rabbis in Europe and lasted until the Nazi persecutions nearly a century later.

Frankel's theology was known as positive-historical Judaism. This school of thought differed from Orthodoxy in its acceptance of the results of historical research and from Reform Judaism in its maintenance of the pattern of Jewish traditional ritual and its adherence to the national aspects of Judaism. Through the faculty and students of the Breslau seminary, Frankel's viewpoint became highly influential in central Europe. In the 20th century it found congenial soil in the United States, where, under the name of Conservative Judaism, it attained its greatest growth. Frankel died at Breslau on Feb. 13, 1875.

Frankel's scholarly works on the historical development of Talmudic literature and the influence of rabbinic thought on the Septuagint are of classic importance. They include: *Die Eidesleistung der Juden* (1840), a study of the oath in Jewish law; *Vorstudien zur Septuaginta* (1841); *Introduction to the Mishnah* (in Hebrew, 1859); and *Introduction to the Palestinian Talmud* (in Hebrew, 1870); as well as other books and many articles. (Rt. Gs.)

FRANKENTHAL, a town of Germany, which following partition of the nation after World War II became part of the *Land* (state) of Rhineland-Palatinate, Federal Republic of Germany, lies in the Rhine valley 13 km. (8 mi.) N.W. of Mannheim on the railway from Ludwigshafen to Mainz. Pop. (1961) 33,949. There are monastery ruins from the 12th century, 18th-century town gates and a town hall built in 1954. There is a swimming pool and a mile of bathing beach. Manufactures include pumps, compressors, armatures, turbines and other machinery, plastic-vinyl floorings and cork. First mentioned as a fishermen's settlement (Franconodal) in 772, it had an Augustinian monastery (1119) and nunnery (1139). It was given civic rights in 1577, and a 3-mi.-long canal was constructed (1772–81) to the Rhine which had shifted from Frankenthal in 888. Although destroyed in the Thirty Years' War (1618–48) and again in the Palatinate succession wars (1688–89), the town recovered and became industrialized toward the end of the 18th century. It was severely damaged in World War II but has since been rebuilt.

FRANKENWALD, a highland in the extreme north of Bavaria, Ger., linking, physically and geologically, the Fichtelgebirge and the Thüringer Wald, is a broad well-wooded plateau, about 30 mi. long, descending gently north and east toward the Saale, but more precipitously west to the Bavarian plain. Its highest point is Döbraberg (2,608 ft.), southwest of Selbitz. Along the centre lies the watershed between the Main and the Saale basins and between the Rhine and Elbe systems. The principal tributaries of the Main from the Frankenwald are the Rodach and Hasslach; of the Saale, the Selbitz. Small hamlets lie in clearings in the heath, bog and forest. The chief centre is Hof (pop. [1961] 57,129), a railway junction and industrial town on the Saale river to the east.

Kulmbach, the city of the margraves, Kronach and Bayreuth, in the lowland to the west of the plateau, have fine medieval castles. (R. E. Dt.)

FRANKFORT, HENRI (1897–1954), Dutch archaeologist, pioneered in developing near eastern archaeology from a technique for the excavation and classification of material remains to a discipline reconstructing the significant aspects of ancient Egyptian and western Asian civilizations. Born Feb. 24, 1897, in Amsterdam, Frankfort presaged in his formative years the breadth of his later interests. Study of history at the University of Amsterdam, Egyptian with Sethe at Berlin, and archaeology under Petrie at the University of London (M.A., London, 1924; Ph.D., Leiden, 1927) was balanced by excavation in Egypt with Brunton (1922) and travel in the Balkans and near east (1922, 1924–25). This period culminated in *Studies in Early Pottery of the Near East*, 2 vol. (1924–27).

As director of the excavations of the Egypt Exploration society at Abydos, Tell el-Amarna and Armant (1925–29) and of the expedition of the Oriental Institute of The University of Chicago in Iraq (1929–37), Frankfort made discoveries and interpretations that filled major gaps in knowledge. Publications of those years ranged from Egyptian funerary texts and architecture to thoroughly documented reconstructions of Mesopotamian culture and art.

The appearance of *Cylinder Seals; a Documentary Essay on the Art and Religion of the Ancient Near East* (1939) marked the transition to the final phase of Frankfort's work (1938–54), spent as professor at The University of Chicago and the University of London, where he headed the Warburg institute. No longer absorbed by the contingencies of excavation, Frankfort brought his far-reaching humanistic interests to bear on comparative studies between the two countries where he had worked, Egypt and Mesopotamia. He approached archaeological materials with keen regard for anthropological, aesthetic and philosophical problems and with rare understanding of religious phenomena. This gave added depth to the syntheses of religion and art which were the product of Frankfort's later years (*e.g., Kingship and the Gods; a Study of Ancient Near Eastern Religion as the Integration of Society and*

Nature [1948]; *Ancient Egyptian Religion: an Interpretation* [1948]; *The Art and Architecture of the Ancient Orient* [1954]). He died in London on July 16, 1954.

See P. Delougaz and T. Jacobsen, "Henri Frankfort," and J. Vindenas, "Bibliography of Henri Frankfort," *Journal of Near Eastern Studies*, vol. xiv, pp. 1–13 (1955). (H. J. Ka.)

FRANKFORT, capital city of Kentucky, U.S., and seat of Franklin county, on the Kentucky river, 52 mi. E. of Louisville, is in the Bluegrass region and surrounded by hills on both sides of the river. The city is a trading centre for the rich surrounding country, which produces tobacco and raises thoroughbred trotting horses. Natural gas and hydroelectric power are available. The manufactures include bourbon whisky, candy, furniture, electronic parts, shoes, clothing, rolled metal parts, ornamental iron rails and columns, store fixtures and cooperage products.

Frankfort was founded in 1786 by Gen. James Wilkinson and was chosen capital of the state in 1792 (when its population was less than 500) because of its central location. It was chartered as a city in 1839. Twice during Frankfort's early history the capitol burned, and both times the larger cities of Louisville and Lexington attempted to become the state capital but Frankfort was retained.

During the Civil War it was occupied for a short time (1862) by Gen. Braxton Bragg (Confederate), who was driven out by Gen. Don Carlos Buell.

In 1900 there was a bitter contest for the governorship, in connection with which the Democratic claimant, William Goebel, was assassinated. Daniel Boone and other national heroes are buried in the Frankfort cemetery. Frankfort was inundated during the Ohio river flood of 1937. Property damage was extensive, and the losses were estimated in millions of dollars.

The state capitol (built in 1905–09 at a cost of $2,000,000) is of granite and white limestone, 400 ft. long by 185 ft. wide, finished on the interior entirely in white marble. The old capitol (1829) is occupied by the Kentucky Historical society. The state arsenal, the state board of health, Kentucky State college (established in 1886 for Negroes) and the Kentucky Training home for feeble-minded persons are also there.

The Orlando Brown house and Liberty hall are noted examples of the many fine homes in the city's environs. The name Frankfort is a corruption of "Frank's Ford," which was named for an early settler, Stephen Frank. Pop. (1960) 18,365. For comparative figures *see* table in Kentucky: *Population*. (J. W. Cl.)

FRANKFURT AM MAIN (Frankfort on Main), a city of Germany in the *Land* of Hesse, which after partition of the nation following World War II was in the Federal Republic of Germany, lies on both sides of the Main about 22 mi. above its confluence with the Rhine at Mainz. Frankfurt, birthplace of the poet Goethe, was famous from the 9th to the 18th century as the town where the German kings were elected, and from the 13th century as a centre for trade and communications. Although severely damaged during World War II it has remained one of Germany's leading commercial and industrial cities. Pop. (1961) 683,081.

The City.—The stages of development can still be seen in its general plan. The old fortified town grew up in the 12th century round the imperial castle of Pfalz, which was built on the cathedral hill. The limits of the old town (Altstadt) are marked by the Main on the south and by street names ending in *-graben* (moat) from Hirschgraben on the west to Wollgraben on the east. (Sachsenhausen, the district south of the river, was also fortified, however.) The new town (Neustadt) arose when the boundaries were extended after 1333. Also fortified, its walls were demolished after 1806 and replaced by promenades, the Anlagen. The only surviving fortifications are the round tower of the Eschenheimer Tor, 155 ft. high (1426–28), the Rententurm (1455–56) on the bank of the Main, and the Kuhhirtenturm (1490) in Sachsenhausen. After 1866 Frankfurt expanded and its area increased to nearly three times its original size. Air raids in 1943–45 largely destroyed the old town. The new town has been rebuilt in modern style.

Churches.—The cathedral, dedicated to St. Bartholomew since *c.* 1215, is of red sandstone and has a 300-ft. tower. It stands on the site of an earlier church, the Salvatorkirche, built in 852 by Louis the German. The present church was originally a Romanesque basilica, but this was replaced by an early Gothic building in 1235–39 and was again reconstructed from 1315 to 1500, when the Pfarrturm was temporarily completed by a cupola. The building, including the tower (309 ft. high with a peal of nine bells including the Imperial bell "Gloriosa" which weighs about 12 tons) was only finished after a fire in 1867. Partly destroyed during World War II, the cathedral was completely restored and rededicated in 1954.

The Roman Catholic St. Leonhardskirche was built after 1219 on a site presented to the town by the emperor Frederick II. Also originally a basilica, it was reconstructed in the 15th and 16th centuries as a Gothic building of the hall type. Two Romanesque towers and two beautiful Romanesque portals still remain, however. The Nikolaikirche, on the south side of the Römerberg square, dates from the 13th century. It served as church to the town council in the 15th century. Some time after the Reformation it was secularized but in 1847 was once more established as a Protestant church. The Protestant Katharinenkirche, in the town centre (1678–81), stands on the site of a 14th-century church where the first Protestant sermon in Frankfurt was preached in 1522.

Other notable churches are the Roman Catholic Liebfrauenkirche, founded in the 14th century and reconstructed in the 15th and 16th centuries as a Gothic hall-type church; the Deutscheordenskirche in Sachsenhausen, a Gothic building (1309), converted to the baroque style (1747–51); the 9th-century Justinuskirche in the western suburb of Höchst; and the Paulskirche (1789–1833), which was the meeting place of the 1848–49 national assembly and since being reconstructed in 1947 has served as a hall for festive civic occasions. All these churches were damaged in World War II and have been restored. Striking examples of modern ecclesiastical architecture include the Allerheiligen church (1953) of white and yellow limestone with steel campanile, the towerless Michaeliskirche (1954), the Weissfrauenkirche (1955) with parabolic interior, the Hedwigskirche (1955), the Heilandskirche (1955) on the plan of a community centre and the Wendelskirche (1957) on the south bank.

Other Notable Buildings.—In the heart of the city lies the Römerberg, a square once surrounded by picturesque old houses. Those on the north and southeast were destroyed in 1944 and are to be rebuilt in modern style. The patrician residence, Zum Römer, which gave the square its name, lies on the western side. In 1405 it was bought by the town and converted into a town hall. Later the two adjacent houses were also acquired, and the five-gabled Gothic façade became famous. Inside the Römer, the only room to have been restored is the Kaisersaal, or imperial hall, where the coronation banquet of the Holy Roman emperors was held, following their election and coronation in the city. The Fernmelde-Hochhaus, or telecommunications headquarters, has replaced the palace of the princes of Thurn and Taxis (1731–36) in which the German *Bundestag* met from 1816 to 1866. Only the palace doorway and entrance pavilion remain.

On the bank of the Main a 13th-century Romanesque chapel remains of the Saalhof, the castle built by the Hohenstaufen kings about 1150. A new building replaced the castle in the 14th century and was given an imposing Renaissance façade in 1715; it contains the historical museum. It was planned to rebuild the war-damaged Leinwandhaus (linen drapers' hall, 1396), near the cathedral, and to use it as a Roman Catholic centre. The house in the Grosser Hirschgraben where Goethe was born and spent his youth was burned to the ground in 1944. It has been faithfully restored and contains the original interior fittings. With the adjoining Goethe museum and library it is one of the city's chief attractions.

Notable modern buildings include the late 19th-century exchange (Neue Börse), the Frankfurter Hof hotel and the main station, the festival hall in the exhibition grounds (1907–08), the wholesale market hall (1927–28) and the former offices of I. G. Farben's chemical works (1928–30). After 1950 a series of skyscrapers was built, among them the offices of the Allgemeine Elektrizitäts-Gesellschaft on the south bank. Among the treasures of the municipal and university libraries are a 9th-century

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THE ESCHENHEIMER TOR, FRANKFURT AM MAIN, A LANDMARK OF THE MEDIEVAL CITY, CONTRASTING WITH THE MODERN POST OFFICE IN THE BACKGROUND

ivory diptych, a Gutenberg Bible, the Schopenhauer records and Gustav Freytag's collection of pamphlets.

The most famous of Frankfurt's museums is the Senckenberg museum of natural history. Its history began in 1763 when Johann Christian Senckenberg, the physician, bequeathed his large fortune to the citizens of Frankfurt. At Goethe's instigation the Senckenberg Society for Scientific Research was founded in his memory in 1817; this society set up the museum which has prehistoric, paleontological, zoological and mineralogical collections. The Städel art institute, Frankfurt's fine picture gallery on the south bank of the Main, contains Italian, German, French, Spanish and Dutch paintings from the 15th to the 18th centuries, as well as contemporary works. The city's collection of sculpture, containing among many masterpieces the "Myron Athena," is housed in the adjoining Liebieghaus. The moated castle (1727) of the von Holzhausen family contains prehistoric and Roman antiquities from the Frankfurt area. The opera house (1875–80) stood in ruins after World War II, and the former Schauspielhaus (playhouse) was rebuilt and renamed Grosses Haus and supplemented by an adjoining theatre.

The Johann Wolfgang Goethe university, one of the largest in Germany, was founded in 1914 by an amalgamation of the existing institutions, including the Paul Ehrlich institute for serum research and the Senckenberg Society for Scientific Research. There are colleges of art and music, and many learned institutions, including the Leo Frobenius institute for ethnography with its great library. The Palmengarten (palm garden), founded in 1868, is known throughout Germany for its large collections of flowers from all parts of the world. South of the city the municipal forest of 10,000 ac. contains a golf course and the zoological gardens are in the eastern part of the city.

Commerce, Industry and Communications.—By the 14th century Frankfurt was already a great trading town. The half-yearly fairs (first mentioned in 1240), before Easter and at the beginning of September, were frequented by merchants from all over Europe. As well as dealing in goods, therefore, Frankfurt also became a banking centre of the first importance, and it was there that the Rothschild family started business.

Besides the two international fairs there are now many specialized fairs (furs, clocks, jewelry, chemical apparatus) and among the international exhibitions are the book fair, which takes place annually in September, and the automobile show. Up to the middle of the 19th century Frankfurt was a purely commercial town; it was only after 1866 that it became industrialized. Frankfurt with its suburbs (Höchst, Bockenheim, Fechenheim, etc.) now has large chemical and pharmaceutical concerns, printing works and electrical and metal industries (machine construction, light machinery, etc.), and it also manufactures leather goods, foodstuffs and beer. Frankfurt is noted for the production of high-class sausages (hence frankfurters). It is the headquarters of many professional associations (automobile industry, engineering, book trade, etc.).

Frankfurt's importance as a communications centre has grown steadily since the 13th century. Up to 1844 there was only one bridge (mentioned in 1222 and pulled down in 1914) over the Main. Ten bridges were destroyed by retreating German troops in 1945. Of the new bridges the most important is the Friedensbrücke (Bridge of Peace). By the construction of a large inland harbour in 1907–12 Frankfurt became a key point for inland shipping. It is the point of intersection of two *Autobahnen*—from Berlin and the north to Munich and Salzburg, and from Cologne to Nürnberg. Similarly, after the opening of the first railway to Kastel in 1840, Frankfurt became the centre of west German rail communications. The Frankfurt airport, 10 km. (6 mi.) S.W. of the city centre, is one of the focal points of international air transport.

History.—Excavations in the area of the former old town have produced evidence that there was already a Roman settlement in Frankfurt in the 1st century A.D. Where the suburbs of Heddernheim and Praunheim now stand was the great Roman camp Nida, the administrative centre for the hinterland (*civitas Taunensium*) of the Roman frontier wall, the Limes.

The name Frankfurt ("ford of the Franks") probably arose about A.D. 500 when the Franks drove the Alamanni south. The first written mention of it occurs in 793, when Einhard, Charlemagne's biographer, states that he spent the winter in the villa Frankonovurd.

In 794 Charlemagne held a western synod in the castle at Frankfurt; in the 9th century the east Frankish Carolingian kings chose the place as their residence. It was only in the 12th century, however, that the castle settlement developed into a town through the favour of the Hohenstaufens. Henry, the son of Conrad III, was elected German king in Frankfurt in 1147, but he died before his father and it was not until 1152, when Frederick Barbarossa was elected, that the first reigning king was elected in Frankfurt.

Between the end of the 12th and the beginning of the 14th century the city's constitution developed into the form which remained effective until 1806. A royal bailiff or magistrate replaced the governor of the castle as head of the town soon after 1200. Gradually a council grew up composed of elder magistrates, counselors and members of the guilds. In 1311 two mayors, annually elected, replaced the royal bailiff as head of the council and in 1372 the town became in fact a free imperial city. The 14th century saw a remarkable advance in all spheres of Frankfurt's life. In the Golden Bull (*q.v.*) of 1356 Charles IV named Frankfurt as the town where the German kings were to be elected. The copy of the bull made specially for Frankfurt in the imperial chancellery is one of the city's treasures. From 1562 to 1792 the kings elected in Frankfurt were also crowned there.

During the Reformation, Frankfurt accepted the Reformed church and remained Lutheran, although the Catholics kept the cathedral and some other churches. In 1554 Frankfurt became the home of many Protestant refugees from England and the Netherlands. The English under John Knox, however, left Frankfurt after the Marian persecution in England ceased, but the Netherlanders remained in Frankfurt. In the 17th century the autocratic rule of the council, whose members came from a small group of aristocratic families, led to a revolutionary movement

among the citizens. An agreed constitution was reached under the leadership of Vincenz Fettmilch in 1612. But the revolution went further and was eventually put down in 1614 by imperial commissioners and in 1616 its leaders were put to death. The situation, however, did not improve. Only in 1705–32, following another popular uprising, was a case (*Frankfurt* v. *Frankfurt*) brought by the emperor in Vienna and judgment given for the citizens of the town. From that time the constitution of 1612, with a measure of popular representation, was in force.

When the empire broke up in 1806 Frankfurt lost its free status. It became the seat of government for the prince primate of the Confederation of the Rhine and in 1810 became capital of the grand duchy of Frankfurt created by Napoleon. In 1815, however, under the new order for Germany made by the congress of Vienna, it became once more a free city, and a sovereign member of the German confederation. As the meeting place of the *Bundestag*, it was the real capital of Germany and so remained for more than 50 years.

A commercial and maritime treaty was concluded with Great Britain in 1832. In 1848 the first German national assembly was held in the Paulskirche. After the war of 1866 Frankfurt was occupied by Prussian troops and forcibly incorporated into the newly formed Hesse-Nassau province of Prussia. It was only after this annexation that it developed into a big industrial city. The peace treaty concluding the Franco-German War was signed there in 1871. After World War I Frankfurt was occupied briefly (for the sixth time) by the French and during World War II, after its capture by U.S. troops, it became the headquarters of the U.S. occupation forces and in 1948 of the U.S.-British administration. *See* also references under "Frankfurt am Main" in the Index. (H. Mt.)

FRANKFURT AN DER ODER, a town of Germany, which following partition of the nation after World War II became the capital of the *Bezirk* (district) of the same name in the German Democratic Republic. It is situated on the Oder about 90 km. (56 mi.) E.S.E. of Berlin. Pop. (1961 est.) 56,995. Frankfurt is a frontier town; a former suburb (Damm-Vorstadt) on the right bank of the Oder was transferred to Poland in 1945 where it became Slubice. Among its interesting buildings are the 13th-century brick-built Marienkirche, the Rathaus (15th century, remodeled 1607–10), the old university and the Kleist-Haus, now a memorial to the poet, Heinrich von Kleist, with a large library. The town was seriously damaged in World War II but was after ward reconstructed. Frankfurt is on the Berlin-Warsaw-Moscow railway and is an important transit point for trade with East Germany's eastern neighbours. The Oder-Spree canal flows into the Oder about 6 mi. S. of Frankfurt, which has an inland harbour. Machinery, furniture, foodstuffs, shoes and textiles are manufactured.

Frankfurt grew out of a settlement of Franconian colonists and traders, receiving its municipal charter in 1253. From 1368 to 1450 it was a member of the Hanseatic league and in 1379 received the right to free navigation on the Oder. Frankfurt's fairs later became important. The university was founded in 1506; it was moved to Cottbus in 1516 but returned to Frankfurt in 1539. Dissolved during the Thirty Years' War and later re-established by Frederick William of Brandenburg (the Great Elector, d. 1688), it was finally transferred to Wroclaw (Breslau) in 1811. In World War II Frankfurt was captured by Soviet forces in April 1945.

FRANKFURTER, FELIX (1882–1965), a major figure in modern U.S. jurisprudence and justice of the United States Supreme Court, was born in Vienna, Aus., on Nov. 15, 1882, the son of a merchant who was heir to six generations of rabbinical culture. His father, Leopold, left Vienna for New York in 1893, and before the next year was up his wife and six children followed him. Felix, who knew no English when he arrived, graduated eight years later from City College of New York, third in his class. After a year as clerk for the New York City Tenement House Commission, he entered the Harvard Law School, where he led his class and from which he graduated in 1906 with highest honours. After graduation he worked for a while with John Chipman Gray on volumes five and six of that master's famous work on property law, and then joined the law firm of Hornblower, Byrne, Miller and Potter in New York.

Plainly private practice was not Frankfurter's forte. After a few months he gave it up to assist Henry L. Stimson (*q.v.*), then newly appointed United States Attorney for the Southern District of New York. In this capacity he gained broad experience in historic litigation concerned with "trust busting," bank failures in the panic of 1907, other business and financial matters, and the flood tide of immigration. When Stimson became secretary of war in 1911, Frankfurter served him as personal assistant. There can be no doubt that "the incredibly effective and wholly scrupulous" Stimson (the description is Frankfurter's) left an abiding mark upon the young man, as did friendships with Oliver Wendell Holmes and Louis D. Brandeis which began in this period.

After Pres. William Howard Taft's defeat in the election of 1912, Frankfurter stayed on for a year in the Wilson administration and then went to Harvard as professor of law. When the United States entered World War I in 1917, he served Secretary of War Newton D. Baker as legal adviser on industrial problems. He became secretary and counsel to the President's Mediation Commission and later became chairman of the War Labor Policies Board. In 1919 he served as legal adviser to Pres. Wilson at the Paris Peace Conference, where incidentally he did much to promote the Zionist cause. Soon after his return to America Frankfurter married Marion Denman, daughter of a Congregationalist minister, and resumed his work at Harvard. There he participated in many liberal causes and in the founding of the *New Republic* and the American Civil Liberties Union. His famous article on Sacco-Vanzetti in the *Atlantic Monthly* (March 1927; *see* SACCO-VANZETTI CASE) made him a central figure in that *cause célèbre*.

Among his extensive journalistic and technical writings during this period, perhaps his books *The Business of the Supreme Court* (with James Landis, 1927), *The Labor Injunction* (with Nathan Greene, 1930), *The Commerce Clause Under Marshall, Taney and Waite* (1937), and *Mr. Justice Holmes and the Supreme Court* (1938) are his major contributions.

In 1932 Frankfurter declined a seat on the Supreme Judicial Court of Massachusetts, the tendered appointment constituting perhaps something of an *amende* for the state's handling of the Sacco-Vanzetti affair. Meanwhile, he had become an adviser to Gov. Franklin D. Roosevelt of New York. When Roosevelt became president of the United States, Frankfurter declined the solicitor generalship but served as a close presidential adviser. On Jan. 17, 1939, he was appointed associate justice of the Supreme Court of the United States. (For the so-called attempt to "pack"—or "unpack"—the Supreme Court, *see* UNITED STATES: *History: From Roosevelt to Roosevelt: The Supreme Court Issue.*) He retired in ill health on Aug. 28, 1962, and died on Feb. 22, 1965, having received a presidential Medal of Freedom (July 1963) and the American Bar Association's Gold Medal "for conspicuous service to the cause of American jurisprudence" (August 1963).

When Frankfurter left Harvard for the bench, he was generally considered a liberal. Later some deemed him a conservative. The apparent change reflects his sensitivity to the difference between a man's private convictions and his duty on the bench. He saw that duty in this light:

As society becomes more and more complicated and individual experience correspondingly narrower, tolerance and humility in passing judgment on the experience and beliefs expressed by those entrusted with the duty of legislating emerge as the decisive factors . . . in adjudication. (Frankfurter, "Holmes, Oliver Wendell," in *Dictionary of American Biography*, vol. xxi, p. 423, Supplement One, Charles Scribner's Sons, New York, 1944.)

Knowing that judges have no special access to the truth, he did not repudiate the ancient judicial power to strike down legislation, but he used it sparingly. For he could not easily bring himself to intrude upon "the exhilarating adventure of a free people determining its own destiny."

BIBLIOGRAPHY.—Glimpses of Frankfurter's life and philosophy will be found in his autobiographical *Felix Frankfurter Reminisces* (1960), and in the two volumes of his occasional papers: A. MacLeish and E. F. Prichard (eds.), *Law and Politics* (1939); and P. Elman (ed.), *Of Law and Men* (1956). For the observations of friends and associates,

see W. Mendelson (ed.), *Felix Frankfurter: a Tribute* (1964) and *Felix Frankfurter: the Judge* (1964). A survey of his jurisprudence will be found in H. S. Thomas, *Felix Frankfurter: Scholar on the Bench* (1960), and in L. L. Jaffee, "The Judicial Universe of Mr. Justice Frankfurter," *Harvard Law Review*, 62:357 (1949). (W. Me.)

FRANKINCENSE (Olibanum), an aromatic gum resin obtained from certain species of trees of the genus *Boswellia*, family Burseraceae (*q.v.*). About five species of *Boswellia* have been distinguished: one, indigenous to the mountainous tracts of central India and the Coromandel coast, and another, found in Ethiopia, though both exude the resin, are not known to yield any of the olibanum of commerce. *B. frereana*, *B. bhua-dajiana* and especially *B. carteri* of the Somali country in east Africa, the last species including a variety found in Hadramaut, Arabia, are the sources of true frankincense or olibanum.

To obtain the frankincense a deep incision is made in the trunk of the tree, and below it a narrow strip of bark five inches in length is peeled off. When the milklike juice that exudes has hardened by exposure to the air, the incision is deepened. In about three months the resin has attained the required degree of consistency. The season for gathering lasts from May until the first rains in September. The large clear globules are scraped off into baskets, and the inferior quality that has run down the tree is collected separately. The collected resin is shipped to Aden or other Arabian ports, or directly to Bombay, then packed for export to Europe, China and elsewhere.

Frankincense or olibanum occurs in commerce in semiopaque, round, ovate or oblong tears or irregular lumps, which are covered externally with a white dust, the result of their friction against one another. It has an amorphous internal structure and a dull fracture; is of a yellow to yellowish-brown hue, the purer varieties being almost colourless, or possessing a greenish tinge; and has a somewhat bitter aromatic taste and a balsamic odour, which is developed by heating. Immersed in alcohol it becomes opaque, and with water it yields an emulsion. It contains about 72% of resin soluble in alcohol; a large proportion of gum soluble in water, and apparently identical with gum arabic; and a small quantity of a colourless inflammable essential oil, one of the constituents of which is the body oliben. Frankincense burns with a bright white flame, leaving an ash consisting mainly of calcium carbonate, the remainder being calcium phosphate and the sulfate, chloride and carbonate of potassium. Good frankincense, according to Pliny, is recognized by its whiteness, size, brittleness and ready inflammability. That which occurs in globular drops, he says, is termed male frankincense; the most esteemed is in breast-shaped drops, formed each by the union of two tears. The best frankincense, Arrian wrote, was formerly exported from the neighbourhood of Cape Elephant in Africa (the modern Ras Fiel); and A. von Kremer, in his description of the commerce of the Red sea (1863), observed that the African frankincense, called by the Arabs *asli*, is of twice the value of the Arabian *luban*.

Frankincense was used by the ancient Egyptians in their religious rites, but not in embalming. It constituted a fourth part of the Jewish incense of the sanctuary and is frequently mentioned in the Pentateuch. As a medicine it was in former times in high repute. Pliny mentions it as an antidote to hemlock, and Avicenna recommends it for tumours, ulcers of the head and ears, affections of the breast, vomiting, dysentery and fevers. In the east frankincense has been used as an external application on carbuncles, blind boils and gangrenous sores, and it has been given internally in the treatment of gonorrhea. In China it was an old internal remedy for leprosy and struma, and is accredited with stimulant, tonic, sedative, astringent and vulnerary properties. It is not used in modern medicine, being destitute of any special virtues, but does find use in incense and fumigants and as a fixative in perfumes. (*See* also Incense.)

The names common or American frankincense are sometimes applied to the hardened resin *gum thus* from which spirits of turpentine is produced.

FRANKING. A term used for the right of sending letters or postal packages free (Fr. *franc*) of charge. The privilege was claimed by the English house of commons in 1660 in "a Bill for erecting and establishing a Post Office," their demand being that all letters addressed to or sent by members during the session should be carried free. The clause embodying this claim was struck out by the lords, but with the proviso in the act as passed for the free carriage of all letters to and from the sovereign and the great officers of state, and also the single inland letters of the members of that present parliament during that session only. The practice, however, apparently was tolerated until 1764, when, by an act dealing with postage, it was legalized, every peer and each member of the house of commons being allowed to send free 10 letters a day, not exceeding an ounce in weight, to any part of the United Kingdom, and to receive 15. The act did not restrict the privilege to letters either actually written by or to the member, and thus the right was very easily abused, members sending and receiving letters for friends, all that was necessary being the signature of the peer or M.P. in the corner of the envelope. Wholesale franking grew usual, and M.P.'s supplied their friends with envelopes already signed to be used at any time. On Jan. 10, 1840, parliamentary franking was abolished on the introduction of the uniform penny rate.

In the United States the franking privilege was first granted in Jan. 1776 to the soldiers engaged in the American Revolution. The right was gradually extended till it included nearly all officials and members of the public service. By special acts the privilege was bestowed on presidents and their widows. The vice-president, members of the house and senate and delegates, the clerk of the house and the secretary of the senate were given the privilege of sending and receiving free through the mail all public documents printed by order of congress, the written name of the official user, or a facsimile, and designation of the office appearing on the envelope or parcel, this privilege continuing until the 30th day of June following the expiration of their respective terms of office. The *Congressional Record* or any part thereof could, under the frank of a member or delegate to be written by himself, be carried free under regulations of the postmaster general. Seeds transmitted by the secretary of agriculture or by any member or delegate receiving seeds from the department for transmission could be sent free in the mails under frank, this privilege applying to former members and former delegates for a period of nine months after the expiration of their terms. The vice-president, members, members elect, delegates and delegates elect could send free through the mails, under their franks, any mail matter to any government official or to any person, correspondence not exceeding four ounces in weight, upon official or departmental business. United States government agencies are entitled to use the so-called "penalty" statement ("penalty for private use to avoid payment of postage $300") in lieu of postage stamps. The equivalent legend in Great Britain is "O.H.M.S." ("on her majesty's service"). (G. B. Gy.)

FRANKLAND, SIR EDWARD (1825–1899), English chemist and pioneer in the field of structural chemistry, was born at Churchtown, near Lancaster, on Jan. 18, 1825. He wished to enter the medical profession and so was apprenticed to a druggist. During this period of six years he became interested in chemistry and taught himself to make experiments and even to carry out rough analyses of water. In 1845 he entered Lyon Playfair's laboratory in London, subsequently working under R. W. Bunsen at Marburg for three months, and again in 1848. In 1847 he was appointed science master at Queenwood school, Hampshire, where he met John Tyndall. He received his Ph.D. at Marburg in 1849. In 1851 Frankland became the first professor of chemistry at Owens college, Manchester. He worked at Giessen, Ger., under Justus von Liebig for a time. Returning to London, he became lecturer in chemistry at St. Bartholomew's hospital, and in 1863 professor of chemistry at the Royal institution as successor to Michael Faraday. In 1865 he succeeded August Wilhelm von Hofmann at the School of Mines, where he remained for 20 years. In 1894 he received the Copley medal, the highest honour of the Royal society. He was made a knight commander of the Bath in 1897 and died while on holiday at Golaa, Nor., on Aug. 9, 1899.

Analytical problems, such as the isolation of certain organic radicals, attracted his attention to begin with, but he soon turned to synthetical studies. He was only about 25 years of age when

he discovered the organometallic compounds. A consideration of these and other substances led Frankland, in 1852, to the conception that the atoms of each elementary substance can combine only with a certain limited number of the atoms of other elements. The theory of valency thus founded dominated the subsequent development of chemical doctrine and formed the basis of modern structural chemistry.

In applied chemistry Frankland's great work was in connection with water supply. He was appointed a member of the second royal commission on the pollution of rivers in 1868, and in the course of six years he brought to light an enormous amount of valuable information respecting the contamination of rivers by sewage, trade refuse, etc., and the purification of water for domestic use. He also showed that the luminosity of a flame was not only connected with the presence of solid particles but also with the pressure of the burning gas or vapour; even hydrogen at a pressure of 10 to 20 atm. burns with a luminous flame. Further, he showed that the spectrum of a dense ignited gas resembles that of an incandescent liquid or solid, and he traced a gradual change in the spectrum of an incandescent gas under increasing pressure. Frankland, in conjunction with Sir Joseph Norman Lockyer, applied these results to solar physics, thereby leading to the view that at least the external layers of the sun cannot consist of matter in the liquid or solid forms but must be composed of gases or vapours. Frankland and Lockyer were also the first to realize the existence of helium (*q.v.*).

See memorial lecture delivered by H. E. Armstrong before the London Chemical Society on Oct. 31, 1901; also H. McLeod, *Journal of the Chemical Society* (1905); *Autobiographical Sketches* (1902); W. A. Tilden, *Famous Chemists* (1902); J. Wislicenus, *Berichte der deutschen chemischen Gesellschaft* (1900). Frankland's original papers, down to 1877, were collected and published as *Experimental Researches in Pure, Applied and Physical Chemistry*.

FRANKLIN, BENJAMIN (1706–1790), American printer, author, publisher, inventor, scientist, public servant and diplomat, has been called "the first civilized American," "the apostle of modern times" and even "the immortal mentor, or, man's unerring guide to a healthy, wealthy, and happy life." Beyond question he was one of the best known and most admired men in the world during the latter half of the 18th century, and he has remained a prominent and symbolic figure in the American gallery of heroes. His life and his thought, however, were so complex and so marked by apparent contradictions that he has puzzled some of his most sensitive interpreters.

His contemporaries knew him as natural philosopher, moralist and diplomat, renowned for his identification of lightning with electricity, for his widely translated and reprinted *Way to Wealth* (the collected sayings of his fictional almanac maker, "Poor Richard" Saunders) and for his skilful furtherance of the welfare of the British colonies which became the United States of America. All educated Europeans knew the epigram of Turgot, the French economist—"He snatched the lightning from the skies and the sceptre from tyrants"—and a great many agreed.

Later generations, however, have known Franklin most directly through his posthumously published *Autobiography*. It is an account of his life to 1757, written at wide intervals between 1771 and 1788 and often inaccurate in details. Addressed to his natural son William, it preaches the gospel of getting ahead in the world by thrift, industry and shrewd use of the lessons of experience. Franklin displayed a keen eye for the main chance, and his book is a classic American example of the rags-to-riches story. To the officers of savings banks and other practical men Franklin has seemed the summation of good sense and morality. To others, those who rate caution below warm human sympathies and reverence for the mysteries of the human spirit, he has often appeared to be only a colourless and materialistic opportunist.

"God helps those who help themselves," one of Poor Richard's maxims, is doubtless typical of one facet of Franklin. Yet he was not an ungenerous, timid or self-centred man. He was often passionate and extravagant; he enjoyed whimsy and hoaxes; he looked at the world with a mixture of hope and cynicism. He loved men and women and thought highly of their potentialities, recognizing at the same time the credulity and inadequacy of mankind in the mass. Much of his political and scientific work was controlled by the world view expressed in a letter of 1780 to Joseph Priestley, the discoverer of oxygen. "The rapid progress true science now makes," Franklin wrote, "occasions my regretting sometimes that I was born too soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter. We may perhaps learn to deprive large masses of their gravity, and give them absolute levity, for the sake of easy transport. Agriculture may diminish its labour and double its produce; all diseases may by sure means be prevented or cured, not excepting even that of old age, and our lives lengthened at pleasure even beyond the antediluvian standard. O that moral science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity!"

Birth and Ancestry.—Franklin was born in Milk street, Boston, Mass., on Jan. 17 (new style; Jan. 6, old style), 1706. His father, Josiah, a maker of soap and candles, had emigrated from Banbury, Oxfordshire, Eng., in 1683, aged 25, taking with him a wife, Anne, and three children. Before Anne died in 1689 she had four more children, two of them short-lived. Josiah quickly remarried, his second wife being Abiah, daughter of Peter Folger, a Nantucket individualist who had attacked in verse (*A Looking-Glass for the Times*, 1677) the persecutors of Quakers and Baptists. Benjamin was the 8th of Abiah's 10 children, the 15th (and the 10th son) of Josiah's 17.

The *Autobiography* begins with some genealogy. Franklin had learned from an uncle's notes that his father's family had lived for more than 300 years on a 30-ac. farm with a blacksmith's forge at Ecton in Northamptonshire. This parish lies about 70 mi. N.N.W. of London, in central England. Franklin, visiting Ecton in 1758, found parish records beginning in 1555 and learned that he was the youngest son of the youngest son for five generations. The Franklins had been Anglicans from the time of Henry VIII, but Josiah became a Congregationalist.

Early Boyhood (1706–18).—Josiah's fondness for music, his handiness with tools and his good judgment are noted in the memoirs. Benjamin obviously respected his father, who presumably taught him to read, so early that he could not remember learning. An uncle, also named Benjamin, was a member of the household for some time after 1715; he and Josiah, both middle-aged, gave much thought to this tenth son's future. For a time they dreamed of making him a clergyman, a tithe to the church, and he had a year in grammar school before Josiah decided he could not afford the cost of a college and theological education. Then George Brownell, a private teacher of such practical arts as writing, bookkeeping and navigation, took Benjamin on. "Under him I acquired fair Writing pretty soon, but I fail'd in the Arithmetic, & made no Progress in it. At Ten Years old I was taken home to assist my Father in his Business." (*Franklin's Memoirs*, ed. by Max Farrand, p. 20, University of California Press, Berkeley, 1949.)

The boy's distaste for cutting wicks led Josiah, one of whose sons had already run off to sea, to walk Benjamin around Boston, observing the craftsmen at work and looking for a congenial trade. One cousin was a cutler, and that occupation was seriously considered. Then, on the ground of his fondness for books, Benjamin was persuaded to sign indentures with his elder brother James, who in 1717 had returned to Boston from London with a printing press.

Apprentice and Author (1718–23).—Benjamin soon learned his trade; he also found time for self-education. He had already read Bunyan's *Pilgrim's Progress* (which has been compared with the *Autobiography*), some other religious and theological works owned by his father, Plutarch's *Lives* and two books which may have contributed to his penchant for social improvement: Defoe's *Essay on Projects* and Cotton Mather's *Essays To Do Good*. Next he took a fancy to poetry and late in 1718 wrote two occasional ballads. One, "The Lighthouse Tragedy," was a popular success, but Josiah's ridicule discouraged further versifying. Friendships developed with other booklovers: Matthew Adams, a tradesman with a "pretty Collection" to lend (Farrand, p. 32), and John Collins, a youngster his own age with a fondness for argument.

About 1719 he read some of the Boyle lectures directed against deism (probably William Derham's *Physico-Theology*, 1712), liked the refutations less than the views abhorred, and "soon became a thorough Deist" (Farrand, p. 146). Franklin years later regretted that his religious skepticism "perverted" others, among them Collins.

Two books, however, provided experiences he never regretted. A volume of the *Spectator* was read repeatedly and the essays rewritten from memory, so that he might improve his style and increase his vocabulary. Thomas Tryon's *Way to Health* led him to a vegetarian diet—and to a bargain with James to feed himself for half the money paid for his board. Half of that Benjamin saved, and he could both buy books and get more time to read. He taught himself some of the mathematics he had missed and, exploring the art of logic, was "charm'd" by the Socratic method into dropping his habits of contradiction to become the "humble Enquirer & Doubter" (Farrand, p. 40), entangling others by hesitance and insidious question.

In 1721 James Franklin founded the *New-England Courant*, a newspaper remarkable both for its criticism of civic and religious leaders, then unaccustomed to such treatment, and for its literary content. Original essays were welcomed, among them Benjamin's first published prose, the "Silence Dogood" series of 1722, slipped surreptitiously under the office door. They intimated, among other things, that money was more valued in Harvard college than intelligence, that New England funeral elegies were hackneyed and ridiculous, and that the euphemisms of drunkards were weird and wonderful. Obviously imitative of the *Spectator*, they are still readable; clearly Benjamin Franklin was to be more than an ordinarily literate printer.

When James remarked late in 1722 that Massachusetts officials were slow in doing something about piracy he landed in jail for a month. Benjamin carried on the *Courant*. A few months later James was forbidden to print or publish the paper and Benjamin, his old indentures discharged, became the nominal publisher. The new indentures which he signed secretly he disregarded after quarrels with his brother, sure that James would not dare to produce them, even though his apprenticeship had nearly two years to run. "It was not fair in me," he was to recall years later, "to take this Advantage, and this I therefore reckon one of the first Errata [mistakes, in printing lingo] of my Life." (Farrand, p. 50.) James blocked employment elsewhere in Boston, so Benjamin persuaded a ship captain to give him passage to New York, hinting he "had got a naughty Girl with Child" (Farrand, p. 52)—a fabrication of no little irony, in the light of later events.

Hard-Earned Lessons (1723–26).—At 17 Franklin had a trade, but he still had much to learn about men and women. He found no work in New York but heard there might be some in Philadelphia. It took him a stormy 30 hours to get across Lower New York bay, three days and 50 mi. of walking to cross New Jersey, and he still had a cold, sleepless night lost along the Delaware river before he arrived on the Market street wharf, tired, hungry and all but penniless. A vivid passage in the *Autobiography* describes his walk that Sunday morning, a large puffy roll of bread under each arm and another being munched on, with Deborah Read, eventually to become his wife, watching with amusement from her doorway. A few weeks later he was solvent, employed in Samuel Keimer's printing shop and rooming at the Reads'. Within months, as the result of a chance remark by a brother-in-law, he was sought out by the provincial governor, Sir William Keith, who urged him to enter business for himself and sent him back to Boston with a flattering letter to his father. Josiah thought his son too young for such a venture and refused immediate support.

On his second trip to Philadelphia Franklin picked up a companion, his old friend John Collins. Now a drinker and wastrel as well as an unbeliever, Collins borrowed money which Franklin was holding but which was not his own and after some disagreeable scenes left for Barbados without returning it. Even more disillusioning was Sir William's cruelty. Refusing to accept Josiah's judgment, he offered to provide letters of credit and introduction if Franklin would go to England to purchase the equipment needed. He repeatedly postponed handing over the promised letters, finally saying they would be on the ship. Bidding Deborah farewell, probably with some promises, Franklin sailed, to find on his arrival that he had no letters and Sir William no friends. It was left to a shipboard acquaintance, Thomas Denham, a Quaker merchant, to explain that the governor was unreliable. Employment was no problem—Franklin was soon at work in a large printing house—but James Ralph was. He had left a wife and child to accompany Franklin to London and become a poet. Ralph borrowed about £27 before (he being away) Franklin "attempted Familiarities (another Erratum)" (Farrand, p. 112) with a pleasant milliner who had become Ralph's mistress. Another debt was unpaid and another friendship ended.

Franklin's temperance did not endear him to the beer-drinking workmen at the shop, but he showed some of them that it saved money and he was eventually accepted. Helping to set in type the second edition of William Wollaston's *Religion of Nature*, he was moved to write a deistical pamphlet, *A Dissertation on Liberty and Necessity, Pleasure and Pain* (1725). His argument that since man has no real freedom of choice he is not morally responsible for his actions later seemed still another erratum, but it brought him the acquaintance of a Dr. Lyons, who introduced him to Henry Pemberton, early popularizer of Newton's philosophy, and Bernard Mandeville, author of the *Fable of the Bees*. He also met Sir Hans Sloane, from whose collections grew the British museum, selling him a purse made of asbestos from Pennsylvania.

Franklin's most impressive talent at this time was swimming (he once swam the Thames from Chelsea to Blackfriars, about three miles), and he was considering starting a swimming school when his friend Denham urged him to return to Philadelphia, offering employment in his store. They sailed in July 1726. Franklin was not happy about facing Deborah, to whom he had written only once. On the voyage he kept a journal which shows an awakening interest in science and which originally contained a plan for his future conduct. This plan is not certainly extant. One would expect that it contained some resolutions about lending money to friends, accepting the word of would-be benefactors and making advances to women.

Achievement of Security (1726–48).—Franklin worked for Denham about four months before his employer died unexpectedly. He then returned to Keimer's printing shop and was soon "quite a Factotum" (Farrand, p. 130), casting type, engraving and making ink, as well as helping train the apprentices. To Hugh Meredith, near the end of his term, he was particularly close, and early in 1728 the two set up in business for themselves. In July 1730 Franklin bought out his partner with borrowed money. At this point his private life was extremely complicated. Deborah Read had understandably not waited for him, but the man she married had deserted her and disappeared. Franklin's demand of a marriage settlement to pay off his business debt ended one match-making venture. A strong sexual drive, "that hard-to-be governed Passion of Youth" (Farrand, p. 178), as Franklin described it, was sending him to "low Women," and in the winter of 1730–31 he had a son, William, whose mother has never been identified. Franklin must have known that a baby was on the way when, his affection for Deborah having "revived," he "took her to Wife" (Farrand, p. 180) on Sept. 1, 1730. Their common-law marriage lasted until Deborah's death in 1774. They had two children, a son who died at four and a daughter, Sarah, later Mrs. Richard Bache, who survived them both. The illegitimate William was brought up in the household.

As his own master and the head of a family, Franklin proceeded to make himself financially secure. He was able to retire from business in 1748, although he seems to have retained some hand in the almanacs published by Franklin and Hall, the firm which between 1748 and 1766 gave him an average annual income of almost £500. His retirement was the result of hard work, clever salesmanship and some good fortune. His shop dispensed not only printing but also books, stationery, soap and occasionally fish, cheese, spices and other commodities; he bought rags for papermakers; he even dealt in slaves and the unexpired contracts of indentured servants.

Government printing was a major source of profit to the trade.

Franklin and Meredith's first success was securing the job of printing paper currency for Pennsylvania. Characteristically, Franklin helped get this business by writing in favour of paper money; his *Modest Enquiry Into the Nature and Necessity of a Paper Currency* (1729) was his first venture into economic theory. For years thereafter Franklin was public printer not only of Pennsylvania but also of New Jersey, Delaware and Maryland. Another money-making venture was the *Pennsylvania Gazette*, a newspaper purchased from Keimer in 1729. It soon surpassed its competitors in liveliness and in advertising. Franklin was a skilful editor and publisher. Another success was the series of *Poor Richard* almanacs, published annually between 1732 and 1757 in issues as large as 10,000. The famous maxims, pillaged from the collections of proverbs and epigrams of the old world, but often Americanized by Franklin's hand, helped make Franklin known far beyond his town and province. Failures, of course, were inevitable for a publisher: a German-language newspaper collapsed in 1732 before it had really started, and in 1741 a monthly magazine lasted only six months. Franklin was generally prosperous, however; he made enough to invest capital in real estate and in partnerships or working arrangements with printers in the Carolinas, New York and the British West Indies.

His energy was not exhausted by business. More than ordinarily gregarious, and with a remarkable social conscience, he was involved in numerous projects for social improvement by collective efforts. The first of these was the Junto, or Leather Apron club, organized in 1727 to debate questions of morals, politics and natural philosophy, and to exchange knowledge of business affairs which might be valuable to the more enterprising members. More than one historian has noted the similarity of the Junto to the so-called "service" clubs of the 20th century, of which Rotary International is the prototype. Franklin worked through the Junto in many ways. The need of its members for easier access to books led in 1731 to the organization of the Library Company of Philadelphia, earliest of the many American subscription libraries. By his own account Franklin spent an hour or two there each day, mastering foreign languages and filling in the gaps in his general education. Through the Junto he proposed a paid city watch or police force, a suggestion eventually but not immediately followed; a paper read to the same group resulted in the organization of a volunteer fire company. In 1743 he called for a "constant correspondence" of virtuosos (men of scientific interests) throughout the colonies, and in the following year the American Philosophical society was modestly functioning. It is often described as an outgrowth of the Junto.

Franklin became, in short, a successful promoter. He noted that Pennsylvania had neither a college nor a militia. An academy was in his mind as early as 1743, but not until 1749 did he find the time ripe for his *Proposals Relating to the Education of Youth in Pennsylvania*, instrumental in founding the Academy of Philadelphia in 1751 and the best-known early American argument for advanced training in the useful arts and sciences. Although his ideas were not wholly followed, the institution which grew out of the academy—the University of Pennsylvania—made notable contributions to professional education. Another pamphlet, *Plain Truth; or, Serious Considerations on the Present State of the City of Philadelphia and Province of Pennsylvania* (1747), written after French and Spanish privateers had invaded the Delaware river, helped enroll a volunteer militia of 10,000 men, despite the Quaker coolness toward armed defense. Eventually he became almost indispensable to those who had good works in mind, helping to raise money for church buildings and, in 1751, for Thomas Bond's project, the Pennsylvania hospital, a pioneer institution important to medical education in America.

Franklin's belief in association for useful ends made natural his joining St. John's lodge in 1731. It claims to be the first Masonic lodge in America. Franklin's loyalty to Freemasonry helped him years later with some of the anticlerical intellectuals in the court of Louis XVI. In 1782 he was elected venerable master of La Loge des Neuf Soeurs, which has been called with some justice the UNESCO of the 18th century.

Before his retirement, moreover, Franklin also began his work as a servant of the public. Appointed clerk of the Pennsylvania assembly (legislature) in 1736, he retained that post until 1751, when he was elected a member. In 1737 he was appointed postmaster of Philadelphia, an unusually valuable office for a newspaper publisher; he held it until he became one of the two deputy postmasters general for the colonies in 1753.

Electrical Science (1748–52).—Franklin's curiosity about natural phenomena can be traced to his boyhood, but not until 1740 did it become more than desultory. In that year he invented the Pennsylvania fireplace, better known as the Franklin stove, a new kind of heating unit. This invention characteristically combined theoretical knowledge and practical advantages. He wrote a pamphlet about this stove in 1744, for his friend Robert Grace, who was manufacturing it, but refused to take out a patent because "as we enjoy great Advantages from the Inventions of others, we should be glad of an Opportunity to serve others by any Invention of ours" (Farrand, p. 794). By this time he was reading all the scientific literature he could find and had some contact with lecturers on natural philosophy (*cf.* I. Bernard Cohen's edition of *Benjamin Franklin's Experiments*, 1941, and the same scholar's *Franklin and Newton*, 1956). He certainly read with care the articles on electricity, at that moment the most novel subject in European science, by William Watson, published in the *Philosophical Transactions* of the Royal Society of London in 1745. Franklin and three friends—Thomas Hopkinson, Philip Syng and Ebenezer Kinnersley—acquired simple apparatus and, in the winter of 1746–47, began an exploration of electrical phenomena. The Philadelphia climate and apparatus makers, combined with Franklin's ingenuity, produced remarkable discoveries, reported by Franklin in a series of letters to a London friend, Peter Collinson. Many of the letters were read before the Royal society and some were printed in the *Gentleman's Magazine*. In April 1751 a collection was printed as *Experiments and Observations on Electricity*. This book, of 80-odd pages, made Franklin famous, first in France, where a translation appeared in 1752, and later throughout Europe. The experiment which Franklin suggested to prove the identity of lightning and electricity was first carried out in France, before Franklin is supposed to have tried the simpler expedient of flying a kite in a thunderstorm. His book stands first among the scientific contributions of 18th-century Americans. It appeared in four later English editions before 1769, usually with additional letters and papers by Franklin and others; there were two additional French editions; and it was also translated into German (1758) and Italian (1774).

Franklin's study of electricity has two noteworthy aspects. First, his "one fluid" theory or hypothesis accounted for more of the observable phenomena than did any previous hypothesis. Second, his suggestion that buildings might be protected from lightning by erecting pointed iron rods seemed both practical and highly dramatic. On the whole his originality was not as great as many of his admirers have thought (Cohen has shown that it decreased as he came into closer touch with his fellow experimenters in Europe), but he invented many of the terms which are still used in discussing electricity (positive, negative, battery, conductor, etc.) and he described his experiments with a clarity that commands respect from all orderly minds.

By 1752 he had made his most important contributions to science, including, outside of electricity, his observation (1743) that storms which apparently came from the northeast actually moved from the southwest. For the rest of his life he occasionally conducted experiments or theorized with his innumerable correspondents. Heat, light, sound and magnetism interested him, as did hydrodynamics, hydrostatics, chemistry, geology, physiology, psychology and oceanography.

Science gave him handsome rewards. In 1753 he received the Copley medal from the Royal society and honorary M.A. degrees from Harvard and Yale. William and Mary gave him an M.A. degree in 1756, Edinburgh an LL.D. in 1759 and Oxford the degree of doctor of civil law in 1762. He was an active, corresponding or honorary member of scientific societies in London, Edinburgh, Paris, Orléans, Rotterdam, Göttingen, Padua, Milan and St. Petersburg.

He has some interest as a social scientist as well (*cf.* L. J. Carey, *Franklin's Economic Views*, 1928). "Observations Concerning the Increase of Mankind, Peopling of Countries, etc." (1755, but written in 1751) speculates on the relation between population and the means of subsistence and states a belief in free trade. Later papers, notably "Positions to Be Examined, Concerning National Wealth" (1769), show a distrust of commerce and manufactures which he may have acquired from his friends among the French economists.

Public Servant (1753–85).—Politics encroached more upon his retirement than did science. From 1753, when he took charge of the mails in all the northern colonies, he tended to think in terms of the bonds of common interest which tied the separate commonwealths together, although it was to be long before the average man in America thought of himself as an American first and a Virginian or Pennsylvanian second. For 20 years Franklin was America's chief spokesman, so far as there was an America to speak for. His base of operations for 16 years was London, where he was thoroughly at home and might easily have settled except for his sense of responsibility. He became an American and a revolutionary almost in spite of himself, working until the last possible moment to reconcile conflicting interests, to interpret America to Englishmen and British politics to Americans. At one time or another he was *persona non grata* to extremists on both sides of the debate. Like most politicians he made mistakes and suffered for them, but he also had some triumphs.

The first of the latter was the adoption of his "Plan of Union" by the Albany congress, assembled in 1754 to make common cause against the French and Indians. It proposed a general council, with representatives from the several colonies, having the power to tax, organize the common defense and supervise Indian relations and new settlements. A president, appointed by the king, was to have the veto power, as was the king himself if he exercised it within three years. Neither the colonial legislatures nor the king's advisers found this scheme acceptable, each fearing some loss of power. The rejection of his scheme was his first lesson in a conflict between reason and justice on the one hand and the factor of power on the other, an antagonism which was probably the central feature of his political career (*cf.* Gerald Stourzh, *Benjamin Franklin and American Foreign Policy*, 1954). Noteworthy, too, was his assertion of the time-honoured principle that taxation should be the prerogative of representatives of the people—soon to become one of the major issues in the American Revolution.

The realities of political action nearly ruined Franklin in 1755, when he promised Pennsylvania farmers to stand good for any losses they might sustain if they used their horses and wagons to supply Gen. Edward Braddock's army in its expedition against Ft. Duquesne. For more than two months it appeared that he might have to pay almost £20,000 out of his own pocket. The government eventually paid, but Franklin was thereafter more cautious about his commitments.

The need of money for defense led the Pennsylvania legislature to seek to tax the lands of the Penn family, proprietors under the charter of the colony. Either their consent or a change in the form of government was required. Chosen to represent the assembly on this matter, Franklin was in London most of the time between July 1757 and Aug. 1762. With the help of a legal adviser, the "all-knowing" Richard Jackson, he eventually effected a compromise, by which the proprietors' improved lands could be taxed, but not those unsurveyed. This was not enough for Franklin, who detested Thomas Penn and wanted to oust the proprietary government altogether. His first mission was nevertheless remarkable for his continued use of his talent as an author to further his cause, and for his establishment of many close friendships. His most significant writing in London was *The Interest of Great Britain Considered With Regard to Her Colonies, and the Acquisitions of Canada and Guadaloupe* (1760), believed to have influenced the makers of the treaty of Paris (1763), which gave Canada to Great Britain as Franklin had hoped.

By then he was back in Philadelphia, where the conflict between legislature and proprietors continued. A petition to make Pennsylvania a crown colony was agreed on and by Dec. 1764 Franklin was again in London, just in time to testify that the proposed Stamp act was the wrong way to raise additional tax money in America. Nonetheless the act was passed. Franklin so greatly underestimated the probable opposition that he nearly ended his political usefulness. Determined to make the best of a bad situation, he meekly ordered stamps for the use of Franklin and Hall and nominated a friend for the post of stamp officer in Philadelphia. The feeling against him was so strong that his wife Deborah brought guns and male relatives into the house to defend it. Shocked by the violence reported from America, Franklin devoted himself to the campaign for repeal and regained his prestige by answering 174 questions before the house of commons in mid-Feb. 1766. The examination, during which he clearly and briefly answered both friends and enemies, gave Britons some understanding of how Americans felt. Immediately published from a stenographic transcript, his remarks made him the hero of the repeal. His real mission, the negotiation of a new charter, was unsuccessful, but the failure was forgotten in the excitement.

Pennsylvania kept him on as agent, and he was employed by three other colonies—Georgia (1768), New Jersey (1769) and Massachusetts (1770). With this support and that of the British Whigs, he rode through the succession of crises ending with the armed clashes at Lexington and Concord. Gradually he was forced to realize that there could be no reconciliation and that his dream of a British empire of self-governing nations would not come true. He did his best to present the American view to his friends and, through newspaper articles (126 between 1765 and 1775), to the British public. At the end he was bitter, in "Rules by Which a Great Empire May be Reduced to a Small One" and "An Edict by the King of Prussia," both first printed in the *Public Advertiser* in 1773. Taken together they are a capsule history of the long-drawn-out contest. In Jan. 1774, because of his writing and his share in the publication of the letters of Thomas Hutchinson, governor of Massachusetts, to his British superiors, Franklin was dismissed from the post office. In March 1775, aware that there might be war, he left England, three days before his friend Edmund Burke delivered his eloquent but futile speech to the commons on conciliation with America. A day after his arrival in Philadelphia he was a delegate to the second continental congress. There he served on committees for the organization of a postal system and for the drafting of the Declaration of Independence, and on a commission which vainly attempted to bring Canada into the war as an ally. He also found time to be presiding officer of the constitutional convention of Pennsylvania.

In Sept. 1776 congress agreed to send a commission to France, hoping to secure economic and military assistance. Its members were Silas Deane, already in Paris, Arthur Lee (as a substitute for Thomas Jefferson, kept home by his wife's illness) and Franklin. He arrived in Paris just before Christmas; before the end of the year he and his colleagues were engaged in secret negotiations with the comte de Vergennes, minister of foreign affairs and, fortunately for the Americans, an enemy of Britain. These negotiations were enormously complicated by cloak-and-dagger intrigue, with spies and informers everywhere. As a diplomat, Franklin had the great advantages of French friends and disciples, a skin ailment which made it reasonable for him to wear a fur hat, and no shyness about his need for spectacles through which to see the world. Before long he was the hero of France, the personification of the unsophisticated nobility of the new world, leading his people to freedom from the feudal past. His portrait was everywhere, on *objets d'art* from snuffboxes to chamber pots, his society sought after by diplomats, scientists, Freemasons, fashionable ladies. There was indeed a Franklin cult, not without its ridiculous side. Franklin rose to the occasion magnificently, however, displaying such wit and social grace as to endear him to the French for generations.

The sought-for treaties were signed in Feb. 1778, after General Burgoyne and 6,000 men had surrendered at Saratoga and it was clear that Britain was not going to crush the rebellion easily. Very considerable loans were obtained for the United States, and without French military and naval aid the final victory at Yorktown

in 1781 might not have been achieved. The marquis de La Fayette, the comte de Rochambeau and Admiral de Grasse are the best known of an estimated 12,000 soldiers and 32,000 sailors, including officers, who left France to support Washington in America.

Despite the strong bonds thus established, the peace was difficult. Spain had entered the war in 1779, hoping to recover Gibraltar but, aware of the conflict of interests in Florida and Louisiana, refused to recognize American independence. France had guaranteed that there would be no separate peace. Franklin worked with Vergennes until his fellow commissioners, John Adams and John Jay, overruled him on procedure, signing preliminary agreements with Britain late in 1781 without prior consultation with France. The formal treaty was signed Sept. 3, 1783.

Before the end of the year Franklin asked congress to be replaced, but he was retained for two more years to help make trade treaties. His popularity unabated, he occupied himself by observing the first balloon ascension and serving on a committee appointed by Louis XVI to report on the claims of a new marvel, "animal magnetism," which Franz Anton Mesmer thought would cure many if not all diseases.

The Last Years (1785–90).—Franklin was 79 when he began his last journey home. He had a large stone in his bladder, which made carriage travel an agony, and other ailments of old age. Carried to Le Havre in one of Marie Antoinette's litters, he was comfortable enough on the voyage to write two scientific papers: "Maritime Observations" and "The Causes and Cure of Smoky Chimneys." In Philadelphia he was elected to the executive council of the state and a few days later chosen president, serving for three years. He lived as quietly as possible, interested himself in improving his property, but was still active in the American Philosophical society and in the new Society for Political Enquiries (1787), of which he was first president. A member of the Constitutional Convention of 1787, he was not able to convince his associates that the American government should have an executive committee at its head rather than a president, nor that there should be a single-chamber legislature. He spoke when the time came for compromise between the large states and the small ones, and his speech on the last day, read for him by James Wilson, was a plea that the objections, his own among them, be forgotten, and that the delegates unanimously support the instrument they had framed. This government, Franklin wrote, "is likely to be well administered for a course of years, and can only end in despotism, as other forms have done before, when the people shall become so corrupted as to need despotic government, being incapable of any other." His motion for adoption by unanimous consent was promptly carried. In the fight for ratification he took no active part. Except for supporting an effort to have the first congress of the United States consider the abolition of Negro slavery, he took no further part in public life.

For the last year he was bedridden, escaping severe pain only by the use of opium. He died on April 17, 1790, aged 84. Philadelphia gave him the most impressive funeral that city had ever seen, and in France, where Louis XVI was imprisoned in the Tuileries, eulogy after eulogy poured forth to the man who to the French was the symbol of enlightenment and freedom.

Private Life.—Franklin, for all his fame, had many personal misfortunes. His son William, who became royal governor of New Jersey in 1763, chose to take his stand with the loyalists in the Revolution; he and his father were never fully reconciled thereafter. William Temple Franklin, William's natural son, was his grandfather's secretary in France and, after long delay, the first editor of the memoirs; he showed no special talent for either task. Deborah Franklin, although a good manager of her husband's affairs and devoted to her family, was far from his equal in intelligence or adaptability to social situations. Jane Mecom, the sister with whom he was most in touch, worried him with a succession of family troubles grave enough to embitter any ordinary man. Franklin did a great deal for his relatives—and was criticized for it—but he had far from an ideal family life.

His most satisfying emotional connections may have come from outside his immediate family, with girls and women younger than he. The first such friendship (at first, perhaps, a flirtation) was with Catharine Ray (later Mrs. William Greene), whom he met in 1754, when she was 23 and he 48. They corresponded for 35 years and met seven times. In 1757, rooming in Craven street, London, Franklin formed a similar attachment to Mary (Polly) Stevenson (later Mrs. William Hewson). They were close for more than 30 years, exchanging many letters, and during the last four years of Franklin's life Mrs. Hewson was in Philadelphia, where she read to him on his deathbed. In Paris, after Deborah's death in 1774, Franklin was more or less seriously in love with Mme Brillon de Jouy, the youthful wife of a public official, and with Mme Helvétius, a widow to whom he proposed marriage. Much of his most polished writing is to be found in the letters written to these women or in pieces written for their entertainment or instruction.

Modernity.—The most remarkable aspect of Franklin is perhaps the variety of ways in which he has remained interesting to his successors. In 1956, for example, the Franklin Institute of Philadelphia, with the co-operation of about 500 other societies and institutions, organized an international celebration of the 250th anniversary of Franklin's birth. Ten areas wherein Franklin's work or thought was believed relevant to the 20th century were defined: (1) education and the natural sciences; (2) international relations and the public service; (3) publishing, broadcasting and communications; (4) science and engineering; (5) medicine and the public health; (6) printing, advertising and the graphic arts; (7) finance, insurance, private enterprise; (8) religion, fraternal organizations and the humanities; (9) agriculture, horticulture and botany; and (10) music, entertainment and special events. The connections in some instances, such as the last two, are rather tenuous, but few other men of the 18th or any other century can even tenuously be related to so many fields. Of all the founding fathers of the United States, Franklin, were there such a thing as reincarnation, would adapt himself most readily to the complexities of the latter half of the 20th century. His modernity is nothing less than astonishing. *See* also references under "Franklin, Benjamin" in the Index volume.

BIBLIOGRAPHY.—A. H. Smyth's edition of Franklin's writings, 10 vol. (1907–10), has long been the best available. In 1954 the American Philosophical Society and Yale University announced their joint sponsorship of an edition of Franklin's papers, to include between 25,000 and 30,000 documents.

The fullest biography is Carl Van Doren, *Benjamin Franklin* (1938), the best brief one Verner W. Crane, *Benjamin Franklin and a Rising People* (1954). Both have useful bibliographies. Generally admired, also, is Carl Becker's article in the *Dictionary of American Biography* (1931), separately reprinted in 1946. The *Autobiography*, to be used, as has been suggested, with caution, presents an exceedingly complicated textual problem; see *Benjamin Franklin's Memoirs*, Parallel Text Edition, ed. by Max Farrand (1949), for its explanation.

A number of the numerous special studies have been cited in the present article. For a survey of Franklin scholarship, *see* Richard D. Miles, "The American Image of Benjamin Franklin," *American Quarterly* (summer 1957). (T. HR.)

FRANKLIN, EDWARD CURTIS (1862–1937), pioneer with H. P. Cady and C. A. Kraus in the field of chemistry of liquid ammonia solutions, was born on March 1, 1862, at Geary City, Kan. He was educated at the University of Kansas, Lawrence (B.S., 1888; M.S., 1890), and Johns Hopkins university, Baltimore, Md. (Ph.D., 1894). He was assistant in chemistry at the University of Kansas, 1888–93; associate professor, 1893–98; and professor, 1898–1903. In 1903 he became associate professor of organic chemistry at Stanford university, Calif., and in 1906 was made professor. He retired as emeritus professor in 1929. He served on the U.S. assay commission in 1906, in 1911–13 was professor of chemistry and chief of the division of chemistry at the Hygienic laboratory of the U.S. public health and marine hospital service. In 1918 he was a physical chemist at the bureau of standards. His honours included membership in the National Academy of Sciences and election to the presidency of the American Chemical society (1923). The chief significance of his work was in extending the horizons of inorganic chemistry as a result of his researches on the ammonia system of compounds and the use of liquid ammonia as an electrolytic solvent. He was the author of

the classic monograph "The Nitrogen System of Compounds." (Jb. Kg.)

FRANKLIN, SIR JOHN (1786–1847), English rear admiral and explorer who discovered the northwest passage, was born at Spilsby, Lincolnshire, on April 16, 1786. He served at the battles of Copenhagen and Trafalgar. In 1818 he commanded the "Trent" in Capt. D. Buchan's arctic expedition. From 1819 to 1822 he led the arctic overland expedition from Hudson bay to the Arctic ocean and surveyed part of the coast to the east of the Coppermine river. From 1825 to 1827 he commanded a second overland expedition and traced the North American coast from the Mackenzie to longitude 149° 37′ W., while John Richardson's party explored the coast between the mouths of the Mackenzie and Coppermine. The two expeditions together had added 1,200 mi. of coast line to the knowledge of the American continent. He published two books giving an account of these journeys: *Narrative of a Journey to the Shores of the Polar Sea* (1823) and *Narrative of a Second Expedition to the Shores of the Polar Sea* (1828). In 1828 Franklin married Jane Griffin, his second wife. The following year he was knighted. From 1836 to 1843 he was governor of Van Diemen's Land (Tasmania).

On his return to England, Franklin took command of an expedition for the discovery of the northwest passage. The "Erebus" and "Terror," with 129 officers and men, sailed on May 19, 1845. They were last seen at the entrance to Lancaster sound on July 25. It was 14 years before the mystery of their subsequent movements was solved. From 1848 onward a series of expeditions organized by the government or by private individuals searched for them and in 1859 Capt. Leopold McClintock, sent by Lady Franklin, finally disclosed the fate of the expedition. Besides skeletons and various articles in King William Island, and reports from an Eskimo in Boothia, a record was found telling the history of the expedition up to April 25, 1848. In 1845–46 they had wintered at Beechey Island, having ascended the Wellington channel to latitude 77°, and returned by the west side of Cornwallis Island. They had navigated Peel and Franklin straits but had been stopped by ice coming down McClintock channel (then unknown). An addendum dated April 25, 1848, signed by J. Fitzjames and F. R. M. Crozier, said that the ships were deserted on April 22, 1848, having been beset since Sept. 1846. Franklin died on June 11, 1847, and by then 24 officers and men had perished. The record stated that they would start the next day for Back river. Strength must have failed; an Eskimo woman said that they fell down and died as they walked. Franklin's expedition is credited with having discovered the northwest passage, as the point the ships reached was within a few miles of the known waters of America.

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FRANKLIN, WILLIAM BUEL (1823–1903), prominent Union general in the American Civil War, was born at York, Pa., on Feb. 27, 1823. He graduated with distinction from the U.S. Military academy, West Point, N.Y.; served in the Mexican War; and engaged thereafter in engineering work. After outbreak of the Civil War he was assigned to the army of the Potomac and served as brigadier general in the campaign against Richmond in 1862. During the battle of Frayser's Farm he performed well in covering the retreat of Gen. George B. McClellan. As major general at Antietam his apparently sound advice that his fresh troops renew the battle was not heeded. Though Franklin was criticized by Gen. A. E. Burnside for inefficiency at Fredericksburg and was blamed by the congressional committee on the conduct of the war for the loss of the battle, it should be pointed out that Burnside's orders to his subordinate were somewhat confusing. Franklin resigned from the army in 1866 and served as vice-president and general manager of the Colt's Patent Fire Arms Manufacturing company in Hartford, Conn., until 1888. He died at Hartford on March 8, 1903.

See James H. England, "William Buel Franklin," *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large*, vol. x, pp. 485–489 (1918); Kenneth P. Williams, *Lincoln Finds a General: a Military Study of the Civil War*, vol. 1 and 2 (1957). (H. H. St.)

FRANKLIN, one of the three divisions of the Northwest Territories of Canada, extending from the Arctic circle to the north pole and including Baffin Island south of the Arctic circle. The larger islands of the territory include Baffin, Ellesmere, Victoria, Banks, Devon, Melville, Axel Heiberg and Prince of Wales; Boothia and Melville peninsulas are also included in the territory. Area, 549,253 sq. mi. Pop. (1961) 5,758. In addition to the Royal Canadian Mounted Police and officials, there are a few Indians, Eskimos and fur traders. The district was named after Sir John Franklin. *See* Northwest Territories.

FRANKLIN, a city of Pennsylvania, U.S., the seat of Venango county, is located 65 mi. N. of Pittsburgh at the junction of French creek and the Allegheny river. Because of its strategic location, Franklin was an important pawn in the English-French struggle for North America after 1750. In 1752 a French expedition under Chevalier Pierre Paul Marin established Ft. Machault at that point. In December of the next year George Washington stopped at the new fort while delivering Governor Dinwiddie's "get out" message to the French commander. The French destroyed the fort during their retreat of 1758 but the British raised a new fortification (Ft. Venango) at the site. This in turn was destroyed by Indians during the uprising of 1763. The town, which derives its present name from Ft. Franklin, erected by the Americans in 1787 and named in honour of Benjamin Franklin, was platted in 1795, incorporated as a borough in 1823 and incorporated as a city in 1868.

Franklin's later history is closely associated with the rise of the American oil industry. The first successful oil well in America (Colonel Drake's well) was drilled in 1859 by William A. Smith of Franklin on an island in Oil creek, near Titusville. Within two years the Franklin-Titusville-Oil creek area was transformed into the "Oil Regions" with an annual production in excess of 2,000,000 bbl. About 2,000 craft of all descriptions transported this harvest downstream. Franklin became a financial, transportation and refining hub of the new industry until development of the Texas-Oklahoma oil fields after 1900 shifted the oil production centre to the southwestern United States. John Wilkes Booth was the owner of one of the early Franklin wells; he left the town in early April 1865, to assassinate Pres. Abraham Lincoln. The frantic atmosphere of the boom period that spawned such diverse characters as "Coal Oil Johnny" and John D. Rockefeller has been captured by Hildegarde Dolson, a native of Franklin, in her colourful history, *The Great Oildorado* (1959).

Franklin continues to bear the imprint of the prosperous oil years; expansive lawns provide a setting for many well-kept, ostentatious houses of the Victorian era. Its population in the 20th century remained fairly stable; for comparative population figures *see* table in Pennsylvania: *Population*. (R. L. Le.)

FRANKLIN INSTITUTE: *see* Museums and Galleries: *Industry Museums*.

FRANKLINITE, a member of the spinel (*q.v.*) group of minerals, consisting of oxides of ferric and ferrous iron, manganese and zinc in varying proportions. It is found in considerable amount, associated with zinc and manganese minerals (zincite and willemite) in crystalline limestone, at Franklin, N.J., where it is mined as an ore of zinc (containing 5% to 20% of the metal); after the extraction of the zinc, the residue is used in the manufacture of an alloy of iron and manganese (spiegeleisen) used in making steel. Franklinite occurs as octahedral crystals, often with rounded edges, and as granular masses. The colour is iron-black and the lustre metallic; hardness 6, specific gravity 5.2. The formula is $(Fe,Zn,Mn)(Fe,Mn)_2O_4$. It resembles magnetite, but is readily distinguished by the fact that it is only slightly magnetic. *See* also Zinc.

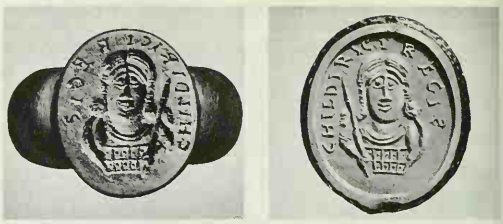
FRANKPLEDGE, the system in medieval England whereby all but the greatest men and their households were bound together by mutual responsibility to keep the peace, can be traced back to the laws of Canute (Cnut), who declared that every man, serf or

free, must be in hundred and tithing that he might be held to good behaviour by surety. By the 13th century, when surviving records reveal the system in working order, it was the unfree and landless men who were so bound. Their land was sufficient pledge for freeholders. A lord had to answer for his household servants: they were in his mainpast. The unfree had to be in frankpledge, generally an association of 12, or in tithing, an association of 10 householders. Frankpledge existed more commonly in the Danelaw, and tithing in the south and southwest of England. In Kent, where it was said that there was no villeinage, the word *borgha* replaced tithing. In Shropshire and the north the system does not appear to have been imposed. These associations were sometimes called by the name of the chief member of the group, the tithingman, and sometimes by the name of the village or hamlet. It is probable that the density of population had much to do with deciding local practice. The sheriff or his bailiff visited the courts of hundreds or wapentakes (*qq.v.*) twice a year to see that the tithings were full, a visitation known as the sheriff's tourn. Since surviving records always show that in many villages men were living "outside frankpledge" and that others had fled on suspicion of crime, this biennial "view of frankpledge" was a profitable part of the sheriff's judicial work. The 1217 reissue of Magna Carta (clause 42) forbade him to take this view more often than twice a year, at Easter and at Michaelmas, and declared that he should then "be content with that which the sheriff used to have for making his view in the time of King Henry our grandfather." By the 13th century many hundred and wapentake courts had passed into private hands (*see* COURT LEET), and their lords continued to hold the view of frankpledge, taking the profits coming from the inquiry.

See W. A. Morris, *The Frankpledge System* (1910). (D. M. S.)

FRANKS, SIR AUGUSTUS WOLLASTON (1826–1897), English museum curator and collector who was first keeper of a department of national antiquities in the British museum, London, was born at Geneva, Switz., on March 20, 1826, and educated in Rome and at Eton and Trinity college, Cambridge. In 1851 he became assistant in the antiquities department of the British museum, and in 1866 the keeper of the newly created department of British and medieval antiquities and ethnography. Franks became the foremost authority on British medieval antiquities and an expert on post-Roman art, ceramics and glass and the material culture of primitive peoples. He was the first British curator to arrange his exhibits according to the Danish system of successive Stone, Bronze and Iron Ages, and his friendliness secured the good will of numerous collectors. He assisted the museum in purchasing antiquities and, on his death in London on May 21, 1897, he made it notable bequests, including the 8th-century bone casket named after him. Director of the Society of Antiquaries in 1858–67 and 1873–80 and president in 1891–97, Franks was also instrumental in establishing the Royal Archaeological institute. Created knight commander of the order of the Bath in 1894, he published departmental catalogues and guides, papers on medals and brasses and *On Recent Excavations and Discoveries on the Site of Ancient Carthage* (1860). (J. M. WI.)

FRANKS, a people first known in the 3rd century A.D. who were to be of major importance in the history of western Europe, were probably formed from a regrouping of the remnants of more ancient peoples. There were three branches of Franks, namely the Salians, the Ripuarians and the Chatti or Hessians, related to each other in language and custom but each composed of independent tribes. In time of war several tribes might unite under one leader, but afterward they would divide again. The earliest mention of the word Frank is the inscription *Chamavi qui et Franci* on the Peutinger Table, referring to the Franks settled north of the lower Rhine (opposite the "island" of the Batavi between the Waal and Lek rivers). These Franks probably belonged to a group of Salians, as their name seems to survive in that of Salland, a region of the Netherlands province of Overijssel. The first author to mention the Franks is Flavius Vopiscus (*Divus Aurelianus,* vii, 1), who records that in A.D. 241–242 the future Roman emperor Aurelian, when a legionary tribune, fought against the Franks in the district of Mainz.



ASHMOLEAN MUSEUM, OXFORD

LEFT: ELECTROTYPE MODEL OF GOLD RING OF CHILDERIC I (D. 481 OR 482). THE ORIGINAL RING WAS FOUND AMONG THE TREASURE IN THE KING'S TOMB DISCOVERED AT TOURNAI, BELGIUM, IN 1653. RIGHT: MATCHING IMPRESSION FROM THE FACSIMILE. THE DESIGN SHOWS CHILDERIC BAREHEADED AND HOLDING A LANCE

For about 30 years in the mid-3rd century, the Alamanni (*q.v.*) and the Franks, who were then established on the east bank of the middle Rhine, penetrated far into Gaul, but the emperor Probus (276–282) managed to regain the towns they had occupied and pushed them back east of the Rhine. After his death, however, Gaul, although not again invaded, suffered constant alarms for about 75 years. In the towns ruins were hastily repaired, fortifications were built and houses were crowded inside the walls. From the middle of the 4th century, the Franks and Alamanni again began to invade Gaul; and the emperor Julian, though he won a decisive victory over the Alamanni near Strasbourg in 375, had to abandon to the Salian Franks from Ijssel the region known as Toxandria, between the Meuse and Scheldt rivers (358). These Salians were established on Roman territory as *foederati* (allies under treaty); they provided contingents in the Roman army and, in the second half of the 4th century, some such Franks who served the empire rose high in the imperial service.

The Salian Franks under their king Chlodio (Clodion) renounced the suzerainty of Rome after 428 and broke across the Scheldt river, spreading southward until they reached Tournai and Cambrai. Their defeat (*c.* 431) by the Roman general Aetius at Helena (Hélesme), between Tournai and Cambrai, prevented further expansion, however, and they were obliged once again to recognize Roman rule. Nothing is known of Chlodio's successor, Merovech (Merwich), after whom the Frankish Merovingian dynasty was named. His successor, Childeric (*q.v.*) I, helped the Romans repulse the Visigoths (463 and 469), who had advanced from the south as far as the Loire; he also drove some Saxon pirates from Angers in 469–470. Childeric died in 481 or 482 and was buried in Tournai, where his tomb was discovered in 1653.

After the Vandal invasion of Gaul in 406, the Ripuarian Franks and the Hessians from the middle Rhine had crossed the river in their turn, attacking its west bank between 413 and 428. Cologne fell to the Ripuarians, as did Trier, finally, although the Romans recovered it from them on three occasions. Aetius, however, restored Roman authority on the Rhine in 428. On the eve of the Huns' invasion, two Frankish princes were disputing for the kingship—probably for that of the Franks settled on the middle Rhine. One of them went to seek the aid of Attila, king of the Huns; the other, who went to the Roman imperial court to seek help from Aetius, is probably to be identified with the Frankish prince who, with a band of followers, is recorded as having fought together with Aetius against Attila (451).

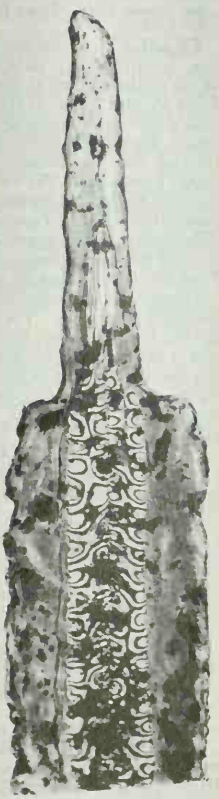
After the death of Aetius (454) the Ripuarians spread through the territory surrounding Cologne, reaching as far south as the Eifel mountains; their westward expansion was bounded, however, by the forest of Charbonnière, which, extending from Brussels to Landrecies, separated them from the Salian Franks. To the southeast, farther up the Rhine, the Ripuarians were opposed by the Alamanni, who were settled in Alsace and were trying to push northward. The Alamanni attacked the Ripuarians (*c.* 496) but were beaten at Zülpich near Cologne. Meanwhile the Hessian Franks spread from the Main river toward the valley of the Moselle. Trier, previously the centre of a Roman area of administra-

tion, stood for a short time after 470 as a frontier town against the barbarians but then fell to the Ripuarian Franks. They then spread southward as far as Thionville, but they were never able to settle in the town of Metz or in the land east of it.

The establishment of the Franks and of the Alamanni in Gaul meant that both the former Roman provinces of Germania and part of the two Belgic provinces were lost for many years to Roman civilization. The small Gallo-Roman population became submerged among the Germanic immigrants, Latin ceased to be the language of everyday speech, and the organization of the Christian church was seriously disrupted (the episcopal lists of many dioceses show gaps for this period).

Germanic paganism now flourished in these areas, and it was not until the 7th century that missionaries from Aquitaine, such as St. Amand and St. Eloi, recovered them for Christianity. The extreme limit of Frankish settlement up to the time of Clovis is marked by the linguistic frontier that still divides the Romance-speaking peoples in western Europe from the Germanic-speaking peoples. This frontier, which has varied little throughout the centuries, runs in practically a straight line from Gravelines on the North sea coast to Liège and then turns southeast toward Mont Donon in the Vosges. The area east of this line, moreover, was to be colonized progressively by the Franks during the 7th and 8th centuries. This area, however, should by no means be regarded as coinciding with that over which, during the second half of the 5th century, Salian or Ripuarian rulers gained political suzerainty. The Salian kings, for instance, subjugated the Roman towns north of the Somme, such as Tournai, Cambrai, Vermand and Thérouanne; the Ripuarian kings subjugated the Roman towns of Metz, Toul and Verdun.

Clovis (*q.v.*), who succeeded his father, Childeric, in 481 or 482 as ruler of a tribe of Salian Franks, achieved the conquest of the whole of Gaul except Burgundy, Septimania and Provence; moreover, he managed to extend his sway over all the Salian and Ripuarian tribes by assassinating their kings. His immediate successors (*see* MEROVINGIANS), who inherited his title *rex Francorum* ("king of the Franks"), firmly established control over the Franks settled on the Main river, whose land came to be called Franconia (*q.v.*); they also achieved the conquest of Thuringia; but the submission of the entire Germanic people to Frankish power was the achievement of the Carolingians (*q.v.*) and in particular of Charlemagne. (*See* FRANCE: *History;* GERMANY: *History.*)



FROM EDOUARD SALIN, "LA CIVILISATION MÉROVINGIENNE," VOL. III, PLATE VII(1) (PICARD, PARIS, 1957)

FRANKISH LONG SWORD FOUND IN LORRAINE, NOW IN THE MUSÉE LORRAIN AT NANCY; PROBABLE LENGTH OF COMPLETE SWORD 0.90 METRE. THE CUTTING EDGES ARE JOINED BY SOLDERING; THE CENTRAL PART OF THE SWORD IS OF DAMASCENE WORK IN WHICH ALTERNATE BARS OF IRON AND STEEL ARE TWISTED, HAMMERED DOWN AND THEN WELDED TOGETHER

Characteristics.—Contemporary descriptions suggest that the Frankish warriors were of unusually tall stature. Their fair or red hair was combed forward, leaving bare the napes of their necks, and they shaved their faces except for the upper lips. The royal family were privileged to wear their hair long on the shoulders; if they were deposed their hair was cut, or, probably, they were scalped. The Franks wore short tunics that reached only to their knees. A dead warrior was buried with his arms, and excavations made in barbarian cemeteries have brought to light a large number and a wide variety of weapons, most of which show great skill of workmanship. Their arms included the *francisca*, a single-edged throwing ax; the *framea*, an iron lance set in a wooden haft; the *scramasax*, a short single-edged sword; a long two-edged sword; and bows and arrows. The warrior was protected by a shield made of wood and wickerwork, strengthened at the centre by a metal boss. Sword handles, buckles and the pins used for fastening clothes were skilfully damascened with gold and silver. *See* SALIC LAW; *see* also references under "Franks" in the Index volume.

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FRANSCINI, STÉFANO (1796–1857), Swiss statesman and reformer whose maxim "Democracy is not so much respect for the vote of the majority as for the thought of the minority" expresses his faith in education and in the importance of public opinion. He was born at Bodio in the Ticino, on Oct. 23, 1796, of a peasant family, and in 1819 went to the seminary at Milan, intending to enter the church. At the age of 23 he became a teacher, but in 1829 he returned to the Ticino where he fought to set up a liberal regime (1830). He was secretary to the new government until 1848, when he became a member of the government of Switzerland until his death (at Bern, July 19, 1857). In the Ticino he did much for state education: as a member of the confederation he supported the establishment of a federal polytechnic and was the first to compile statistics in Switzerland. He had educated himself on the works of Montaigne, Adam Smith, Jeremy Bentham and Melchiorre Gioja, and was a typical liberal Illuminist and humanitarian. He was the first to develop in the people of the Ticino a sense of duty and a realization of the need to collaborate with the other Swiss cantons. In *La Svizzera italiana* (1837), *Statistica della Svizzera* (1827), *Annali del Canton Ticino* (publ. 1953) and numerous minor works, he shows himself a lucid and honest writer on political and social problems, often disappointed in the people whom he was trying to educate to a sense of impartial justice; but steadfast in his own love for his country, "the more so in that I dare tell her the truth in everything."

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FRANTISKOVY LAZNE (Ger. FRANZENSBAD), a spa in the extreme northwest of Bohemia, Czech., lies 1,500 ft. above sea level on the southeastern spurs of the Fichtelgebirge (Hory Halstrovske), a plateau straddling the German-Czech frontier. The resettled population (1960) was 4,626, mainly Czech. In 1939 its 3,800 inhabitants were almost entirely German. It is famous for its springs which are rich in carbon dioxide, iron, Glauber's salt, lithium and radium. They have an average temperature of 50.2°–54.5° F. These were first recorded in the 16th century, but the development of the spa dates from the late 18th century. In 1793 it was named after the Holy Roman emperor Francis II (Francis I of Austria), and its waters began to provide recommended treatment for a wide range of illnesses. It was declared a town in 1865. The moor of Soos (Franzensbad moor), 3 mi. S., yields peat rich in mineral substances for mud baths. Frantiskovy Lazne is a popular holiday resort for the industrial workers of the Ohre valley.

FRANZ, ROBERT (1815–1892), German composer of songs in the tradition of Schubert and Schumann. The son of Cristoph Franz Knauth (known as Cristoph Franz), he was born at Halle, June 28, 1815. He studied the organ under J. C. F. Schneider at Dessau (1835–37), and on return to Halle became a friend of Wilhelm Osterwald, many of whose poems he later set to music.

In 1841 he was appointed organist at the Ulrichskirsche at Halle and in 1842 became director of the Singakademie. In 1843 he published his "Twelve Songs," Opus 1, the intimate character of which was admired by Schumann and also by Liszt, who later transcribed a series of Franz's songs for the piano. In the same year his hearing became affected and he was later afflicted with nervous disorders. Obliged to relinquish his post at the Singakademie in 1868, he was supported for the rest of his life by a singer, Arnold von Pilsach. Franz devoted his later years to arranging works by Bach, Handel, Mozart and Schubert. He died at Halle, Oct. 24, 1892.

Franz wrote about 350 songs, remarkable for their sensitive musical prosody. "My music does not pretend to be much in itself," he told Liszt, by which he meant not to undervalue his work but to indicate the subservience of his settings to the poetic texts. Heine's poems form nearly a quarter of his texts. Most of his songs are in strophic form and were written for mezzo-soprano of limited range. Among his most expressive songs are "Gewitternach," "Die Heide ist braun" and "Es hat die Rose sich beklagt." He also wrote a series of choral and religious works.

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FRANZÉN, FRANS MIKAEL (1772–1847), Finnish-Swedish poet, a forerunner of Swedish romanticism, was born on Feb. 9, 1772, at Uleåborg, Fin. He studied at Åbo, where, in 1798, he became professor of philosophy. After the annexation of Finland by Russia, Franzén went to Sweden (1811). In 1831 he was appointed bishop of Härnösand, where he died on Aug. 14, 1847. Franzén was a master of a new poetic style in Swedish literature. Shakespeare, Milton and Gray made a deep impression on him.

His work consists chiefly of simple, idyllic lyrics, and his best poems embody the imaginative spirit of the romantic era. His images have the vividness of the bright, northern summer nights. His hymns breathe a quiet and cheerful confidence.

Franzén's collected poems were published in 7 vol. (1867–69). *See* also G. Castren, *F. M. Franzén in Finland* (1902); S. Ek, *Franzéns Abodiktning* (1916). (S. E.)

FRANZ JOSEF LAND (Zemlya Frantsa-Iosifa), an arctic archipelago administratively in Archangel *oblast*, Russian Soviet Federated Socialist Republic of the U.S.S.R., lies east of Spitsbergen and north of Novaya Zemlya. It comprises approximately 100 islands which extend northward from about 80° to 82° N. and between 43° and 65° E. They are similar in appearance and consist of platforms of fossiliferous clay, shales and sandstone rising to 400–600 ft. capped by 500–700 ft. of Tertiary basalt. Intrusive sills also occur. The basalts are related to those of Jan Mayen Island, Iceland, Greenland and western Scotland. The islands are remains of a more extensive land surface that was broken and partially submerged along lines of faults subsequent to the volcanic period. Raised beaches indicate recent elevations. The islands have icecaps and glaciers. Vegetation is scanty and includes 37 flowering plants and some mosses and lichens. Pack ice renders access difficult. The bear and fox are the only land mammals, but there are walrus and seal and birds of at least 26 species, of which probably 15, including the ivory gull, nest there.

The existence of land in this region was first postulated in 1865 by N. G. Shilling, a Russian naval officer, from study of ice drift and currents. Stories of its discovery by Nicholas of Lynn in 1360 and William Baffin in 1614 may be disregarded, but Norwegian sealers in the 1860s may have sighted it. The first discovery was by the Austro-Hungarian expedition under Julius von Payer and Karl Weyprecht, who saw land from the "Tegetthof," then beset, on Aug. 30, 1873. During the next spring this party explored parts of the archipelago and named it after the Austrian emperor. In 1879 the Dutchman A. De Bruyne sighted the islands, but did not land; British parties under B. Leigh Smith made further discoveries in 1880 and 1881–82. Franz Josef Land then attracted attention as a good starting place for the north pole, especially as more land to the north was expected. The British Jackson-Harmsworth expedition (1894–97) had this in mind when carrying out extensive investigations of the whole region. F. Nansen and a companion from the "Fram" reached the islands over the ice from the north in 1895 and thus virtually ruled out the possibility of more land in that direction. A series of primarily pole-seeking expeditions then used Franz Josef Land as a base, and each furthered knowledge of the area: a U.S. expedition under W. Wellman (1898–99), an Italian under the duke of the Abruzzi (1899–1900), two more U.S. parties, under E. B. Baldwin (1901–02) and A. Fiala (1903–05), and a Russian expedition under G. Ya. Sedoff (1912–14). All this while Norwegian sealers and walrus hunters continued to visit the region. The U.S.S.R., having proclaimed sovereignty over the archipelago in 1926, erected a permanent weather station there in 1929 and since then has had a monopoly of exploration and has carried out much scientific work. In the early 1960s three permanent stations were functioning (Bukhta Tikhaya, Ostrov Rudolfa and Nagurskaya), and another was set up for the International Geophysical year (Ostrov Kheysa). There is at least one airfield, and ships call every summer. There is little economic activity.

See Gunnar Horn, "Franz Josef Land" in *Skrifter om Svalbard og Ishavet*, no. 29 (1930). (T. E. A.)

FRASCATI, a town and episcopal see in Rome (Roma) province, Lazio (Latium), Italy, is situated 1,056 ft. above sea level on the northern slopes of the Alban hills, 26 km. (16 mi.) S.E. of Rome by road. Pop. (1957 est.) 14,740 (commune). The cathedral contains a memorial to Charles Edward, the Young Pretender, whose body rested there for a time; his brother Henry, Cardinal York, was bishop of Frascati and left a library, the Biblioteca Eboracense. The villas of the Roman nobility with their beautiful gardens and fountains include the Falconieri (the earliest, planned before 1550), Torlonia, Lancellotti, Rufinella (Tuscolana), Aldobrandini, Borghese and Mondragone. There are archaeological and Ethiopic museums and nearby are the ruins of ancient Tusculum (*q.v.*). Frascati is linked with Rome by railway and bus service. It is a residential area mainly concerned with tourism and wine production. The town seems to have arisen on the site of a large villa about the 9th century. For most of the middle ages it belonged to the papacy. During World War II Frascati was the German army headquarters of Field Marshal Albert Kesselring and suffered severe damage from Allied bombings. Restoration of the churches and villas has, wherever possible, taken place. (N. No.)

FRASER, CLAUD LOVAT (1890–1921), British artist who exercised a rejuvenating influence on English stage designs, was born in London on May 15, 1890, and was educated at Charterhouse. He began to follow his father's profession as a solicitor in 1908, but abandoned this three years later for art. After working with Walter Sickert for a time, he exhibited in 1913, being responsible in the same year for the decoration of the *Flying Fame* chapbooks and broadsheets.

His gift for spirited design and lively colour, based to a great extent on 18th-century conventions, developed rapidly, and he not only successfully illustrated many books, but produced designs for *The Beggar's Opera* (1920), *As You Like It* (1920) and *If* (1921). A career of great promise was cut short by his death, June 18, 1921.

See J. Drinkwater and A. Rutherston, *Claud Lovat Fraser* (1923).

FRASER, JAMES BAILLIE (1783–1856), traveler and author, was born at Reelick, Inverness-shire, on June 11, 1783. He went early in life to the West Indies and then to India, and in 1815 made a journey of exploration in the Himalayas, described in his *Journal of a Tour through . . . the Himala Mountains* (1820). An account of his Persian travels, which followed in 1821–22, was published in *Narrative of a Journey into Khorasan . . .* (1825). This included valuable astronomical observations of the latitude and longitude of various Persian cities. In the course of a diplomatic mission to Teheran, 1833–34, he rode on horseback from Istanbul to Isfahan. He supervised in 1835 on behalf of the British government arrangements for the visit of two Persian princes to England. Retiring in later years to his estate at Reelick, he died there in Jan. 1856. (H. M. Ws.)

FRASER, JAMES EARLE (1876–1953), U.S. sculptor, was born at Winona, Minn., on Nov. 4, 1876. Growing up on the Dakota prairies, he found friends among the Indians, which influenced his later Indian subjects—"The End of the Trail," equestrian statue shown at the Panama-Pacific exposition (San Francisco, Calif.) in 1915 and subsequently placed in Waupun, Wis.; and the United States buffalo five-cent coin, 1913. In 1894 he studied at the Art Institute of Chicago and then was the pupil of J. A. J. Falguière in Paris, assistant to Augustus Saint-Gaudens, 1898–1902, and instructor at the Art Students' league, New York city, 1906–11. In 1913 he married a sculptress and former pupil, Laura Gardin.

Until 1932 Fraser's work showed the romanticism and animation of Falguière, and some of the refinement and dignity of Saint-Gaudens. He changed his style to a more heroic, monolithic massiveness, however, after he was summoned to Washington, D.C., to create several works for the capital. He did the groups in the pediments of the Commerce Department building (1932), the figures in the huge pediment of the National Archives building and two heroic statues by the entrance steps (1935), as well as two other allegorical figures by the steps of the Supreme Court building. Most of his other works are in Washington and New York city. In Washington are a full-length bronze statue of Alexander Hamilton, Treasury building; "Journey Through Life," Keep monument, Rock Creek cemetery; Ericsson monument, Potomac park; etc. In New York city are a bust of Saint-Gaudens, Hall of Fame; sarcophagus of Bishop Potter, Cathedral of St. John the Divine; equestrian group of Theodore Roosevelt, Museum of Natural History. Fraser also designed many medals. He died in Westport, Conn., on Oct. 11, 1953. (J. W. Le.; X.)

FRASER, PETER (1884–1950), New Zealand statesman, who was prime minister during World War II, was born in Scotland, at Fearn, Ross-shire, on Aug. 28, 1884, the son of the village shoemaker. After the usual elementary schooling Fraser was apprenticed to a carpenter. He educated himself, theoretically by the reading of economics and socialism, practically in agricultural workers' agitation. First a Liberal, he later, having gone to London, joined the Independent Labour party, and in 1910 decided to try the newer and more socially advanced climate of New Zealand. He arrived at a moment important in the history of Labour development. The Liberal-Labour alliance in politics was outworn, but Labour was not organized for political action; though the "militants" were very vocal in the industrial sphere and were having some success, they were not strong enough to fight a really severe battle. Fraser, earning his living in wharf labour first in Auckland and then in Wellington, quickly became prominent as an organizer and negotiator, particularly in Labour's "Unity" conference of 1913 and the organization of the New Zealand Labour party in 1916. Opposing conscription during World War I, he was imprisoned for several months in 1916–17, but was elected to parliament in 1918. He was secretary to the parliamentary Labour party, 1919–35, and deputy leader, 1933–40.

Labour came into power in 1935. Besides being minister for marine and police, Fraser took the two major portfolios of education and health, and in both spheres did remarkable work as a reformer. Though not a good administrator, he was an inspiring chief; and a new education system and the Social Security act of 1938 providing health benefits and improved pensions were very much founded on his massive and liberal planning. The social program was interrupted in 1939 by the outbreak of World War II. Michael Joseph Savage, the prime minister, was dying; Fraser succeeded him in April 1940, but already as acting prime minister he had begun the travels and discussions that during those critical years and throughout his period of office made him one of the most effective and highly regarded of commonwealth statesmen. He was determined that all the country's strength should be thrown into the struggle, even to the extent of taking great risks, and at one stage New Zealand itself was practically defenseless; but at the same time he insisted that New Zealand should have final control of its own armies and policy. At San Francisco in 1945 and the United Nations general assembly meetings of 1946 and 1948 his constructive statesmanship found real scope, as it did in the settlement of important postwar commonwealth problems. In New Zealand itself, however, Labour was after the war a declining force, and was defeated in the election of 1949. A year later, on Dec. 12, 1950, Fraser died in Wellington.

See James Thorn, *Peter Fraser* (1952); Bruce Brown, *The Rise of New Zealand Labour* (1962). (J. C. Be.)

FRASERBURGH, a small burgh on the northeastern coast of Aberdeenshire, Scot., stands close by Kinnaird Head lighthouse at the southern entrance of the Moray firth, 43 mi. N. of Aberdeen by road. Pop. (1961) 10,462. It is the main seat of the Scottish herring industry with a fleet of about 100 modern diesel fishing vessels. After World War II the whitefish industry grew considerably and after the mid-1950s vied with herring landings in value and quantity. The harbour has more than 2½ ac. of wharfage and can accommodate vessels of 4,000 tons. Besides having engineering, canning and deep-freeze plants, Fraserburgh is a seaside resort with a fine beach and golf course. Included in the burgh is the old fishing village of Broadsea.

The burgh was granted a charter of burgh of barony in 1546 by the then regent of the infant Mary, queen of Scots. This charter conveyed burghal rights on the community under the superiority of the Fraser family, now represented by Lord Saltoun, and fell into abeyance by the erection of the burgh as a police burgh under the Burgh Police (Scotland) act, 1892. (J. M. Be.)

FRASER OF NORTH CAPE, BRUCE AUSTIN FRASER, 1st Baron (1888–), British admiral in World War II and chief of the naval staff (1948–51), was born Feb. 5, 1888, at Molesey, Surrey. He entered the navy in 1902 and served as a gunnery officer in World War I. He continued his interest in gunnery after the war and in 1933 became director of naval ordnance. At the start of World War II he was controller of the navy and was in large part responsible for directing the expansion of the navy during the 1939–41 period. Fraser then became commander in chief of the Home fleet and was chiefly concerned with the protection of convoys to the U.S.S.R. On Dec. 26, 1943, aboard his flagship "Duke of York," he fought and sank the German battleship "Scharnhorst" off Norway's North Cape in an engagement conducted largely at night with the aid of radar. As admiral in 1944 he was appointed commander in chief of the British Pacific fleet and on Sept. 2, 1945, signed the Japanese surrender papers for Great Britain in Tokyo bay. He was made a peer in 1946 and admiral of the fleet in 1948, and from 1948 to 1951 was first sea lord.

FRASER RIVER, chief river of British Columbia, Can., drains about 90,000 sq.mi. of the Interior plateau and its perimeter of rugged mountains. It was named for Simon Fraser who first descended it to the sea in 1808. The Cariboo gold rush, which began in 1858, took place in the Fraser river basin. Rising near Yellowhead pass on the British Columbia–Alberta border the Fraser flows 850 mi. to its mouth on Strait of Georgia. From its mountain source, the river's course is initially northwestward, descending by gentle gradients along the Rocky mountain trench. Near latitude 54° N. the river makes a great bend southward to traverse the Interior plateau and then the Coast mountains. Entrenchment and gradients increase progressively downstream, and through the Coast mountains the raging waters traverse a canyon about 5,000 ft. deep. Below this canyon the Fraser turns westward to flow placidly across an alluvial plain to its debouchment near Vancouver. The Thompson river which enters the Fraser about 145 mi. from its mouth is the most important of numerous tributaries, many of which rise in extensive mountain lakes. Hydroelectric developments on the tributaries have been carried on, and it is estimated that the Fraser river system has a total potential of about 13,000,000 h.p. The Fraser is also the largest salmon-producing river in North America. Navigation is important only in the tidal estuary where New Westminster serves deep-sea ships. (G. A. W.)

FRATERNAL ORGANIZATION, a voluntary association of persons having certain ethnic, social, religious or economic characteristics in common, formed primarily for social, benevolent or economic purposes. Despite the fact that social purposes had come to predominate by the middle of the 20th century, most

fraternal organizations still exhibited the strong ties developed to solve common problems or to meet common needs, and a good many still utilized secrecy and rituals.

Fraternal associations may be divided into three categories according to their primary purpose: (1) benevolent or protective associations, ordinarily with marginal social activities permitted by their bylaws, termed the fraternal benefit societies; (2) mixed social organizations, many of which marginally may support benevolent programs, termed mixed fraternal associations; and (3) social fraternal associations, which offer neither protective nor benevolent programs.

Purely social organizations, to be classed as fraternal associations, ordinarily have a legal charter providing for a secret ritual and initiation ceremony and often establish membership criteria. Those organizations include collegiate social fraternities and such groups as the International Associations of Lions clubs. This article is not concerned with them but only with fraternal benefit associations. (*See* FRATERNITY AND SORORITY; SERVICE CLUB.)

Fraternal associations perform a number of functions. The secret fraternity enables a group of individuals with common interests to associate exclusively. That is particularly important to minority groups in whom such associations engender a sense of belonging, a feeling that is strengthened through the ritual which helps to create a personal bond. In addition, through use of eligibility criteria, election for membership usually is controlled to provide greater unity in the organization. Ethnic minority groups, as the central and eastern European immigrants during the period of rapid American population growth, found strength and purpose as well as social satisfaction in a new environment through such associations, which led them to assist each other to adapt more rapidly to their new homeland.

Education to perpetuate past traditions, in many cases ethnic or moral in character, is another major purpose of fraternal organizations. The training process is oriented largely toward the new member and is designed both to promote his integration into the group and to assure the continuance of his group's culture, though no longer in contact with the homeland. While social functions predominate, the oldest functions of fraternal organizations were to provide group security through benevolent and later protective activities. These activities were designed to aid members and their families in case of sickness or death. The earliest payment noted in the United States was to a widow who received a $5 per month benefit payment beginning in March 1857 from the Czecho Slovak Society of America, founded in 1854.

Later, such activities assumed larger dimensions, going beyond the parochial limits of the membership. The earliest attempts to provide group security took the form of direct personal aid. Later the groups tended to centralize the function and to provide it on a more or less standard basis. In that context, the Ancient Order United Workmen, founded in 1868, is generally credited with being the first U.S. fraternal insurance society.

In later years the beneficial activities were supplemented through adoption of insurance techniques which, however, were not always correctly used. With that program the risks and benefits were considerably standardized, and the risks of the loss of income to the member and his family from sickness and death were shared. In that pattern the beneficiary status became a right rather than a privilege, and benefits were related to contributions rather than need alone.

History is replete with examples of fraternal activity. Mystical, ritualistic associations have been identified as early as the early Egyptian period. In modern times the first legislation covering their activities was written in Great Britain in 1793 and was entitled "An Act for the Encouragement and Relief of Friendly Societies."

Origins of Fraternalism in the United States.—The predominance of the British influence in colonial America tended to force the associations into a form more or less parallel to that of their British counterparts. Among the organizations imported were the Free and Accepted Masons; Independent Order of Odd Fellows; Ancient Order of Foresters; a number of ethnic orders, *e.g.*, the Ancient Order of Hibernians in America; and the United Ancient Order of the Druids. These early imported associations were mainly of the beneficial society and mixed society type. The first native fraternal association, Actors' Order of Friendship, was founded in 1849.

In the period following the American Civil War, as the characteristics of immigrants changed, so also did the fraternal organizations. Minority groups found that close association with their countrymen seemed to make their adjustment to a new world easier. The organizations provided a common meeting place for social activities and a medium for transmitting their common heritage to new generations. The social function was soon supplemented with benevolent or protective activities. The ethnic character demonstrated by the names of the organizations and the dates of their founding are closely correlated with the successive waves of immigrants by country of origin. These were typified by the Lithuanian Roman Catholic Alliance of America (1886); Croatian Fraternal Union of America (1894); and the Brith Sholom (1905).

Mutual aid in the solution of economic and related problems for individuals with common interests or employment served as the basis for other fraternal organizations, such as the fraternal orders of police, firemen and mechanics. In general, these groups engaged in many types of social and benevolent activities.

Political or patriotic bases exist for the formation of some fraternal organizations, such as those for veterans of military service. Their activities are largely devoted to the support of national traditions and the establishment of a centre for social activities. (*See* AMERICAN LEGION; VETERANS OF FOREIGN WARS.)

A religious origin or basis for solution of social and economic problems is evident in some fraternal organizations that provide for indigent members, their wives and orphaned children. This is typified by activities of the Lutheran Brotherhood, established in 1917 as a mutual benefit order. The Knights of Columbus and many others are of the same type.

Membership Requirements.—Qualifications for membership are largely set within the ethnic, religious, economic and political tenets of the associations. Age and sex also enter into consideration as qualifications in many cases. The ethnocentric associations usually require birth in a certain country or direct descent from immigrants from that country. The religious associations require public confession of belief in a particular faith. In some cases this statement of faith is broad enough to admit almost anyone, as, for example, in the case of the Masonic Order, which merely requires belief in the Almighty God. The Knights of Columbus, on the other hand, requires belief in a particular theology and performance of a ritual of worship.

Employment in a particular occupation often is required, as in the case of the Firemen's Mutual Aid and Benefit association, established in 1897. In the political or patriotic orders, prior military service or descent from a particular group (*e.g.*, a revolutionary soldier) is required. As to age, most organizations require majority; some have a junior status, with age of admission falling as low as 15. Usually these groups require that the initiate be the child of an adult member, as in the Order of DeMolay.

The majority of fraternal organizations are true fraternities in the sense that only men are admitted to active status. A few specialized organizations exist for women, such as the Catholic Women's Benevolent Legion. Many of the men's organizations have women's auxiliaries, such as the International Order of the Eastern Star, established in 1876.

The requirements for introduction into the beneficial and mixed fraternal associations indicated above differ significantly from those of the social fraternal organizations. In the social fraternal association some requirements tend to be more catholic in nature, in many cases cutting across ethnic, racial and religious lines. In other cases they tend to be even more selective as in the case of the educational, professional and honorary Greek-letter fraternities.

Growth and Decline.—From the colonial period to the Civil War the development of the fraternal system of the United States was marked primarily by the establishment of imported orders. The English, German, Irish, Scotch-Irish and Welsh origins are

particularly identifiable in these groups. In the years following the Civil War the purposes were modified and increasing numbers of associations were founded annually. This was true for each of the three categories of fraternal associations. The largest number of fraternal benefit orders for any decade was founded between 1890 and 1900 when more than 65 societies were established. During that period the patriotic orders also showed a rapid growth. In the second quarter of the 20th century there were fewer foundings than in any earlier period, the formation rate being about one every four years.

As the numbers of benefit associations increased, the insurance function of providing protection to members was developed and specific legal regulations governing it were adopted. A class of membership frequently was provided that did not require contributions or carry any protection rights. During the period from the Civil War to the early 1900s the number of insurance policies in force increased rapidly and the average value of the policies also rose. Many forces contributed to this result: the ethnocentrism of the immigrants; their economic insecurity; the need for low premium insurance; insurance company failures; the lack of low cost group and industrial insurance; the relative inaccessibility of ordinary insurance to the subject groups; and the immigrants' frequent suspicion of financial institutions.

The subsequent decline of these fraternal benefit associations was the result of other forces. The gradual assimilation of immigrants into the social, political, economic and ethnic patterns of the United States probably has been the most significant of these forces. With the increase in the security, flexibility and availability of insurance following the turn of the century, the need for group provision of personal security of the type provided by the fraternal organization has gradually diminished. Although a large volume of new insurance is written each year by fraternal associations, the rate of growth in the net total in force has declined. However, in 1959 there was more than $12,000,000,000 of insurance in force in fraternal associations on 9,300,000 certificates.

The Social Fraternal Association.—Prominent among the fraternal organizations in which ethnocentrism is lacking are the following with nationwide membership: the Fraternal Order of Eagles (founded 1898); the Benevolent and Protective Order of Elks (1868); and the Loyal Order of Moose (1888). All of these provide ritualistic orders for social activities only. Altogether there were several hundred organizations of this type in the United States in the early 1960s, having a total membership of about 90,000,000. Much of this membership must be discounted because of the multiple membership held by many persons. Of this total more than 10,000,000 persons were members of fraternal organizations that provide member protection through insurance. *See* also FRIENDLY SOCIETY.

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(J. F. A.; Jo. C. S.)

FRATERNITY AND SORORITY, social, professional or honorary organizations whose membership is drawn primarily from college or university students. Those for men are generally referred to as fraternities, while those exclusively for women are popularly called sororities. With few exceptions, fraternities and sororities use combinations of letters of the Greek alphabet as names.

Social Fraternities.—The social fraternity is peculiar to America, although attempts have been made to compare it with student organizations in other areas of the world, such as the corps of German universities. Its function, although basically to serve as a collegiate "home" for its members, varies from school to school. At some universities fraternities are the nucleus of campus political and social life, and affiliation with a Greek-letter society is a prerequisite for positions of importance in student activities, while at other schools, where fraternities are barely tolerated, affiliation might be considered detrimental to anyone seeking class or campus office.

The college chapter, basic unit of a fraternity, consists of all its undergraduate members at a specific school. The chapter house is the centre of fraternity activity, serving as meeting place, dormitory and dining hall for members. Each chapter has its own alumni group and, in many metropolitan areas, there are organized alumni chapters whose members may come from different schools. Alumni chapters cannot elect new members, but serve as sponsors of collegiate chapters.

Members of social fraternities and sororities are usually, although not exclusively, chosen from first-year students by a system known as "rushing." This usually consists of the fraternity's inviting prospective members, or "rushees," to the chapter house for meals or special rushing parties. Each rushee who is acceptable to the fraternity members is then extended a bid, or invitation to join, which he may accept or decline.

The initial probationary membership, called "pledgeship," is followed by initiation into active membership. Eligibility for active membership is controlled jointly by the school and the fraternity. Active membership is held during the remaining college years, and upon leaving school or graduating the active member assumes alumni status. Membership is for life and initiation is considered a permanent bar to membership in any other social fraternity. Members are, however, eligible for membership in both professional and honorary fraternities.

Each national fraternity has a general headquarters, with governing and supervisory officers who assist collegiate chapters in their operation and in maintaining the ideals and standards of the fraternity and the college. There also are many fraternities and sororities with only one chapter, often organized for the purpose of later affiliation with one of the established national groups. Many of these locals, however, have deep-rooted traditions on a particular campus and do not wish to subordinate themselves by national affiliation.

Traditionally, each fraternity has characteristic insignia—a badge or pin, coat of arms, seal, flag, certain colours and a fraternity flower. The fraternity ritual, in most cases a secret document, is an exposition of the ideals and aims of the organization and contains an explanation of its symbolism. This may include a password, grip, motto and recognition sign. The ritual also contains formal ceremonies used on occasions such as pledging and initiation.

Criticism.—There have been charges that fraternities promote irresponsibility, pay too much attention to social life at the expense of scholarship and carry on dangerous hazing practices. The modern fraternity or sorority, however, if for no other reason than self-preservation, has had to stress high standards of scholarship; the development of leadership and loyalty; and participation in community and national service projects. In addition, universities have regulated hazing practices, and fraternities which violate hazing regulations are severely punished and even may be denied recognition by the school.

The rushing system, too, has often been denounced as undemocratic, since, in those fraternities using a blackball system, a minority of the members may prevent bidding someone of whom the majority approves. Other criticism has been directed against the restrictive nature of certain fraternities which automatically bar members of certain racial, religious, national or ethnic groups from consideration. In the second half of the 20th century, a number of universities ruled that fraternities with discriminatory policies could not operate on campus. This led many fraternities to drop restrictive clauses from their constitutions.

History of the Social Fraternity.—Social fraternities trace their origin to student clubs existing during colonial days. The most famous of these and the first to use Greek letters for its name was Phi Beta Kappa, organized on Dec. 5, 1776, at the College of William and Mary, Williamsburg, Va. Five students, meeting in the Apollo room of the Raleigh tavern, on that date formed a secret society, adopting as their insignia a square silver medal, bearing on one side the Greek letters Phi, Beta and Kappa;

three stars; and an index. The stars represent the guiding principles of the society—friendship, morality and literature. On the reverse are the Roman letters *S.P.*, for *Societas Philosophiae*. In the course of time, Phi Beta Kappa became an honour society rather than a social fraternity. Its secrets were revealed to the public following anti-Masonic agitation in the 1820s.

In 1812 four students at the University of North Carolina formed Kappa Alpha or Kuklos Adelphon. This group had over 15 chapters, but disintegrated prior to the American Civil War. In 1825 Kappa Alpha society, the oldest social fraternity still in existence as such, was established at Union College, Schenectady, N.Y. Sigma Phi and Delta Phi were organized at Union in 1827. These three form the "Union Triad"; also founded at Union were Psi Upsilon (1833), Chi Psi (1841) and Theta Delta Chi (1847). The fraternity idea spread to the midwest with the founding of Beta Theta Pi (1839), Phi Delta Theta (1848) and Sigma Chi (1855), at Miami university, Oxford, O. These constitute the "Miami Triad." After the Civil War, fraternities appeared on the west coast of the U.S. and in Canada when Zeta Psi, founded at New York university in 1847, established chapters at the University of California (1870) and at the University of Toronto (1879).

Although most fraternities are secret societies, in 1834 there was founded at Williams college, Williamstown, Mass., the Social fraternity, an antisecret group organized as a protest against the influence of the secret fraternities. Similar organizations were later formed at other colleges and in 1847 formed the Antisecret confederation. In 1864 the name was changed to Delta Upsilon and thereafter, except for its nonsecret nature, it functioned much like any other national fraternity.

The first women's fraternities, or sororities, were the Adelphean (1851), later Alpha Delta Pi; and the Philomathean (1852), later Phi Mu, established at Wesleyan college, Macon, Ga. These were followed by the I.C. Sorosis (1867), which became Pi Beta Phi; Kappa Kappa Gamma (1870) at Monmouth college, Monmouth, Ill.; and Kappa Alpha Theta (1870) at DePauw university, Greencastle, Ind. The expansion of the sorority system came at about the same time that women were accepted as students in state-supported universities. In some cases men's fraternities aided in the organization of early sororities, thus bringing about the official brother-sister relationship which exists between certain fraternities and sororities.

Professional Fraternities.—Professional fraternities are specialized organizations whose membership is limited to students and faculty members engaged in one field of educational specialization. These have broader membership qualifications than the social groups and emphasize activities designed to develop professional competency rather than social life.

Professional fraternities began at Transylvania college, Lexington, Ky., where medical students formed the Kappa Lambda Society of Aesculapius (1819). Phi Delta Phi (law) was organized in 1869; Nu Sigma Nu (medicine) and Delta Sigma Delta (dentistry) in 1882, all at the University of Michigan. Other professions represented include agriculture, commerce, education, engineering, pharmacy, foreign service, journalism, optometry, osteopathy, etc.

Honorary Fraternities.—Honorary fraternities recognize superior attainment in a given field of activity. There are three classes: (1) those with requirements for membership based upon scholastic excellence in all fields; (2) those recognizing outstanding achievements in both extracurricular activities and scholarship; (3) those recognizing excellence and achievement in a single field. All candidates for membership must be of exemplary character.

Honour societies include Phi Beta Kappa (general scholarship, 1776); Tau Beta Pi (engineering, 1885); Sigma Xi (scientific research, 1886); and Phi Kappa Phi (general scholarship, 1897). Other groups, of more recent origin, represent architecture, civil engineering, commerce, forensics, history, journalism, industrial engineering, leadership, music, medicine, pre-medicine, Romance languages, etc.

Interfraternity Relations.—Although the first fraternity preceded the first sorority by 75 years, it was the women who first recognized the need for an organization in which Greek letter societies could exchange ideas and take united action on common problems. The first call for a meeting of women's groups in 1884 had no results, but discussions were held in 1891 and 1893. Nine years later, in 1902, representatives from seven sororities met in Chicago and the organization which became known as the National Panhellenic conference was born. Agitation for a men's interfraternity group began in 1907, and the first meeting, attended by representatives of 26 fraternities, was held in 1909. The following year a constitution and bylaws were adopted for the Interfraternity conference. The word National was added in 1931.

Among the problems with which the conferences concern themselves are rushing, pledge rules, fraternity-college and fraternity-community relations, hazing, scholarship, etc. In addition to these national groups, each campus has its own undergraduate Panhellenic and Interfraternity councils which exercise certain controls over the societies on that campus, and, in many cases, do liaison work between the college and the fraternities.

Professional and honorary fraternities and sororities have similar organizations which promote high standards and ethics within the individual organizations.

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FRAUD. Fraud, as a legal term, is a constituent of a number of statutory and common-law offenses and is the basis of a number of civil actions. In civil law, fraud is actionable as the tort of deceit. Also it may vitiate a contract, if it is an ingredient, as may mere innocent misrepresentation, which is not a tort in itself if, following rescission, the parties are placed in the same position as before. To sustain an action of deceit there must be proof of fraud and nothing short will suffice. Fraud is proved when it is shown that a false pretense has been made knowingly or without belief in its truth, or recklessly, careless whether it be true or false (*Derry* v. *Peek*, 14 app. cases 337). Although fraud may be a crime or an essential element in a crime, it has been held by the court of appeal in England that the standard of proof is that normally applicable in civil actions in English law, namely the balance of probability, and not that applicable in criminal matters, proof beyond reasonable doubt. U.S. practice is based largely on British precedents. (B. T.; J. C. Bs.)

UNITED STATES

More damage is done to the U.S. pocket and purse by so-called white-collar racketeers in a single year than by all of the armed thugs in a lifetime of violence. Few people have gone through life without having been mulcted or defrauded more than once.

Dubious investments, products and services are apparently marketed in the U.S. more expeditiously than anywhere else in the world. Perhaps because U.S. history contains so many success stories of persons grown fabulously rich from humble beginnings, the U.S. investor has seemed always ready to take a chance on a new "get rich scheme" or to give credence to a "something for nothing" offer. His innate gullibility and his generally high standard of living have also helped to make the American an especially easy and lucrative mark for the professional swindler.

While the word fraud, in its legal sense, has a strictly limited meaning applicable only in cases where guilt has been established under rules of evidence and law, the word may also be applied in its looser sense to the many types of ventures which, while not provable violations of law, depend nevertheless on guile and deceit to part the investor and consumer from his earnings and savings. These schemes, operating cleverly on the borderline of illegality but only rarely overstepping the line, are by far the more numerous, effective and widespread. In the sections below, both types of frauds will be discussed and illustrated.

MERCHANDISE FRAUDS

Rackets and frauds always follow the trend of the times and

capitalize on people's natural desires. In the generation following the stock market crash of 1929, the investment boom declined. As the country lifted itself out of the depression of the 1930s and the American people began once again to accumulate extra savings, their interest shifted to the newly developed products which were being produced by fast-growing industry. Instead of seeking to put their money into stocks, bonds and other financial investments, they turned to automobiles, washing machines, refrigerators and television receivers, and the adaptable professional swindler turned with them. For this reason, merchandise frauds, some of which are described below, have grown substantially in extent and importance. The home-building and home-improvement field offered many opportunities for fraudulent contractors and repairmen. After World War II there was a revival of interest in investment and speculation. One of the most spectacular forms of the "get rich quick" fraud was uranium stock sold at ridiculously low prices.

"Bait and Switch."—This type of scheme constitutes one of the most subtle and widespread merchandise frauds in the U.S. The scheme consists of advertising a product at a ridiculously low price simply as a lure to gain entrance into the prospect's home or to entice him to the advertiser's place of business. When the prospect responds to the advertisement, the salesman disparages the advertised product and makes a high-pressure attempt to switch him to a much more expensive one which is frequently an unknown, inferior and overpriced brand. If the prospect insists on the advertised product, the salesman may refuse to take his order or, if he does, delivery is rarely made.

"Bait and switch" tactics are used in the sale of a variety of products but particularly in connection with certain household appliances which are often sold through demonstration in the home. In the case of the low-priced special "bargain" it has been found that the demonstration model was deliberately tampered with to impair its efficiency. One company, for example, followed the practice of removing a vital part from its demonstrator model, resulting in a reduction of performance to 1/40 of its normal capacity. This was deliberately done so that the prospect would find the advertised machine so completely unacceptable as to be readily switched to the high-priced machine which the salesman "just happened to have in his car."

Fake Contests.—These have been widely used for promoting the sale of inferior merchandise at high prices. Such contests take many forms but are characterized by the fact that every contestant wins the "prize" and the award is usually a credit voucher applicable to the purchase of some piece of merchandise. One common type is the so-called "mystery melody" contest. Melodies are played on the radio and listeners are told, for example, that the first 25 persons who send in the name of the melody will receive a $50 credit applicable to the purchase of certain merchandise. The melodies played are simple, familiar tunes which are known to almost every schoolchild.

As a further indication of the falsity of the contest, tests have shown that persons sending in incorrect answers also "win" the prize. There is, of course, no limit on the number of "winners." In all of these cases, the price has been marked up in advance so that the application of the $50 credit would result in a price which is not lower and often higher than the normal selling price for the merchandise.

Door-to-Door Selling.—While the honest door-to-door salesman plays an important part in the distribution of goods and usually represents highly respectable and reputable companies, this method of selling has been subject to many frauds and abuses. The young salesman who is "working his way through college" or, as he grows older, is "working his way through medical school" was, after the end of World War II, joined by the "wounded war veteran" who used this fictitious appeal to gain the sympathy of his potential victims. As the market survey became an important technique of business research, many door-to-door salesmen also adopted the guise of the survey taker. After going through the motions of taking a survey by asking the housewife some questions about the soap powder she uses or the magazines she reads, for example, the "survey taker" offers her a "gift" for her cooperation—merchandise "valued at" $150 for only $50. The actual value, however, may be less than half of $50.

Another common fakester is the door-to-door house-improvement salesman who claims that the prospect's house is the first approached in the area and that, if he will agree to have his home repaired or improved at a special bargain price and permit it thereafter to be used as a model for others in the neighbourhood to view, the property owner will receive a $50 bonus for every additional job done in that area. Such promises are never included in the formal contract and are seldom fulfilled.

Fake Jewelry Salesmen.—These have used a reprehensible method to sell watches to illiterate industrial, restaurant and hotel workers. They approach their victims during their lunch hours at their places of employment or after work and show them gaudy watches at "bargain" prices. The salesman suggests to the victim that he wear the watch a day or two and show it to his friends and family before making up his mind. All that is required, says the salesman, is the signing of an overnight receipt so that he can account for the watch to his employer. If the victim is gullible enough to sign the "receipt," he subsequently finds that what he has actually signed is a firm contract for the purchase of the watch on installment payments and that the agreement also gives the firm the right to attach his wages if he does not keep up his payments.

"Going-Out-of-Business" Sales.—An old and time-worn trick of unscrupulous merchants is the fake going-out-of-business sale. Such tricks are used particularly by certain merchants located in sections of large cities frequented by out-of-towners who have no way of knowing that the merchant is perpetually closing out his business. In many U.S. communities, laws have been enacted requiring the special licensing of all "going-out-of-business" sales, their duration being strictly limited.

Certain types of merchandise frauds which formerly enjoyed widespread success but were largely eliminated through legislation and special precautionary measures are worth mentioning for their historical interest in famous frauds. Two of these are stuffed flats and suit clubs.

Stuffed Flats.—Dealers in furniture, furs, jewelry, etc., rent an apartment and pose as private parties obliged to sell their furnishings and belongings at great sacrifice. The apartments are actually furnished from the dealer's own stocks. The merchandise is grossly misrepresented, exorbitant prices are charged, and the flats regularly "restuffed."

Suit Clubs.—Suit club swindles require the payment to the promoter of $1 or $2 per week for 25 weeks or more for the "chance" of winning a suit in one of the weekly lucky drawings. It is understood that those whose numbers are not drawn are to receive a suit anyway upon the completion of their payments. Actually, very few legitimate drawings are held. The suit which the member of the club gets at the completion of his payments is made of the shoddiest material and is worth far less than the total amount paid in. Operators of the clubs often abscond before the end of the payment period.

Commercial Frauds

"Clip-and-Paste" Schemes.—While possessed of greater business judgment and acumen than the ordinary consumer, the businessman himself is the victim of a surprising number of frauds and rackets, usually the result of his own carelessness. One of the most common promotions by which businessmen are duped is the "clip-and-paste" directory. In this scheme, a promoter of an obscure trade directory with little or no circulation clips a company's advertisement or listing from a well-known and recognized directory and pastes it on an invoice form of his own. The form is cleverly prepared and worded, usually cluttered with print and marked "Rush" and "Final Proof" in bold letters. In most respects, the form looks like a renewal invoice. The careless businessman approves the invoice and sends his remittance in the belief that he is simply renewing his previous advertisement.

Homework Schemes.—An advertisement appears offering high earnings for addressing envelopes at home or for doing home embroidery work. Persons who respond are asked to send in from $2 to $5 as evidence of their "good faith," or to cover the cost of

a "working kit," this cost to be reimbursed to the respondent out of future "earnings." In actual fact, these homework offerings usually involve the addressing of envelopes by the respondent as part of a plan whereby he attempts to sell merchandise which he must purchase from the advertiser, or an attempt on the part of the promoter to sell kits and equipment to respondents.

"Death Vultures," also known as "hearse chasers," victimize recently bereaved families by attempting to collect payment for items which they falsely claim had been ordered or purchased by the deceased just before his demise. In their grief, the family frequently fails to check the claim and pays the bill. Other "hearse chasers" send C.O.D. packages addressed to the deceased. The family pays for the goods believing the deceased had ordered them before his death.

Gardening Rackets.—Spring is the time of the year for gardening frauds—quack tree surgeons, fake seed salesmen and spurious humus peddlers. Housewives are approached by truckmen with loads of "fine humus" for lawns. The truckman offers to spread the material on the lawn at a cost of 75 cents a basket. Scattering some sample baskets as a demonstration of how little is needed, the truckman receives permission to proceed. The housewife goes about her chores and when the job is done she is presented with a bill of $150. Although greatly chagrined, she usually feels she has no choice but to pay. In many cases, laboratory analysis of "fine humus" discloses it to be entirely worthless as a lawn invigorator.

Radio and Television Repair Schemes.—Advertisers of television and radio repair service in the home at ridiculously low prices often follow the practice of removing the receiver to their shops even when the repair is a simple one which can easily be performed in the home. They finally return the set with a large bill for repairs for work never needed and never done. Some unscrupulous service companies of this nature have been trapped by the police by calling them in to repair sets which had previously been prepared by experts so that one small tube and nothing more required replacement. Identification marks were placed on each of the tubes and parts. Subsequently, when the crooked company rendered a bill for the replacement of parts which examination of the set showed were never replaced, criminal proceedings were instituted.

Child Model Schemes.—Agents approach mothers with the tale that their children had been observed at play and appeared, in the opinion of the agent, to be remarkably precocious and attractive. The agent paints a picture of a large unsatisfied demand for child models to pose for advertisements which could easily make the child the family breadwinner. An additional inducement is the enticing suggestion that the child may even find his way to Hollywood to star in motion pictures. For a $50 listing fee, the child's photograph is included in a catalogue which, states the agent, is circulated to all of the "right people." While the catalogue is actually produced and distributed, it carries no weight and receives little attention from persons in a position to employ child models. In only the rarest case does a child earn any money as a result of inclusion in the catalogue and in practically no case do the earnings even repay the cost of inclusion in the catalogue.

Song Sharks.—These are "song publishing" companies which, for a fee, will accept for publication any song submitted by a hopeful but, regrettably, untalented songwriter. The song shark fulfills his contractual obligation by obtaining copyrights and by printing a handful of copies of the song. It has been estimated that approximately 1% of all songs copyrighted and published in the United States ever achieve success. Legitimate publishers do not require the payment of a publishing fee.

Charity Frauds.—In the 1950s it was estimated that Americans were unknowingly contributing approximately $100,000,000 a year to corrupt and fraudulent appeals made in the name of charity. Using the mails, personal canvass and "boiler rooms" (batteries of telephones at which professional solicitors make calls to persons listed on carefully prepared "sucker lists"), the charity fraud became one of the most lucrative fields of endeavour for the white-collar underworld. Many of the erstwhile operators of financial swindles, with their financial operations restricted by government legislation, turned to the greener pastures of charity solicitations.

Charity frauds may be divided into two categories: those appeals conducted by crooked promoters in behalf of a nonexistent charity in which they pocket all of the funds collected; and the more subtle and widespread procedure of obtaining permission of an established charity to use its name, thus giving the solicitation an aura of respectability and legitimacy, in which the promoter turns over a small part to the charity instead of keeping all for himself.

In 1953 a joint legislative committee of the New York state legislature conducted public hearings into charity rackets. The report issued at the conclusion of its investigation exposed a large organization of wounded veterans as having collected more than $21,000,000 in a three-year period. Of this sum, the report showed, $14,000,000 was used to pay promoters and to cover other fund-raising expenses. This organization had been using the names of the president of the United States and a former president in its fund-raising campaigns. A national organization which based its appeal on rendering assistance to children raised almost $4,000,000, of which $3,250,000 was consumed in fund-raising expense. A cancer hospital which existed purely in the mind of the promoter was able to collect $630,000 in its nationwide solicitations. Another prevalent solicitations racket exposed by the committee was the operation of a self-styled "bishop" who sent six "nuns" out into the streets every day to solicit funds. No church received any benefit. The "bishop" received $2.50 a day from the "nuns" in return for which he gave them a certificate as evidence that they were soliciting funds for his church. None of the paid solicitors were actually nuns. They would come to the church in the morning in their street clothing, change into a nun's habit and then go out with little metal trays to solicit funds. At the end of the day they would come back to the church, change their clothes and go home. All they collected over $2.50 was clear profit to themselves.

Financial Frauds

Between World War I and the market crash of 1929, financial frauds reached a volume and a degree of success never equalled before or after. According to Andrew Mellon, secretary of the treasury during most of this period, the annual American loss in financial ventures alone in those years was $1,700,000,000. One flourishing business in itself was the marketing of "sucker lists" of persons who had already been victimized, on the theory that these were the best potential subjects for future "fleecing." In the aftermath of the 1929 collapse, the United States congress enacted a series of laws designed to protect the public from fraudulent and speculative investments. A federal agency, the Securities and Exchange commission, was established to administer the laws and to require the registration of security offerings. Many states adopted similar local requirements. The result was that while investment frauds still continued to appear from time to time, most of the free and easy stock swindles of the 1920s became extinct. No record of the subject of frauds would be complete, however, without some reference to two of the more famous frauds.

The Ponzi Scheme.—During its relatively short existence, the swindle operated by Charles Ponzi was one of the most remarkable individual operations in the history of fraud. Beginning in Dec. 1919 Ponzi, who had served a previous prison sentence for forgery, produced a scheme involving the purchase of International Postal Reply coupons in countries where the exchange was low, trading them in for postage stamps at their face value in a country where the rate was high and then selling the stamps at a great profit. International Postal Reply coupons were an instrumentality or device of the international bureau of the Universal Postal union which stipulated that the coupons were to be sold at a price not less than 28 centimes gold. The slogan of the swindle was 40% in 90 days. In the first month of operation, there were only 15 customers whose investment totaled $870. In the third month, there were 17 people contributing $5,290. In the fourth month, 110 customers invested a total of $24,724. In the sixth and last month the swindle reached its final fantastic proportions—20,000 individuals invested nearly $10,000,000. In fact Ponzi could not have done what he was promising to do even if he had bought the coupons. Actually,

however, Ponzi made no purchases whatever of International Postal Reply coupons. When the bubble finally burst, the investors who still had money entrusted to Ponzi lost it all; Ponzi himself was sentenced to a federal prison where he spent the next five years.

Tipster Sheets.—There were at one time at least 50 of these in existence on the eastern seaboard alone. They were publications put out by crooked stock promoters who pretended to furnish unbiased advice on investments. Almost everything in a tipster sheet was true and almost all of the advice obviously sound, thus creating an atmosphere of responsibility. The sole reason for publishing the sheet, however, was the advice it contained to buy a certain stock which the publisher was trying to unload. The most notorious and successful tipster sheet was the *Wall Street Iconoclast,* a biweekly publication of George Graham Rice, who subsequently served a term in a federal penitentiary in connection with one of the fraudulent stocks he successfully sold with the help of his tipster sheet. Among other things, the *Wall Street Iconoclast* attacked financial swindlers and warned its readers against them. So plausible were the writings contained therein that a professor was found using it for instruction in economic subjects.

Real-Estate Frauds

The Free Lot Scheme.—In this scheme the victim is informed he has won a "free" lot, and he and his wife are taken by the salesman to see the new homesite they have so luckily acquired. They find, however, that the lot they have "won" has a completely undesirable location. The salesman then persuades the victim to accept a $100 "allowance" on the "free" lot to be deducted from the sale price of a more desirable one. The price of the second lot is, of course, inflated to absorb the allowance and, often, much more.

Advance Fee Schemes.—Certain crooked real-estate firms demand a fee in advance to cover their "expenses" in selling their client's property. No real effort is made to sell the property, however, and the agent simply pockets the advance fee. This scheme has also had application in connection with attempts to locate living accommodations, especially in areas where housing is scarce. The applicant pays the "agent" a $50 advance fee for help in finding a suitable apartment or house. If the quest is successful, he is told, the $50 will be kept by the agent as his fee. If not, the applicant may at any time request the return of $40, the remaining $10 being retained by the agent for his troubles. The unscrupulous agent makes no bona fide effort to locate accommodations for his applicants, but nets the $10 "service" fees.

Development Frauds.—One of the most spectacular real-estate frauds in history involved real estate at Muscle Shoals, Ala. During World War I a gigantic project to manufacture nitrates was started there by the government, together with the Wilson dam and its hydroelectric system. The project was not completed until the early 1920s—too late to be of any value in the war. Nevertheless, a group of promoters bought up surrounding farm land, divided it up into city lots, and proceeded to unload them on the public at prices far in excess of the actual value of the land.

Others

The "Spanish Prisoner Fraud."—Many frauds, although exposed over and over again, continue to reappear, sometimes with slight variations. One which constantly recurs in different sections of the United States is the "Spanish prisoner" letter. This particular swindle is of historical interest as one of the oldest of international frauds and is said to have been started in 1588. The writer of the letter states he is a prisoner in Spain or Mexico and has $200,000 in cash which he will divide with the victim if he will advance the money necessary to purchase his release. Frequently, an alluring *señorita* is also a part of the bait.

Missing Heirs.—One of the most successful confidence swindles is based on a fortune allegedly left unclaimed at the time of the owner's death. The confidence man convinces his victim that he is the rightful heir to the estate and is usually able to extract substantial sums to cover the supposed expenses of establishing the rightful proprietorship. One of the best-known "missing heir" schemes revolved around Jacob Baker. For almost 100 years after his death, many persons named Baker were convinced by fakers that he had been the owner of most of the land on which Philadelphia was built and each of these Bakers was willing to pay to have their inheritance recovered. In 1937 a United States attorney established that Jacob Baker had died penniless. His alleged will, which fakers had used to dupe their victims, was proved a forgery.

Quack Doctors.—Fake medical men with counterfeit diplomas and quack cures are practitioners of one of the most dangerous of frauds, known to have produced the death of more than one gullible patient. What adds to the success of their masquerade is the willingness of their "patients" to speak of them in the most laudatory terms. Persons beyond middle age, for example, frequently develop harmless growths which are solemnly diagnosed by the quack as cancer. When simple caustics remove the growth, the patient goes home in fine health to serve henceforth as a living advertisement of an alleged cancer cure.

One of the most reprehensible frauds involving fake medical men is the "glimmer scheme" practised by quack eye doctors. The eye "doctor" and a confederate drive through rural areas and learn from talkative storekeepers which farmers in the neighbourhood are having difficulty with their vision. The confederate, posing as a chauffeur, drives to the farmer's house and stops for water. Pretending to notice the farmer's eye condition he confides that he is driving a famous eye surgeon to a convention in a near-by city. The chauffeur persuades the "doctor" to examine the victim's eyes. The gullible victim is told he suffers from cataracts and his eyesight is in danger, but that this can be cured by a simple operation. The farmer pleads for the surgeon to save his sight. The surgeon agrees reluctantly, pointing out that he is not licensed in that state. The farmer, however, agrees to keep the operation a secret. A harmless fake operation is then performed and a piece of egg membrane displayed to the farmer as the removed cataract. Numerous persons have paid $100 to $2,500 for such "operations." *See* also Quackery; Sale of Goods. (H. R. J.)

GREAT BRITAIN

Legal Aspects.—It is probable that the action of deceit originated in England as a remedy for abuse of legal proceedings and existed as such in the 13th century. Early forms of tort depended upon an act with physical damage as a consequence, while the state of the wrongdoer's mind was practically disregarded. In the middle of the 14th century, it was developed by "an action on the case" so as to include a wider aspect of fraud; thus an action lay to a plaintiff who bought cattle from a man to whom they did not belong. So, by stages, it was developed until by modern times any false statement made willfully so that the plaintiff acts to his detriment will probably be actionable (*Pasley* v. *Freeman,* 1789). The development of contractual liability was similar and was related to the economic development of the country. When property was retained by force, the remedy to fraud lay in the strength of the arm of the dispossessed person, but as trade developed it became essential that the standards of honesty which were required in business should be protected by the courts. In the 16th century there was a liability in contract if a warranty were included and that warranty were false, but in 1603 there was still some doubt as to whether a knowledge on the part of the defendant as to the veracity of the warranty was essential. By the 18th century, warranty was implied and thus there developed liability in contract for misrepresentation whether fraudulent or otherwise, but there was no corresponding extension in the action in tort of deceit. Even today the principle of *caveat emptor* (let the purchaser beware) applies in contract, so that every misrepresentation is not necessarily fraudulent but only if a warranty is implied.

In criminal law there is no such offense as fraud in itself, though it is an essential ingredient of many offenses. Of these the most important are: obtaining money by false pretenses (s. 32, Larceny act, 1916); fraudulent conversion (ss. 20–21); obtaining credit by false pretenses or any other fraud (s. 13, Debtors act, 1869); and a number of offenses under the Companies act, 1948, and the Prevention of Fraud (Investments) act, 1958. In most of these cases, fraud or some similar expression is specifically an ingredient,

but even in those offenses where no fraud is mentioned it is still to a lesser degree an ingredient, for with all criminal offenses there must be *mens rea* (criminal intent).

The history of criminal fraud is recent compared with that of offenses of violence which have always been crimes. The maintenance of public order free from violence was more important for the preservation of the king's peace than the fraudulent acquisition of private property. Hence to this day offenses entailing fraud are classified generally as misdemeanours, whereas larceny and crimes of violence are felonies. The distinction has in many ways lost its significance, but even today a man who has stolen sixpence may be arrested without a warrant whereas a man who has defrauded a large section of the community of thousands of pounds can only be arrested on the order of a magistrate.

Probably the first attempt to bring fraud within the criminal law was in the 16th century, when Britain's reputation in commerce was beginning to develop. Two statutes were passed in the reign of Elizabeth I dealing with conveyances in fraud of creditors and in fraud of purchasers which curtailed the current fraudulent practice of disposing of assets prior to bankruptcy.

An act had been passed earlier, in 1541, which made it an offense to issue a document in furtherance of fraud. This was later extended to any fraudulent writing; but a lie, however blatant, unless it was such as to affect the public at large, was not fraudulent. Thus, where a woman obtained money by stating that she had been sent by her mistress to obtain silks for the queen, and both statements were false, it was held that as no false document was given, no fraud was committed. This narrow interpretation of the law did not meet the needs of the developing community and, as a result, in 1757 it became an offense to obtain goods by false pretenses, and from this act (30 Geo. 2 C4) the present offenses of false pretenses have developed.

Some Types of British Fraud.—The variations of fraud are as infinite as the ingenuity of the perpetrators, but some of the better-known forms are "kite flying"; "teeming and lading"; "share pushing"; "bucket shops"; "long firm fraud"; and the "confidence trick."

"Kite flying" is the use, as credit, of the time taken in the course of banking machinery for a check to be cleared. Thus, if A pays a check drawn by B into A's account, it will be some days before it is debited against B's account. During these days it may be possible, under certain circumstances, to make use of the credit shown in A's bank account, by A's being allowed to draw on the "uncleared effects," namely B's check.

"Teeming and lading," which strictly means unloading and loading, is merely an accountant's term for the system of robbing Peter to pay Paul. Thus a cashier, having misappropriated part of one day's takings, appropriates part of the next day's takings to make up his deficiency, and so continues from day to day. He usually increases his appropriations until either the deficiency overtakes the total drawings of a day or, for some extraneous reason such as illness, his actions are discovered.

"Share pushing" is a colloquial expression for high-pressure salesmanship of shares in limited companies. It is probable that the provisions of the Prevention of Fraud (Investments) act, 1939, have curtailed this form of activity which was rife between World Wars I and II. The method was simple but the offense difficult to prove. Shares were bought at a low price in a company doing practically no business, then by balance sheets which failed to show the true position, eulogistic reports by experts on gold findings or other operations and careful circularization of potential speculators, the shares were run up to many times their original value. Having unloaded his supply of shares on the public, the fraudsman disappeared, probably to another continent. It became an offense under the 1939 act to circularize in this way, and dealing in shares generally was restricted. The offenses of publishing fraudulent balance sheets or prospectuses were so widened that a mere misleading statement or forecast might be an offense.

"Bucket shop" means the business of a sham share broker who gambles with his customers on the rise or fall in the prices of stock exchange securities without acquiring these securities at all. The origin of the name may well lie in the activities of smalltime wheat dealers who dealt with odd lots which were described as "bucketsful." The expression is loosely used to describe any fraudulent financial firm, but the true bucket shop is not necessarily fraudulent though its activities would probably be an offense under the Prevention of Fraud (Investments) act, 1958.

"Long firm fraud" is a term loosely used for any firm which fraudulently obtains goods on credit and sells these goods without attempting to pay for them. Strictly speaking, it is restricted to those cases where the person supplying credit is induced to do so by the production of false references. The goods are usually sold under cost to obtain a quick return and to enable the operator to make his money before the creditors and police become interested in his activities. Until 1948 the offense was usually dealt with as false pretenses, but, so far as companies are concerned, it is now more easily proved to be fraudulent trading under the Companies act.

The "confidence trick" is the cultivation of the confidence of the victim often by prompt repayment of small debts or by lavish entertainment until he is willing to part with a large sum. The confidence man is a convincing talker who preys upon the ignorance and gullibility of his victims, many of whom are elderly widows.

See ART FORGERY; CONTRACT: *Fraud;* EMBEZZLEMENT; FORGERY; QUACKERY; SALE OF GOODS; *see* also references under "Fraud" in the Index volume. (B. T.; J. C. Bs.)

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FRAUENFELD, the capital of the Swiss canton of Thurgau, is situated on the Murg, close to its junction with the Thur, 38 km. (27 mi.) N.E. of Zürich by road. Pop. (1960) 14,702, about 75% of whom were Evangelicals and 25% Catholics. The old town centres round the 13th-century castle which houses the cantonal museum. Frauenfeld-Oberkirch, the mother church of the town, is famous for its stained-glass windows of the 14th century. The old Capuchin convent (1591–1848) is now a vicarage. Frauenfeld is a rail and road junction. There are iron, textile and preserve manufactures and a federal military training camp.

First mentioned in 1246, Frauenfeld was founded by the count of Kyburg and the abbot of Reichenau on land belonging to the abbot. The political powers of the Kyburger were inherited by the Habsburgs in 1264 and in 1460 seized by the seven Swiss Confederate states. From 1712 the federal diet met annually at Frauenfeld until the Old Confederation was disbanded by the Helvetic republic in 1798. Two great fires (1771 and 1788) destroyed the whole town except the castle, one house and the Evangelical church. (BR. M.)

FRAUENLOB, the nickname of HEINRICH VON MEISSEN, German lyric poet of the late 13th and early 14th centuries, founder of the first *Meistersinger* school (*see* MEISTERSINGER). The origin of his nickname ("praiser of ladies") apparently lies in his championship of the appellation *Vrouwe* (*i.e.*, lady, a designation of noble rank) against *Wip* (woman, the female sex in general) in a famous contest, or *Sängerstreit*, with his contemporary, Regenbogen. He came of a burgher family and led the life of a wandering minstrel, serving a succession of patrons from Bohemia to Brandenburg. In 1312 he settled in Mainz, and there he founded his *Meistersinger* school. He died in Mainz on Nov. 29, 1318. His extant *Leiche*, or lays (religious and secular), and shorter religious, moral and didactic poems show him to be a serious, highly sophisticated and mannered artist; on the one hand he filled his works with learned, often obscure allusions, on the other he lavished on his forms all conceivable refinements of rhetoric and prosody. The result is intellectual poetry of great

complexity, often affected and bizarre, the product of virtuosity for its own sake.

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(Rd. J. T.)

FRAUNCE, ABRAHAM (*c.* 1558–1633), English poet whose critical textbook *Arcadian Rhetorike* (1588) is original in illustrating each precept by a quotation from a classical, continental or English author. The English quotations are mainly from works by Sir Philip Sidney and from Spenser's *The Faerie Queene*, then unprinted, and show that these two poets had achieved fame while their chief works were still in manuscript.

A native of Shropshire, Fraunce was born between 1558 and 1560, and was educated at Shrewsbury school and St. John's college, Cambridge. He was called to the bar at Gray's Inn in 1588, and apparently practised in the court of the Welsh marches. His works include *Victoria*, a Latin comedy, edited by G. C. Moore Smith (1906); *The Lawiers Logike* (1588); and *The Countess of Pembroke's Emanuell* (1591).

FRAUNHOFER, JOSEPH VON (1787–1826), German physicist, is best known for his study of the dark lines in the sun's spectrum, known by his name. He was born at Straubing in Bavaria on March 6, 1787. He gained experience as an optician and obtained work at the Utzschneider optical institute at Benedictbeuern, near Munich, of which he became sole manager in 1818; the institute was in 1819 moved to Munich. Fraunhofer acquired great skill in the manufacture of achromatic lenses and various optical instruments.

While measuring the refractive index of glass of various kinds, he noticed and made use of the D lines in the sodium spectrum, and continued work led to observation of "Fraunhofer lines." His researches were published in the *Denkschriften der Münchener Akademie* for 1814–15. These dark lines had been noted earlier by W. H. Wollaston (*Phil. Trans.*, 1802), but were for the first time carefully observed by Fraunhofer. He mapped 576 of these lines, the principal of which he denoted by the letters of the alphabet from A to G; and by ascertaining their refractive indices he determined that their relative positions are constant, whether in spectra produced by the direct rays of the sun, or by the reflected light of the moon and planets. The spectra of the stars he obtained by using, outside the object glass of his telescope, a large prism through which the light passed to be brought to a focus in front of the eyepiece.

In 1823 he was appointed conservator of the physical cabinet at Munich, where he died on June 7, 1826.

FRAY BENTOS, a port on the Uruguay river and capital of the department of Río Negro in western Uruguay, was founded as Independencia in 1859. Pop. (1962 est.) 18,038. It became important when the first industrialized meat-packing plant in Uruguay was established there in 1861, using the meat-extracting method invented by Justus von Liebig. The industry grew rapidly and, with the expansion of refrigeration and cold-storage facilities, Fray Bentos developed a significant share of the nation's meat-packing trade, exporting the produce of its stock-raising hinterland. Its modern port is the deepest on the Uruguayan side of the Uruguay river. It has rail, road and air connections with Montevideo, 170 mi. S.E. (M. I. V.)

FRAZER, SIR JAMES GEORGE (1854–1941), British anthropologist, folklorist and classical scholar, who wrote *The Golden Bough*, was born in Glasgow on Jan. 1, 1854. From an academy in Helensburgh, Dumbarton, Scot., he went to Glasgow university in 1869, entered Trinity college, Cambridge, in 1874 and became a fellow of the college in 1879. In 1907 he was appointed professor of social anthropology at Liverpool, but returned to Cambridge after one session, remaining there for the rest of his life.

Frazer's early classical interests were broadened by acquaintance with E. B. Tylor's *Primitive Culture* (1871), and his study of comparative religion was encouraged by association with W. Robertson Smith in Cambridge. His outstanding position among anthropologists was established by the publication in 1890 of *The Golden Bough; a Study in Magic and Religion* (reissued in 12 vol., 1907–15; abridged edition in 1 vol., 1922; in 2 vol., paperback, 1957). The underlying theme of *The Golden Bough* is Frazer's theory of a general development of modes of thought from the magical to the religious and, finally, to the scientific. His distinction between magic and religion (magic as an attempt to control events by technical acts based upon faulty reasoning, religion as an appeal for help to spiritual beings) has been basically assumed in much anthropological writing since his time. The evolutionary sequence of magical, religious and scientific thought is no longer accepted; but though Frazer's broad general psychological theory has proved unsatisfactory, it enabled him to synthesize and compare a wider range of information about religious and magical practices than has been achieved by any other single anthropologist. *The Golden Bough* continues to be referred to as an encyclopaedia of such practices. It also directed attention to the combination of priestly with kingly office in the "divine kingships" widely reported from Africa and elsewhere. According to Frazer, the institution of divine kingship derived from the belief that the well-being of the social and natural orders depended upon the vitality of the king, who must therefore be slain when his powers began to fail him and be replaced by a vigorous successor.

In making a vast range of primitive custom appear intelligible to European thinkers of his time, Frazer had a wide influence among men of letters and, though he traveled little himself, he was in close contact with missionaries and administrators who provided information for him and valued his interpretation of it. His works include *Totemism and Exogamy* (1910), *Folk-Lore in the Old Testament* (1918) and many others.

He received a Civil List pension of £200 a year in 1905 for services to literature and anthropology, was given many academic honours and was knighted in 1914. He died at Cambridge on May 7, 1941.

See R. A. Downie, *James George Frazer: the Portrait of a Scholar* (1940). (Go. L.)

FRÉCHETTE, LOUIS HONORÉ (1839–1908), French-Canadian poet noted for his patriotic poems, was born at Lévis, across the St. Lawrence from Quebec city, on Nov. 16, 1839. He studied law at Laval university, Quebec, and was admitted to the bar in 1864. After a year spent at Lévis in radical journalism, he chose political "exile" from 1866 to 1871 in Chicago, where he edited *Amérique* for Franco-Americans. In *Mes Loisirs* (1863) he had exhibited the spell of the nationalist school of Quebec, led by Octave Crémazie (*q.v.*). Next he was inspired by Victor Hugo; in *La Voix d'un Exilé* (1866–68) he attacked political and clerical dealings in Quebec in that period of Canadian confederation and voiced patriotism for France idealized as a republic. Returning to Lévis to enter politics, he suffered defeat in several elections but represented Lévis from 1874 to 1878 in the federal house of commons. From 1888 until his death on May 31, 1908, he lived in Montreal, traveling frequently to Quebec city to act as clerk of the provincial legislative council.

Meanwhile he had made literary history. *Les Fleurs Boréales et Les Oiseaux de Neige* (1879) were acclaimed in France and awarded the Prix Montyon in 1880—the first time the work of a Canadian had been crowned by the French Academy. Famous now, and representative of liberal nationalism, Fréchette then wrote *La Légende d'un Peuple* (1887), conceived as the epic of French Canada in the manner of Hugo's *La Légende des Siècles*. Popular success drew criticism from his rivals, but left him with many honours and a secure place in French-Canadian letters. Some admirable, less pretentious poems may be found in the volumes mentioned and in *Pêle-Mêle* (1877), *Feuilles Volantes* (1891) and *Poésies Choisies* (1908). Fréchette's prose stories were published in *Originaux et Détraqués* (1892) and *La Noël au Canada* (1900; Eng. trans., *Christmas in French Canada*, 1899). He also wrote the polemical *Lettres à Basile* (1872) and the dramas *Félix Poutré* (1871), *Papineau* (1880) and *Véronica* (1908).

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FREDEGARIUS, the name assigned, apparently by some mistake, to the author of a chronicle of Frankish history composed between 658 and 661. All the extant manuscripts of this chronicle are anonymous, and the attribution of it to "Fredegarius" dates from the edition of it by Claude Fauchet in 1579. The author (if suggestions that the work was written by three authors can be disregarded) set a fairly detailed history of his own times in the framework of a universal chronicle, drawing, for early Merovingian times, on information derived from the *Historia Francorum* of Gregory of Tours, which ends at the year 591, three years before Gregory's death. After 584 the so-called Fredegarius is an original source for events in the Frankish kingdoms until 642. Though written in barbarous Latin and excessively dull, it is of great importance since the author was writing of contemporary happenings and the chronicle is almost the sole literary source for this period. Differing hypotheses have been put forward concerning the nationality and career of the author; most students of the text attribute to him Burgundian origin, but some consider that he either spent much of his life in Austrasia or at any rate that his sympathies were with the Austrasian mayors of the palace; others consider that he became an important official at the Neustrian court of Clotaire II.

See L. Dupraz, *Le Royaume des Francs et l'ascension politique des maires du palais (656–680)* (1948); J. M. Wallace-Hadrill (ed.), *The Fourth Book of the Chronicle of Fredegar* (1960). (C.-E. P.)

FREDEGUND (d. 597), queen consort of Chilperic I, the Merovingian king of Tournai. Originally a servant, she became Chilperic's mistress; and it was she who caused him to repudiate his first wife, Audovera, and then, in 567 or 568, to arrange the assassination of his second wife, Galswintha, daughter of the Visigothic king Athanagild. Another daughter of Athanagild, Brunhilda (*q.v.*), had married Sigebert, king of Austrasia. The murder of Galswintha opened the way for Fredegund to become Chilperic's lawful wife but engendered a violent enmity between her and Brunhilda and perpetuated for almost 40 years an irreconcilable feud between the eastern and western Frankish kingdoms. For the opening events, including Sigebert's death, *see* CHILPERIC. During the struggle, moreover, Theudebert and Merovech, two of Chilperic's sons by Audovera, were killed; and the third brother, Chlodovech, accused by Fredegund of having by witchcraft compassed the deaths of her own three sons (they died in a pestilence), was subsequently found dead in his prison, probably murdered.

After the mysterious assassination of Chilperic at Chelles (584), Fredegund seized his treasure and hastily took refuge in the cathedral at Paris. Both she and her surviving son, Clotaire II, were at first protected by her brother-in-law Guntram, king of Burgundy and of Orléans. But Guntram came to doubt the legitimacy of Clotaire; Fredegund, much mortified, was obliged to get 3 bishops and 300 nobles to swear with her that he was Chilperic's son. Subsequently she made an unsuccessful attempt to assassinate Guntram. When Guntram died (592), his nephew Childebert II annexed his lands and tried to take Clotaire's kingdom. On Childebert's death (595) the old feud between Fredegund and Brunhilda was revived, the former intriguing for Clotaire II, and the latter for her grandsons Theudibert II, king of Austrasia, and Theuderic II, king of Burgundy. In a battle at Laffaux, near Soissons, Clotaire's troops were victorious. A few months later, in 597, Fredegund died in her palace at Paris. Gregory of Tours, in his *Historia Francorum* ("History of the Franks"), gives innumerable instances of this forceful queen's infallible resource and fabulous cruelty.

See Gregory of Tours, *History of the Franks,* ed. and Eng. trans. by O. M. Dalton, 2 vol. (1927); F. Lot, *Naissance de la France* (1948). (JE. H.)

FREDERIC, HAROLD (1856–1898), U.S. journalist and author, whose novel *The Damnation of Theron Ware* gained him his greatest fame, was born in Utica, N.Y., on Aug. 19, 1856. He received a respectable education by the standards of the time although he went to work at an early age. His first interests were photography and journalism, and by the age of 20 he was a reporter for the *Utica Observer;* by 1882 he was editor of the *Albany Evening Journal.* In 1884 he went to London as the correspondent for the *New York Times* and remained there as an expatriate for the rest of his life. As a reporter, Frederic was able and courageous. In 1884 he made a hazardous tour investigating outbreaks of cholera in certain districts of southern France and Italy. In 1891 he visited Russia to investigate the persecution of the Jews. His novels fall into certain natural groupings because of their subject matter. *Seth's Brother's Wife* (1887) and *The Lawton Girl* (1890) draw upon his memories of upper New York state; *The Return of O'Mahoney* (1892), a fantasy, reflects Frederic's lifelong interest in the Irish; *In the Valley* (1890) is about the American Revolution; and *The Copperhead* (1893) and *Marsena and Other Stories* (1894) are concerned with the American Civil War. In 1896 he combined his memories of the Mohawk valley with his interest in the meaning of American history to produce his best novel *The Damnation of Theron Ware* (published in England as *Illumination*), the story of the decline and fall of a young Methodist minister.

Frederic wrote three other novels (two of which were published posthumously) concerned with English life: *March Hares* (1896), *Gloria Mundi* (1898) and *The Market Place* (1899). (J. H. RH.)

FREDERICIA, a town in Vejle *amt* (county), Denmark, on the southeast coast of Jutland. Pop. (1960) 29,870. A garrison town surrounded by the original earthen ramparts, it is connected with Fyn by the Little Belt bridge (1935) and has excellent communications by rail, road and sea and extensive marshaling yards. Buildings include a modern theatre, *Købestaevnet* (Danish Industries fair), the Deaf-Mute institute and five churches, the oldest being St. Michaelis (consecrated 1669). Exports include silverware, frozen fish and electrical plant. Among other industries are the manufacture of cotton goods, tobacco, superphosphates and cellulose, and by the early 1960s the establishment of an oil industry was rapidly extending the town's industrial activities. Fredericia was built as a fortress by Frederick III and granted a charter in 1650. (J. F. DI.)

FREDERICK I BARBAROSSA (*c.* 1123–1190), Holy Roman emperor from 1155, was the son of Frederick II of Hohenstaufen, duke of Swabia, and Judith, daughter of the Welf Henry IX, duke of Bavaria. When his father died in 1147 Frederick became duke of Swabia and immediately afterward accompanied his uncle, the German king Conrad III, on his disastrous crusade. In 1152 the dying king advised the princes to choose Frederick as his successor to the exclusion of his own young son. Frederick was chosen German king at Frankfurt on March 4, 1152, and crowned at Aachen on March 9, owing his election partly to the fact that he united in himself the blood of the rival families of Welf and Waiblingen.

The new king saw clearly that the restoration of order in Germany was a necessity preliminary to the enforcement of the imperial rights in Italy. Having secured peace at home and obtained the homage of the Danish king Sweyn (Svend) III, Frederick began negotiations for the first Italian expedition. By playing on their fear of the Norman kingdom of Sicily, he hoped to make allies of both the Byzantine emperor Manuel I Commenus and the pope Eugenius III. But though he divorced his wife Adela in order to propose a Byzantine marriage for himself, it was only with the pope that he could make a treaty. Eugenius needed his help badly, not only against the Normans but also against Arnold (*q.v.*) of Brescia, who was in control of Rome.

The six expeditions to Italy engaged Frederick's main energies for 30 years, during which the subjugation of the peninsula was the abiding aim of his policy. He set out for Rome in 1154, hanged Arnold of Brescia and was crowned emperor on June 18, 1155. He left Italy in the autumn of 1155 and restored law and order in Germany by vigorous measures. Bavaria was transferred from Henry II Jasomirgott, margrave of Austria, to Henry the Lion, duke of Saxony; and the former was pacified by the erection of his margraviate into a duchy, while Frederick's stepbrother Conrad was invested with the Palatinate of the Rhine. On June 9, 1156, Frederick was married at Würzburg to Beatrix, daughter and heiress of the dead count of Burgundy, Raynald III. An expedi-

tion into Poland reduced Duke Boleslaw IV to submission, after which Frederick received the homage of the Burgundian nobles at Besançon in Oct. 1157.

In June 1158 Frederick set out on his second Italian expedition, during which he established podestas in the cities of northern Italy and captured Milan, which had revolted. At the diet of Roncaglia (Nov. 1158), attended by doctors of Bologna as well as by representatives of the cities, he successfully claimed the valuable regalian rights of the kingdom of Italy, but trouble arose over the disputed papal election which followed the death of Pope Adrian IV in 1159. Frederick supported the claims of Victor IV and thereby earned the hostility of Alexander III, by whom he was excommunicated on March 2, 1160. Milan promptly revolted again. After a long siege Frederick captured it and razed it to the ground. Then, thinking that he had pacified Lombardy, he returned to Germany late in 1162. There he prevented a conflict between Henry the Lion, duke of Saxony, and a number of neighbouring princes and severely punished the citizens of Mainz for their rebellion against Archbishop Arnold. In 1163, on his third expedition to Italy, his plans for the conquest of Sicily were checked by a powerful league against him provoked by the exactions of the podestas and the enforcement of the rights declared by the doctors of Bologna. In 1164, moreover, his antipope Victor IV died, but Frederick had another antipope, Paschal III, elected. A temporary alliance with Henry II of England, the magnificent celebration of the canonization of Charlemagne at Aachen and the restoration of peace in the Rhineland occupied Frederick's attention until Oct. 1166, when he made his fourth journey to Italy. He stormed the Leonine city of Rome and procured the enthronement of Paschal and the coronation of his wife Beatrix; but the sudden outbreak of a pestilence destroyed the German army. Immediately a number of north Italian cities formed the Lombard league (*q.v.*), their first act of defiance being to rebuild Milan. Having lost his army, Frederick could do nothing but retreat to Germany (spring 1168). During the next six years imperial authority was asserted over Bohemia, Poland and Hungary. Friendly relations were entered into with the Byzantine emperor Manuel, and a better understanding was sought with Henry II of England and with Louis VII of France.

Frederick's fifth expedition to Italy in 1174 was a complete failure. The refusal of Henry the Lion to bring help was followed by the defeat of Frederick at Legnano on May 29, 1176, when he was wounded and believed to be dead. He concluded the treaty of Venice with Alexander (July 1177), and a truce with the Lombard league was arranged for six years. Frederick recognized Alexander and knelt before him and kissed his feet.

The last part of Frederick's reign was dominated by his desire to punish Henry the Lion for his defection. Finding a pretext in a quarrel between Henry and the bishop of Halberstadt, he summoned Henry before the princes of the empire and, on his refusal to obey the summons, deprived him of all his fiefs (1179). The duchy of Bavaria was given to Otto of Wittelsbach, but without Styria, which was made a separate duchy. Saxony east of the Weser was given to Bernhard of Anhalt, its western portion forming the new duchy of Westphalia. The old "tribal" duchies were thus disrupted and the new class of princes of the empire was brought into being. Having rearranged the affairs of Germany, Frederick made a definitive peace with the Lombard league at Constance in June 1183 and renounced his more extravagant claims. In the next year he betrothed his son Henry to Constance, heiress of the Norman kingdom of Sicily. The marriage took place in 1186, and this, together with the impossibility of reaching an agreement over the Tuscan inheritance of the countess Matilda (*q.v.*), strained Frederick's relations with the papacy. Pope Urban III prompted the revolt of Philip of Heinsberg, archbishop of Cologne, and after his submission (1188) hostilities might have broken out again if Frederick had not taken the cross and set out on the third crusade.

Frederick left Regensburg in May 1189 at the head of a splendid army and, having overcome the hostility of the Byzantine emperor Isaac II Angelus, marched into Asia Minor. On June 10, 1190, Frederick, while crossing the Saleph (Calycadnus or Göksu) river in Cilicia, was drowned. The legend which says that he still sits in a cavern in the Kyffhäuser mountain in Thuringia waiting until the need of his country shall call him originally referred to his grandson Frederick II. He left five sons by Beatrix, of whom the second afterward became emperor as Henry VI.

Frederick's power rested on his earnest and commanding personality and also on the support which he received from the German church and nobility, the possession of a valuable private domain and on the care with which he exacted feudal dues. Even in Italy, though his general course of action was warped by wrong prepossessions, he in many instances showed exceptional practical sagacity in dealing with immediate difficulties and emergencies. In appearance he was of well-proportioned, medium stature, with flowing yellow hair and a reddish beard (whence his Italian surname of Barbarossa). He delighted in hunting and in the reading of history.

See also references under "Frederick I" in the Index volume.

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FREDERICK II (1194–1250), Holy Roman emperor from 1220, having been German king from 1212, also king of Sicily from 1198, and king of Jerusalem from 1229, was born on Dec. 26, 1194, in Italy, at Jesi in the march of Ancona, the son of the emperor Henry VI and Constance, daughter of the Norman king Roger II of Sicily. He was baptized Frederick Roger. Henry failed in his attempt to unite permanently the Sicilian and the imperial crowns by making the latter, like the former, hereditary. But he obtained, in Dec. 1196, the election of Frederick as king of the Romans. Henry's death on Sept. 28, 1197, followed by the election in Jan. 1198 of Pope Innocent III, created a new situation. Two rival German kings were elected: Philip (*q.v.*) of Swabia, Frederick's uncle, in March; and Otto of Brunswick, as Otto IV (*q.v.*), in June. Constance abandoned Henry's imperial policy. After Frederick's coronation with the Sicilian crown (May 1198), the title of king of the Romans disappeared from his acts; and before her death on Nov. 28, Constance appointed the pope, suzerain of the kingdom, as guardian to her son.

By that time Innocent III was well on the way to establishing papal authority in the duchy of Spoleto and in the march of Ancona, despite the resistance of Markward of Anweiler. In the Sicilian kingdom, however, there was strong opposition to papal control, and in Nov. 1201 Markward captured Palermo and, with it, Frederick. Markward's death in 1202 improved the papal position; but the kingdom was in the throes of anarchy. When Frederick reached his majority in Dec. 1208, Innocent handed the government of Sicily over to him. In the following year, Frederick married Constance, sister of King Peter II of Aragon.

In Aug. 1209 Otto IV's Italian expedition started a series of events that culminated in Frederick's accession to the imperial throne. After the double election of kings in 1198, Innocent III had recognized Otto against Philip, and Otto had pledged himself to support the pope's territorial policy in Italy and to respect his supremacy over Sicily. But it soon became evident that Otto did not intend to keep his promises. In Nov. 1210 he invaded the mainland part of the Sicilian kingdom; and in Sept. 1211 he was probably in Calabria, and preparing to attack the island. In the same month, a number of German princes deposed him at Nürnberg and elected Frederick as king. Innocent had little choice but to give his consent to the election of the only prince who could effectively oppose Otto. Before embarking at Messina in March 1212, Frederick did homage to the pope by proxy and confirmed the concordat concluded by Constance in 1198, in which she

had abandoned many of the ecclesiastical privileges of the Norman kings of Sicily; and he had his infant son Henry crowned king of Sicily.

After an adventurous journey in which he successfully eluded Otto's supporters, Frederick arrived in Germany in Sept. 1212, and soon prevailed over Otto. In November he concluded an alliance with France against Otto and John of England; and the French victory in the battle of Bouvines (*q.v.*) in July 1214 decided Otto's fate. Having been elected again at the diet of Frankfurt on Dec. 5, 1212, and crowned at Mainz four days later, Frederick was crowned German king for the second time in Aachen, which had been in Otto's hands, on July 25, 1215. When Otto died in 1218, his power was confined to his Brunswick dominions.

On July 12, 1213, in the Golden bull of Eger, Frederick had renewed the concessions made by Otto in 1201 and in 1209 to the pope, this time with the official consent of many princes. His recognition of papal supremacy over Sicily was further substantiated, on July 1, 1216, by his undertaking to hand over that kingdom, after his imperial coronation, to his son Henry (VII). If Innocent hoped in this way to prevent the union of Sicily and the empire under one ruler, Henry's election as king of the Romans in April 1220 deprived Frederick's promise of its practical value. He had in fact no intention of giving up Sicily. Crowned emperor in Rome on Nov. 22, 1220, despite Pope Honorius III's misgivings, he spent the following years in his Sicilian kingdom strengthening the authority exercised by his Norman ancestors.

Frederick's summons of a diet to Cremona for Easter 1226, to restore imperial rights, indicated that, while acting in Sicily as the heir to his Norman predecessors, he was planning in northern Italy to revert to the policy of his German father and grandfather. The consequent renewal of the Lombard league (*q.v.*) under Milan's leadership was followed by the imperial ban and by papal arbitration to prevent the long-planned crusades from being jeopardized by an Italian conflict. Frederick had taken the crusading vow at his coronations in 1215 and 1220; after repeated postponements, he had promised, in 1225, under penalty of excommunication, to embark in Aug. 1227. Moreover, his first wife, Constance, having died in 1222, he had in Nov. 1225 married Isabella (or Yolande), daughter and heiress of John of Brienne, the titular king of Jerusalem, and assumed that title himself. But when, in Sept. 1227, the crusade was interrupted after an epidemic at Brindisi, Pope Gregory IX did not accept Frederick's justification and excommunicated him (Sept. 29). Gregory's subsequent alliance with the Lombard league showed that, beside his grievances over the crusade and over Frederick's treatment of the Sicilian church, he was determined to oppose Frederick's plans in northern Italy.

Despite the papal ban, Frederick left Brindisi on June 28, 1228, for the Holy Land, where he obtained, by treaty, Jerusalem, Bethlehem and Nazareth from the sultan al-Kamil. On March 17, 1229, he entered Jerusalem, where he crowned himself king. On June 10 he landed again at Brindisi, and in a short campaign expelled the papal troops, which had penetrated far into the kingdom of Sicily. In the peace of San Germano (July 23, 1230) he renounced any claims to the papal states and granted the Sicilian clergy exemptions from royal taxation and jurisdiction; on Aug. 28, he was absolved from the excommunication.

The constitutions of Melfi (Aug. 1231), inspired by Roger II's assizes, reflect the various aspects of the system of government that Frederick was creating on Norman foundations. Influenced by Justinian law, they show a degree of royal power and state control unparalleled in contemporary western Europe. They were bound to increase the apprehensions of the Lombard cities, which refused to attend a diet summoned by Frederick to Ravenna for Nov. 1231. Once more Frederick placed them under imperial ban, and the pope intervened to arbitrate; but his sentence (June 5, 1233) left both emperor and cities dissatisfied. Even so, after 1230 relations between pope and emperor had temporarily improved; Frederick helped Gregory in 1234 against a Roman revolution and gave powerful support to his campaign against heresy. Having legislated against heretics at his coronation in 1220, he introduced the death penalty for heresy in the Sicilian kingdom in 1231 and in Germany in 1232 and extended it to the empire in 1238.

Soon afterward, Frederick was forced to turn his attention from Italy to Germany. During Henry's minority, Germany had been governed by regents, until Henry assumed the government himself in 1228. His support of citizens against their bishops angered the princes, who, in 1231, extorted from him numerous concessions protecting them against the expanding cities and extending their control over their own territories. A similar though less extensive privilege had been granted by Frederick to the ecclesiastical princes on occasion of Henry's election in 1220; and in May 1232 he confirmed at the diet of Cividale, with slight limitations, Henry's *Statutum in favorem principum*. In the circumstances, he could hardly have acted differently; but the *Statutum*, by legalizing the *de facto* independence of the German princes, became a landmark in the development of the territorial principalities. Soon afterward, Henry tried to check the inquisition in Germany, and in Sept. 1234 he rebelled against the emperor; but the rebellion collapsed on Frederick's arrival in Germany in spring 1235. Deposed by Frederick in July, Henry died a prisoner in Calabria in 1242.

His second wife having died in 1228, Frederick in July 1235 married Isabella, sister of Henry III of England. This English connection may have been responsible for the final settlement of the feuds between the Welfs and the Hohenstaufen; at the diet of Mainz in Aug. 1235 Frederick invested Otto of Lüneburg as duke of Brunswick-Lüneburg (*see* BRUNSWICK). At the same diet, he issued an edict of imperial peace, which was designed to enforce and enhance imperial jurisdiction; a new office, that of *justitiarius curiae regiae*, was created for this purpose on the Sicilian model. The influence that Frederick enjoyed at that time among the German princes is shown by the diet's decision to wage war on the Lombards. Between 1236 and 1239 the emperor deprived the rebellious duke Frederick of Austria and Styria, and in Feb. 1237 he had his son Conrad IV elected king of the Romans in Vienna. After the duke's death in 1246 he kept Austria and Styria, which had escheated to the crown, and, following Italian precedents, administered them by captains general.

The German army descended into Lombardy in Aug. 1236, with the help of the new lord of Verona, Ezzelino (*q.v.*) da Romano, who also greatly helped imperial progress in the march of Verona. On Nov. 27, 1237, Frederick defeated the Lombard league at Cortenuova. Milan was prepared to submit to him; but after his demand of unconditional surrender, Lombard resistance continued, with setbacks for the emperor. In Oct. 1238 he had to raise the siege of Brescia; in agreement with the pope, Genoa and Venice made an alliance against him. The marriage, in 1238, between his natural son Enzio (Enzo) and the heiress of part of Sardinia, and his designation of Enzio as king of Sardinia, over which the papacy claimed supremacy, provoked the final rupture with Gregory, who had already been organizing resistance against him in northern Italy. On March 20, 1239, Gregory excommunicated Frederick for the second time.

Frederick now seized the duchy of Spoleto and the march of Ancona from the papal territory and threatened Rome itself. The Sicilian kingdom was placed under wartime controls, the mainland and the island being put in charge each of a great justiciary. Northern and central Italy were reorganized, from 1238 onward, under a centralized administration, whose Sicilian inspiration was given additional relief by the fact that the new officials—vicars (or captains) general for the larger districts, imperial podestàs for the towns—were recruited chiefly from the kingdom. Enzio was appointed legate general for the whole of imperial Italy.

The struggle with the papacy was accompanied by an unprecedented spate of manifestoes issuing from the papal and from the imperial chancery, where Pietro della Vigna (Peter of Vinea) used his great literary gifts and the new rhetorical discipline to plead Frederick's cause. The struggle was temporarily interrupted by Gregory IX's death, on Aug. 22, 1241, a few months after the imperial navy had captured a large number of prelates on their way to a Roman council (May). Celestine IV's brief pontificate (Oct.–Nov. 1241) was followed by a long vacancy. Innocent IV opened negotiations with Frederick after his election on June 25, 1243. These seemed to be on the eve of being concluded when the pope

in June 1244 secretly left Rome and fled to Lyons where he summoned a council for 1245. Innocent accused Frederick of unwillingness to evacuate the occupied papal territories; but the unsolved problem of the Lombard communes, on whose submission Frederick continued to insist, appears to have been the final stumbling block. On July 17, 1245, the pope deposed Frederick at Lyons.

The deposition intensified Frederick's struggle with the pope and the Guelph cities in Italy and weakened his position in Germany. Though most secular princes remained neutral and though neither of the two successive antikings (Henry Raspe, landgrave of Thuringia, and William, count of Holland) received extensive backing, almost the entire German episcopate deserted Frederick in the end. In Italy the revolt of Parma was followed by the destruction of the imperial camp Vittoria by the besieged citizens (Feb. 18, 1248), a serious blow to Frederick's prestige, which led to the loss of nearly the whole of the Romagna. He no longer seemed to be safe at his own court; in 1246 a widespread conspiracy was discovered. In 1249 the chief of the chancery and his closest collaborator, Pietro della Vigna, was found guilty of corrupt practices and committed suicide in prison. Yet Frederick's position in Italy was once more improving when he suddenly died at Castel Fiorentino in Apulia on Dec. 13, 1250. He was buried in the cathedral of Palermo, next to his parents and his Norman ancestors. His death proved to be the beginning of the end of Hohenstaufen rule. (For his sons *see* CONRAD: *Conrad II*; ENZIO; MANFRED.)

Frederick's reign has given rise to much controversy; especially the question of whether he sacrificed German interests to his Italian policy has been variously answered. His remarkable personality has often been obscured by the hostile propaganda of the papal party as well as by the panegyrics of his courtiers. Brought up in cosmopolitan Palermo and with a wide knowledge of the Byzantine and the Muslim east, his intellectual attitude was scientific and rationalist rather than skeptic and unorthodox. His scientific and philosophical interests are reflected in his book on falconry, *De arte venandi cum avibus*, and in the translations he caused to be made from Greek and Arabic. His poems in the Sicilian *volgare*, like those of his court, were modeled on the poetry of the troubadours; but by creating an Italian poetic language, the Sicilian school of poetry came to occupy a decisive place in the development of Italian literature. Classical influence is noticeable in some of his buildings. His eclectic interests doubtless contributed to the elusiveness of his personality; Matthew Paris called him *stupor mundi* ("the amazement of the world"). But Frederick always insisted on his devotion to the church and received absolution from a priest before his death.

See also references under "Frederick II" in the Index volume.

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FREDERICK III (1415–1493), Holy Roman emperor from 1452, also duke of Austria, as Frederick V, from 1424 and German king from 1440, was born on Sept. 21, 1415, in Innsbruck, the son of Duke Ernest of Austria and his second wife, Czimbarka of Mazovia. By virtue of the partition treaties of 1379 his father's share of the Habsburg possessions was "Inner Austria" (Styria, Carinthia, Carniola and Gorizia), which Frederick inherited on his father's death (1424). In 1439 Frederick became the senior member of the house of Habsburg and took over the guardianship of the minor sons of the two other branches of the dynasty (*see* HABSBURG), so that for several years all the Austrian dominions were united in his hands. On Feb. 2, 1440, Frederick was elected German king; he was crowned at Aachen on June 17.

In the schism of the papacy that had started with the election of the antipope Felix V at the council of Basel in 1439, Frederick initially remained neutral, as most Germans desired; but from 1445 he began to incline toward Pope Eugenius IV, and finally, on Feb. 7, 1447, his envoys brought the dying Eugenius a declaration of obedience in the name of Germany. Differences with the German princes and the awareness that he would not be able to carry out his ideas of constitutional reform led the king to an almost complete withdrawal from German affairs, for which he was sharply criticized even at the time. As the guardian of the young Ladislas Posthumus (son of his cousin the German King Albert II; *see* LÁSZLÓ V) of Upper and Lower Austria, Frederick attempted to exploit his ward's claims to Hungary and Bohemia for his own advantage, but soon encountered the resistance of the nobility of those countries, as well as opposition in Austria itself to his guardianship. Even so, he ventured to go to Rome, taking Ladislas with him. There he married Leonora of Portugal on March 16, 1452, and then, on March 19, was crowned emperor by Nicholas V—the last emperor to be crowned in Rome by the pope. His new dignity, however, gave him no greater prestige in Austria. In autumn 1452 he was compelled to release Ladislas prematurely from his guardianship, whereupon Ladislas fell completely into the hands of political adventurers till his unexpected death in Prague in 1457. In Germany also there now arose pretenders against Frederick, including his own brother, Albert VI of Austria, but Frederick was capable of holding his own.

Meanwhile the Ottoman Turks, having taken Constantinople in 1453, presented a growing threat to central Europe and were already undertaking predatory expeditions into Styria and Carinthia. Frederick saw the danger but he was much too weak to take effective counteraction so long as the resources of Hungary and Bohemia were denied to him. In these countries, however, national kings appeared (Matthias Corvinus and George of Podebrady), and in Austria the nobility was in open revolt. His own revenues of Inner Austria were insufficient to fight Islam, and he exercised no decisive influence over the Tirolean and Swabian territories of his cousin and former ward Sigismund. Yet it was precisely in the Tirolean administrative circle, where closer contacts with Burgundy had developed, that the momentous plan of a matrimonial connection between the Habsburg and Burgundian dynasties formed. In return for the German royal and Roman imperial dignity, Charles the Bold, duke of Burgundy, was to give his only daughter, Mary (*q.v.*), in marriage to Frederick's only son, the future Maximilian I (*q.v.*), who would later succeed Charles. The first talks (at Trier in 1473) failed, but a few years later Charles gave his consent; and though he himself soon afterward met his death (1477), the marriage was concluded in the same year. The Burgundian inheritance was the beginning of the greatness of the house of Habsburg in the world beyond the confines of the Holy Roman empire and central Europe.

Despite this important success and the death of his restless brother Albert VI (1463), Frederick's last years did not pass happily. He had to suffer the conquest of Austria by Matthias of Hungary, who finally occupied Vienna (1485); and he had to accept the fact that the German princes, although no longer putting up an antiking, appointed his own son as co-regent (1486). Not until shortly before his death did he see the first fruits of his tenacious and farsighted policy. After the sudden death of Matthias, Maximilian reconquered Austria (1490–91); and Sigismund, debilitated by old age, ceded Tirol to Maximilian likewise. Thus before he died, at Linz, on Aug. 19, 1493, Frederick could see that he had made safe the future of his house.

Unintelligible to many, Frederick was already in his lifetime the object of violent aversion and severe reproaches, which modern historians have not qualified. Only Leopold von Ranke and Jacob Burckhardt understood him more deeply and judged him more justly. Frederick's education was good, but rather old fashioned; he was surrounded by humanists, but showed little interest in their activities. His superstition (astrology) was that of the late middle ages, while his interest in collecting books, precious stones, etc., was not yet that of the Renaissance. His notebook, begun in the

year of his return from a journey to the Holy Land (1437), gives many valuable hints of his intellect. The pretentious interpretation of his famous device "AEIOU" as "*Austriae est imperare orbi universo*" ("For Austria is the empire of the whole world") was certainly not his own. His personal life was very modest, but when the splendour of his house required it he knew how to show himself in dignified fashion. *See* further AUSTRIA, EMPIRE OF; GERMANY; *History*. (A. LH.)

FREDERICK I (1471–1533), king of Denmark from 1523 and of Norway from 1525, was born on Oct. 7, 1471, the younger son of Christian I of Denmark and Dorothea of Brandenburg. His elder brother, Hans, having succeeded their father as king in 1481, their mother tried to gain the duchies of Schleswig and Holstein for Frederick, but Hans opposed the scheme, and finally, in 1490, the brothers partitioned the duchies. Likewise Frederick failed in his claims for half of Norway and parts of Denmark. He therefore settled in Gottorp and set to work reforming the administration of his territory. His style of life was modest and he knew how to save and invest his resources. Still, he was dissatisfied with his position and was never on good terms with Hans or with the latter's son Christian II, king from 1513. He was married first, in 1502, to Anne of Brandenburg (d. 1514), then, in 1518, to Sophia of Pomerania.

When the widespread discontent against Christian came to a head late in 1522, some Jutish nobles offered the Danish crown to Frederick, who accepted. He was proclaimed king at Viborg in spring 1523, and Christian fled to the Netherlands. Frederick's charter of Aug. 1524, however, favoured the *rigsraad* and the nobles rather than himself, so that the royal income and executive power were much curtailed. In 1525 Frederick was recognized as king in Norway.

Frederick continued to reside at Gottorp, partly on the excuse that his income was inadequate. His caution, however, did not prevent his showing his sympathy with Lutheranism; in 1526 his eldest daughter, Dorothea, was married to Albert, duke of Prussia, and Frederick did much to promote Lutheranism in Denmark in the late 1520s, thus antagonizing the Catholic majority in the *rigsraad*. The *rigsraad*, however, was ready to support Frederick both against Christian II, who invaded Norway in 1531 and was taken prisoner, and against the Holy Roman emperor Charles V, who had never recognized Frederick's title and who seemed likely to attack Denmark or the duchies until the diplomatic efforts of Frederick's German chancellor Wolfgang Utenhof and the prominent Holstein councilor Melchior Rantzau achieved a temporary settlement with him. Frederick died at Gottorp, on April 10, 1533.

See *Danmarks Riges Historie*, vol. 3 (1900–06); B. Kornerup, article in K. Fabricius (ed.), *Danmarks Konger*, pp. 199–216 (1944). (As. F.)

FREDERICK II (1534–1588), king of Denmark and Norway from 1559, was born at Haderslev on July 1, 1534, the son of Christian III and Dorothea of Saxe-Lauenburg. His mother was the eldest sister of Catherine, first wife of Gustavus Vasa and mother of Frederick's lifelong rival, Eric XIV of Sweden. At the *rigsdag* of Copenhagen on Oct. 30, 1536, Frederick was proclaimed successor to the throne; homage was paid to him at the Danish *landsting* in 1542, and at Oslo, for Norway, in 1548; on his father's death in 1559 he became king.

In June 1559 Frederick joined his uncles John and Adolphus, dukes of Schleswig-Holstein, in reducing the old peasant republic of Dithmarschen (*q.v.*) and dividing it between them. In 1563 began the Seven Years' War of the North. The immediate cause of this was the detention at Copenhagen of a Swedish embassy on its way to Germany (to negotiate a marriage between Eric XIV and Christina of Hesse) at a moment when the Danes were alarmed for the safety of their own embassy in Sweden. All the Baltic states were angered by Denmark's closing of the Sound to foreign shipping in order to interrupt Sweden's supplies of salt and munitions, and the war was so unpopular in Denmark itself that on Jan. 1, 1570, Frederick, who wanted its continuance, threatened to abdicate. Finally convinced, however, that the people no less than the *rigsraad* were against the war, he assented to the peace of Stettin (Dec. 13, 1570), thus renouncing his dream of reuniting Sweden with Denmark-Norway, but having at least maintained Danish supremacy in the north. Thenceforward he sought to dominate the seas round Scandinavia; with constant patrols by Danish warships he cleared the Baltic and the North sea of the pirates that had long haunted them, and at Elsinore he built the fortress of Kronborg castle to guard the Sound.

To his ministers Frederick gave a free hand, conscious that they were best in their own sphere and that his own early distaste for serious study had left him, regrettably, somewhat uninformed. His chief amusement was hunting, and his drinking habits were those of his time. Before becoming king he had much wanted to marry a beautiful young girl of the nobility, but had bowed to the general opposition to this project. Married eventually, in 1572, to his young cousin Sophia of Mecklenburg, he lived happily with her and was one of the few kings of the Oldenburg line not to keep a mistress. He died at Antvorskov on April 4, 1588.

See *Danmarks Riges Historie*, vol. 3 (1900–06); P. Goulding, article in K. Fabricius (ed.), *Danmarks Konger*, pp. 236–260 (1944). (As. F.)

FREDERICK III (1609–1670), king of Denmark and Norway from 1648, was born at Haderslev on March 18, 1609, the second son of Christian IV and Anne Catherine of Brandenburg. While still a boy he became successively bishop coadjutor of Bremen, of Verden and of Halberstadt. In 1643 he married Sophia Amelia of Brunswick-Lüneburg. During the disastrous Swedish War of 1643–45 he was appointed generalissimo in Schleswig-Holstein by his father; he quarreled with the earl marshal Anders Bille, who commanded the Danish forces, and the Danish nobility began to regard him with extreme distrust. His elder brother Christian's death in June 1647 paved his way to the succession, but the matter was still unsettled when Christian IV died on Feb. 28, 1648. On July 6 Frederick III was acknowledged king, after signing a charter that further diminished the royal prerogative.

Frederick was sober, moderate and self-controlled where his father had been brilliant, jovial and impulsive. Foreseeing danger for Denmark from Charles X of Sweden, he watched the latter's war in Poland (begun in 1654) for an opportunity to intervene. The *rigsdag* of 1657 granted funds for mobilization and other military expenses, and on April 23 a majority in the *rigsraad* sanctioned an attack on Sweden's German provinces. Early in May negotiations with Sweden were broken off, and on June 1 Frederick signed the manifesto justifying a war he never formally declared. Charles, however, upset his enemies' plans when he crossed the frozen Belts (Jan.–Feb. 1658). Frederick at once sued for peace, and Charles, on the advice of the English and French ministers, at last agreed not to destroy him utterly. By the treaties of Taastrup (Feb. 18) and of Roskilde (Feb. 26) Frederick lost Skåne, Bornholm and Trondheim. A few days later Frederick entertained Charles at Frederiksborg castle (March 3–5, 1658) and friendship seemed to reign, but on July 17 Charles suddenly launched a new attack. The main Swedish force landed at Korsor in Sjaelland. Quite unprepared, the Danes had only three days in which to restore the feeble defenses of Copenhagen. Prompted, however, by the king and queen and by the burgomaster, Hans Nansen, the inhabitants withstood a regular siege till on Oct. 29, 1658, a Dutch squadron arrived to reinforce and reprovision them. This squadron then joined with the Danish fleet to drive the Swedish navy from the Sound.

By the peace of Copenhagen (1660) Denmark recovered Bornholm and Trondheim. The Danish burgher class, always loyal to the monarchy, was gripped with enthusiasm for the king himself after his victory. Frederick took advantage of this brief spell of popularity to transform his kingdom from an elective to a hereditary monarchy by the so-called revolution of Oct. 1660 (*see* DENMARK: *History*). The *Kongelov* or king's law of 1665, drafted by Peder Schumacher (later Count Griffenfeld) to make the monarchy absolute, was kept a secret between Frederick, Schumacher and Kristoffer Gabel till after Frederick's death. Frederick died on Feb. 9, 1670, in the castle at Copenhagen.

See K. Fabricius (ed.), *Danmarks Konger*, pp. 293–311 (1944). (As. F.)

FREDERICK IV (1671–1730), king of Denmark and Norway from 1699, was born in the castle of Copenhagen on Oct. 11, 1671, the son of Christian V and Charlotte Amalia of Hesse-Kassel. His education was somewhat neglected, but in succeeding his father as king (Aug. 25, 1699) he showed great diligence and a strong sense of responsibility, meeting difficult situations with strength and sound judgment. In his choice of advisers he was less judicious and clashed with the old aristocracy. In his foreign policy he continued the Danish efforts to sever Gottorp's link with Sweden, but his first attempt to do so by force of arms, in 1700, at the outbreak of the Great Northern War, was checked by Charles XII of Sweden, who had the support of an Anglo-Dutch fleet. Frederick then accepted the peace of Traventhal, but he re-entered the war in 1709. The immediate consequences were inauspicious, but Sweden's enemies increased in number as the war went on, and at the peace of Frederiksborg (1720) Denmark obtained English and French guarantees for the sole possession of the duchy of Schleswig, which came under the Danish crown, though remaining administratively separate. (*See* NORTHERN WAR.)

At home the king introduced a number of reforms. A local militia was instituted in 1701. Serfdom in the Sjaelland Islands was gradually abolished after 1702. On the crown estates Frederick reorganized defense measures and established 240 elementary schools. In his later years he was extremely religious; he was the first Protestant sovereign to concern himself directly with missions to the heathen, and he introduced strict regulations concerning the observance of religious festivals. Even so, his private life often aroused indignation. Having married Louisa of Mecklenburg-Güstrow in 1695, he entered into two morganatic marriages during her lifetime. The second of these, in 1712, was with Anna Sophie, daughter of the chancellor, Count Conrad Reventlow; and after Louisa's death (1721), despite opposition within the royal family, he raised Anna Sophie to the dignity of queen. After his death, at Odense on Oct. 12, 1730, she had to withdraw to the estate of Clausholm in Jutland, where she died in 1743.

See E. Holm, *Danmark-Norges indre Historie under Enevaelden fra 1660 til 1720* (1885–86), *Danmark-Norges Historie 1720–1814*, vol. i (1891). (F. SK.)

FREDERICK V (1723–1766), king of Denmark and Norway from 1746, was born at the castle of Copenhagen on March 31, 1723, the son of Christian VI and Sophia Magdalena of Brandenburg-Kulmbach. He had had mostly German tutors, but broke with his parents' strict pietism. In 1743 he married Louisa, a daughter of George II of England, who, like her husband, was held in affection for her gentle and engaging nature. When Frederick became king on his father's death (Aug. 6, 1746), drama and the arts were again permitted to develop without pietistic restraint, and public discussion of the country's economic life seemed to prepare the way for social reforms. Real power lay in the hands of two outstanding ministers, Adam Gottlob Moltke and J. H. E. Bernstorff. Denmark was kept out of the Seven Years' War of 1756–63, and the danger of war with Russia in 1762 passed with the death of the emperor Peter III (a member of the ducal house of Gottorp, and so the enemy of the Danish crown). Nevertheless the expenses of the army and navy increased, leading to heavy sales of crown lands. Still, trade benefited from Denmark's neutrality, and progress was also made in farming (an agricultural commission was set up in 1757). After Queen Louisa's death (1751) the king in 1752 married Juliana Maria of Brunswick-Wolfenbüttel. Neither the queen nor successive mistresses had any influence in affairs of state. Frederick died at Christiansborg castle on Jan. 14, 1766.

See E. Holm, *Danmark-Norges Historie 1720–1814*, vol. iii (1897–98); H. Schultz, *Danmarkshistorie*, new ed., vol. iii (1942). (F. SK.)

FREDERICK VI (1768–1839), king of Denmark from 1808 to 1839 and of Norway from 1808 to 1814, was born at Christiansborg castle on Jan. 28, 1768, the son of King Christian VII and Queen Caroline Matilda. After his mother's banishment in 1772 the crown prince's upbringing was mostly left to his father's stepmother, the queen dowager Juliana Maria, who, with her son Prince Frederick (next in succession to the throne after the crown prince) and Ove Höegh-Guldberg (*q.v.*), virtually ruled Denmark until 1784. Acting in concert with a group of men of high standing, at a cabinet meeting in April 1784, the crown prince brought about changes in the government which transferred the real power to himself. Thereafter his support enabled men who favoured reforms, such as Andreas Peter Bernstorff and Christian Ditlev Reventlow, to prepare measures granting personal liberty and legal protection to the peasants; the *stavnsbaand*, which had tied the peasants to the soil, was abolished in 1788 (*see* DENMARK: *History*). Other reforms promoted trade and set up a system of poor laws and general education. The crown prince became popular with burghers and peasants alike. Married in 1790 to Maria Sophia Frederica, daughter of the landgrave Charles of Hesse, he became king on his father's death on March 13, 1808.

As time went on, Frederick inclined more to personal rule, and the cabinet's influence decreased. He took great interest in the army but was an indifferent diplomat. During the war with England, after the bombardment of Copenhagen in 1807 (*see* NAPOLEONIC WARS), he held to the alliance with Napoleon far too long, and he failed to take advantage of Sweden's troubles in 1809, when he might have got that kingdom for himself (*see* SWEDEN). At the peace of Kiel (Jan. 1814) he had to cede Norway to Sweden, but at the congress of Vienna he worked hard to gain better terms for Denmark and thus won his people's gratitude. In the lean years that followed he showed his best qualities and became an energetic, responsible and upright "father of the country." After disturbances in Schleswig-Holstein, inspired to some extent by the success of the July revolution of 1830 in France, Frederick introduced, from 1834, four consultative diets—for Jutland, for Sjaelland and the islands, for Schleswig and for Holstein. He died in Copenhagen on Dec. 3, 1839.

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FREDERICK VII (1808–1863), king of Denmark from 1848, was born at Amalienborg castle on Oct. 6, 1808, the son of the future king Christian VIII and Charlotte of Mecklenburg-Schwerin. After a somewhat unsettled youth, he was in 1839 appointed governor of Fyn and then began to show that combination of simplicity and royal dignity which later endeared him to his people. As crown prince, however, he made two unhappy marriages: first, in 1828, to his second cousin Wilhelmina Maria, a daughter of Frederick VI (dissolved in 1837); then, in 1841, to Caroline of Mecklenburg-Strelitz (dissolved in 1846).

On Jan. 20, 1848, Frederick succeeded his father, who had already enjoined him to introduce constitutional rule. After the popular demonstrations of March 1848 he appointed a Liberal ministry. Even so, it was not until after some hesitation that he signed the constitution of June 5, 1849. At the same time, however, he had become the symbol of the Danes' struggle against the rebels in Schleswig-Holstein; despite his cabinet's majority vote, he had rejected the proposal of partitioning Schleswig in the autumn of 1848. The war against Prussia over Schleswig-Holstein (1848–50) ended successfully for Denmark (*see* SCHLESWIG-HOLSTEIN QUESTION).

Frederick's third wife, Louise Christine Rasmussen, whom he married morganatically in 1850 and to whom he gave the title countess of Danner, had a good influence on him. Politically she sided with the Bondevenner ("Friends of the Peasants" party), who did not despise her as the National Liberals did. Moreover the National Liberals, who had more ministers in the cabinets from 1854 onward, came increasingly into conflict with Frederick over the question of the eventual succession to the throne, which the childless king secured for Christian of Glücksburg (*see* CHRISTIAN IX), and over the constitutional problem, as the king favoured a joint constitution for all the lands under the crown.

In foreign affairs, Frederick was in his later years inclined to an inter-Scandinavian policy and to a military alliance with Sweden-Norway. A joint constitution for Denmark and the duchy of Schleswig, which seemed likely to precipitate war with the German powers, had just been passed (Nov. 13) when the king died in Glücksburg castle on Nov. 15, 1863. (F. SK.)

FREDERICK VIII (1843–1912), king of Denmark from 1906, was born at Copenhagen on June 3, 1843, the eldest son of the future Christian IX and Louisa of Hesse-Kassel. Having served in the war of 1864 against Austria and Prussia, in which the duchies of Schleswig-Holstein and Lauenburg were lost, he then assisted his father in the duties of government till he succeeded him as king on Jan. 29, 1906. In the summer of 1907, during a visit to Iceland, Frederick appointed a mixed commission to draft a measure of home rule but this came to nothing. The king, who won his people's confidence by his energetic interest in politics, his congenial manner and his simple mode of living, died suddenly at Hamburg in Germany on his way home from the south of France on May 14, 1912. In 1869 he had married Louise (1851–1926), daughter of Charles XV of Sweden and Norway. The eldest of their four sons succeeded him as Christian X; the second had become king of Norway as Haakon VII in 1905.

FREDERICK IX (1899–), king of Denmark from 1947, was born at Sorgenfri castle on March 11, 1899, the eldest son of the future king Christian X and Alexandrine of Mecklenburg-Schwerin. Crown prince from 1912, Frederick matriculated in 1917. Unlike most Danish kings, he was trained not in the army but in the navy, in which he was to rise to the rank of rear admiral by 1946. On reaching the age of 18, he began to take part in affairs of state. In 1935 he married Ingrid (1910–), only daughter of the crown prince Gustav Adolf of Sweden. After acting as regent for his father on two occasions (in 1942 during his illness and from April 8, 1947), he succeeded him as king at his death on April 20, 1947.

Democratic in outlook, Frederick kept in easy contact with the Danish people. From his training days he retained a liking for seafaring folk. Always interested in music, he sometimes conducted the royal opera orchestra and the royal life guard band. A believer in international co-operation, he stressed Denmark's obligations (for instance, as a member of the North Atlantic Treaty organization) and paid several visits to other countries (to the United States, for example, in 1960). The eldest of his three daughters, Margarethe, became heir to the throne under the constitution of 1953, which introduced female succession. (F. Sk.)

FREDERICK III THE FAIR (*c.* 1286–1330), German king from 1314, also duke of Austria from 1308, was the second son of the German king Albert I (*q.v.*). After his father's murder (1308) he became the head of the house of Habsburg and duke of Austria but did not succeed him as king, the count of Luxembourg being elected instead, as Henry VII. Frederick and his brothers made a treaty with Henry at Speyer in 1309, whereby they renounced the Habsburg claim to Bohemia in return for a sum of 50,000 marks. Frederick suppressed a revolt of the Austrian nobility and the citizens of Vienna, who had allied themselves with Otto III, duke of Lower Bavaria, but his quarrel with his cousin Louis IV of Upper Bavaria concerning the wardship of Otto's young successor, Henry III, ended with Frederick's defeat at Gammelsdorf, northeast of Munich (Nov. 9, 1313).

Henry VII's death (Aug. 1313) led to a double election. Four electors chose Frederick as German king at Sachsenhausen, near Frankfurt, on Oct. 19, 1314, and he was crowned by the correct archbishop, namely the archbishop of Cologne, but at the wrong place, Bonn (instead of Aachen), on Nov. 25. On the other hand, five electors chose Louis of Bavaria outside Frankfurt on Oct. 20, and Louis was crowned at the correct place but by the wrong archbishop (Mainz) on Nov. 25 likewise. The resultant war between the two rivals lasted nearly eight years. Finally Frederick was decisively defeated by Louis on Sept. 28, 1322, at Mühldorf in Bavaria and was imprisoned in the castle of Trausnitz (Upper Palatinate). In March 1325 he was freed after taking an oath to recognize Louis as king and to see to it that his brother Leopold did so too. When he proved unable to do so he returned voluntarily to prison, though the pope had freed him from his oath. In Sept. 1325 Louis accepted Frederick as co-ruler, but after Leopold's death (Feb. 1326) Frederick's power was confined to Austria. He died in the castle of Gutenstein (Lower Austria) on Jan. 13, 1330, and was buried at the Carthusian monastery of Mauerbach, near Vienna, which he had founded. His remains were translated to St. Stephen's cathedral, Vienna, in 1789. His marriage with Isabella of Aragon (d. July 12, 1330) produced two daughters, Elizabeth and Anna.

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FREDERICK I (1657–1713), king in Prussia from 1701, also elector of Brandenburg, as Frederick III, from 1688, was born in Königsberg on July 11, 1657, the second surviving son of Frederick William, the Great Elector, by his first wife, Louisa Henrietta of Orange. Mentally insignificant and disfigured by curvature of the spine, Frederick grew up in the shadow of his elder brother Karl Emil, whose early death (1674) made him the heir apparent. The Great Elector could never get over the loss of his promising Karl Emil and showed Frederick neither love nor respect. Frederick was married first, in 1679, to Elizabeth Henrietta of Hesse-Kassel (d. 1683); next, in 1684, to the energetic and highly talented Sophia Charlotte of Hanover (1668–1705).

After his accession (May 9, 1688) Frederick at once refused to recognize his father's last testament of 1686 in which each of the four sons of Frederick William's second marriage was endowed with parts of the territory of Brandenburg. The new ruler, however, had more feeling for the semblance than for the essence of power and satisfied his strong desire for self-assertion and ostentation by the maintenance of a wasteful and glamorous court which was out of all proportion to the modest resources of his country. Furthermore, he no longer managed personally the affairs of the state to the same extent as his great predecessor had done. Almost always he ruled through his prime ministers: first, from 1688 to 1697, his tutor Eberhard von Danckelmann; then, from 1702 to 1711, J. K. von Kolbe, Graf von Wartenberg. Both were overthrown by court intrigues; Danckelmann's dismissal was due largely to Sophia Charlotte's influence. The first of these periods coincides with the War of the Grand Alliance (*q.v.*) against Louis XIV and is characterized by the close co-operation of Brandenburg with William III of Orange. Frederick effectively supported the latter's landing in England by deploying a strong body of troops on the lower Rhine, which was to cover William's passage to England against an expected French attack on the Netherlands.

In the War of the Spanish Succession, Frederick likewise joined the coalition of the emperor Leopold I with the maritime powers against France and remained loyal to it up to his death. His troops fought in every theatre of this great war (Turin, Malplaquet, Blenheim), but their efforts brought only modest territorial gains (the Swiss county of Neuchâtel and some minor readjustments of the frontiers of Brandenburg's possessions on the lower Rhine). On the other hand, the favour of the European situation and the emperor's wish for Brandenburg's military help against France led to Frederick's elevation to a higher rank, for which he had been working since the beginning of his reign; he succeeded in obtaining the emperor's consent to his assumption of the royal crown. This dignity he wished to base not on his territories within the empire but on his sovereign duchy of Prussia. Accordingly, on Jan. 18, 1701, he crowned himself in Königsberg "king in Prussia" (not "king of Prussia," because Poland, which ruled the western part of the ancient territory of the Teutonic Order would have raised objections to that title; *see* PRUSSIA; also EAST PRUSSIA). The new title not only raised the external prestige of the house of Hohenzollern but also formed a common bond for the various posts of the monarchy to which the designation "kingdom of Prussia" was gradually applied. In this respect Frederick's action, motivated by personal vanity, was politically the most important result of his reign.

Frederick's rule showed itself most productive in his deliberate care for the arts and sciences. The king gathered at his court important artists and architects (Eosander von Göthe, Andreas Schlüter) and built some splendid palaces which changed the face

of the capital, Berlin. Intellectual life also gained in breadth and depth, thanks largely to the influence of French Protestant refugees, who flocked to Brandenburg-Prussia in even greater numbers than under Frederick's father, so that French theologians and philologists came to dominate the life of Berlin. The men of learning of the capital were gathered into a society formed on the lines of the Académie Française in Paris and the Royal society in London; it was called the Societät der Scienzien (1700; later Societät der Wissenschaften; *see* ACADEMIES), and its first president was Leibniz, the greatest German scholar of the time. In religious matters the king took up a position between Calvinism and Lutheranism and promoted the emotional rather than dogmatic movement of Pietism (*q.v.*), which, together with the new political science based on natural law and expounded by Christian Thomasius, grew up at the University of Halle (founded 1694).

Frederick's third marriage (1708), with the mentally unstable Sophia Louisa of Mecklenburg (1685–1735), was unhappy. He died in Berlin Feb. 25, 1713. The only son of his second marriage succeeded him as Frederick William I.

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FREDERICK II THE GREAT (1712–1786), king of Prussia from 1740, was born in Berlin on Jan. 24, 1712, the third son of Frederick William I of Prussia and Sophia Dorothea of Hanover, sister of George II of England. As two elder sons had died before his birth, he was heir apparent to the throne.

Youth and Political Self-Instruction.—His father wished Frederick to be brought up in his own strictly military and Protestant ideas, but met with the boy's instinctive opposition. Frederick's first tutor, the French Calvinist refugee Jacob E. Duhan de Jandun, inspired his pupil with a love for books, and especially for French literature. To the king's disappointment the young prince showed no interest in military matters or in the pleasures of hunting. He withdrew increasingly into a world which his father did not understand, secretly collecting a library, learning to play the flute (Johann Joachim Quantz was his master) and adopting a freethinking philosophy. Frederick William, seeing his son, as he thought, on the way to damnation and the future of his state threatened, inflicted upon him brutal and humiliating treatment. The queen's ambitious plans moreover gave a political aspect to the conflict between father and son. She intended that her daughter Wilhelmine should marry her nephew Frederick Louis, prince of Wales, while her son was to marry the latter's sister Amalia. The king, however, who at that very time had withdrawn from the western powers in favour of an Austrian connection, forbade the English marriage.

In 1730, during a tour in western Germany on which he had to accompany his father, Frederick saw his opportunity to put into practice a plan of escape to England which he had long been plotting. The plan, however, was betrayed at the last minute; the prince, treated as a deserter from the army, was degraded and brought before a court-martial. Since the court declared itself incompetent, Frederick was imprisoned in the fortress of Küstrin. There he was made to watch the execution of Lieut. Hans Hermann von Katte, who had taken part in planning the escape. Frederick now threw himself entirely on his father's mercy and the king sent him on probation to the provincial administration in Küstrin. A formal reconciliation with his father took place in 1732 and Frederick was then appointed colonel of an infantry regiment. Frederick also obeyed his father by marrying, in 1733, Elizabeth Christina of Brunswick-Bevern, a niece of the Holy Roman emperor Charles VI, goodhearted but ugly and intellectually barren. The unhappy marriage remained childless. During the War of the Polish Succession (1733–35) Frederick went as an observer with the army of Prince Eugene of Savoy, the most famous commander of the period.

The year 1735 was a turning point in Frederick's life. The king's unexpected recovery from a serious illness set back his hopes of an early accession to power. Having withdrawn to the castle of Rheinsberg, he devoted himself to systematic and extensive reading. In his correspondence with Voltaire (*q.v.*), begun in 1736, he developed a personal style, and also a complete mastery of French, which became the natural means of expression to him. Through French literature he discovered the philosophy of the ancients and of the English and French deists, on whom he based his own philosophy of life and politics. His ideal of government became an "enlightened" but "absolute" monarchy grounded in natural law and in the theory of contract (Thomas Hobbes and Pierre Bayle), serving the welfare of the people and limited only by the ruler's sense of responsibility.

At the same time, Frederick's correspondence with Gen. Friedrich Wilhelm von Grumbkow, one of his father's ministers, deepened his interest in the great issues of European politics, which had been awakened by the French envoy J. J. Trotti, marquis de La Chétardie. His political thinking now developed a strong bias against the emperor and the house of Habsburg. His first political essay, *Considérations sur l'état présent du corps politique en Europe* (1738), shows his dissatisfaction with the weak position of Prussia, which had recently been forced to abandon the Hohenzollern claims to the duchies of Jülich and Berg (*qq.v.*) on the lower Rhine in the face of the united opposition of the great powers. His *Antimachiavell*, however, expounded the ideals of the pacific and enlightened ruler in opposition to the maxims of the Florentine statesman so often followed in political practice. The work contains the often misquoted sentence: "The ruler is in no way the absolute lord of the people under him, but merely the first servant." Published by Voltaire at The Hague in 1740, *Antimachiavell* circulated very widely in France where literary circles regarded it as the political program of the young ruler, who on May 31, 1740, had succeeded his totally different father on the Prussian throne.

Frederick's Accession and the Silesian Wars.—Frederick began his reign with the intention of putting into practice those humane and enlightened principles which he had enunciated. The philosopher Christian Wolff, exiled by Frederick William I, was recalled to Halle, torture was abolished and penalties for crime mitigated. The new king's interest in science, literature and the arts expressed itself in his intercourse with Voltaire, in the summoning of Maupertuis to Berlin, in his lavish patronage of musicians (notably K. P. E. Bach, son of J. S. Bach) and in the building of a Berlin opera house. It became clear at once, however, that the *"roi philosophe"* was also a statesman and soldier. Frederick's succession to the throne did not inaugurate a mild or an easy-going regime. Though he dissolved the "Potsdam giants' guard," his father's military toy, he at once raised seven new regiments: he recognized and valued the military power left to him by his father and meant to use it. He therefore paid close attention to foreign affairs and personally conducted the correspondence with his envoys.

Political developments enabled Frederick to deploy the weight of Prussian military strength in Europe. The period between the peace of Utrecht (1713) and Frederick's accession had been largely determined by Anglo-French co-operation in the great issues of European politics. The latent antagonism between France and Great Britain was veiled and checked by the peaceful tendencies of the cardinal de Fleury's policy in France and Sir Robert Walpole's in England. Just before Frederick's accession, however, Great Britain, for commercial interests in America, went to war with France's ally Spain (1739). This gave Prussian policy a fresh starting point. Instead of having to face, as heretofore, the united opposition of Great Britain and France to Prussian aspirations, Prussia was henceforth assured of support from one or other of these rivals in return for an alliance, which Prussia's military power made most valuable. At first Frederick tried to exploit this new situation in pursuing his claims on the duchy of Berg, but while negotiations were still going forward, the unexpected death of the emperor Charles VI at the age of 55 (Oct. 20, 1740) made him look for aggrandizement in a different direction.

The "complete transformation of the old political system" through the European war that could be expected over Charles VI's

inheritance prompted Frederick, as he himself said, to "give his fever free rein" and to secure Silesia by a lightning campaign. His troops marched in on Dec. 16, 1740. Prussia had some doubtful dynastic claims on part of Silesia, but Frederick thought little of them and left their substantiation to his ministers. Decisive for him, apart from his personal lust for fame, was the desire to use the favourable circumstances for revenge on the house of Austria and for the expansion of Prussia; moral considerations had no part in his policy. His hopes to gain the Silesian province without war were disappointed as Maria Theresa, Charles VI's heiress, proudly refused Frederick's offer of Prussian help in return for the cession of it. He had thus to secure by war what he had snatched in youthful overconfidence. Even so, his assessment of the general situation proved correct when he won the support of one of the great European powers in the War of the Austrian Succession (*q.v.*), which was now breaking out; his first important victory, at Mollwitz on April 10, 1741, brought him the alliance of France (treaty of Breslau, June 5, 1741)—to which, however, he adhered only so long as his military situation required it. After his decisive victory over the Austrians at Chotusitz (May 17, 1742) Frederick withdrew from the war and, by the peace of Berlin (July 28, 1742), received Silesia and the county of Glatz.

Austria's subsequent success in the European war gave Frederick cause to fear for his hold in Silesia. On June 5, 1744, therefore, he concluded a second alliance with France, hoping that with his army increased to 140,000 men he could finally crush Austria. The disastrous campaign of 1744, however, brought Frederick near to catastrophe, but a series of victories in 1745 restored the situation in his favour. By the peace of Dresden (Dec. 25, 1745) Maria Theresa had to confirm her cession of Silesia.

The Decade of Peace (1746–56).—The Silesian War revealed to the world Frederick's military genius and the efficiency of his army. He himself emerged as a man matured by experience. He now genuinely believed himself at the end of his wars and was determined henceforth to devote all his energies to the works of peace. Nevertheless, he knew that Maria Theresa and her statesmen would never be reconciled to the loss of Silesia and that to keep his gains he would have to be perpetually prepared for war. The strengthening and the intensified training of the army therefore remained Frederick's foremost consideration; he became the personal teacher and instructor of his army. His aim was to bring its strength up to 180,000 men and to accumulate a war chest of at least 20,000,000 thalers. The oblique line of battle which had proved its value in the Silesian War remained the basis of the tactical schooling which Frederick tried to deepen by lectures and courses for his generals. The administrative organization of Frederick William I was retained, but was developed by the creation of special departments within the General Directory.

Economic policy retained its old mercantilist characteristics, but was directed even more exclusively than under Frederick William I toward the protection and development of trade and manufacturing. Whereas his father had promoted the woolen industry Frederick concentrated on the silk industry, which became the high school of commercial enterprise and set in motion the industrialization of Berlin (which in 1755 already exceeded 100,000 inhabitants apart from the garrison).

With methodical zeal and the careful organization of his working day, Frederick himself directed all aspects of the state from his cabinet. The service of the state became the religion of this mocking skeptic. The "philosopher of Sans Souci" found his relaxation only in learning and in literature, in flute playing and in art collecting. In the rococo palace of Sans Souci (built 1745–47) near Potsdam, Frederick gathered round him a circle of literary friends. Among them, from 1750 to 1753, was Voltaire, who completed his *Le Siècle de Louis XIV* there. The flaws in Voltaire's character and the king's unrestrained mockery caused a break between them, but their intellectual affinity was so close that their correspondence was soon resumed and continued up to Voltaire's death.

With the *Histoire de mon temps* (begun in 1746) Frederick's own literary work reached its height. In power and elegance of style this is vastly superior to the writings of contemporary academic historians, especially as regards the clarity and accuracy of its political judgments. Originally meant for the political education of the heir to the throne and not for publication, the book reflects the king's inner thoughts as well as his concept of history. This unites the political philosophy of the Enlightenment with a high estimate of the part played by that will to self-assertion which Frederick saw embodied in all the great personalities of world history. The effect of the *Histoire de mon temps* on later literature was, however, impaired by the fact that, like all Frederick's writings, it was in French; Frederick was completely unfamiliar with the blossoming German literature of his time.

Frederick's musical interests led him to write several librettos and also to compose 25 flute sonatas and 4 concertos himself, as well as other pieces.

The Seven Years' War.—The Seven Years' War (*q.v.*) was not only a struggle for Silesia between Austria and Prussia but also one between Great Britain and France for colonial supremacy. The greatest military conflict of the 18th century originated, not in European disputes, but in the American rivalries of the two Atlantic powers. Frederick had foreseen the extension of the Anglo-French colonial war into Europe, but as a purely continental statesman he considerably underestimated its effect on the European balance of power. Here lay the origin of that fatal misjudgment by which he helped to create the diplomatic setting for the war; namely the so-called "reversal of alliances" or "diplomatic revolution." Trusting in the persistence of Austro-France enmity, he concluded the convention of Westminster with Great Britain (Jan. 16, 1756) without appreciating that he thereby forced France into the arms of Austria, which so far had tried in vain to win French support against Prussia. Thus Frederick was faced by a coalition of France, Austria and Russia. He tried to forestall their concerted offensive, planned for 1757, by the occupation of Saxony in Aug. 1756, but his hope to conclude the war with a few decisive victories was not fulfilled. Despite brilliant feats of arms that impressively demonstrated his versatility as a commander, the strength of his opponents increasingly forced Frederick into defensive strategy. The unexpected length of the war compelled him to overtax the economic resources of Prussia and to depend on British subsidies. After the heavy defeats of 1759 he feared the possible destruction of the Prussian state and even thought of suicide. The deaths of his mother (1757) and of his favourite sister Wilhelmine of Bayreuth (1758), coinciding with those of three of his best friends—generals Kurt Christoph Schwerin (1757), Hans Karl von Winterfeldt (1757) and James Keith (1758)—on the battlefield, left Frederick spiritually lonely. Only his unbending will, the comfort that he found in the works of Latin and of French authors and in music, and the stoical indifference to adversity which his philosophy offered him saved him from despair.

In 1762 a quite unlooked-for reversal of Russian politics, the death of the empress Elizabeth, saved the situation. The new emperor, Peter III, an ardent admirer of his, concluded an alliance with him that enabled Frederick to secure Silesia, this time permanently, at the peace of Hubertusburg (Feb. 15, 1763). He had now won for Prussia the status of a great European power.

Reconstruction.—After the peace Frederick's first concern was the reconstruction of his country, which the war had left in utter ruin. In this great work of re-establishment the repair of war damage was combined with far-reaching plans for economic reform. The king himself toured the provinces and initiated the necessary measures. Grain and seed corn were distributed, depleted stocks of cattle were replenished with state aid and damaged houses rebuilt. In the first year of peace 6,000,000 thalers were expended in this way. The currency, debased during the war, was withdrawn, and the collection of taxes was reformed on French models. The state monopoly, in which nearly 200 French inspectors were employed, was highly unpopular, but the immediate fiscal success was considerable. For the relief of the debt-encumbered estates of the Junkers special credit institutes, the so-called *Landschaften*, were established. The interests of the landowners, of the workers and of the soldiers, who had to maintain themselves on their pay, were safeguarded by state regulation of the price of bread. When the price of grain fell too low for farm-

ing to be profitable, it was stabilized by bulk buying for the government storehouses. When the price rose beyond the means of the poor, the storehouses sold their surplus at reduced prices. This system proved its worth during the bad harvests of 1771 and 1772.

The Old King.—The reconstruction of Prussia, Frederick's greatest peacetime achievement, equals his military performance during the Seven Years' War. In foreign affairs from 1764 onward Frederick mainly relied on an alliance with Russia. This brought him west Prussia (but without Danzig and Thorn) as a result of the first partition of Poland in 1772, prepared by the diplomacy of his brother Henry. The acquisition of west Prussia as well as the simultaneous aggrandizement of Russia and Austria at Poland's expense was a clear breach of international law. For Frederick the most important outcome of the acquisition was that it provided a land bridge between East Prussia and the Brandenburg Neumark, and thus gave coherence at least to the eastern parts of the widely scattered territories of the Prussian monarchy. By an intensive settlement of peasants and craftsmen west Prussia, a thinly populated and decaying area, was soon raised up to the economic standard of the other Prussian provinces.

Even after the Seven Years' War the foreign policy of Prussia was largely determined by persistent antagonism to Austria. For a while Frederick believed that a basis of agreement could be found with Joseph II, Maria Theresa's ambitious son and coregent, but his two meetings with Joseph, at Neisse in 1769 and at Mährisch Neustadt in 1770, convinced him that co-operation between Prussia and Austria was not possible. In the interests of Prussia, therefore, he vigorously thwarted all Joseph's plans. In the War of the Bavarian Succession (*q.v.;* 1778–79) the armies of the two old enemies once again faced each other, in Bohemia, but there was little fighting. The conflict was settled by Russian and French mediation at the peace of Teschen (May 13, 1779), and Joseph was forced to abandon his designs on Bavaria. The League of Princes which Frederick founded in 1785 was intended to strengthen the constitution of the Holy Roman empire against Joseph's activities, and to revive the old opposition of the princes to the preponderance of the house of Habsburg.

The second half of Frederick's reign also saw many reforms and projects of great promise. For example, he showed a care for the prompt and impartial administration of justice, which even in an absolute monarchy should protect the private sphere of the subjects against the arbitrary will of the prince. This was the idea underlying the great reform of justice prepared by the chancellor Samuel von Cocceji, and put through by the chancellor J. H. C. von Carmer. Its ripest fruit, however, was the codification of the existing law, published under Frederick's successor as the *Allgemeines Landrecht* (1794). In this code Frederick's "enlightened despotism" found its classical expression. It showed both his humanitarian tendencies and his conservative conception of the structure of society. It is characteristic of his system that, instead of bridging the gulf between the social classes, the social distinctions were carefully preserved in the interests of the state. To the nobility, which supplied the officers and the higher bureaucracy, was reserved the exclusive ownership of manorial estates and jurisdiction. The *bourgeoisie* was to devote itself to trade and to industry, activities forbidden the nobility. The peasantry paid the bulk of direct taxes and supplied the army recruits and had therefore to be protected against the encroachments of the lords of the manor. The financial and police pressure exerted on the population was severe and heavy. The essence of the system was that, despite all its paternal care for the welfare of the subject, its supreme concern was not with the people themselves but with the abstract greatness of the state, in whose service the king exhausted himself.

"Der alte Fritz" ("Old Fred"), in his threadbare uniform and with his silver walking stick, became a popular and shyly admired figure. In the loneliness of old age his inclination to cynical mockery and the hardening of his character in the fulfillment of his daily round of duties became increasingly marked. Concern for the future of his state, which he would have to leave to an undistinguished nephew (Frederick William II), clouded his last years. Frederick died at Sans Souci on Aug. 17, 1786.

Conclusions.—Frederick II was as great a ruler as any in the 18th century, representing as he did in a unique way both the potentialities and the contradictions of his time. Already in 1746, after the peace of Dresden, his subjects were calling him "the Great." He made the Prussia of his day a model state of "enlightened despotism," which deeply impressed his contemporaries but also reveals the inherent weakness of his system. It was an artificial machine whose complex workings only the "omnipresent" king himself knew how to control. It was the most thoroughgoing realization of a form of government that, in essence, was already outmoded when the king died. Exactly because it united the typical traits of "enlightened despotism" in a perfection found nowhere else, it could neither develop nor renew itself, as was to be seen in Prussia's collapse during the Napoleonic Wars. Frederick stood at the beginning not of a new but of a waning age. To admit this, however, is not to diminish the significance either of his creative achievement or of his personality as a statesman. He never fully resolved the tension between the ethical impulses of a philosopher and his country's expansionist drive—a tension which persisted throughout his life. Yet the intensity and the self-discipline with which he strove after a harmonious solution assure him of true historical greatness. *See* also references under "Frederick II" in the Index volume.

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FREDERICK III (1831–1888), king of Prussia and German emperor in 1888, was born at Potsdam on Oct. 18, 1831, the son of the future king and emperor William I and Augusta of Saxe-Weimar-Eisenach. He received a thorough liberal and military education, and was the first Prussian prince to attend a university. His marriage in 1858 to the British princess royal, Victoria (1840–1901; from 1888 called "the empress Frederick"), was of decisive importance since she far excelled him in intelligence and in vigour and brought him into contact with English liberalism. Frederick, crown prince from 1861, was hardly a true liberal, but, like some other German princes, recognized the necessity of the modern constitutional state and was imbued with the spirit of 19th-century middle-class civilization in the arts and sciences.

It was the tragedy of his life that Frederick had to spend nearly 30 years as heir to the throne without any possibility of independent action. His military service as commander in the German-Danish War (1864), in the Seven Weeks' War (1866) and in the Franco-German War (1870–71) assured his popularity, though his successes were chiefly due to his chief of staff, Leonhard von Blumenthal. Like his father, Frederick became a symbol of German unity, which he furthered with all his powers. His inclination toward strongly centralized government and his willingness to exert far greater pressure on the allied German princes than Bismarck thought prudent are revealed in his diaries.

In view of his marked sense of monarchical dignity it is therefore somewhat doubtful whether, if his reign had been longer, Frederick would have been that exemplary constitutional ruler who would have ensured the ultimate victory of the "missing generation" of the Liberals. In the army conflict of the 1860s (over grants for military expenditure and the length of service) Frederick decidedly opposed Bismarck (*q.v.*); and in a speech at Danzig in June 1863 he openly protested against Bismarck's press ordinances. He had already refused assent to his father's proffered

abdication in 1862 and now, sharply rebuked by the king, silently faded into the background. However, he repeatedly gave Bismarck material assistance (*e.g.*, in the dispute over the war aims of 1866 and as an intermediary between Bismarck and Moltke in 1870–71); but the brutal aspects of Bismarck's home and foreign politics were alien to him. From 1871 the tedium of inactivity induced in Frederick a growing sense of frustration which not even his short period as his father's representative in 1878 could assuage. Bismarck's ruthless battle against the crown prince's court undoubtedly overstepped all reasonable limits.

In 1887 Frederick showed symptoms of cancer of the throat, and after a bitter dispute between the British specialist Morell Mackenzie (*q.v.*) and the German doctors a tracheotomy had to be performed in Jan. 1888. This reduced Frederick to a voiceless invalid just when the death of William I (March 9, 1888) called him to a reign of only 99 days. He was unable to rule according to his own conceptions or to implement the advice given him by his Liberal friends, save only that he dismissed the ultrareactionary minister of the interior, Robert von Puttkamer. His son and heir, William II, entirely opposed to his parents' political conceptions, was impatiently waiting in the wings. Frederick died in Potsdam on June 15, 1888. His letters and speeches were edited by G. Schuster (1906), his diaries for 1848–66 by H. O. Meissner (1929) and his war diaries for 1870–71 also by Meissner (1926).

See W. Richter, *Kaiser Friedrich III.* (1938); A. Dorpalen, "Emperor Frederick III and the German Liberal Movement," *American Historical Review*, liv (1948–49). (Ha. H.)

FREDERICK III (1272–1337), king of Sicily from 1296, was the third son of Peter III of Aragon. He first went to Sicily in April 1283, a year after the Sicilians, having risen against the Angevin Charles I (*q.v.*), had elected Peter as king. Peter at his death (1285) left Aragon to his eldest son, Alfonso III, and Sicily to his second son, James, but on Alfonso's death (1291) James became king of Aragon also, reuniting the two crowns. He then made Frederick his regent in Sicily.

War over Sicily continued between the Guelphs, led by the pope and by France in support of the Angevins, and the Ghibellines, who sided with the Aragonese and with the Sicilian rebels. The Aragonese were successful in Italy, but James, wanting to keep Aragon secure from French and Castilian threats, agreed to the peace conditions proposed by Pope Boniface VIII (1295). James was to hand Sicily over to the church, which would hand it back to Charles II of Anjou; in exchange James was to receive Sardinia and Corsica, over which the papacy claimed to have feudal rights.

The Sicilians quickly reacted to this shameful treaty, deciding not to withdraw from the struggle for independence. This decision had already encouraged Frederick of Aragon, in an interview with Boniface at Velletri, to resist the pope's offers of a settlement. On his return to the island he was acclaimed by the people, the parliament elected him king of Sicily at Palermo (Dec. 11, 1295) and he was crowned on March 25, 1296. To revive the Ghibelline tradition of the Holy Roman emperor Frederick II, the new king called himself Frederick III, though he was in fact only the second Frederick king of Sicily. To strengthen the Sicilian nation as a political entity, he increased the power of the parliament of the kingdom and associated it with himself in affairs of state. He also increased local autonomy.

Frederick's refusal to treat with the pope led to a renewal of the war. The Angevins effected landings at several points on the island and were supported by James of Aragon, who had become the ally of Charles II. In spite of a victory over the Sicilian fleet off Cape Orlando, the Angevins' attempts to occupy the whole island failed. The position of the belligerents remained unaltered even after Charles of Valois arrived in Sicily, and Charles was forced to make peace, signed at Caltabellotta on Aug. 31, 1302. It was agreed that Frederick should retain Sicily with the title of "king of Trinacria" until his death, when the island would revert to the Angevins; and that the latter were to withdraw their troops from Sicily, while Frederick would withdraw his from Calabria. A further condition was fulfilled in Frederick's marriage (1303) to Eleanor, daughter of Charles II of Anjou.

Frederick now devoted himself to restoring the prosperity of his kingdom, with such success that in 1311 he could attempt the conquest of the duchy of Athens and Neopatria in the Balkans. Trouble with the Angevins, however, broke out again when Charles II's successor, Robert, allied himself with the Guelphs to resist the emperor Henry VII, who had descended into Italy in 1310. Frederick took Henry's side, invaded Calabria and then left for Tuscany to join the Ghibellines and the emperor, but on his way heard of Henry's sudden death (1313). After his return to his kingdom he reassumed the title "king of Sicily" and had his son Peter, born in 1305, elected as his successor by the parliament. Further warfare with Naples was suspended by a truce in 1317, but started again in 1321. Frederick sent his galleys to help in the siege of Genoa, which the Ghibellines were trying to wrest from Robert of Anjou. To finance the expedition, he seized some ecclesiastical property, whereupon Pope John XXII excommunicated him and put Sicily under an interdict (1321–35). Angevin raids and attacks on Sicily, however, were checked when the descent of the emperor Louis IV into Italy (1327) distracted Robert's attention. Frederick sent his son Peter with a fleet to help Louis, but the emperor returned to Germany in 1330, and Sicily was again exposed to harassing raids from Naples, as well as to trouble arising from party quarrels among the Sicilian aristocracy.

Frederick died on June 25, 1337, at Paterno. Despite the treaty of Caltabellotta, he was succeeded by his son Peter.

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FREDERICK I (1676–1751), king of Sweden from 1720 to 1751, was born on April 28, 1676, the eldest surviving son of the landgrave Charles of Hesse-Kassel. His natural bent was toward scientific and military studies, and he became an exceptionally brave and resourceful officer, serving under William III of England (1695–97) and in the War of the Spanish Succession. He married Louise of Brandenburg (1700), but she died childless in 1705. In 1708 a more ambitious project was suggested; viz., that Frederick should marry the sister of Charles XII of Sweden, Ulrika Eleonora, who, after the recent death of her elder sister, seemed likely to succeed her unmarried brother on the throne. After protracted negotiations (chiefly necessitated by Ulrika Eleonora's fears that her marriage to a Calvinist might prejudice her chances and benefit those of her Lutheran nephew, Charles Frederick of Holstein-Gottorp) the wedding took place in 1715.

Ulrika Eleonora became so devoted to her husband that his hopes of finally possessing the Swedish crown for himself seemed justified. Frederick got on well with Charles XII and took an active part both in the campaigns in Norway and in the organization of Swedish defenses against Russian attacks from the east. During the preparations for the big military offensive of 1718, however, he became increasingly preoccupied with safeguarding his wife's interests vis-à-vis the Holstein-Gottorp candidature in case Charles XII should die without having named his heir. He established contacts with the antiabsolutist opposition to Charles XII, and it has been strongly suspected that the king's death (Dec. 11, 1718) was a murder arranged by Frederick in order to prevent the situation's moving in favour of his wife's rival. Opinion on this matter is divided, but it would seem that Frederick had neither the desire nor the need to plot Charles XII's death. He was, however, very well prepared for it and, by seizing the initiative, he secured Ulrika Eleonora's proclamation as queen, though at the cost of concessions to the antiabsolutist forces in the estates (*riksdag*).

He himself emerged as the real leader in foreign policy and made great efforts, both militarily and diplomatically, to get peace from Russia without making too many concessions. He was unsuccessful, largely because of circumstances beyond his control: he made sacrifices to Hanover, to Denmark and to Prussia in order to obtain help against Russia, but this help did not materialize on the scale arranged, so that Sweden was forced in 1721 to agree to the humiliating peace of Nystad. Frederick had ostensibly

greater success in his personal aims in Sweden: in March 1720 the queen declared the estates freed from their oath of loyalty to her, and Frederick was proclaimed king of Sweden. In reality opponents of royal absolutism had taken advantage of both Frederick and the queen, and he took over the crown in a much more dependent position in relation to the estates than had Ulrika Eleonora.

Frederick's reign was a disappointment. He was given far less opportunity to govern than he had expected, and his gifts in the military and diplomatic fields were hardly used. In the enforced idleness to which the Swedish "age of liberty" thus condemned him, his intelligence rusted and his character deteriorated though his charm survived. He filled his time with hunting and love affairs. He had no children by Ulrika Eleonora (though he had two sons and two daughters by one of his mistresses, Hedvig Taube), and his hopes of having the succession fixed in the Hesse family were disappointed. From 1743 he was overshadowed by the heir to the throne, Adolphus Frederick of Holstein-Gottorp, who was chosen in conformity to Russian wishes as a result of the disastrous war against Russia. Frederick suffered the first of several strokes in 1748 and died in Stockholm on March 25, 1751.

See Walfrid Holst, *Frederik I* (1953). (R. M. Ha.)

FREDERICK I (1371–1440), elector of Brandenburg from 1417, founder of the greatness of the house of Hohenzollern, was born at Nürnberg between Aug. and Nov. 1371, the second son of Frederick V, burgrave of Nürnberg. He first came into prominence by saving the life of Sigismund, king of Hungary, at the battle of Nikopolis in 1396. After his father's death in 1398 he obtained Ansbach, and shared the smaller possessions of the family with his elder brother John, whose principality of Bayreuth fell to him after John's death in 1420. New opportunities for Frederick, however, had come already in 1410 with the contested election to the German throne. Sigismund, younger son of the Holy Roman emperor Charles IV, had used his inherited dignity as elector of Brandenburg mainly to establish himself as king of Hungary. When he appointed Frederick as his representative in the negotiations of the electoral college, he authorized him to cast the Brandenburg vote as his delegate. Frederick succeeded in having Sigismund elected German king, and, as a reward, obtained his appointment as a governor of Brandenburg (July 8, 1411). By using heavy siege guns against the strongholds of the lawless nobility, he restored a certain degree of order and was formally invested with the electorate and margraviate by Sigismund at Constance on April 18, 1417.

In 1423 the house of Wettin obtained from Sigismund the Saxon electorate with its valuable possessions on the middle reaches of the Elbe, which Frederick had hoped to acquire for his second son. Moreover, in 1425 Frederick's attempt to gain a foothold on the Baltic coast was defeated by a combination of Pomerania, Poland and the Teutonic Order. After these disappointments he handed over the control of Brandenburg to his eldest son, John the Alchemist, returned to Franconia and concentrated for the rest of his life on the affairs of the empire. He was active in the negotiations with the Hussites as a champion of a policy of moderation, and was instrumental in bringing about the pacts of Prague (1433) and of Iglau (1436). He took part in the election of Frederick III as German king in 1440, and died at Kadolzburg on Sept. 21, 1440.

See E. Brandenburg, *König Sigismund und Kurfürst Friedrich I von Brandenburg* (1891). (H. Lz.)

FREDERICK III THE PIOUS (1515–1576), elector palatine of the Rhine, was born at Simmern on Feb. 14, 1515, the eldest son of John II, count palatine of Simmern (d. 1557). Brought up a Catholic he yet married, in 1537, the Lutheran Maria of Brandenburg-Culmbach and himself adopted in 1546 the reformed doctrines, inclining to Calvinism. In 1559 Frederick succeeded his kinsman Otto Henry as elector palatine. Influenced by the theologian Caspar Olevianus, Frederick after 1561 began systematically to introduce Calvinism into the Palatinate. In 1563 he authorized the Heidelberg Catechism, written by Olevianus and Zacharias Ursinus. Within the Palatinate, Frederick was opposed by the Lutheran nobles led by his eldest son Louis (d. 1583), while his position as a prince of the empire was insecure since the religious peace of Augsburg (*q.v.*; 1555) covered relations only between Catholics and Lutherans. Frederick's attempts to unite the Protestant princes against the house of Habsburg failed. But, recognizing the importance of the religious struggles in France and the Netherlands, he sent his second son, John Casimir (d. 1592), to assist the French Huguenots, while his third son, Christopher, died in the Dutch cause at the battle of Mooker Heath in 1574. In the same year, Augustus, the Lutheran elector of Saxony, hitherto friendly to Frederick, withdrew his support because of crypto-Calvinist activities in his territories. When Frederick died at Heidelberg on Oct. 26, 1576, the Palatinate was the centre of German Calvinism. His assistance to the French and Dutch Protestants was historically important because it enabled them to maintain their political identity.

FREDERICK V (1596–1632), elector palatine of the Rhine and king of Bohemia, was born on Aug. 26, 1596, at Amberg in the Upper Palatinate, the son of the elector Frederick IV and Louisa Juliana, daughter of William of Orange, the liberator of the Netherlands. He received a French education at Sedan and succeeded his father in Sept. 1610. He married Elizabeth, daughter of James I of Great Britain, in Feb. 1613, but was not declared of age until July 1614. Against the advice of his palatine councilors he accepted the election as king of Bohemia (Aug. 26, 1619) by the Bohemian estates who had revolted against the Habsburg king, the Holy Roman emperor Ferdinand II (*q.v.*). He was crowned in Prague on Nov. 4, 1619, but his reign lasted little more than a year—hence his nickname "the Winter King"—as his army was completely routed by the Catholic league under Tilly in the battle of the White Mountain near Prague on Nov. 8, 1620 (*see* THIRTY YEARS' WAR). Frederick and his family, including the newly born prince Rupert (*q.v.*), fled without further resistance. The Protestant union, of which Frederick was the nominal head, was restrained by French pressure from assisting him; the Lutheran elector of Saxony was won over by Ferdinand with the cession of Lusatia; James I of England was bent on appeasing Catholic Spain. After two years Frederick's cause collapsed through lack of funds for the maintenance of his troops under Ernst von Mansfeld and Christian of Brunswick (*qq.v.*). The Palatinate was occupied by the league and the Spaniards, and the electoral dignity was transferred to Maximilian I (*q.v.*) of Bavaria. Frederick spent the rest of his life as a pensioner of the Dutch states-general and a hanger-on of Gustavus Adolphus of Sweden. He died in Mainz on Nov. 29, 1632. Through his youngest daughter Sophia (1630–1714), the mother of George I, Frederick became the ancestor of the Hanoverian dynasty in Great Britain.

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FREDERICK I THE WARLIKE (1370–1428), elector of Saxony from 1423, was born on April 11, 1370, the son of Frederick III the Stern, margrave of Meissen. In 1382 the Wettin family lands in Meissen and Thuringia were divided: one part fell to Frederick, his brothers William and George and their uncle William I; the other to their uncle Balthazar and his son, Frederick the Younger. In 1407 William I died. A dispute between Frederick and William and their cousin ended with the treaty of Naumburg (1410), which stipulated that the family lands should remain inalienable. In 1409 the brothers had founded at Leipzig a university for the German students from Prague.

From 1408 the Wettins withdrew their support for the German king Rupert, and in 1414 Frederick sent a representative to the coronation of Sigismund of Luxembourg. However, at Constance in 1417, Sigismund refused Frederick's demand for certain Wettin lands acquired by the Luxembourgs as kings of Bohemia. Nevertheless, since the Bohemian Hussites were a potential threat to him, Frederick, from 1420, assisted Sigismund in his wars against them. Relations between king and margrave improved, and Frederick gained the Bohemian lands that he had claimed.

In 1422 Albert III, the last Ascanian elector of Saxe-Wittenberg,

died. The elector of Brandenburg, Frederick I, was connected with the Ascanian house, but in 1423 Sigismund, not wishing to see two electorates in one hand, nor approving Brandenburg's alliance with Poland, conferred Saxe-Wittenberg on Frederick of Meissen. With this acquisition Frederick ensured the future importance of the Wettins. At the treaty of Waizen (1425) Frederick and his sons swore loyalty to Sigismund and his son-in-law Albert (later Albert II) as future king. Frederick died on Jan. 4, 1428. In 1402 he had married Catherine of Brunswick, by whom he had four sons and two daughters. He was succeeded by his eldest son, Frederick II.

See I. von Broesigke, *Friedrich der Streitbare* . . . (1938).

FREDERICK II THE MILD (1411–1464), elector of Saxony, eldest son of the elector Frederick I, was born at Leipzig on Aug. 22, 1411. In 1428 the family lands went to Frederick and his brothers Sigismund, Henry and William III the Brave. Attacks by the Bohemian Hussites lasted until a treaty was concluded in Aug. 1432. In 1438 Frederick established his right to the electoral vote against the Ascanian Saxe-Lauenburg line. The year after, with the help of his friend the German king Albert II, he gained control of the burgraviate of Meissen. In 1440 his cousin Frederick, margrave of Thuringia, died. Sigismund had taken holy orders in 1437 and Henry had died in 1435. This left Frederick and William III to divide the family lands, including Thuringia; but despite treaties at Altenburg in 1440 and 1445 a war ensued, the so-called *Brüderkrieg* (1446–51), during which Frederick also became involved against Brandenburg over Lower Lusatia. However, the Bohemian Utraquists joined Brandenburg; and at Zerbst in 1450 Frederick had to abandon most of his claims. In Jan. 1451 Frederick and William settled their differences in a new division of their territories.

In July 1455 Frederick's two sons were abducted and later recovered, an incident known as the *Prinzenraub* (*see* ALBERT III, duke of Saxony). At Eger in 1459 Frederick reached an understanding with George of Podebrady, the Bohemian leader; and in 1464 his eldest son Albert married Podebrady's daughter Sidonia. Frederick died at Leipzig on Sept. 7, 1464.

FREDERICK III THE WISE (1463–1525), elector of Saxony from 1486 to 1525, was born at Torgau on Jan. 17, 1463, the eldest son of the elector Ernest and Elizabeth, daughter of Albert duke of Bavaria. His education was wide and strongly influenced by the Renaissance, his main early interests being music and German history. Succeeding his father as elector in 1486, Frederick retained the government of Saxony in his own hands but shared the possessions of his family in other parts of Germany with his brother John the Steadfast (1468–1532).

Frederick made his court at Wittenberg a centre of artistic activity, Albrecht Dürer and Lucas Cranach the elder being among the many artists patronized by him. He was also a great collector of religious relics, bringing many back from a pilgrimage to the Holy Sepulchre (1493) and housing them in the ducal chapel at Wittenberg. To add to the collection he maintained agents in Venice and in the Netherlands. He further took an interest in scholarship, being a friend of the humanist Georg Spalatin and founding, in 1502, the University of Wittenberg.

In 1495 Frederick had been among the princes who pressed the need for constitutional reform upon the German king Maximilian I, and in 1500 he became president of the newly formed imperial regency council (*Reichsregiment*). In 1519, however, he declined to stand as a candidate in the imperial election and assisted in procuring the election of Charles V, being the only elector to refuse a bribe.

Frederick, who had appointed Martin Luther professor of philosophy at Wittenberg in 1508 and Phillip Melanchthon professor of Greek there in 1518, refused to implement the papal bull against Luther in 1520. In 1521, after Luther had been placed under the imperial ban by the diet of Worms, Frederick had him conveyed to Wartburg castle and there protected him. He himself finally accepted Luther's reformed doctrines in 1524, but died shortly afterward at Langau, near Annaberg, on May 5, 1525.

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FREDERICK, a city of Maryland, U.S., 45 mi. W. of Baltimore and the same distance northwest of Washington, D.C., on a tributary of the Monocacy river; the seat of Frederick county. It is a trading, farming and manufacturing centre, with large flour and feed mills, brush and silo factories, creameries and corn-canning factories. Manufactures include chrome cooking utensils, stokers, pumps and electronic equipment.

Hood college for women, affiliated with the United Church of Christ, was organized as a college in 1893 but was originally founded as a ladies' seminary in 1839. Also located in Frederick is the state school for the deaf (1867); on its grounds is a stone barracks built in 1777, which quartered British prisoners from the battles of Saratoga, Trenton and Yorktown during the American Revolution and served as a Union hospital during the Civil War. The town clock, in the tower of Trinity chapel, has been in constant service since 1796.

Frederick was the birthplace of Francis Scott Key and of Adm. Winfield Scott Schley. A number of beautiful colonial homes remain in and near the city. Settled by Germans in 1733 and laid out in 1745, Frederick was named for the last Lord Baltimore or the then prince of Wales, or possibly for Frederick the Great of Prussia. There in 1755 Gen. Edward Braddock prepared for his ill-fated expedition against Ft. Duquesne, and in the county courthouse on Nov. 23, 1765, the 12 county judges took official action (the first jurists of the country to do so) repudiating the British Stamp act. The city was incorporated in 1817. During the Civil War Frederick was occupied at different times by Union and Confederate troops. The battle of Monocacy (July 1864) was fought 3 mi. S. The flag-waving by Barbara Fritchie, which through John Greenleaf Whittier's ballad became a cherished national legend, took place, if at all, during "Stonewall" Jackson's march to Harpers Ferry in 1862. A replica of Mrs. Fritchie's house serves as a museum for Civil War and early Frederick historical items. For comparative population figures *see* table in MARYLAND: *Population.* (R. M. LA.)

FREDERICK AUGUSTUS I (1750–1827), king of Saxony from 1806, was born at Dresden on Dec. 23, 1750, the son of the elector Frederick Christian, whom he succeeded in 1763 as the elector Frederick Augustus III. Declared of age to rule in 1768, he married Maria Amalia of Zweibrücken in 1769. His government of internal affairs was conscientious and methodical. Siding with Prussia against Austria in the War of the Bavarian Succession (*q.v.*), he received satisfactions in territory and in cash at the peace of Teschen (1779). Though he joined Prussia's league of German princes, the *Fürstenbund,* in 1785, he insisted on conserving his neutrality and took no part in the Austro-Prussian quarrel of 1790. He was offered the Polish crown in 1791, but declined it. On the eve of the French Revolutionary Wars (Feb. 1792), he refused to join the Austro-Prussian league against France. When war broke out, however, he adhered to the coalition, and even after Prussia's separate peace with France (1795) he went on fighting till the French advance, under J. B. Jourdan, into central Germany forced him to make peace (Aug. 13, 1796).

Saxony joined Prussia against Napoleonic France in 1806 (*see* NAPOLEONIC WARS). After the battle of Jena, however, Frederick Augustus signed the peace of Posen with Napoleon (Dec. 11, 1806), which secured the title of king of Saxony for him and the entry of Saxony into the Confederation of the Rhine. Thenceforward he was one of Napoleon's most loyal allies. After the Franco-Russian treaty of Tilsit (1807) he received the duchy of Warsaw, to be made a grand duchy in 1808, and he joined Napoleon against Austria in 1809. When Napoleon reached Dresden on his way back from his disastrous Russian campaign in 1812, the king received him well; though Frederick Augustus made overtures to Austria in April 1813 his faith in Napoleon was restored by the latter's victory at Lützen in May. In the battle of Leipzig, however, on Oct. 18, 1813, the Saxon troops went over to the enemy, who took Frederick Augustus prisoner. The congress of Vienna,

because of Austrian resistance to Prussian and Russian designs, restored him to his kingdom, but he had to cede the northern part of it, with most of Lusatia, to the Prussians (*see* SAXONY).

The rest of Frederick's life was spent in the rehabilitation of what was left of Saxony. He sought to develop agriculture, commerce and industry, to reform the administration of justice and to promote the welfare of his people and the arts. The park at Pillnitz bears witness to his special interest in botany. Frederick Augustus died on May 5, 1827.

FREDERICK AUGUSTUS II (1797–1854), king of Saxony from 1836 to 1854, was born in Dresden on May 18, 1797, the eldest son of Prince Maximilian of Saxony and of Carolina of Parma. In Oct. 1819 he married the archduchess Caroline, daughter of the Austrian emperor Francis I. Nominated as joint regent of Saxony with his uncle King Antony in Sept. 1830 (as a consequence of the July revolution in Dresden), Frederick Augustus was partly responsible for the constitution of 1831, which introduced a measure of representative government. In May 1832 his first wife died, and in April 1833 he married Maria, daughter of Maximilian I, king of Bavaria. On June 6, 1836, he became king in succession to his uncle Antony. At first he favoured the plan for German unity put forward at Frankfurt in 1848, though refusing to acknowledge the democratic constitution of the Frankfurt assembly. This attitude led to the May insurrection in Dresden in 1849, which was suppressed with the help of Prussian troops. F. F. von Beust, the minister who had called in the troops and who was also the leader of the reactionary pro-Austrian party in Saxony, then became the director of Saxon policy.

From that time Frederick Augustus took little part in government and devoted himself to the study of botany, in which he had long been interested, having already published *Flora Marienbadensis, oder Pflanzen und Gebirgsarten* (1837), and traveled extensively in search of specimens. He died, childless, on Aug. 9, 1854, as a result of a carriage accident near Brennbühel in the Tirol.

See C. W. Böttiger and T. Flathe, *Geschichte des Kurstaates und Königreiches Sachsen*, vol. iii (1873); H. Kretzschmar, "Die Sächsische Königtum in 19 Jahrhundert," *Historische Zeitschrift*, no. 70 (1950).

FREDERICK CHARLES, PRINCE (1828–1885), Prussian field marshal and victor of Königgrätz (Sadowa; 1866), was born in Berlin on March 20, 1828, the eldest son of Prince Charles of Prussia and nephew of the future German emperor William I. From childhood he was educated for a military career. He first saw service, as a captain, in 1848, when Prussia sent troops into Holstein. He became a colonel in 1852 and a major general in 1854, in which year he married Princess Marie Anne of Anhalt. In 1858 he visited France and, as far as the conditions of his visit allowed, made a detailed study of the French army. Two years later he gave a lecture on the French army to a group of German officers; he was a man with forthright views and did not mince his words, and as the substance of his lecture reached France, it gave great offense there.

In 1861 he was made a general of cavalry and distinguished himself as a commander in the campaigns against Denmark (1864) and in the Seven Weeks' War against Austria (1866). In command of the 1st army, he was mainly responsible for the great Prussian victory at Königgrätz (July 1866), which virtually ended the war.

During the Franco-German War of 1870 Frederick commanded the 2nd army, consisting of four army corps and two cavalry divisions. In the early stages he drove Marshal A. F. Bazaine back on Metz and on Oct. 27, 1870, received the capitulation of that city. He was made a field marshal on the following day. Although these operations ended in complete success, they had been costly and were not above criticism. The prince's forceful character and tactlessness moreover resulted in friction with the commander of the 1st army, Gen. K. F. von Steinmetz. Subsequently Frederick captured Orléans, brought about the disintegration of the French army of the Loire and broke up Gen. A. E. A. Chanzy's part of it at Le Mans.

Despite his overbearing and tactless manner Frederick Charles was undoubtedly an able and forceful general. He died at Klein Glienicke, near Potsdam, on June 15, 1885.

See H. Müller-Bohn, *Der Eiserne Prinz* (1902); C. H. Falls, *A Hundred Years of War* (1953). (C. N. B.)

FREDERICK HENRY (1584–1647), prince of Orange, the youngest child of William the Silent and Louise de Coligny, was born at Delft in Holland, on Jan. 29, 1584, that is, about six months before his father's assassination. In 1594 he went to the University of Leiden. In 1597 he joined the army under his brother Maurice and was present at the siege of Rijnberk. From Dec. 1597 to April 1599 he was in France with his mother, who wanted him to know and understand her country. On his return to the Netherlands, Frederick Henry again joined the army, becoming colonel of a Walloon regiment. In 1603 he was a member of the embassy sent by the estates of Holland to James I of England to congratulate him on his accession. During the conflicts which divided the Dutch republic in the 1610s Frederick Henry favoured the Remonstrants, but he did not actively support them since his brother Maurice, the stadholder, supported the Counter-Remonstrants.

The 12 years' truce with Spain ended in 1621 and Frederick Henry took a leading part in the war which followed (*see* NETHERLANDS, THE: *History*). On Maurice's death in 1625 Frederick Henry succeeded him as stadholder of Holland, Zeeland, Utrecht, Gelderland and Overijssel and was also appointed captain-general and admiral-general of the United Provinces. Thenceforward his military genius—exemplified by the capture of Grol (1627), 'S Hertogenbosch (1629), Maastricht (1632) and Breda (1637)—his political skill and the tenacity with which he pursued his dynastic ambitions all combined to win him a semimonarchical prestige, and his court at The Hague became an international centre. In 1640 his position at home was made still stronger by his succession to the stadholderships of Groningen and Drenthe. In 1625, moreover, he had married Amalia of Solms, and the marriage of his son William to Mary, the daughter of Charles I of England, in May 1641 enhanced the standing of his house abroad.

In domestic affairs Frederick Henry used his great powers to stabilize the situation, as for example in his toleration of the Remonstrants, and this policy was fairly successful until 1644. After that year, however, weakened in mind and body, he was unable to resist the increasing opposition to the dynastic and pro-Stuart tendencies of his regime and to his reluctance to end the war with Spain by breaking the French alliance of 1635. In 1646 negotiations were begun which were to culminate in the treaty of Münster between Spain and the United Provinces in 1648, but meanwhile Frederick Henry had died on March 14, 1647. He left an account of his campaigns, which was published as *Mémoires de Frédéric Henri* in 1733.

See P. J. Blok, *Frederik Hendrik, Prins van Oranje* (1924); also G. Edmundson, "Frederick Henry, Prince of Orange" *Cambridge Modern History*, vol. iv (1907). (E. H. K.)

FREDERICK LOUIS (1707–1751), prince of Wales, as the eldest son of George II and Caroline of Ansbach, from 1729 until his death, was born at Hanover in Jan. 1707. After his grandfather became king of Great Britain as George I in 1714, Frederick was known as duke of Gloucester, but he was never formally created duke. He had been betrothed to Wilhelmina Sophia Dorothea, daughter of Frederick William I, king of Prussia, but the match was prevented by the ill will between the parents. On the accession of George II (1727) Frederick returned to England, was created duke of Cornwall, and in 1729 became prince of Wales.

The relations between father and son deteriorated rapidly, the chief bone of contention being the king's refusal to make Frederick an adequate allowance. In 1735 the prince wrote or inspired the *Histoire du Prince Titi*, which contained offensive caricatures of both the king and queen. After a marriage with Lady Diana Spencer (afterward duchess of Bedford) had been frustrated by Sir Robert Walpole, Frederick married in April 1736 Augusta, daughter of Frederick II, duke of Saxe-Gotha. George proposed to give his son an allowance of £50,000 a year, but this Frederick considered inadequate. The breach became irreparable when Frederick allowed his opposition friends to raise the matter, unsuccessfully, in parliament (1737). He went to the length of re-

fusing to allow his first child to be born under the parental roof, carrying off his wife, almost in labour, from Hampton Court.

After this insult, Frederick was banned from the court and foreign ambassadors were told not to visit him. His new home, Leicester house, became a centre for political opposition (*see* GEORGE II). Frederick hated Walpole in particular; after Walpole's downfall he was formally reconciled with his father but continued until his death to intrigue against all George's ministers. In 1745 George refused to allow him to command the army against the Jacobites. Frederick died at Leicester house on March 20, 1751, and was buried in Westminster abbey. Although he never showed any sign of statesmanship, his father was as much to blame as himself for his unconstructive career.

Frederick's eldest son, George, succeeded to the throne as George III in 1760. His second daughter, Caroline Matilda, married Christian VII, king of Denmark.

FREDERICKSBURG, a city of Virginia, U.S., lies in Spotsylvania county but is politically independent of it. It is served by the Richmond, Fredericksburg and Potomac railway; it marks the head of navigation for the Rappahannock river. Fredericksburg's chief industry is a viscose company. Mary Washington college, the women's branch of the University of Virginia, is located in the city. (For comparative population figures *see* table in VIRGINIA: *Population.*)

Fredericksburg was laid out as a town in 1727 and named for the father of King George III of England. Its founders and earliest residents included Col. Henry Willis, Rev. James Marye, John Tennent, Susanna Livingston and William Lynn. William Paul, brother of John Paul Jones (*q.v.*), set up the first tailor shop there. In 1732 George Washington's father, who owned "Ferry Farm" across the Rappahannock, bought three lots in the town and became one of its trustees. Fredericksburg was incorporated as a town in 1781. Among Fredericksburg's historic sites are the homes of Mary Ball Washington, mother of George Washington; "Kenmore," the home of Washington's only sister; the law office of James Monroe (*q.v.*); the Hugh Mercer apothecary shop; and the Civil War battlefields.

The Battle of Fredericksburg.—A bloody engagement of the Civil War was fought at Fredericksburg on Dec. 13, 1862. In search of more aggressive leadership, the Lincoln administration had removed Gen. G. B. McClellan from command of the army of the Potomac on Nov. 7 and appointed Gen. A. E. Burnside (*q.v.*) in his place. In the middle of November, Burnside began moving from Warrenton, Va., planning to cross the Rappahannock at Fredericksburg and advance on the southern capital at Richmond. Gen. R. E. Lee countered by taking a strong position on high ground behind Fredericksburg and extending his right about five miles south. His force numbered about 78,000. Burnside, with 122,000 men, held off attacking until his pontoon bridges arrived. When he finally began his assault on Dec. 13, he made it piecemeal. Gen. W. B. Franklin, commanding the Union left, interpreted Burnside's vague orders as restricting his action to a single division. At first this division made good headway against Gen. "Stonewall" Jackson on the heights below Fredericksburg. But, without support, it fell back about midafternoon. Troops brought across the river from Gen. Joseph Hooker's reserve arrived too late for another attempt. Meanwhile, at 1 o'clock, Burnside had sent Gen. E. V. Sumner with the troops on the right to strike behind Fredericksburg itself. Two Union divisions and then a third advanced over exposed ground in front of a stone wall below Marye's heights. Still more troops were added, but few ever got within 100 yd. of the wall. A final Union charge lost over 1,000 men in 15 min. Thus, Burnside's attack on the right proved as futile as that on the left and far more costly. In the end his casualties totaled 12,653 compared with only 5,309 for the carefully entrenched Confederates. And yet Burnside had to be dissuaded from renewing the attack next morning. During a storm on the night of Dec. 15, the army of the Potomac recrossed the Rappahannock and took up its bridges. For his conduct of this battle Burnside has been strongly criticized by students of military history. Lincoln relieved him of his command on Jan. 27, 1863. Like McClellan, and Gen. John Pope before him, Burnside had failed in what should have been the Union objective—destruction of the army of northern Virginia. Richmond seemed as far away as ever. For the south, the victory restored morale lost after Lee's retreat from Maryland following his unsuccessful Antietam (*q.v.*) campaign in September. *See* also AMERICAN CIVIL WAR.

See J. T. Goolrick, *Historic Fredericksburg* (1922); R. U. Johnson and C. C. Buel (eds.), *Battles and Leaders of the Civil War,* 4 vol. (1888), vol. 3, pp. 71–147; Col. G. F. R. Henderson, *The Civil War: a Soldier's View,* ed. by J. Luvaas, (1958). (E. J. N.)

FREDERICK WILLIAM I (1688–1740), king in Prussia from 1713, was born in Berlin on Aug. 15, 1688, the son of Frederick III elector of Brandenburg (from 1701 king in Prussia as Frederick I) and Sophia Charlotte of Hanover. His character was formed decisively by his experiences in the War of the Spanish Succession, during which, at the duke of Marlborough's headquarters, he discovered the army to be his natural field of action; the battle of Malplaquet (1709) was "the greatest day of his life." Seeing how military and financial weakness made Prussia dependent on the alignments of the great powers, he gradually formed the resolution to develop a powerful Prussian army so that he would be able to conduct an independent foreign policy. His political education was completed in 1711, when he was acting as regent for his father. In the same year, through A. H. Francke, he came into contact with Pietism, the religious movement which was to shape his spiritual development. The practical Christianity of Pietism, directed toward social reform, suited both his strict Protestantism and his energetic disposition, which spurred him on to active participation in public affairs.

Almost on the day of his accession to the kingdom (Feb. 25, 1713), Frederick William reduced his father's luxurious and extravagant court to the standards of a middle-class household. In the same spirit of rigorous economy and dedication the king ruled his state, industriously directing all departments of government; in his own words he wished to be "the minister of finance and fieldmarshal of the king of Prussia." His ministers became mere instruments of his will. In 1723 the entire interior administration was united under a central office, the "general directory"; and the provincial administration, too, was simplified and reorganized. Above all, he was passionately devoted to the army; he considered himself primarily an officer and always appeared in uniform. His special delight was his regiment of grenadiers, the so-called "Potsdam giants' guard," a corps of extremely tall men recruited from all parts of Europe. He doubled the peacetime strength of the Prussian army (80,000 men out of a total population of 2,200,000), made it for the first time independent of foreign subsidies and even amassed a war chest of 8,000,000 thalers, which he left to his successor. This was possible only because the economic development of the country was artificially promoted by an industrial and commercial policy on rigidly mercantilist lines. The king was particularly interested in fostering the woolen industry, which was clothing the army and was protected by a ban on the export of raw wool and on the import of foreign cloth.

As Prussia was essentially an agricultural country, administrative attention had also to be extended to agriculture. The royal domains, which under Frederick William's father had largely been pawned, were redeemed, their yield increased and their area extended. By the end of his reign Frederick William controlled one-third of the agricultural and forest land in the country; its revenues had almost doubled between 1713 and 1740 and represented half the income of the state. The "conservation of the peasants" was an important aspect of this development: statute labour was reduced and their position, bordering on serfdom, was somewhat ameliorated. Barren areas were made fertile by large-scale internal colonization and improved agricultural methods. The so-called "re-establishment" of East Prussia is particularly famous: the province had suffered fearfully from the plague of 1709 and had been seriously depopulated.

Frederick William is rightly known as Prussia's "greatest ruler in home affairs." His uncertain and ineffective foreign policy provides a strange contrast. He adhered to the European settlement created by the peace of Utrecht (1713) which gave Prussia little room for maneuvering. By the peace of Stockholm (1720),

as the Northern War was ending, he acquired Swedish Pomerania between the Oder and Peene rivers, including Stettin; but his chief interests lay in the west. There he hoped to acquire Jülich and Berg (*qq.v.*) on the lower Rhine, with the concurrence of the emperor Charles VI, to whom he promised his adherence to the Pragmatic Sanction (treaty of Wusterhausen, 1726) and whom he supported during the War of the Polish Succession (1734–35). Moreover, Frederick William felt a genuine devotion toward the empire and emperor whereas his consort, Sophia Dorothea of Hanover (1687–1757; married to him in 1706), sister to George II of England, tried to bring him over to the coalition formed round the Anglo-French treaty of Hanover (1725) against imperial designs. This was the political reason for the unsuccessful attempt at flight by the crown prince Frederick in 1730, when Frederick William was opposing Sophia Dorothea's plans for marrying him to an English princess. Thus Frederick William felt the more disillusioned when in 1738 the emperor, deferring to France and England, withdrew his earlier promise to assist Prussian designs on Jülich and Berg. Finally he completely reversed his policy and sought an alliance with France. He died at Potsdam on May 31, 1740.

Frederick William's character was an amalgam of the most disparate traits: a delight in coarse pleasures and a torturing sense of his inadequacy; a deep religiosity and a fearful brutality. Even his passion for work seems to have had something unhealthy about it, and the restlessness of his life certainly hastened his death. Yet he pursued his aims with remarkable pertinacity: the establishment of a rigidly centralized monarchy was something new at that time. Frederick William was without doubt the founder of the Prussian military and bureaucratic state with all that it entailed. He constituted the army as the backbone of the entire state, applying military discipline even to the civil service; and he transformed the fractious nobility into a loyal officer class and established for two centuries the characteristic features of the Prussian state: efficiency, organization and discipline. Frederick William's achievement was, however, bought at a terrible cost in human happiness and with neglect of all intellectual, spiritual and cultural forces, which the king completely failed to appreciate. He exiled the greatest German philosopher of his time, Christian Wolff, whom he regarded as an atheist; and only valued the applied sciences which were useful to the state.

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FREDERICK WILLIAM II (1744–1797), king of Prussia from 1786, was born in Berlin on Sept. 25, 1744, the son of Frederick the Great's brother Augustus William. His father's death in 1758 made him heir presumptive to Frederick. Frederick, though his opinion of him was slight, allowed Frederick William to accompany him during the Seven Years' War and later to his meetings with the Holy Roman emperor Joseph II. Frederick William was intellectually receptive, devoted to the arts, pleasure-loving and weak of will, without either military or political gifts. Thus when he succeeded Frederick as king (Aug. 17, 1786) he was in no position to continue the latter's system of personal government, and the direction of the Prussian state lay, in effect, with a few favourites. Under this insignificant ruler Prussia nevertheless reached its greatest expansion. As the margrave Charles Alexander renounced his territories in Dec. 1791, Ansbach and Bayreuth fell to Prussia; by participating in the partitions of Poland in 1793 and 1795 Frederick William acquired Danzig (Gdansk), Thorn (Torun) and a large part of central Poland, including Warsaw.

At home, Frederick William failed to carry out any reform of the overcomplicated machinery of government, while squandering the financial resources. He gained easy popularity by abolishing the state monopoly on coffee and tobacco, although the loss of revenue had to be made good by increasing the excise duty on beer, flour and sugar. His most notorious domestic measure was the religious edict of 1788, put through by his favourite Johann Christoph von Wöllner, which gave legal recognition to the principle of toleration but restricted the freedom of religious instruction and bound the clergy to a narrow interpretation of the symbolic books of the Protestant Church. The edict was zealously enforced, but in fact had little effect. Immanuel Kant was reprimanded and important journals moved abroad to avoid the censor.

In foreign affairs, Frederick William co-operated with Austria after Joseph II's death (Reichenbach convention, July 1790; meeting with Leopold II at Pillnitz, 1791; Austro-Prussian alliance, Feb. 7, 1792). This *rapprochement*, based on a common opposition to the French Revolution, led, after the French declaration of war on Austria in April 1792, to Prussia's participation in the War of the First Coalition (*see* FRENCH REVOLUTIONARY WARS). However, after the advance and shameful retreat in 1792, Frederick William conducted the war halfheartedly, being preoccupied with getting his share in the partitions of Poland; and in 1795 he withdrew from the coalition with the separate peace of Basel. The legacy of his reign was an uncertain peace, which did not rest on its own strength, and a weak state, which could last only as long as the peace.

Under Frederick William cultural life flourished impressively, especially in Berlin. Mozart and Beethoven visited the king and dedicated pieces of chamber music to him (he himself played the cello); the music academy was founded, and the theatre flourished under A. W. Iffland; the architects J. G. Schadow and K. G. Langhans (the Brandenburg gate) and the painter Daniel Chodowiecki worked in Berlin. The law code (Allgemeines Preussisches Landrecht), marked by its liberal statutory provisions, was promulgated in 1794.

After a first marriage (1765–69) to Elizabeth of Brunswick-Wolfenbüttel (d. 1840), by which he had one daughter but which was dissolved, Frederick William married in 1769 Frederica Louisa of Hesse-Darmstadt (1751–1805), by whom he had seven children. From 1767 he had a liaison with a musician's daughter, Wilhelmine Enke (1733–1820), whom he married to his valet, Rietz, and in 1796 ennobled as Gräfin Lichtenau; she bore him five children. With the connivance of his court preachers he contracted, during his wife's lifetime, two morganatic marriages: in 1787 with Julie von Voss (1766–89), whom he made Gräfin Ingenheim; and in 1790 with Countess Sophia Juliana Dönhoff (1768–1834), whose son by him was the future statesman Friedrich Wilhelm, Graf von Brandenburg, but who was banished from court in 1792. The king died in Berlin on Nov. 16, 1797, after a protracted heart illness.

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FREDERICK WILLIAM III (1770–1840), king of Prussia from 1797, was born at Potsdam on Aug. 3, 1770, the son of Frederick William II. Neglected by his father, he never mastered the inferiority complex which grew from his unhappy youth. Only under the influence of his wife, Louisa of Mecklenburg-Strelitz (1776–1810), whom he married in 1793, he occasionally went beyond the narrow limits of his essentially prosy and pedestrian character.

His accession (Nov. 16, 1797) was greeted with high hopes. The end of his father's petticoat government, the repeal of J. C. von Wöllner's religious edict and the king's professed readiness for reform released a temporary spate of monarchist enthusiasm. However, his policy of neutrality in the Wars of the Second and of the Third Coalition accelerated the decline of Prussia's prestige and finally, after Austria's defeat in the battle of Austerlitz, left the country in an untenable position (*see* NAPOLEONIC WARS). The domestic reforms before the battle of Jena (*q.v.*), especially the emancipation of the peasantry on the royal estates, foreshadowed the later reforms, without, however, altering the absolutistic structure of the state. Until 1807 Frederick William clung to the traditional cabinet government, influenced by mediocre adjutants and privy counselors.

After the military collapse of 1806–07 and the loss of all provinces west of the Elbe river, even Frederick William realized that Prussia would have to make decisive changes. He therefore sanctioned the reforms proposed by Stein and Hardenberg (*qq.v.*), by K. von Altenstein and W. von Humboldt, by G. von Scharnhorst and H. von Boyen (*see* PRUSSIA: *The French Revolutionary and Napoleonic Period*), but even these amounted to a reform of the higher bureaucracy rather than of the royal prerogative: the king never lost his fear lest reform might lead to "Jacobinism"; nor could he tolerate men of outstanding ability as his advisers. He reconciled himself to the tranquil objectivity of Scharnhorst and to the diplomatic flexibility of Hardenberg, whom he appointed chancellor in 1810; but he was repelled by the impetuosity of Stein and Gneisenau, particularly after Queen Louisa's death in 1810. However, he had the patience to follow Hardenberg's advice and to wait for the hour when the situation became ripe for an overwhelming European coalition against Napoleon. Still hesitating at the beginning of the national rising in 1813, he made the final break with Napoleon only in March, when he called to arms his loyal people. Throughout the War of Liberation (1813–15) he remained remote from his people's ardour and from the army's fierce *élan*, being always subservient to the Russian emperor Alexander I and more in harmony with the cool political calculations of the Austrian Metternich than with the enthusiasm of his own people. In the crisis of the Vienna congress over the partition of Saxony he sided firmly with Alexander I, thus bringing Prussia to the brink of war against England, France and Austria (Jan. 1815). The final compromise allowed Prussia to acquire the Rhine province, Westphalia and the greater part of Saxony.

In contrast to these territorial gains, the last 25 years of Frederick William's reign show a downward trend of Prussia's fortunes, to which his personal limitations contributed largely. The era of reform ceased with the dismissal of Boyen and Humboldt in 1819. The assimilation of the western provinces was accomplished only with severe frictions. The promise of a constitution, given in May 1815, was fulfilled only in the stunted form of utterly conservative district and provincial estates. In 1819 Prussia unconditionally accepted Metternich's reactionary policy. In fact the persecution in Prussia of so-called "demagogues" took on particularly oppressive forms, which were intensified after the July revolution of 1830. Further troubles were caused by conflicts with the Roman Catholic Church over the problem of mixed marriages and with the Lutheran Church over the enforced union of it with the Calvinists and the introduction of a unified liturgy, a pet idea of the king's. He took no part in the most important achievements of this period, viz., the customs law of 1818 and the German customs union of 1834.

In 1824 Frederick William contracted a second marriage, morganatically, with Auguste von Harrach, whom he created princess of Liegnitz. He died in Berlin on June 7, 1840. There are editions of his correspondence with Alexander I, edited by P. Bailleu (1900), and with Queen Louisa, edited by K. Griewank (1929), but the king's personal character was so devoid of interest that even at the height of 19th-century Prussian historiography no one felt tempted to write his complete biography. (HA. H.)

FREDERICK WILLIAM IV (1795–1861), king of Prussia from 1840, the "romantic on the throne," was born in Berlin on Oct. 15, 1795, the son of the future king Frederick William III and Louisa of Mecklenburg-Strelitz. He was especially carefully educated by tutors such as Friedrich Delbrück and the future foreign minister J. P. F. Ancillon (*q.v.*). Though he was completely unsoldierlike by nature, his experiences in the German War of Liberation (1813–15) left lasting traces on his political and intellectual development. He became and remained a disciple of the German Romantic movement, which appealed to his extremely sensitive if always dilettante artistic nature. Himself a draftsman and interested in architecture and landscape gardening, he was a patron to Christian Daniel Rauch and Karl Friedrich Schinkel. His marriage in 1823 to Elizabeth of Bavaria (1801–73), a convert to Lutheranism, proved happy, though they had no children.

As crown prince, Frederick William developed romantic-conservative convictions which led him to approach even politics as a question of ideas and problems rather than as a matter of hard reality. Leopold von Gerlach and Christian Bunsen (*qq.v.*) were among his friends; he associated with the German-Teutonic dining club and, in 1831, with the editors of the *Historisch-politisches Wochenblatt;* and he admired Ranke, Savigny, Schelling (whom he later called to Berlin to counteract Hegel), Albrecht von Haller and Friedrich Julius Stahl. He made his influence felt to restrict the implementation of the promised constitution of 1815 to the creation of district and provincial estates, in which the landed aristocracy had an overwhelming majority. For him liberalism meant revolution; a modern constitution was "a scrap of paper" interposed as an intolerable barrier between the patriarchal king by divine right and his people. Though he was no absolutist and had no genuine will to domination, yet, by his romanticizing mystique and his unlimited respect for the alleged "organic growth" of the medieval estates, he stood irreconcilably opposed to the political ideas of the 19th century and to the heritage of the French Revolution. Tensions were not lessened by his genuine personal piety. He was fundamentally opposed to the movement toward a German national state, since for him cultural homogeneity outweighed political unity; and, after the experience of Napoleon I, Prussia's close alignment with Austria seemed essential. He never contested the Habsburg empire's primacy, which he saw as consecrated by history; for the king of Prussia he claimed only the military dignity of an "arch-general" of the empire.

The great hopes surrounding Frederick William's accession (June 7, 1840) were quickly disappointed, since he was by no means willing to fulfill the constitutional aspirations of the Liberals. In 1842 he permitted only "united committees" of the provincial estates; and in 1847, after long delay, he summoned not a popular representative assembly but the "united diet" comprising all the provincial estates, with the right to grant taxes and loans but without the right to meet at regular intervals. This unwieldy corporation remained his ideal, even though the narrow limits of his concessions immediately produced a conflict (the refusal of the proposed loan for the Berlin-Königsberg railway) and even though this first assembly of all Prussia powerfully increased the people's self-confidence on the eve of the revolution of 1848.

Despite belated attempts to organize a common resistance by the German governments, Frederick William IV was eventually completely overwhelmed by the March revolution of 1848. He could neither prevent the street fighting in Berlin (March 18) by last-minute concessions, nor ride the wave; after the withdrawal of the troops to barracks, he masked his submission to the revolution by a processional ride through Berlin under the black and red and golden flag, by paying homage to the bodies of the victims of the soldiery and by his promise that "Prussia is henceforth merged in Germany" (March 19). Finally he had to convene a Prussian national assembly. However, under the influence of his entourage (the *Camarilla*) he roused himself to a stubborn resistance: he appointed Friedrich Wilhelm, Graf von Brandenburg (a son of Frederick William II by Gräfin Dönhoff), to be prime minister; removed the assembly from Berlin and then dissolved it; and imposed a constitution (its first draft mildly liberal on the Belgian model). These measures gave the leading role back to the crown and its instruments, the army and the bureaucracy, firmly supported by the recently formed Conservative party.

As Germany's "man of destiny," Frederick William destroyed the constitution drafted by the national assembly in Frankfurt when on April 3, 1849, he refused the proffered imperial crown "baked with mud and clay." Under Russian and English pressure, moreover, he had withdrawn Prussian support of the rising in Schleswig-Holstein (convention of Malmö, Aug. 26, 1848; *see* SCHLESWIG-HOLSTEIN QUESTION). Next, however, through his Roman Catholic confidant Joseph von Radowitz (*q.v.*), he attempted to establish a German union under Prussian leadership (1849–50)—though this, as a "Little German" federation, should remain allied with a "wider" federation embracing Austria. He soon lost heart when he met the determined opposition of the Austrian premier Felix, prince von Schwarzenberg, who alienated the other German kingdoms from Prussia and urged the restoration of the German federation of 1815, under Austrian presidency.

Faced with the crisis over Hesse-Kassel, where the elector appealed to the Austrian-sponsored federal diet at Frankfurt for support against his own subjects, the king shrank from war, preferring capitulation at the Olmütz convention (Nov. 28–29, 1850). Though Prussia had to return to the federal diet at Frankfurt, Prussian leadership of the German customs union remained unchallenged.

In religious affairs Frederick William, in 1841, settled the "Cologne church conflict" on terms very favourable to the Roman Catholics, with whom he had great sympathy; he also furthered the reconstruction of Cologne cathedral. On the other hand he actively promoted the joint Anglican-Lutheran bishopric of Jerusalem.

The final years of the reign, before a stroke in 1857 reduced the king to imbecility and made him incapable of ruling, were a period of reaction. Frederick William, rejecting the bureaucratic absolutism of his prime minister Otto von Manteuffel, worked above all for recasting the constitution of 1848 in a conservative mold. This included the disastrous introduction of three-class suffrage in 1850 instead of universal suffrage, the retention of the monarchical character of army and bureaucracy, the re-establishment of the conservative district assemblies and the provincial diets, and the conversion (1854) of the first chamber into a house of lords entirely dominated by the predominantly aristocratic landowners ("the old-established landed interest"). Though he believed this house of lords to be modeled on the English upper house, the king nevertheless in a political testament (burned by William II in 1890) implored his successors to refuse to take the oath on the constitution. In foreign affairs he was again at the mercy of his advisers' conflicting influences during the Crimean War; and in the affair of the Swiss canton of Neuchâtel (*q.v.*) in 1856–57 he suffered a defeat which hurt him deeply.

Frederick William died at Sans Souci on Jan. 2, 1861. Despite great gifts and an admirable idealism, he ultimately failed completely as a ruler. There are editions of his correspondence with Bunsen, edited by L. von Ranke (1873), with Ludolf Camphausen, edited by E. Brandenburg (1906), with Radowitz, edited by W. Möring (1922), and with the archduke John, edited by G. Küntzel (1924).

Bibliography.—H. von Petersdorff, *König Friedrich Wilhelm IV* (1900); E. Lewalter, *Friedrich Wilhelm IV* (1938). *See* also P. Haake, *Ancillon und Kronprinz Friedrich Wilhelm* (1920). (Ha. H.)

FREDERICK WILLIAM (1620–1688), elector of Brandenburg, called the "Great Elector," was born in Berlin on Feb. 16, 1620, the son of the elector George William of Brandenburg and Elizabeth Charlotte, daughter of Frederick IV elector palatine. From 1634 to 1637 he was at the University of Leiden, where his outlook was strongly influenced by what he saw of the maritime and commercial strength of the Netherlands and of the policy of the house of Orange, conducted as it was in the shadow of the great powers Spain and Austria.

In Dec. 1640 Frederick William succeeded his father. He came to power at a time when Brandenburg, devastated already in the course of the Thirty Years' War (*q.v.*), was closely bound to Austria by the peace of Prague of 1635 but in fact still occupied by Swedish troops. In these circumstances a new ruler could attempt no sudden change of policy, and Frederick William's aim was to extricate himself gradually from the oppressive Austrian connection and to gain an armistice with Sweden. The latter he achieved in July 1641, thus terminating the fighting in Brandenburg without waiting for the general peace negotiations, which were not concluded till the peace of Westphalia (1648). By this treaty Frederick William had to abandon his designs on western (Swedish) Pomerania—with its control of the Oder estuary and the important harbour of Stettin—and to be content with eastern Pomerania together with the secularized bishoprics of Halberstadt and Minden and the reversion of Magdeburg.

During the Swedish invasion of Poland (1655–56) Frederick William, by unscrupulously breaking his alliance with the Poles, was able to assert Brandenburg's sovereignty over ducal Prussia (East Prussia), hitherto held as a fief of the Polish crown; and he won international recognition for this change at the peace of Oliva (1660). His growing activity in foreign affairs reflected the increasing military and financial strength of his lands. His widely scattered territories, hitherto united only by allegiance to the ruling house, were now integrated administratively, while the ruler made his revenues independent of the consent of the estates by developing a fixed system of direct and indirect taxation, thus laying the financial basis for a standing army. These developments provoked strenuous opposition from the estates, especially in Prussia, and entailed the abrogation of many traditional liberties, but Frederick William overcame all resistance. Thus under him the Hohenzollern state received the imprint of absolutism, and the foundation of the future strength of the Prussian monarchy was laid.

From his time the army was the focus of the developing state and its administrative organization, and the mercantilist economy, invigorated by increasing income from taxation, was orientated to meet the army's requirements. Under Frederick William, however, the strength of the army was still variable between peacetime and wartime. Moreover, it could not yet be maintained solely on the electoral and ducal revenues, so that foreign subsidies were also required, and these in turn restricted Brandenburg's freedom in the diplomatic field.

During the struggle between Louis XIV of France and the Habsburgs of Austria and of Spain the elector had alternately sought an alliance with France and with Austria, and the changeability of his policy demonstrated the relative weakness of a ruler not yet able to maintain an independent course between the great powers. This weakness was emphasized by the scant attention paid to Brandenburg in the various peace negotiations. Thus in spite of extreme military exertions he never achieved his ultimate aim, the acquisition of western Pomerania, and Brandenburg remained with no satisfactory seaport. Even after his brilliant victory over the Swedes at Fehrbellin (June 1675) and their final expulsion from Germany (Jan. 1679), Frederick William was obliged, under French pressure, to give up his conquests at the peace of Saint-Germain-en-Laye (June 1679). Thus he could never realize fully his plans to found a maritime and commercial power on the Dutch model. His establishment of a navy and his formation of an Africa company (1682), with the subsequent colonizing ventures along the Guinea coast, are a mere episode in Brandenburg-Prussian history.

Nevertheless by the edict of Potsdam (Nov. 8, 1685), which welcomed French Huguenot immigration, Frederick William introduced to his state a new population both shrewd and industrious, without which the industrial and commercial development of 18th-century Prussia would have been unthinkable. In this, the interests of the state and the elector's personal convictions combined as in no other of his undertakings. The protection of Protestantism in Europe was always an essential element in Frederick William's policy no matter how often it might have to give place to expediency. His tenacious political ambition drew much of its strength from his Calvinistic belief in predestination, which enabled him to regard himself and his state as the instruments of God.

Frederick William represented the best type of 17th-century continental ruler. For him as for Louis XIV the person of the monarch and the interest of the state constituted an inseparable unity. His dynastic-patrimonial view of the state and his belief in the traditionally religious nature of the princely office were expressed in his political testaments of 1667, 1680 and 1686. Frederick William died at Potsdam on May 9, 1688.

During his stay in the Netherlands Frederick William had made the acquaintance of Frederick Henry, prince of Orange, whose daughter, Louisa Henrietta, he married in 1646. Their two elder sons had both died young, and it was the third son Frederick who succeeded to the electorate on Frederick William's death. By his second wife, Dorothea of Holstein-Glückburg, whom he married in 1668, Frederick William had four other sons, who received territories from the family lands under his will. Frederick William's enactments have been published as *Urkunden und Aktenstücke zur Geschichte des Kurfürsten Friedrich Wilhelms von Brandenburg*, 23 vol. (1864–1929).

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FREDERICTON, the capital of New Brunswick, Can., and the seat of York county, is situated on the banks of the Saint John river, about 85 mi. from its mouth, and is surrounded by wooded hills. A small city (1961 pop. 19,683), it is the site of the provincial University of New Brunswick, founded 1785, and the provincial Teachers' college, founded 1847, and is the episcopal seat of the Anglican diocese of Fredericton and the headquarters of the New Brunswick area of the Canadian army and of the Royal Canadian Mounted Police. There are many fine buildings including those of the university, the provincial legislature, the Lord Beaverbrook Art gallery, the buildings of the dominion research station maintained by the federal department of agriculture, and the Anglican cathedral.

Originally settled by United Empire Loyalists under the name of St. Ann's Point in 1783, Fredericton was made provincial capital in 1785 and became a city in 1848. Primarily a centre of government and education, it also has some industrial and commercial importance: it is the shopping and distributive centre of central New Brunswick; it has several quality shoe factories; and it has a number of industries concerned with the processing of wood—a canoe factory, lumber mills and a plastics plant. But perhaps Fredericton's chief claim to distinction is its literary tradition: among its first Loyalist residents was the Rev. Jonathan Odell, the Tory satirist of the American Revolution; the first novel by a native Canadian, *St. Ursula's Convent*, or, *The Nun of Canada* (1824) was written there by Julia Catherine Hart; three of the leading Canadian poets, Charles (later Sir Charles) Roberts, Bliss Carman and Francis Sherman, were born there; and the city is the site of publication of two literary magazines—*The Fiddlehead* and *The Atlantic Advocate*. (D. P.)

FREDERIKSBERG, an independent municipality in the metropolitan area of greater Copenhagen (*q.v.*), Den. Pop. (1960) 114,285. Founded in 1651 by King Frederik III, it became completely encircled by Copenhagen early in the 20th century when the capital absorbed several former municipalities. It contains the Frederiksberg park, the Copenhagen zoo, the town hall (1953), the Royal Veterinary and Agricultural High school, the state broadcasting service, a commercial college and the military academy in Frederiksberg palace (*c.* 1700). The main industries include the Royal Copenhagen Porcelain factory and a cable and wireworks. (C. F. G. A.)

FREDERIKSBORG, a county (*amt*) in northeast Zealand, Den., named after the magnificent castle of Frederiksborg in the town of Hillerod. Pop. (1960) 181,663. Area 519 sq.mi. Lying between Ise Fjord and the busy Oresund, its greatly undulating surface of glacial sands and clays is lake strewn and well wooded. The fertile loams support prosperous mixed farming. The port of Elsinore (*q.v.*; Helsingor) is the largest town (pop. 26,658 in 1960) followed by Hillerod (11,605), the county administrative centre. Kronborg castle near Elsinore once controlled the northern entry to Oresund. (HA. T.)

FREDHOLM, ERIK IVAR (1866–1927), Swedish mathematician, whose chief contribution to mathematics was on integral equations, was born at Stockholm, April 7, 1866, and died there Aug. 17, 1927. He took his doctor's degree at Uppsala in 1898, became an actuary and in 1906 was appointed professor of theoretical physics in Stockholm. He published his paper on integral equations in 1903, inaugurating the modern theory of this topic. For this he received the Wallmark prize of the Swedish Academy of Science and the French Academy's Poncelet prize.

See *Oeuvres complètes de Ivar Fredholm* (1955). (O. OE.)

FREDONIA, a village of Chautauqua county in western New York, U.S., 45 mi. S.W. of Buffalo. It was settled in 1804 and incorporated in 1829. It is in the grape-growing region and manufactures grape products as its major industry. The first gas well in the U.S. to be harnessed for fuel was discovered nearby in 1821 and Fredonia soon boasted the nation's first gaslit street. General La Fayette visited Fredonia during his 1824–25 visit to the U.S. The first local unit of the Grange and one of the first local organizations that helped found the Woman's Christian Temperance union were formed there. The village is served by excellent rail, highway and air transportation facilities, and ocean-going vessels serve Dunkirk, two miles away on Lake Erie. The State University of New York college of education is in Fredonia. For comparative population figures *see* table in NEW YORK: *Population*. (A. W. B.; X.)

FREDRIKSTAD, a town of Østfold *fylke* (county), Norway, located 58 mi. S. of Oslo. Pop. (1959 est.) 13,827. It lies at the mouth of the Glomma river on the eastern shore of Oslo fiord and has a first-class harbour that is kept open in winter. It is a lumber-milling and fishing town with a variety of manufactures. In 1957 a 2,700-ft. high-level bridge over the Glomma was opened. The town was founded by Frederick II in 1567, and its grass-covered ramparts and fortified gates date from that time. The environs of Fredrikstad are rich in rock carvings, monumental stones and grave barrows from the early centuries of the Christian era. (S. KN.)

FREE CHURCH FEDERAL COUNCIL, an organization that enables the free churches of England and Wales to act unitedly in matters of common concern, was formed in 1940 by the union of the National Council of the Evangelical Free Churches (founded 1896) and the Federal Council of the Evangelical Free Churches (formed 1919). It works through nearly 500 local councils, which send delegates to an annual congress and elect representatives to the national council; the associated free church denominations, which include the Methodists, Baptists, Congregationalists, Presbyterians and some others, send direct representatives to congress and council. The annual congress hears distinguished preachers and speakers and discusses matters of common concern. The council attends to continuing business, which includes encouragement of co-operation between the free churches, maintenance of rights, representation of the free-church viewpoint to parliament, negotiation with central and local authorities and the expression of free-church opinion on public questions. The council has a chaplaincy department, responsible with the ministry of health for free-church chaplains in hospitals, and a youth and education department, which co-ordinates youth work among the free churches and maintains contact with the ministry of education and the Church of England on religious instruction in schools.

The council is presided over by the moderator, who holds office for a year and is the representative leader of the free churches.

See E. K. H. Jordan, *Free Church Unity* (1956). (A. R. V.)

FREEDMEN'S BUREAU. Popular name for the bureau of refugees, freedmen, and abandoned lands created as part of the U.S. war department by congress on March 3, 1865, at the end of the Civil War. It was designed to meet demands of the abolitionist wing of the Republican party, Northern cotton mill owners and those Republican politicians known as "the Radicals." The abolitionists wanted a federal agency to safeguard the Negroes from any form of re-enslavement and to help them improve their condition. Businessmen assumed this agency would teach the freedmen to be industrious and to attain a higher standard of living. Then they would both produce the raw material needed in cotton mills and buy increasing amounts of manufactured goods. The Radicals hoped a freedmen's bureau might help assure Republican governments in the southern states.

In its earliest months the bureau helped Negroes return home, provided them with medical and hospital care, doled out clothing and fed from 50,000 to 150,000 freedmen daily. Soon, however, the bureau's commissioner, Gen. Oliver O. Howard (*q.v.*) ordered his assistants to press the freedmen into earning their living instead of depending on charity. By means of labour contracts, approved and enforced by bureau agents, the bureau tried to assure Negroes of a fair return for their work. But very soon most of the contracts provided for sharecropping arrangements, and the Negro's share generally afforded him only a bare subsistence.

While the bureau continued to dispense charity to destitute freedmen throughout its career, the most important work it accomplished was in the field of education. It probably built more

than 1,000 schools for Negroes and spent more than $400,000 to establish Negro teacher-training institutions. Most teachers were employed by other agencies, but the bureau frequently kept them teaching by supplementing their salaries. It did not create the Negro school, but it nurtured that institution through its early years.

Much less successful were the bureau's efforts to get land for freedmen and civil rights for Negroes. The former efforts were frustrated by Pres. Andrew Johnson's restoration of abandoned lands to pardoned southerners, and the latter by southern whites' opposition to racial equality. The bureau's own courts were poorly organized and short-lived, and in civil courts the bureau was unable to get rights for Negroes other than just the bare forms of due process of law.

After congress gave the freedmen the right to vote many bureau officials served as Republican organizers among the Negroes. This political activity probably hurt the freedmen more than it helped them, for Negro support of the Republicans increased the race prejudice of white southerners. It also aroused political opposition in the North, and the bureau's functions were greatly curtailed from 1869 to July 1872, when congress ended its existence.

See George R. Bentley, *A History of the Freedmen's Bureau* (1955). (G. R. Be.)

FREEHOLDER, the owner of a substantial interest in land of indefinite duration. In law the term originally designated the owner of an estate held in free tenure, and the *liber homo* of Magna Carta (*q.v.*) is a freeholder. A freehold estate was either an estate in fee simple, an estate in fee tail or a life estate and was to be distinguished from the nonfreehold estates such as a copyhold (*q.v.*), a tenancy at will and a tenancy for a fixed period such as the customary landlord-tenant relationship. The free tenures were knight service, serjeanty, free socage (*qq.v.*) and frankalmoign; *i.e.*, with the exception of socage, those tenures which required military and ceremonial services of the tenant rather than things or manual labour. (*See* Real Property and Conveyancing, Laws of; Feudalism.)

In the United States, the opening of the public domain gave great impetus to the creation of a large freeholding class. As a consequence suffrage was expanded; the original property qualification for the voter was ownership of a freehold, but later, with the rise of a mercantile class, the property qualification was reduced to ownership of property of a specified value.

Liberalization of suffrage is practically complete in England, but general property or taxpaying qualifications for voting still exist in several states of the United States. Where this qualification is stated in terms of a freeholder, interpretation has reduced the term almost to that of householder; *i.e.*, either an owner or rent payer. (A. Dm.)

FREEMAN, EDWARD AUGUSTUS (1823–1892), English historian, an authority on English history of the 11th and 12th centuries, was regius professor of modern history at Oxford from 1884 until his death. He was born at Harborne, Staffordshire, on Aug. 2, 1823, and educated privately. He went to Trinity college, Oxford, with a scholarship in 1841 and became a fellow there four years later. Thereafter he devoted himself to a life of study, publishing an enormous number, even by 19th-century standards, of books, pamphlets and articles in periodicals. A great controversialist, he campaigned actively in support of Gladstone, especially in condemning the "Bulgarian atrocities," and stood unsuccessfully for parliament on several occasions. He died while on holiday at Alicante, Spain, on March 16, 1892.

Freeman's cardinal virtue is insistence on the unity of history and on the use of original sources, but he was insufficiently critical to be a reliable interpreter of those sources he himself used and he brought to historical controversy acerbity, bias and intolerance, notably in his prolonged attack on J. A. Froude (*q.v.*) through the agency of the *Saturday Review*, in a degree which was harmful and misleading. Modern scholarship would hardly differ from the emphasis placed in Freeman's great work, *History of the Norman Conquest* (6 vol., 1867–79), on the continuity of Anglo-Saxon elements after 1066, but in detail the work exhibits many of the faults which its author was quick to criticize in others. In particular, Freeman's description of the battle of Hastings, or, as he with mistaken pedantry would have it, the battle of Senlac, was shown by J. H. Round (*Feudal England*, 1895) to be quite inaccurate.

FREEMAN, MARY ELEANOR (née Wilkins) (1852–1930), U.S. writer whose best stories and novels are concerned with New England village life, was born in Randolph, Mass., Oct. 31, 1852. In 1867 the family moved to Brattleboro, Vt. Mary graduated from high school there, had one year at Mount Holyoke seminary, South Hadley, Mass., and read omnivorously. She began writing stories and verse for children. When death took her immediate family, she returned to Randolph and lived with the John Wales family; in their house, in the 1880s and 1890s, she did her best writing. In 1902 she married Charles M. Freeman of Metuchen, N.J., where she lived till her death on March 13, 1930.

Though she produced a dozen volumes of short stories and as many novels, Mrs. Freeman is remembered chiefly for the first two collections of stories *A Humble Romance* (1887) and *A New England Nun and Other Stories* (1891), and the novel *Pembroke* (1894). Her theme is pride within poverty. Typically, her upstanding characters ask more of life than could be had in their cramped New England villages. Defeated, they develop abnormalities of pride and will. This is a grim subject but it is handled deftly, at times humorously and with fine narrative art.

See Edward Foster, *Mary E. Wilkins Freeman* (1956), a full length study with bibliography. (E. F.)

FREEMAN, SIR RALPH (1880–1950), British civil engineer, distinguished as the designer of great bridges, was born in London on Nov. 27, 1880. On leaving the Central Technical college, Kensington, in 1901 he joined a firm of consulting engineers, of which he was made a partner 11 years later. He became senior partner in 1921 and remained in active control of the firm, known later as Freeman, Fox and partners, until his death. He carried out important work in many parts of the world, including the Victoria Falls bridge over the Zambesi river, the Royal Naval Propellant factory during World War II, the Furness shipbuilding yard and the five major bridges constructed in the Rhodesias for the trustees of Alfred Beit.

Freeman's best-known work was the Sydney Harbour bridge, completed in 1932; its main arch span, 1,650 ft. long, is one of the largest in the world. Freeman prepared designs for the bridge over Auckland harbour, N.Z.; the Dome of Discovery for the Festival of Britain, 1951; and, as joint engineer, for the projected River Severn suspension bridge. He played an active part in the development of engineering science, being from 1928 to 1936 a member of the Steel Structures Research committee and chairman of the panel responsible for producing the committee's recommendations for design.

He was knighted in 1947 and died at Finchley, London, on March 11, 1950. (J. F. Br.)

FREEMAN was originally a definition of status in feudal society, but in England it later came to mean people possessing the full privileges and immunities of a city, borough or company, to which admission was usually by birth, purchase or apprenticeship to a freeman. Before the Municipal Corporations act of 1835, freemen were men of great power, since not only did they possess privileges in trading and local taxes but usually were also the exclusive electorate and consequently had a vast influence in local government and parliamentary elections. During the 19th century this narrow oligarchic power was undermined—first by the Reform act of 1832 which widened the parliamentary franchise in towns, second by the government's increasing concern for local problems such as public health and slum clearance, and finally by legislation affecting the corporations themselves. The act of 1835 respected existing customs of admitting freemen and they still controlled exclusively municipal or corporate property. The admission of freemen was further regulated by the Municipal Corporations act of 1882.

By the Honorary Freedom of Boroughs act of 1885, councils were allowed to admit distinguished people as honorary freemen, and by the 20th century this had become the most notable aspect

of the status. In London, a person may become a freeman of one of the livery companies by apprenticeship, purchase, birth or gift.

FREEMASONRY, a term descriptive of the fraternity to which men called Freemasons belong; and of the government and relationship of its local units, called lodges. It is secret in so far as it has rituals and other matters which those admitted take an oath never to divulge. Its meeting places, however, are prominently identified and its governing bodies publish annual proceedings, while its membership is a matter of public knowledge.

Having begun in medieval times as an association of craftsmen—hence its name—Freemasonry has been since the 18th century a speculative system. It admits adherents of all faiths, claiming to be based upon those fundamentals of religion held in common by all men and to inculcate, through allegories and symbols connected with the art of building, a lofty morality laying particular stress upon benevolence.

From the time of the first bull of condemnation (Pope Clement XII's *In Eminenti*, 1738), the Roman Catholic Church repeatedly has declared those of its faithful who join the fraternity to be guilty of grave sin and thereby excommunicated; the chief reason for this is that the church holds that the beliefs and observances of Freemasonry constitute it a deistic or pagan religion and that the masonic oath and the secrecy imposed are unlawful. Certain Protestant bodies also have declared Freemasonry to be incompatible with Christianity. Many lodges, however, welcome Christian applicants and do not oblige them to abandon their church membership or their distinctive tenets.

In Great Britain, the Commonwealth, Scandinavia, the United States and other countries, heads of government, church dignitaries and distinguished citizens are Freemasons; in Communist and certain other countries Freemasonry is proscribed.

The Term Freemason.—In all probability "Freemason" originally meant a craftsman working with ax, mallet and chisel in freestone. That is suggested, first, by the occurrence of medieval Latin and French terms such as *sculptor lapidum liberorum, mestre mason de franche peer* and *magister lathomus liberarum petrarum.* Second, the building accounts relating to Eton college in 1442 and 1445–46 and Kirkby Muxloe castle in 1481 distinguish between freemasons and rough masons or row masons, the latter including bricklayers. Third, there are other examples of workmen called after the materials in which they worked; such were hardhewers (working in the hard ragstone of Kent), marblers and alabasterers. It may be, however, that in later times the freemason was understood to be a mason who was free in the sense of being a member of a guild or company or of being free to carry on his trade in a municipality.

Organization of Medieval Masons.—Such craftsmen differed from most others of the medieval period in several respects, and the organization of masons was determined to a large extent by these special characteristics. First, unlike the weaver or blacksmith, the ordinary mason was entirely a wage earner; second, he was commonly more mobile than they, traveling voluntarily in search of employment or further experience, or, as was often the case during the 13th and later centuries, being conscripted for work on the crown's large building operations, as, for example, the castles of Caernarvon and Windsor. These and other works, such as Cistercian abbeys, were often carried out in remote parts of the country and, for that and other reasons, the municipal craft guild was not a suitable form of organization for all masons. Such a guild did, indeed, exist in 14th-century London; but for many masons a nearer and more familiar association was the lodge connected with the building on which they were employed. The lodge was not only a workshop but the place for a siesta in the middle of the day, for drinking at permitted times and also, no doubt, for the exchange of news, the airing of grievances and the discussion of matters relating to the craft. Hence the stress on keeping secret, from nonmasons and from employers, what was said in the lodge.

The Old Charges.—Of the Old Charges, known also as the *MS. Constitutions of Masonry*, about 100 versions exist, and there is reason to believe that another 15 have existed (see *Bibliography*). The oldest surviving manuscript is almost certainly the *Regius MS.*, written probably about 1390, in verse, and the next oldest the so-called *Cooke MS.*, dating from about 1400 or 1410, in prose. Nothing is certainly known about the circumstances in which either was written, but it is probable that their main elements are older than the manuscripts. The masons' customs, or articles and points, there set out may be presumed to have been gradually developed over a comparatively long period, but the account given of the history of the craft may well have been supplied by a single, if unknown, author.

His curious legend deals first of all with the number of noblemen's children in early times who, not being provided with an income, had to find work "that they mygth gete here [their] lyuynge ther-by." Euclid was consulted and recommended "thys onest craft of good masonry"; thus the genesis of masonry is found in Egypt. Many years afterward it reached England "yn tyme of good kynge adelstonus [Aethelstan's] day." He called an assembly of dukes, earls, barons, knights, squires and burgesses, at which 15 points and articles were drawn up for the amendment and regulation of the craft. Some of them are addressed to master masons in charge of building operations and others to ordinary skilled workmen. Masters are to pay the workmen, or fellows, as they deserve and the fellows honestly to earn their pay; one master is neither to supplant another without cause nor to undertake work which he cannot complete; and he must come, when summoned, to the general assembly of the craft. Thieves are not to be harboured nor adultery committed. A mason is not to defame his fellow nor to decry his work but, at need, to help him to do better. Great stress is laid on the teaching of apprentices, who are to be whole of limb and not of servile origin. In short, the rules attempt to harmonize and further the interests of all parties: the person for whom building work is undertaken, the master in charge of it, the journeymen working upon it and the apprentices learning the trade.

There follows an account of the *Quatuor Coronati* ("Four Crowned Ones"), Christian martyrs of Roman times alleged to have been masons. (Their cult was widespread on the continent of Europe among workers in the building trades but, though known to English masons, never became very important among them, and is certainly no evidence that English Freemasonry was derived from Germany.) Then comes a longer account of the origin of masonry in which the tower of Babylon and Euclid are mentioned and the seven sciences, or seven liberal arts, including geometry, are enumerated and described. The compiler was apparently a priest, line 629 reading "And when the gospel me rede schal." The last 100 lines are evidently based in part upon John Mirk's *Instructions for a Parish Priest*, instructions such as boys and even men would need who were ignorant of the customs of polite society and of correct deportment in church and in the presence of their social superiors.

The simple narrative of the *Regius MS.* does not conflict with known historical fact. The authors of later manuscript versions of the same narrative, however, added embellishments and details that do not stand up under scrutiny, tending to make the legend or history of doubtful validity.

The major elements in these late medieval documents (*i.e.*, a legend or history, the craft regulations, including the injunction about secrecy, and a prayer) are found, in various arrangements, in the later versions of the *MS. Constitutions.* (For particulars, see *Bibliography.*)

It may be presumed that some version of the history and charges was read or recited to operative masons in medieval times; and there is proof that this was also done in lodges of Freemasons in the 17th and 18th centuries, each lodge apparently having one or more copies kept for the purpose. The Aberdeen lodge, for instance, in 1670 ordered that the Mason charter, which was a version of the Old Charges, should be read "at the entering of every entered prentice"; a similar order was made at Alnwick in 1701.

The Mason Word.—The second main element in the masonic tradition, the Mason word, is more obscure in its origin and development than the Old Charges, but it was certainly a Scottish institution and it may have existed as early as 1550. In Scotland the organized craft contained, besides apprentices, a category of entered apprentices; *i.e.*, craftsmen who had learned their trade and might be allowed to undertake a limited amount of work by them-

selves but who were required to serve for several years before becoming masters of the craft, or fellows. The interests both of entered apprentices and fellows might, however, be harmed by cowans (*i.e.*, workmen who had not been apprenticed or had been inadequately or irregularly taught), and it is probable that the Mason word originated as a method of distinguishing either between cowans and entered apprentices or between entered apprentices and fellows and that it consisted of a sign, either a word, a handgrip or both, communicated in such a fashion that unauthorized persons could not acquire it. By 1696, as the *Edinburgh Register House MS.* (text in D. Knoop, G. P. Jones and D. Hamer, *The Early Masonic Catechisms*) shows, whatever the original method may have been, the Mason word was communicated in two steps or ceremonies, one for entered apprentices and a second for fellows.

Development of Speculative Masonry.—The lodges in which the Mason word was given and the Old Charges were read during the 16th and part of the 17th centuries were, no doubt, for the most part lodges of working craftsmen—operative masons. Those of the 18th century, on the other hand, were nearly all lodges in which operative masons were few or nonexistent. The intervening period, which has been called the age of Accepted Masonry, was one in which nonoperatives either joined existing lodges or formed new ones; and it was from these lodges, constituted increasingly or entirely of gentlemen masons (Adopted or Accepted Masons), that there developed symbolical or speculative Masonry—Freemasonry in the modern sense of the term.

The first nonoperative Mason about whom there is certainty was John Boswell, laird of Auchinleck, who attended the Edinburgh lodge in June 1600. Others who joined the same lodge were Lord Alexander, Sir Anthony Alexander and Sir Alexander Strachan in 1634, Gen. Alexander Hamilton in 1640 and Quartermaster General Robert Moray, who was initiated at Newcastle in 1641, while the Scottish army was in occupation. The famous mother lodge Kilwinning had the earl of Cassillis for its deacon in 1672, and among his successors were Sir Alexander Cunningham and the earl of Eglinton. The oldest membership roll of the Aberdeen lodge contains the names of the earl of Finlater, the earl of Erroll, the earl of Dunfermline and Lord Pitsligo. Among English nonoperative Masons were the famous antiquary Elias Ashmole, admitted at a lodge held in Warrington in 1646, and Randle Holme, the Chester genealogist, who belonged to a lodge in Chester. There is evidence to suggest that a duke of Richmond attended a lodge at Chichester in 1696. Sir George Tempest presided in 1705–06 over a York lodge in which, at Bradford in 1713, "18 gentlemen of the first families in that Neighbourhood were made Masons." There would, therefore, appear to be confirmation of the statement made by Robert Plot in 1686 in his *Natural History of Staffordshire* that the custom "of admitting Men into the *Society of Free-masons*" was "spread more or less all over the *Nation*." Especially in the Staffordshire moorlands he "found persons of the most eminent quality, that did not disdain to be of this *Fellowship*."

Evidence is too scanty to enable the nature of these lodges to be determined in every instance. Some of them, such as the one maintained in Warrington in 1646 and the one at Chichester in 1696, were perhaps of an occasional kind. The Aberdeen lodge (on which *cf.* A. L. Miller, *Notes on the Early History and Records of the Lodge, Aberdeen*) may have originated as far back as 1483 and was probably for long an operative lodge, though, by 1670, out of 49 fellows belonging to it only about 10 were operative masons. In the Chester lodge, about 1673, there were six masons (and 15 other tradesmen possibly connected with building and house decorating) out of 26 known members. Of the persons present at the Warrington lodge in 1646 not one was an operative mason.

There can be little doubt that during the transitional era Masonry was more highly organized in Scotland than in England. There is evidence of that in the statutes promulgated in Dec. 1598 by William Schaw, master of work to the crown of Scotland, "with the consent of the masters after specified," whose names, unfortunately, have not been preserved. A year later, further statutes and ordinances were issued by the same authority, giving to the lodge of Kilwinning certain supervisory powers over others in lower Clydesdale, Glasgow, Ayr and Carrick. South of the border there is no very conclusive evidence of any effective link between lodges or of any district or central control, though it is asserted in a document of 1722 (text in D. Knoop, G. P. Jones and D. Hamer, *Early Masonic Pamphlets*, pp. 71 ff.) that a general assembly was held on Dec. 8, 1663, at which new articles were agreed upon. Two of these imply the existence of some regional authority:

I. That no Person, of what Degree soever, be accepted a Free Mason, unless he shall have a Lodge of five Free-Masons at the least, whereof one to be a Master or Warden of that Limit or Division where such Lodge shall be kept, and another to be a Workman of the Trade of Free Masonry. . . .

III. That no Person hereafter, which shall be accepted a Free Mason, shall be admitted into any Lodge or Assembly, until he hath brought a Certificate of the Time and Place of his Acception from the Lodge that accepted him, unto the Master of that Limit and Division where such Lodge was kept, which said Master shall enroll the same in Parchment in a Roll to be kept for that Purpose, and give an Account of all such Acceptions, at every General Assembly.

The last sentence implies a wider authority, as does another article:

V. That for the future the said Society, Company and Fraternity of Free-Masons shall be regulated and governed by one Master, and as many Wardens as the said Company shall think fit to chuse at every Yearly General Assembly.

Even if, on the strength of a statement made nearly 60 years after the alleged event, the assembly of 1663 be accepted as a fact, there is no record of any further assembly nor any proof that the new articles, if made, were observed. It is, therefore, likely, on the whole, that 17th-century English Masonry was in some danger of developing haphazardly in a way that might well have given rise to irregularities. Sooner or later, therefore, an attempt was likely to be made to provide Freemasonry with a degree of unity and uniformity more in accord with its past traditions and its existing needs.

Foundation of the Grand Lodge (1717).—The main and perhaps the only independent evidence relating to the foundation of the Grand Lodge is that of the Rev. James Anderson (1679–1739), who included an account of the matter in the second edition (1738) of the *Book of Constitutions*. Anderson, who was not himself connected with the Grand Lodge at its foundations, is now regarded as a careless and uncritical historian; but there seems no reason to doubt that in 1716 a meeting was held at the Apple Tree tavern, near Covent Garden, attended by "some old Brothers" and by Masons from four separate lodges that met at the Goose and Gridiron alehouse in St. Paul's churchyard, the Crown alehouse in Parker's lane, the Apple Tree tavern and the Rummer and Grapes tavern in Westminster. As a result of the deliberations at this meeting, presumably, another was held at the Goose and Gridiron in June 1717, at which Anthony Sayer was elected grand master and installed. His high-sounding title implied, however, no extensive jurisdiction, the authority of the early Grand Lodge being limited to lodges in or near London and Westminster and the major purposes of the new authority being to arrange an annual feast, to establish a quarterly communication between lodge officers and generally to promote union and harmony among lodges.

Not long after its foundation, however, though there may have been some inertia and resistance at first, the authority and scope of the Grand Lodge increased considerably. The number of lodges in its jurisdiction rose from 4 in 1717 to 63 (in places as distant as Bath, Bristol, Carmarthen, Chester and Salford) in 1725 and to 126 in 1733. Provincial organization had begun by 1725, when there existed a provincial grand master, provincial deputy grand master and provincial grand wardens in Cheshire. The collection of old writings relating to Freemasonry was started in 1719, and *The Constitutions of the Free-Masons* (*see* above), an officially approved revision and restatement of the history and articles, was first published by Anderson in 1723. Provision was made for an important part of masonic activity by the establishment in 1730 of the standing committee for charity.

One significant characteristic of Freemasonry in the period following 1721 was the aristocratic origin of its highest officials, a fact which no doubt conferred upon the craft a much greater degree of respectability than any order of merely operative masons

could have achieved. It is indeed true that one of the four old lodges which set up the Grand Lodge may have consisted mainly of operatives; and that of the ten first grand wardens two were stonecutters, two were carpenters, one was a mason and one a blacksmith. But another of the four lodges, meeting at the Rummer and Grapes in Westminster, had the duke of Richmond for its master in 1723, at which time most of its members were titled persons or army officers. The first grand master, Anthony Sayer, before the end of his life was a recipient of charity; the second, who was also the fourth, George Payne, was probably a man of more wealth and at the time of his death was secretary to the tax office; the third, J. T. Desaguliers, was a man of greater eminence, being a fellow of the Royal society and chaplain to the duke of Chandos and the prince of Wales. His successor, in 1721, was the duke of Montague. Thereafter Irish and Scottish peers shared with those of England the distinction of presiding over the Grand Lodge; and from 1782 to 1813 the duke of Cumberland, the prince of Wales or the duke of Sussex occupied the masonic throne. From 1753 to 1813 there existed a rival Grand Lodge, but, under the "ancient" grand master the duke of Kent, amalgamation was decided upon and the duke of Sussex became grand master of the united body. On his death in 1843 the earl of Zetland succeeded, and he was followed in 1870 by the marquess of Ripon, on whose resignation in 1874 to become a Roman Catholic the prince of Wales became grand master. Soon after succeeding to the throne as King Edward VII he ceased to govern the English craft and his place was taken by the duke of Connaught. From 1737 to 1907 about 16 English princes of royal blood joined the brotherhood. The list of past grand masters up to mid-20th century includes the names of eight princes who later became monarchs: George IV, Edward VII, Edward VIII and George VI of England; Oscar II and Gustav V of Sweden; and Frederick VIII and Christian X of Denmark.

The premier Grand Lodge, formed in 1717, did not immediately acquire jurisdiction over all lodges in England. The extension of its authority was a gradual process throughout the remainder of the 18th century. Existing lodges independent of the Grand Lodge continued to work and to make Masons. The old lodge at York denominated itself the "Grand Lodge of All England," held assemblies and even created other lodges. Masonry at York did not come under obedience to the Grand Lodge in London until late in the century. In 1751 a group of Irish Masons in London formed a rival Grand Lodge in protest against alleged innovations practised by the Grand Lodge of 1717 which they claimed departed from ancient tradition. The rival Grand Lodge became known as the Ancients and the original Grand Lodge as the Moderns. For a time, supported by the Grand Lodges of Ireland and Scotland, the Ancients were more active and influential than the Moderns, but by 1813 both united in the present United Grand Lodge of England.

Freemasonry and Religion.—During the third and fourth decades of the 18th century not only was the jurisdiction of the Grand Lodge extended geographically but the speculative lodges were opened to men who would have been excluded from the operative ones for lack first of Roman Catholic and later of Anglican orthodoxy. Medieval operative masons were required "princypally to [loue] god and holy chyrche & alle halowis." By 1583 reference to the saints had disappeared and masons were bidden to be "trewe men to god and holly Churche and . . . vse no Errour nor heresye," an injunction which in England required membership of the established church and in Scotland of the kirk. These limits were removed by the first charge as that is given in Anderson's *Constitutions:*

> A *Mason* is oblig'd, by his Tenure, to obey the Moral Law; and if he rightly understands the Art, he will never be a stupid Atheist, nor an irreligious Libertine . . . 'tis now thought more expedient only to oblige them [masons] to that Religion in which all Men agree, leaving their particular Opinions to themselves; that is, to be *good Men and true,* or Men of Honour and Honesty, by whatever Denominations or Persuasions they may be distinguish'd.

Jews were admitted not long after 1723. Atheists and agnostics were, of necessity, barred. In the 18th century, however, some Masons were probably deists and, moreover, the French, Italian and other Latin lodges were often hostile to the church. It is thus no wonder that Freemasonry was condemned by Pope Clement XII.

Masonic Ceremonies.—Experts have differed on the way in which the modern form of masonic ceremonies were reached, and the matter remains obscure partly because of difficulty in deciding how far some of the evidence, the catechisms, can be trusted. It may, however, be regarded as almost certain, first, that the ceremonies were not simply invented or arbitrarily elaborated by Anderson and Desaguliers but were developed from the practices of lodges, possibly from practices known in the 17th century. Second, the changes came about under speculative influence, so that the Old Charges, of importance to operative masons, played a less important part. Third, though the development cannot be fully traced, it is likely that two ceremonies used by operative masons, often telescoped into one when nonoperatives were admitted in Scotland, were elaborated into three ceremonies—one for each grade in what is now known as the trigradal system of the degrees of entered apprentice, fellow of the craft and Master Mason. These, and the ritual and secrets connected with them, are fundamental in modern Freemasonry. The ceremonies were carried out in a room representing a lodge. The Grand Lodge, no doubt, played an important part in bringing about uniformity in the ceremonies and acceptance of the trigradal system. This is believed to have been stimulated also by the wide circulation of Samuel Prichard's *Masonry Dissected,* first published in 1730, about 30 editions of which are known to have been printed in England and 8 in Scotland.

World Diffusion of Freemasonry.—Within half a century of the foundation of the Grand Lodge, Freemasonry had spread not only to the European continent but also to America and Asia. In Ireland, where a Freemasons' lodge existed as early as 1688, a Grand Lodge was established perhaps in 1723 and certainly by 1725, and in 1726 there was a Munster Grand Lodge. The Grand Lodge of Scotland, formed on a basis similar to that of the Grand Lodge of England, dates back to 1736. In India, lodges were constituted at Ft. William, Bengal (1729), Calcutta (1730), Madras (1752) and Bombay (1758). In the West Indies Freemasonry was practised in Antigua (1728), St. Christopher (1739) and Jamaica (1742). A "deputation" was issued in 1730 appointing one Daniel Cox provincial grand master in New York, New Jersey and Pennsylvania, but there is no proof that he ever constituted a lodge there.

There is a tradition that in 1725 the earl of Derwentwater founded a lodge in Paris, but the first in France to be constituted by the Grand Lodge was in 1732. Four years earlier, as the Grand Lodge minute book shows, one had been constituted in Madrid and in the next year another at Gibraltar. Others were opened in Germany (1733), Portugal (1735), the Netherlands (1735), Switzerland (1740), Denmark (1745), Italy (1763), Belgium (1765), Russia (1771) and Sweden (1773). In most of these countries Grand Lodges were subsequently created and continued in existence except in states where Freemasonry was proscribed. In Germany, following suppression of Freemasonry by the Nazis, the United Grand Lodge was re-established in 1949, although in eastern Germany it remained proscribed.

In at least two continental countries there had been associations, of some importance, of operative masons, namely the *Steinmetzen* in Germany and the *compagnonnages* in France; but there would appear to be no evidence in either case of any close or continuous connection with speculative Masonry. In some respects the *compagnonnages* resembled organizations of English or Scottish operative masons, having arrangements to help journeymen traveling the country in search of employment or wider experience. They also had rituals for initiation and legends connected with Hiram, Solomon's master mason, who was murdered by three apprentices, with Maître Jacques, Hiram's colleague and the maker of two pillars, and with Père Soubise, also one of Solomon's master workmen. These legends, however, cannot be satisfactorily dated nor can their evolution be clearly traced. It is by no means impossible that the *compagnonnage* rituals were based on, or greatly influenced by, English masonic catechisms (E. Martin St. Léon, *Le Compagnonnage,* p. 223, 1901), and legends may have been borrowed as well. In any event, even if it be taken that French, English and

Scottish operative masons had some common traditions of medieval origin, it is also clear that in one important respect the *compagnonnages* differed from other organizations of craftsmen. They consisted of journeymen only and excluded independent masters. Their primary concern was with the economic conditions of journeymen, a matter of little or no interest to French speculative Masons, for whom, during the 18th and 19th centuries, provision could be made in lodges following the English Grand Lodge tradition. Lodges and *compagnonnages* alike were subject to difficulties because both church and state, under the *ancien régime* and restored Bourbons, regarded them unfavourably. The theological faculty in Paris in 1645 declared the rituals of the *compagnonnages* to be blasphemous and the use of their watchwords to be mortal sin; and Popes Clement XII and Benedict XIV in 1738 and 1751 respectively condemned Freemasonry in bulls which, however, the secular authority did not enforce. Nevertheless, under Louis XVIII and Charles X, Freemasonry was only barely tolerated. French Freemasons tended to be hostile to both ecclesiastical and secular authorities: and finally the French *Grand Orient* became so anticlerical as to abolish what English Freemasons regarded as a fundamental condition of membership, the requirement to believe in the Great Architect of the Universe. For that reason the English Grand Lodge in 1878 severed relations with it and thereafter refused to recognize any variety of Freemasonry erring in the same way.

While Freemasonry was thus being carried to the ends of the earth it was also developing additional activities and manifestations. In addition to the three fundamental degrees, others were at various times established. Among them are those of the Royal Arch, connected with a legend of Zerubbabel and the rebuilding of the Temple (Ezra iii, 2; iv, 2–3; v, 2), and governed by the supreme grand chapter of Royal Arch Masons, whose authority by 1952 was recognized by 2,450 chapters throughout the world. Others are those respectively of the Mark Grand Lodge, the Grand Priory of Knights Templars and the Ancient and Accepted Rite. Only those already members of the craft may proceed to these degrees but they are optional and many do not seek admission to them. They are mutually complementary and intimately connected in England and more or less so in Ireland, Scotland, North America and wherever the degrees are worked on a similar basis. Those European countries in which Masonry is permitted have likewise their own *hautes grades*.

Some idea of the strength of modern Freemasonry may be gathered from the fact that there are over 9,000 lodges in all parts of the world under the jurisdictions of the Grand Lodges of England, Ireland and Scotland (United Grand Lodge of England, 7,000; Grand Lodge of Ireland, 1,000; Grand Lodge of Scotland, 1,000). In addition, there are many lodges under the jurisdiction of independent Grand Lodges in most countries of the British Commonwealth. There are also in the United States 50 autonomous Grand Lodges recognized by the Grand Lodge of England; 5 in Central America and Mexico; 11 in South America; and 2 in the West Indies. In Europe there are recognized Grand Lodges in Austria, Denmark, Finland, the Federal Republic of Germany, Greece, Iceland, the Netherlands, Norway, Sweden and Switzerland, and one in Israel. (G. P. J.)

UNITED STATES

As the organizational structure of Freemasonry in the United States is not exactly duplicated elsewhere in the world, its evolution deserves particular attention.

Freemasonry was planted in the American colonies by English, Scottish and Irish Masons during the early decades of the 18th century. In 1734 Benjamin Franklin, then 28 years of age, was elected grand master of Masons in Pennsylvania; and in the same year he published the first masonic book printed in America, a reprint of Anderson's *The Constitutions of the Free-Masons*. At that time it was estimated there were about 6,000 Masons in all the colonies along the Atlantic seaboard. Individual lodges had small memberships, ordinarily about 15, and a lodge with 25 or more members was considered quite large.

During the colonial period a majority of the lodges worked under English constitutions, Ancient or Modern, a few receiving their charters from the Grand Lodges of Scotland or Ireland. They were governed by provincial Grand Lodges, and the provincial grand masters were authorized or appointed from Great Britain. At the culmination of the Revolutionary War these provincial grand bodies set themselves up as independent Grand Lodges, their sovereignty becoming everywhere recognized within a few years. Each confined itself within the geographical area corresponding to state boundaries, a custom followed by all Grand Lodges subsequently organized in the United States. This was the origin of the now firmly established American masonic doctrine of "exclusive jurisdiction," the point of which is that each Grand Lodge is sole and sovereign in masonic matters within its own acknowledged territory; invasion of such territory by another masonic body is grounds for discontinuing fraternal recognition. Accordingly, in the second half of the 20th century the United States had 50 independent Grand Lodges with a total membership of approximately 4,000,000. Belief in God, the presence of the Holy Bible on the altar, the forbidding of any political activity or discussion within the lodge, strict nonsectarianism in religion and cognizance of the moral law are among the fundamentals adhered to by all grand lodges.

In the latter part of the 18th century, and at intervals thereafter, efforts were made to establish a general Grand Lodge for the United States. All these attempts failed, and each of the Grand Lodges remained independent without a national governing body. In 1912 a co-operative undertaking among the Grand Lodges to erect in Alexandria, Va., a George Washington Masonic National memorial led to annual meetings and to a separate annual conference of grand masters of North America and the conference of Grand Lodge secretaries. These conferences became forums for the exchange of ideas and information but exercise no administrative authority over any Grand Lodge. A majority but not all of the Grand Lodges participate in another national body, the Masonic Service Association of the United States. As its name implies, this association, with headquarters in Washington, D.C., acts for the participating Grand Lodges in matters of service, relief and education but is in no sense a governing body over any Grand Lodge.

During the 18th century masonic degrees beyond those of the first three were being devised in Great Britain and Europe and becoming known in America, but throughout this time they remained degrees only and lacked organizational form. In America, as in England, the Royal Arch degree was conferred in lodges of Master Masons or by lodge authority. By the end of the century Royal Arch chapters had begun to appear, leading to the establishment of the Capitular Rite. That rite consists of local chapters conferring four degrees: Mark Master, Past Master (Virtual), Most Excellent Master and the Royal Arch. Chapters are governed by grand chapters in the same form and jurisdictional pattern as lodges and Grand Lodges. Applicants must be Master Masons in good standing. There is also a general grand chapter in which the grand chapters of Pennsylvania, Texas, Virginia and West Virginia do not participate.

In America the earliest surviving written record of the conferral of the Knights Templar degree is in St. Andrew's lodge, Boston, 1769. Like the Royal Arch degree, it was conferred in a lodge or by authority of a lodge, until the appearance of local commanderies. In 1816 earlier efforts culminated in the formation of the General Grand Encampment of Knights Templar and the Appendant Orders for the United States, now known as the Grand Encampment of Knights Templar of the United States of America. The point of entrance is the local commandery, and applicants must be Royal Arch Masons in good standing. The commandery confers three orders: Red Cross, Knights of Malta and Knights Templar, and is governed by grand commanderies under the grand encampment. The Templar Rite is exclusively Christian.

Prior to 1870 the Scottish Rite of Freemasonry conferred three side or optional degrees: Royal Master, Select Master and Super-Excellent Master. In that year these degrees were relinquished by the Scottish Rite and thereafter conferred in local councils of Royal and Select Masters, governed by grand councils, a general

grand council, and known as the Cryptic Rite. The grand councils of Pennsylvania, Texas, Virginia and West Virginia do not participate in the general grand council. Capitular and Cryptic work being combined in those grand jurisdictions.

The York Rite.—The term "York Rite" is merely a name and has no separate organizational substance. It is an over-all name for the bodies of the Capitular, Cryptic and Templar rites and is symbolic of antiquity in Freemasonry. As the Knights Templar is the culminating degree of the York Rite, the Cryptic Rite follows the Capitular and precedes the Templar degrees. The Cryptic degrees have retained their optional character and are not a requirement for applicants in the commanderies. Since the Capitular, Cryptic and Templar Masonry evolved in this form and sequence in the United States, and is not exactly duplicated elsewhere, it has frequently been proposed that these bodies should be named the American Rite, but the term York Rite persists through long usage.

The Scottish Rite.—The degrees of the Ancient and Accepted Scottish Rite first evolved on the continent of Europe, and its conception as an organization was set forth in what are known as the Grand Constitutions of 1762 and 1786, the latter traditionally believed to have had the sanction of Frederick the Great in Germany, himself a Mason. The "Scottish" appelation is obscure, possibly derived from the influence of early Scottish Freemasonry in Europe, particularly in France. Transmitted through Jamaica to the American mainland, the first supreme council of the Scottish Rite was established at Charleston, S.C., in 1801. French Masons had brought some of the Scottish Rite degrees to America in the late 18th century, and local lodges of perfection had conferred them; but the organization of the Scottish Rite began with the formation of the supreme council at Charleston, and all regular supreme councils in the world descended from it.

The Grand Constitutions provide for only one supreme council in any one country, but difficulties of travel in the colonial states led in 1813 to the establishment of a second American supreme council. The Charleston supreme council authorized a supreme council for the northern jurisdiction, to govern the rite in a territory consisting of all states north of the Ohio river and east of the Mississippi river; and retained, as the supreme council for the southern jurisdiction, the remaining states and territorial possessions of the United States.

A supreme council is the parent body, elects its own members and is self-perpetuating. Unlike the grand bodies of the York Rite, a supreme council is not composed of representatives from the subordinate bodies. It charters the subordinate local bodies. These are four in number and, in the southern jurisdiction, are called Lodge of Perfection, conferring the 4th through the 14th degree; Chapter of Rose Croix, conferring the 15th through the 18th degree; Council of Kadosh, conferring the 19th through the 30th degree; and the Consistory, conferring the 31st and 32nd degrees. Applicants must be Master Masons in good standing. The names of these four local bodies, the degrees conferred by each, as well as the names and character of the degrees, vary somewhat under different supreme councils. In the late 19th century Albert Pike (1809–91) rewrote the degree rituals of the southern jurisdiction. While the Pike versions are widely used they are not universal throughout the rite under other supreme councils.

The supreme council confers the 33rd degree, which is honorary, in recognition of outstanding services, and may not be requested. In the United States, under both supreme councils, there were by the 1960s approximately 900,000 Scottish Rite Masons; and of this number there were approximately 6,000 of the 33rd degree (honorary). A supreme council itself is composed of "active" 33rd degree Masons, and each of these Masons is the highest officer of the Scottish Rite in his respective jurisdiction (states being referred to as orients). In states where there is no "active" 33rd degree Mason, the highest officer of the rite is a deputy of the supreme council.

In addition to the two American supreme councils there were, by the latter 1950s, supreme councils in 31 other countries. Those which existed in Poland, Czechoslovakia and Rumania had been suppressed by the Communists. All Freemasonry had likewise been proscribed under Franco in Spain, but a supreme council of Spain in exile had been set up in Mexico.

Appendant Orders.—The masonic bodies properly so called are those of the symbolic lodges of the first three degrees (often referred to in the United States as "blue lodges," for the official colour) and the bodies of the York and Scottish rites. This main body of Freemasonry should not be confused with a large number of independent, primarily social organizations predicating their membership upon good standing in a lodge or body of the York or Scottish rites. Notable among these many appendant groups are: the International Order of the Eastern Star, admitting Master Masons and the wives, daughters or sisters of Master Masons; the Ancient Arabic Order of Nobles of the Mystic Shrine, in which applicants must be either 32nd degree Masons or Knights Templar (the "Shrine," so-called, is well known to the general public because of its colourful costumes and parades and the events it sponsors to support the organization's hospitals for the care of crippled children of all races and creeds); the Royal Order of Scotland, in the United States composed of those who have been five years or longer a 32nd degree Mason; the Red Cross of Constantine, with a membership limited in number and to Royal Arch Masons; the Mystic Order of Veiled Prophets of the Enchanted Realm, and the Tall Cedars of Lebanon, open to Master Masons; the Order of DeMolay for boys; the Order of Job's Daughters, for girls; and many others. In addition to these there are several hundred masonic clubs, most of them local, social and benevolent in character, some independently organized. Many of these clubs are chartered by the National League of Masonic Clubs, the province of which is sufficiently indicated by its title. Again, these appendant orders are a United States development in Freemasonry not duplicated on the same scale elsewhere.

See also references under "Freemasonry" in the Index volume.

(R. B. Hs.)

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All the masonic grand bodies in the United States publish annual *Proceedings*, and most of them have published histories of their respective jurisdictions; the general grand bodies publish triennial *Proceedings;* the supreme council, southern jurisdiction, publishes biennial *Transactions*, and the supreme council, northern jurisdiction, publishes annual *Proceedings*. The Conference of Grand Masters of Masons in North America and the Conference of Grand Lodge Secretaries publish annual *Proceedings*, and many of the separate Grand Lodges publish official magazines or bulletins. (R. B. Hs.)

FREEPORT, a city in northern Illinois, U.S., 110 mi. W.N.W. of Chicago, the seat of Stephenson county, is located in a prosperous dairy-farming area where corn, oats and wheat are major crops.

Founded by William Baker in 1835, the town was first settled by Pennsylvania Germans disappointed with conditions in the Galena lead-mining district, where they had planned to live. Freeport was designated the county seat in 1837 and changed its name from Winneshiek at that time. It was incorporated as a city in 1855. Manufactures include batteries, food products, oil burners, hardware, toys, medicines and toilet preparations. (For comparative population figures *see* table in ILLINOIS: *Population.*)

Freeport was the site of the second Lincoln-Douglas debate on Aug. 27, 1858. There Abraham Lincoln asked Stephen A. Douglas to answer four questions, the second being: "Can the people of a United States Territory, in any lawful way, against the wish of any citizen of the United States, exclude slavery from its limits prior to the formation of a state constitution?" Douglas' affirmative answer pointed out that in spite of contrary supreme court decisions ". . . the people have the lawful means to introduce it or exclude it as they please, for the reason that slavery cannot exist . . . unless it is supported by local police regulations." This Freeport doctrine was generally accepted by Illinois Democrats but was attacked savagely in the south. So profound was its effect on the south that it is cited as one of the reasons Douglas could not control the Democratic party in the presidential campaign of 1860. "Lincoln the Debater," a statue by Leonard Crunelle, in Taylor park, commemorates the debate. (C. C. W.)

FREE PORT. A free port or free zone within a port is an area within which goods may be landed, handled, manufactured and reshipped without the intervention of the customs authorities. The defined area is subject to all the usual laws concerning health, labour conditions, inspection of vessels, immigration and postal service but is entirely exempt from customs. It is only when the goods are moved to consumers within the country in which the free port zone is located that they become subject to the prevailing customs duties.

The primary purpose of a free port or a free port zone is to remove from a port with many geographical advantages for trade those hindrances to trade caused by high tariffs and complex customs regulations. Hamburg and Bremen, both admirably situated for trade between highly developed areas of Europe and the rest of the world, have long been associated with the practice. Hamburg was one of the most famous of Hanseatic towns and, from the period of freedom of trade associated with the Hanseatic league (*q.v.*), retained the principle so that, through a free zone within this great port, the advantages of geographical location for transshipment were strengthened and the range and variety of commodities handled much increased. Many ports of northwestern Europe (*e.g.*, Copenhagen, Danzig, Stockholm, Göteborg and Lübeck) and other ports along the Adriatic coast (*e.g.*, Trieste and Fiume [Rijeka]) have had long experience with the system and through its application may well have both maintained and extended their trade. From the end of the 19th century several additions were made to the list of free ports or free port zones, including Singapore, Penang, New York city, Coatzacoalcos (formerly Puerto México) and Salina Cruz (Mexico). The primary objectives in creating a free port zone are not always the same; for example, when it was adopted in Colón, Panamá, in 1950 much emphasis was placed on the values to be obtained through encouraging the manufacture of commodities as well as from amplifying the transit trade. Thus an area was deliberately set aside as a free zone industrial area, and a number of industries were thereafter established.

Several important trading countries, however, including Great Britain, did not adopt the practice. In the United States, with the passing of the Celler Foreign Trade Zones act in 1934, it seemed that several free ports might come into being; but only limited developments followed as, for example, in the ports of New York city and New Orleans.

Among the advantages of the system are the quicker turnaround of ships through the reduction in the formalities of customs examinations and the ability to display and often fabricate goods freely. Any increase in trade attributable to the existence of a free port zone must lead to greater receipts for the port authority and to the provision of additional employment. Yet in many instances there is no strong case for believing that an increase in trade would result from the introduction of the system. On the other side it has been stated that the free port zone system tends to allow the dumping and holding duty-free of goods which are later released on the market at a critical time to the detriment of the manufacturers of the country concerned. Furthermore, the physical features and built-up character of some ports do not allow the setting aside of a distinct and closely supervised free port zone.

In several cases the free port function has declined. Alternative devices, *i.e.*, the bonded warehouse and associated systems, are used in some large seaports such as London, Rotterdam and Amsterdam. It is probable that the free port system is most defensible and most successful for large zones within busy major ports. A free zone associated with air freight was established at Shannon airport, Republic of Ireland, in 1961.

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FREE RADICALS. According to 19th-century chemical nomenclature a radical is a group of atoms which, in combination with another radical or atom, forms a stable molecule. Thus a free radical may be defined as a molecule in which one of the atoms has one of its valences unoccupied; *i.e.*, a molecule in which one of the atoms exhibits a valence one unit lower than normal. In a free radical, therefore, carbon appears to be trivalent rather than quadrivalent, nitrogen bivalent rather than trivalent. Numerous unsuccessful attempts to prepare free radicals at one time led to the belief that free radicals were incapable of existence. However a number are now recognized as stable entities, and others play important roles as transient intermediates in chemical reactions. An alternative definition of a free radical derives from the theory of chemical valence developed by G. N. Lewis (1916 and later, *see* VALENCE). Most molecules contain an even number of electrons. The chemical bond, or valence, which holds together two atoms consists of a pair of electrons shared by the two atoms. The free valence of a free radical consists of a single unshared electron, and the radical is an odd molecule containing an odd number of electrons (Lewis, 1923). If consideration is restricted to molecules containing only the elements most commonly encountered in organic chemistry (*i.e.*, carbon, hydrogen, nitrogen, oxygen, the halogens and the like) the two definitions are equivalent. However, if one wants to consider also compounds containing atoms of the transitional groups of the periodic system (*see* PERIODIC LAW), this is no longer true. Thus, although the ferric ion Fe^{3+} contains an odd number of electrons, it is not ordinarily considered a free radical. Further, complex organic molecules may be imagined having two unsatisfied valences but an even number of total electrons. Examples of such diradicals are also known.

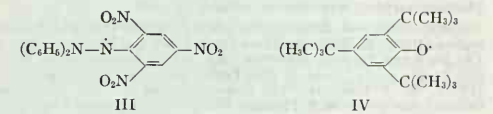
Radicals of Appreciable Stability.—The history of this field

begins in 1900 with M. Gomberg's discovery of triphenylmethyl with the structure I. In this compound the central carbon

$(C_6H_5)_3C\cdot$ $(C_6H_5)_3C{-}C(C_6H_5)_3$

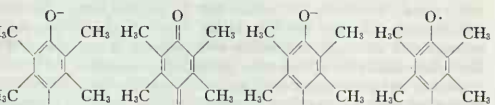
I II

is trivalent since it is combined with three phenyl groups instead of four, and its unshared electron is represented by a dot. By withdrawing chlorine from triphenylchloromethane, $(C_6H_5)_3CCl$, Gomberg expected to obtain hexaphenylethane II as a result of the combination of two triphenylmethyl radicals I. The product obtained (in solution) was, however, a mixture of I and II. Actually, solution I and II are in rapid equilibrium with each other, hexaphenylethane forming by the dimerization of two triphenylmethyl radicals, a process in which the two odd electrons become paired to form the central carbon-carbon bond, and the free radicals are continuously being regenerated by dissociation of the hexaphenylethane. Free radicals of this type are stable only in certain organic solvents, and are rapidly destroyed by irreversible reactions in the presence of air, water or strong acids. The degrees of dissociation of compounds such as hexaphenylethane vary considerably when the phenyl groups are replaced by other aromatic groups. Thus, when each phenyl, C_6H_5, is replaced by biphenyl, $C_6H_5.C_6H_4$, dissociation into free radicals is practically complete. In an analogous manner, free radicals are formed to a small extent by the breaking of the nitrogen-nitrogen bond in aromatic hydrazines of the general structure $R_2N{-}NR_2$, or, to a greater extent, by the breaking of the central nitrogen-nitrogen bond in aromatic tetrazanes, $R_2N{-}RN{-}NR{-}NR_2$. Thus, the radical diphenylpicrylhydrazyl III exists as a stable violet solid, showing no tendency to dimerize to a tetrazane even in the solid state. Examples of free radicals with the odd electron on oxygen are also known, *e.g.*, the 2, 4, 6-tri-*t*-butylphenoxy radical IV, a blue substance which is also unknown in the dimeric form.



III IV

Another free radical is typified by the semiquinones. If the dianion of durohydroquinone V (existing in alkaline solutions of durohydroquinone) is treated with oxidizing agents, it loses two electrons and is converted to duroquinone VI. An intermediate stage of oxidation is possible in which a single electron has been lost to yield the free radical semiquinone ion VII. Actually,



V VI VII VIII

in partially oxidized systems all three species are in mobile equilibrium, and mixing solutions of V and VI immediately gives rise to detectable quantities of the yellow semiquinone. Semiquinones of a variety of types are known, and in some cases may be obtained in pure form in the solid crystalline state. However, they are usually in rather unfavourable equilibrium with the completely oxidized and reduced forms of the molecule, so that for many years their existence was overlooked.

Another type of stable radical ion, a metal ketyl, forms when a substance such as benzophenone, $(C_6H_5)_2C{=}O$, is treated with metallic sodium to give the coloured ketyl $(C_6H_5)_2C{-}O^-$. The reaction involved is essentially a reduction, the sodium being oxidized to sodium ion, Na^+. Rather similarly, in certain solvents such as tetrahydrofuran sodium reacts with complex aromatic hydrocarbons such as naphthalene $C_{10}H_8$ converting it to the highly coloured radical ion $C_{10}H_8^-$.

A final class of relatively stable organic free radicals are those containing the group $>NO$. Such a group necessarily contains an odd electron (apparently distributed between the nitrogen and oxygen) and the resulting molecule is thus a free radical. An example is diphenylnitrogen oxide, $(C_6H_5)_2NO$, which is obtained by the oxidation of diphenylhydroxylamine, $(C_6H_5)_2NOH$, and which shows no tendency to dimerize or to disproportionate to products of higher and lower oxidation state. A somewhat similar behaviour of nitrogen is found in nitric oxide, NO, and nitrogen dioxide, NO_2, which are also odd molecules.

Structural Requirements for Stable Radicals.—Certain structural features appear to be requirements for the existence of stable free radicals. One condition of particular importance is shown by the semiquinone radical ion VII. As depicted, the upper oxygen atom has a negative charge, and the lower one an odd electron. However, this assignment is arbitrary, and the same molecule would be represented if the charge and odd electron were interchanged. When a situation of this type is encountered, the actual average distribution of electrons within the molecule is presumed not to be that of either of the structures just described, but to be intermediate between the two. This ambiguity is called delocalization or resonance (*see* RESONANCE, THEORY OF); according to quantum mechanics the resonance increases considerably the stability of the molecule, and, in this case, the probability of existence of the semiquinone ion. When the oxidation of durohydroquinone is conducted in an acid medium, so that the semiquinone anion would be converted to the neutral radical VIII, this ambiguity as to structure disappears, and under such conditions no semiquinone can be detected.

Similar arguments account for the stability of the other free radicals discussed above. In the case of triphenylmethyl I, it is considered that the odd electron is in effect distributed over the three phenyl groups as well as the central carbon atom. In addition, the dissociation of hexaphenylethane may be considerably facilitated by repulsive forces between the three bulky phenyl groups on one carbon atom and those on the other. As a measure of the magnitude of these two phenomena, dissociation of the carbon-carbon bond in the simple molecule ethane, $H_3C{-}CH_3$, requires an energy of 84 kg.cal. per mole of ethane. In hexaphenylethane only 12 kg.cal. are required.

Magnetic Properties of Free Radicals.—The magnetic properties of free radicals provide a powerful tool for their detection and study. Molecules with even numbers of paired electrons are diamagnetic; *i.e.*, they are slightly repelled by a magnet. However, free radicals are paramagnetic and attracted by a magnet because of the spin of the odd electron (*see* QUANTUM MECHANICS: *Electron Spin*), the spins of the remaining paired electrons effectively canceling each other. The magnetic property of a substance which is commonly studied is its magnetic susceptibility, effectively its behaviour in an inhomogeneous magnetic field, and the extent of its paramagnetism is described in terms of its magnetic dipole moment, expressed in Bohr magnetons. The magnitude of this dipole moment is the same for all free radicals, and, when arising from the spin of a single electron, amounts to $\sqrt{3} = 1.73$ Bohr magnetons. This value has been confirmed experimentally with free radicals which may be obtained in the solid state, or at known concentrations in solution. Magnetic susceptibility measurements also may be used to demonstrate the existence of free radicals and to measure the position of equilibrium between radicals and their dimers or disproportionation products (*see* also MAGNETOCHEMISTRY). Diradicals, with even numbers of electrons two of which are, however, not paired, are also paramagnetic, the oxygen molecule, O_2, being probably the simplest example.

The paramagnetic resonance spectra of free radicals provide another technique for their detection and study. According to quantum mechanics, the spin of the odd electron of a free radical, when placed in a magnetic field, may have two, and only two, orientations, one with and the other against the field. These two orientations differ slightly in energy by an amount proportional to the strength of the magnetic field, and the majority of the electrons have the orientation of lowest energy. If a system containing free radicals is placed in a magnetic field and exposed to electromagnetic radiation (usually in the microwave region of very short radio waves), molecules with the lower energy

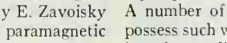
orientation absorb radiation of a frequency corresponding to an energy just sufficient to flip over the electron into its higher energy state. This phenomenon was first observed by E. Zavoisky in 1945, and, in the simplest case, gives rise to a paramagnetic resonance absorption spectrum consisting of a single sharp absorption line. The technique is sensitive, and will detect extremely small concentrations of free radicals, examples of as little as one part in 10^7 having been reported. In many organic free radicals, interaction of the odd electron with the magnetic moments of the nuclei of different atoms in the molecule (most commonly with the nuclei of hydrogen atoms) gives rise to a more complicated system of energy levels, and an absorption spectrum consisting of a series of lines. The nature of the spectrum observed permits the identification of particular free radicals, and also gives information about their electronic structure. As an example, the simple semiquinone radical ion, $\cdot OC_6H_4O^-$ (analogous to VII, but with the CH_3 groups replaced by hydrogen atoms), exhibits a spectrum of five equally spaced lines, indicating that the odd electron spends part of its time near the hydrogen nuclei. Accordingly it is not only associated with the two oxygen atoms, but is effectively delocalized over the entire molecule. Similarly, the triphenylmethyl radical I shows a complex spectrum, consistent with the idea that its stability arises from the spreading of its odd electron over all three phenyl groups.

Unstable Radicals of Short Life.—Simple free radicals such as methyl, $\cdot CH_3$, are also capable of existence, and play important roles as transient intermediates in many chemical reactions. The existence of the methyl radical was first demonstrated by F. Paneth and W. Hofeditz in 1929 by the following experiment. The vapours of tetramethyl lead, $Pb(CH_3)_4$, mixed with gaseous hydrogen, H_2, were passed through a silica tube at low pressure. When a portion of the tube was heated to about 800° C. the tetramethyl lead was decomposed and a mirror of metallic lead deposited on the internal surface of the tube. The gaseous products of the decomposition were found capable of causing the disappearance of a second lead mirror, deposited at a more distant cool point in the tube.

Since none of the recognized stable products of the decomposition was able similarly to dissolve a lead mirror, the inference was drawn that methyl radicals, formed in the high-temperature decomposition, reacted with lead at the cool mirror to regenerate tetramethyl lead. The methyl radicals obtained in this way proved to be highly reactive and short-lived. They not only reacted with lead and other metals, but disappeared rapidly and spontaneously, largely by dimerization to ethane, CH_3CH_3. In hydrogen at a total pressure of 2 mm., for example, the concentration of methyl radicals was estimated to decrease to half its original value in about 0.006 seconds. In subsequent years, techniques for producing reactive free radicals in the gas phase have been greatly extended by Paneth and his co-workers and many other investigators. It has been found that a variety of unstable species such as ethyl, $\cdot C_2H_5$, propyl, $\cdot C_3H_7$, and hydroxyl, $\cdot OH$, can be obtained by several methods which include: (1) the thermal or photochemical decomposition (*see* PHOTOCHEMISTRY) of a wide variety of organic and inorganic materials; (2) the reaction between sodium vapour and an alkyl halide; (3) the discharge of electricity through a gas at low pressure. Atoms which arise from dissociation of a diatomic molecule (such as the chlorine atom, $\cdot Cl$, from the dissociation of the chlorine molecule Cl_2) can also be obtained, and have the properties of short-lived radicals of this type.

The existence of the various known unstable free radicals, like that of methyl itself, is most commonly demonstrated by the reactions which they undergo. Thus, ethyl radicals, formed from tetraethyl lead, $Pb(C_2H_5)_4$, dissolve zinc and antimony mirrors. The resulting ethyl derivatives of zinc and antimony, $Zn(C_2H_5)_2$ and $Sb(C_2H_5)_3$, have been isolated and identified by the usual chemical and physical tests. In a few instances, unstable radicals also have been identified spectroscopically. Here the important technique of flash photolysis, the use of a single, intense flash of light to produce a momentary high concentration of free radicals, has been developed by R. G. W. Norrish and G. Porter.

Transient unstable free radicals also may be produced in the liquid phase (*e.g.*, in solution in a liquid solvent) by several means. A number of molecules, of which organic peroxides are typical, possess such weak chemical bonds that they decompose irreversibly into free radicals on warming in solution. The behaviour of diacetyl peroxide,



has been studied by M. S. Kharasch, M. Szwarc and others, and it is considered to decompose, at least in large part, into carbon dioxide, CO_2, and methyl radicals.

These in turn rapidly attack most organic solvents, often by abstracting hydrogen to give methane, CH_4, together with other products. Irradiation of solutions of many organic substances with ultraviolet light leads to the absorption of sufficient energy to disrupt chemical bonds and produce free radicals, and in fact most photochemical processes are at present thought to involve free radical (sometimes diradical) intermediates. The chemical changes which occur when solutions (and also gases) are exposed to high-energy radiation (α, β, and γ rays from nuclear reactions, X-rays, electron beams, etc.) also frequently appear to involve the transient formation of free radicals. Thus, a major consequence of passing high-energy radiation into water, H_2O, is believed to be its dissociation into hydroxyl radicals, $\cdot OH$, and hydrogen atoms, $\cdot H$. Short-lived radicals are also formed in some oxidation-reduction processes. Organic hydroperoxides of the general formula R—OOH react rapidly with ferrous ion, Fe^{2+}, the first step being the formation of ferric ion, Fe^{3+}, hydroxide ion, OH^-, and an alkoxy radical, $RO\cdot$.

An interesting method for prolonging the lifetime of highly reactive radicals is to produce them in a glassy or solid medium where they are unable to diffuse together and disappear by dimerization and similar processes. The technique was first developed by G. N. Lewis who irradiated various organic molecules, chiefly dyes, in glassy solvents at liquid air temperatures and was able to observe the colours of the resulting unstable radicals, which, in some cases, could be preserved for days. Similarly, the irradiation of organic plastics (and many other solid organic materials) with high-energy radiation at ordinary temperatures can produce high concentrations of trapped radicals which may be detected and studied via their paramagnetic resonance spectra.

Radicals as Intermediates in Chemical Reactions.—It is commonly believed that free radicals are transient intermediates in many high-temperature reactions such as combustion and the thermal cracking of hydrocarbons, in many photochemical processes, and in a number of other important reactions in organic chemistry, although their concentrations are in general too low for direct detection. One class of free radical reaction is of particular importance, and is illustrated by the following example. Methane, CH_4, reacts with chlorine, Cl_2, by an over-all process which gives methyl chloride, CH_3Cl, and hydrogen chloride, HCl. The reaction is enormously accelerated by light, and apparently involves the following steps:

$$Cl_2 \xrightarrow{\text{light}} 2Cl\cdot \qquad (1)$$

$$Cl\cdot + CH_4 \longrightarrow \cdot CH_3 + HCl \qquad (2)$$

$$\cdot CH_3 + Cl_2 \longrightarrow CH_3Cl + Cl\cdot \qquad (3)$$

$$2\,Cl\cdot \longrightarrow Cl_2 \qquad (4)$$

Chlorine atoms are produced in (1) and destroyed in (4), while the products which are actually isolated arise from (2) and (3). Since chlorine atoms consumed in (2) are regenerated in (3), a single atom of chlorine can lead to the production of many (actually many thousand) molecules of methyl chloride. Such processes, in which an intermediate is continually regenerated, are known as chain reactions, and their study constitutes an important branch of chemical kinetics (for further details *see* articles on CATALYSIS; REACTION KINETICS; and POLYMERIZATION). Similar chains in-

volving transient free radicals are involved in the halogenation of many other organic molecules, in many of the polymerization reactions employed in the manufacture of plastics and synthetic rubber, and in the reaction of molecular oxygen, O_2, with a great number of organic molecules. In general these chain processes occur with great rapidity—a typical lifetime of a chain may be of the order of a second, during which many thousands of individual steps such as (2) and (3) may occur—although at any one time perhaps only one molecule out of 10^9 in the system exists as a free radical. Since a relatively small number of free radicals can produce significant chemical reaction in this manner, the initiation of typical radical chain processes (such as polymerization of certain unsaturated molecules) provides one of the best demonstrations of the existence of transient free radicals in chemical systems.

While most reactions of molecular oxygen with organic molecules appear to involve free radical intermediates, the situation in other oxidations and reductions depends much upon the particular system involved. Thus, the oxidation of isopropyl alcohol, $(CH_3)_2CHOH$, to acetone, $(CH_3)_2C=O$, by ferrous ion and hydrogen peroxide apparently involves the intermediate radical $(CH_3)_2C-OH$. On the other hand, there is good evidence that when chromic acid, H_2CrO_4, is the oxidizing agent, the oxidation occurs in one step without the intervention of any intermediate radical. Basically, the presence or absence of intermediate free radicals in oxidations and reductions depends upon whether the reactions involve the transfer of single electrons (which necessarily produces an odd molecule as an intermediate), or involve two-electron transfers (which do not produce odd molecules). In many reactions, including most of the important oxidation-reductions occurring in biochemical systems, which sort of path is followed is not yet known.

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FREESIA, a genus of South African tender herbs belonging to the iris family (Iridaceae), containing three species but scores of horticultural forms. The plants grow from a bulblike corm (as in *Gladiolus*), which sends up a tuft of long narrow leaves and a slightly branched stem bearing a few leaves and loose, one-sided spikes of fragrant, narrowly funnel-shaped, but slightly irregular flowers, which are typically yellow, but white, pink or red in some of the horticultural forms.

In temperate climates freesias are grown as winter-flowering greenhouse plants. They are extensively grown for the florists, as their fragrance is much desired. By potting successively (about every two weeks) throughout the autumn a supply of flowers is obtained throughout winter and spring. The culture of freesias in the United States is extensive. Corms are planted in a rich loam, somewhat sandy, about the middle of August and kept in a cool greenhouse. After the plants bloom, watering is continued till the leaves ripen; then the plants are allowed to dry gradually. The corms, shaken clean, are then stored in a cool, dark place for replanting the following August. (N. TR.; X.)

FREE-SOIL PARTY, a minor 19th-century U.S. political party which opposed the extension of slavery. The Free-Soilers later became one of the component elements in the Republican party on its organization in the mid-1850s.

Abolitionists were scarce in mid-19th century United States but opponents of the slave power as it dominated the national government were growing in numbers. When Pres. James K. Polk, in 1846, asked congress for an appropriation to be used in settling the Mexican boundary, Rep. David Wilmot moved that the money be granted provided that any territory bought with it be free soil. This Wilmot proviso was defeated but it was to provide the fundamental principle of the emerging Free-Soil party.

In 1848, when over 500,000 sq.mi. were acquired from Mexico, Free-Soilers insisted that slavery be forever excluded from this land. They knew that otherwise states formed from it would strengthen the slave power with more senators, representatives and presidential electors.

In Aug. 1848 the Free-Soilers held their first national convention at Buffalo, the geographic centre of the zone of greater New England settlements, New England furnishing the strongest 19th-century opposition to the extension of slavery. Seventeen states sent delegates, among whom were antislavery Whigs, antislavery Democrats and the remnants of the declining Liberty party, all determined to fight extension of slavery. They were less exasperated with slavery as an institution than with the slave power which dominated the national government in the interest of cotton and tobacco to the neglect of important northern interests.

The ideology uniting Free-Soilers was not abolition of slavery but repugnance to the presence of the Negro and they wanted no Negroes, either free or slave, in the territories. "Let the soil of our extensive domains," as they put in their 1848 platform, "be kept free for the hardy pioneers of our own and the oppressed and banished of other lands, seeking homes of comfort and fields of enterprise in the New World." The final plank contained their historic slogan, "Free soil, free speech, free labor, and free men." They nominated former Pres. Martin Van Buren of New York for president and Charles F. Adams of Massachusetts for vice-president but polled only slightly more than 10% of the popular vote for president.

In 1852 the Free-Soil candidates were John P. Hale for president and George W. Julian for vice-president; they polled not quite 5% of the popular vote. In 1856 the Free-Soilers were absorbed by the new Republican party (*q.v.*), which had adopted the Free-Soil program. In terms of economic interests the Free-Soilers constituted a combination of small farmers, village merchants, household and mill workers and debtors.

See Theodore Clarke Smith, "The Liberty and Free Soil Parties in the Northwest," *Harvard Historical Studies,* vol. vi (1897).
(W. E. BY.)

FREETOWN, the capital and main port of Sierra Leone, an independent republic of west Africa within the Commonwealth of Nations, lies on the south side of the estuary of the Sierra Leone river about 5 mi. E. of the cape of that name. Pop. (1960 est.) 88,000. It stands on the seaward tip of the range of wooded hills to which the Portuguese Pedro da Cintra gave the name Sierra Leona ("Lion Mountains") about the year 1460. The climate is humid, wet tropical and trying for the white man, with an annual average rainfall of 138 in.

Freetown possesses one of the world's finest natural harbours, which, during World War II, was an important naval base. The city extends along the water front for a few miles and rises inland on gently sloping ground. The historic buildings and places of interest include the Anglican St. George's cathedral (1852); the old Fourah Bay college building (1851); Fort Thornton, residence of the governor general, first built in 1796 and modernized in 1952; the giant silk-cotton tree (1787); and the stone bearing the name of the Dutch admiral Michiel Adriaanszoon de Ruyter who landed there for water in 1664. New buildings for the Fourah Bay college (affiliated with the University of Durham, Eng.) stand on Mount Aureol, which overlooks the city, and modern commercial offices (including the country's first multistoried building) are rapidly changing the town centre. In 1957 a museum was opened near the famous cotton tree. The main streets include Water street, along the water front; Westmoreland street, running through the central ward; and Kissy street, leading to the eastern suburbs and into the main road to the provinces.

The airport of Lungi is 13 mi. N. on the sea coast across the estuary. Air services link Freetown with Europe and with other parts of west Africa and the world, and there is an internal air service to provincial towns. The port has a deepwater quay near the old Fourah Bay college, and regular shipping services link Freetown with British and other overseas ports. A state-owned railway and a steadily expanding road system link the city with provincial centres.

Freetown is not an industrial city. As the chief port of Sierra

Leone, the country's principal exports and imports pass through it, and many of the inhabitants are occupied in handling the merchandise. Many others, including women, are engaged in professional and public services. A large proportion of the merchants are Lebanese.

Freetown was founded as an attempt to atone for the horrors of the slave trade which made the area now occupied by the city and surroundings a raiding ground for about three centuries. In the movement to abolish slavery, Freetown was designed as a home for slaves freed and destitute in England. The first settlers were sent out in 1787, and in 1790 the enterprise was taken on by the Sierra Leone company, which was given a royal charter in 1799. Freetown acquired effective municipal government in 1893 and was the first British colonial municipality in Africa. The descendants of the liberated Africans, known as Creoles, are in a minority in the city. The majority of inhabitants are mainly members of the country's two largest tribal groups, the Mende and Temne. *See* also SIERRA LEONE. (T. A. L. D.)

FREE TRADE, the antithesis of protection, is a policy by which a government does not discriminate against imports in favour of national products or interfere with exports in order to favour consumers in the home market. This meaning became accepted usage in the struggle to abolish the English Corn laws (import duties on wheat and other grain) in 1846. Before then the term was used in other senses. Thus, early in the 17th century "free-trade" bills were promoted by those seeking entry into the closed corporations of the chartered companies (such as the East India company). Later, "free trade" was used to mean the right to trade in a foreign region without joining a company. It was sometimes used as a euphemism for smuggling.

Free trade does not mean that a government abandons all control and taxation of imports and exports but only that this control and taxation are not used to protect the home producer against foreign competition or to favour the home against the foreign consumer. Thus, if an import tax is imposed for revenue only, it is balanced (countervailed) in a free-trade system by an excise duty on home-produced goods (*see* COUNTERVAILING DUTIES). Export taxes formed an important part of the British protective system in the 18th century and were so much resented by the American colonists that sec. 9 of the constitution of the United States included export taxes among the powers denied to the federal government.

The Case for Free Trade.—There is a long history of the struggle for free trade in the broadest sense of absence of governmental restraint upon the freedom of traders to move and to transact business within a country and between countries. It was widely discussed by the French physiocrats, an 18th-century school of economists who coined the phrase *laissez faire, laissez aller* ("let them act," "let them go") still used to describe free enterprise. (*See* PHYSIOCRATIC SCHOOL.) Freedom of movement and trade was deduced from the philosophic principle of natural liberty.

The Scottish philosopher Adam Smith applied the principle to economic activity, and particularly to trade, in his *Inquiry Into the Nature and Causes of the Wealth of Nations,* published in 1776. The economic case for free trade is still based on his argument that division of labour leads to specialization, efficiency and greater production. Each country will specialize in the production of those goods for which it has natural advantages and can produce at lower cost than other countries. It will be driven by competition to adopt efficient methods.

There is also a strong political case for which Adam Smith's work laid the foundation. If governments interfere with competition to protect local interests, there is great danger that small and inefficient producers will be subsidized at the expense not of the foreigner but of the majority of their fellow countrymen, who as consumers must pay higher prices. Moreover, the regulation of trade becomes expensive and cumbersome. Duties and regulations which serve no useful purpose survive and develop into a network of restrictions.

Adam Smith's argument was particularly effective on this political level. His economic argument was elaborated by the English school of classical economists headed by David Ricardo (1772–1823), who propounded the theory of comparative costs. This theory explained the advantages of specialization. The argument for free trade on a competitive private enterprise basis was systematized by John Stuart Mill (1806–73) and was accepted by the majority of economists well into the 20th century. After the turn of that century economic discussion centred not upon the case for securing the maximum of production by territorial division of labour but upon the division of the gains between trading countries. It was shown that there are cases where governmental intervention may, in theory, secure to a country a greater share of the gain from its external trade than would accrue under free competition. There are obvious administrative difficulties in timing such intervention and in judging its extent but the theoretical argument weakened the economic case for free trade.

Economists since Adam Smith have always recognized that exceptions to free trade might be justified on noneconomic grounds. Smith himself made exceptions on grounds of defense, to countervail domestic taxation, to retaliate against other countries and on grounds of humanity when foreign competition might inflict hardship upon great numbers of workers. Following the publication of J. M. Keynes's *General Theory of Employment, Interest and Money* in 1936 and the widespread acceptance of "full employment" as a criterion of economic policy, this latter exception became the main argument against free trade. It was reinforced in countries of backward industrial development by the argument that temporary protection is necessary to modernize production methods. It should be recognized, however, that in practice much of the protection extended to local industries may be a device in which minority interests justify their action by invoking patriotic reasons that will not bear analysis. Despite theoretical refinements and exceptions, many economists claim that the broad economic case for free trade has never been refuted.

Adam Smith's criticism of arguments for protection and of the administrative abuses of protective practices quickly stimulated a movement toward freer trade. In 1786 William Pitt the Younger negotiated a commercial treaty with France, which lowered tariffs and removed prohibitions in both countries. War broke out in 1793 and further steps toward free trade were not possible until after the end of the Napoleonic Wars in 1815.

METHODS OF PROMOTING FREER TRADE

There are three methods of achieving freer trade. The most direct and effective is the unilateral reduction of trade barriers by each country independently of the policy followed by other countries. This was the method advocated and carried to completion by the British free-trade movement in the second quarter of the 19th century. A second method, not in conflict with but supplementary to the first, is the negotiation of bilateral commercial treaties or agreements in which a reciprocal bargain is struck to remove tariff and other trade barriers to an approximately equal degree in both countries. The third method, followed after the negotiation of the General Agreement on Tariffs and Trade (G.A.T.T.) at Geneva in 1947, is the multilateral negotiation of a simultaneous agreement among many countries.

Unilateral Free Trade.—After the Napoleonic Wars, a strong free-trade movement in Britain was directed and financed by manufacturers and merchants who tried to break the power of the landowners so that food and raw materials might be imported more cheaply.

The British tariff was then very complicated, partly because it was the result of special legislation accumulated over a long period, partly as a result of the additional duties imposed to finance the wars. When William Huskisson became president of the board of trade in 1823 he found no fewer than 1,500 statutes operative. He began to consolidate and simplify these statutes as well as the supporting regulations and customs procedures. The Navigation acts, which imposed heavy duties on a long list of enumerated articles if carried in foreign ships, were an important part of the protective system. (*See* NAVIGATION LAWS.) In 1823 a Reciprocity of Duties bill relaxed the acts. Huskisson also reduced import duties on such materials as raw silk and wool, lowered the export duty on wool and gave artisans freedom to emigrate.

The main battle for free trade, however, was fought over wheat. With growing population and developing industrial manufactures, Britain had become a wheat-importing country. Prices, and with them the rent of agricultural land, rose during the Napoleonic Wars as a result of inflation and restricted imports. In 1815 and 1822 import duties were raised in an effort to maintain prices, but deflation followed the wars, and there was an outcry against high bread prices in recurring crises of unemployment and falling prices, notably in 1825–26. The privy council was then authorized to suspend the wheat duties as an emergency measure, but in 1828 a Tory government imposed a sliding-scale tariff in which duties went up as prices went down. The landowners controlled parliament. Until the Reform bill of 1832 extended the franchise and redistributed seats, the manufacturing north of England had little political power. In 1837 another acute crisis brought an Anti-Corn Law league into existence in London. Leadership, however, was taken over by the Anti-Corn Law league formed in Manchester in 1838 by Richard Cobden and John Bright, two cotton manufacturers who devoted themselves to a great campaign of education and agitation throughout the country. They identified free trade with the cause of peace, attacked the landowners and adduced practical examples of the costs of protection. Resistance was strong but minor tariff concessions were obtained, notably in 1842. In 1845 the English harvest was short and the Irish potato crop failed almost completely. The league redoubled its efforts. In June 1846 Sir Robert Peel reduced the wheat duties immediately and abolished them as from 1849. (*See* CORN LAWS.)

In 1849 also the Navigation acts were abolished. Successive budgets, notably those of W. E. Gladstone in 1853 and 1860, continued the process of tariff reduction. The latter incorporated the reductions negotiated in the Cobden-Chevalier treaty. By 1874, when some timber duties were abolished, the British tariff was reduced to a small number of revenue duties on such items as spirits, wine, beer and tobacco, countervailed by excise duties on competing domestic products. Shipping was freed of protective restraints and migration of persons was also freed. All export duties were abolished.

Britain, in its own interests, had adopted complete free trade and maintained it until World War I, when "safeguarding duties" were introduced. The principle was not abandoned until the great depression of the 1930s, when a protective tariff was again adopted. During the free-trade era, which lasted for nearly three-quarters of a century, Britain was the greatest manufacturing, shipping and investing country in the world, but became dependent upon imports for the bulk of its food and raw materials.

Not only the United Kingdom but the dependent empire, including India, Burma, Malaya and the African and West Indian colonies, followed a free-trade policy. Most of the self-governing colonies which later became dominions imposed protective tariffs for development, but the rest of the British empire was a solid free-trade area until 1932.

Bilateral Commercial Treaties.—There is a long history of commercial agreements dating back to antiquity. (*See* COMMERCIAL TREATIES.) They were common between towns and city-states in the middle ages. As nation-states developed, friendly states from time to time concluded trading agreements. Some British commercial treaties still in force in the 1960s date from the middle of the 17th century. The United States signed its first commercial treaty with France in 1778. Treaties with the Netherlands (1782), Sweden (1783) and Prussia (1785) preceded the important treaty with Britain (1794).

The 19th-century world trading system was built upon a commercial treaty network. The rights of private traders and of private property were guaranteed. A substantial body of international law in specific detail was accepted over the larger part of the trading world and gave legal security to international enterprise and investment. Traders were free to come and go, organize, invest and trade almost as freely and as safely abroad as at home. They traveled without passports or visas, could buy or rent property, employ labour and take legal proceedings on an equal footing with nationals. Customs formalities were simple. There were no monetary and few immigration controls at the frontiers. Exchange rates were stable because the national currencies were pegged on gold and freely convertible. The principle of "national treatment" by which an alien was placed on an equal footing with nationals was not only embodied in treaties of commerce and navigation but was defined in detail and supported by a growing body of case law.

This legal basis for trade was more important than the reciprocal tariff reductions sometimes embodied in commercial treaties. When Cobden and Chevalier negotiated the Anglo-French treaty of 1860, they were attacked by free-trade advocates who maintained that each country should reduce its tariffs unilaterally and not clutter the treaties and endanger the continuance of their legal guarantees by injecting the tariff issue. However, the successful conclusion of this treaty initiated a chain of similar agreements incorporating tariff reductions among many European countries.

The effect of reduced tariffs was generalized by widespread adoption of the "most-favoured-nation clause." Before the end of the 18th century it had become common for the parties to a bilateral commercial treaty to guarantee to each other treatment as favourable as that accorded to any other country. The wording of this clause became standardized. Incorporated in the Anglo-French treaty of 1860 and copied in subsequent treaties, it became a powerful instrument of tariff reduction. Every reduction in any treaty immediately applied to imports from all countries enjoying most-favoured-nation treatment with the country making the reduction. Moreover, treaties ran for long periods and sometimes until denounced, so that it became more difficult to engage in tariff wars or retaliations since the lower duties were embedded in the treaty network. The general adoption of most-favoured-nation treatment is best described by the modern American phrase "equality of trading opportunity."

There were two forms of the clause—conditional and unconditional. The former accorded the lower duties only when there were reciprocal concessions by another trading country. The latter grants them, without any question of reciprocal concessions, to every country with which there is a treaty incorporating the clause. The United States adhered to the conditional form until 1923, when it adopted the practice, by then almost universal, of the unconditional form. It had proved difficult to define the reciprocal concessions that warranted application of the conditional clause.

The method of bilateral negotiation, incorporating most-favoured-nation treatment, was adopted by the United States in the Reciprocal Trade Agreements act of 1934. This act gave power to the administration for three years to negotiate executive agreements rather than treaties requiring the advice and consent of two-thirds of the senate. The act was renewed by congress at periodic intervals thereafter. Between 1934 and the entry of the U.S. into World War II in Dec. 1941, agreements were signed with 17 countries. The negotiation of G.A.T.T. in 1947 was followed by negotiations at Annecy, France (1949), Torquay, Eng. (1950–51), and Geneva, Switz. (1955) and in subsequent years the negotiations became frequent. In connection with G.A.T.T., the U.S. had agreements with 36 countries (many formerly had reciprocal trade agreements with the U.S.). Eight other countries, not party to G.A.T.T., also had bilateral agreements with the U.S. Most of the original agreements under the Reciprocal Trade Agreements act had been amended and extended. The original act in 1934 gave power to the administration to raise or reduce duties up to a limit of 50%. The 1945 renewal gave power to cut duties up to 50% of the existing level, even if they had already been cut 50% from the original levels of the 1930 (Hawley-Smoot) tariff. An effort was made to make the reduction in the agreement with the "principal supplier" of an import but most-favoured-nation treatment generalized the reduction to all suppliers.

The United States had moved substantially toward a low-tariff policy but foreign exporters pointed out that the tariff remained effective on competitive imports. They also asserted that the complicated and restrictive regulations, particularly for valuation of imports, remained those of the Tariff act of 1930 and that other protective methods such as import prohibitions and quotas, export subsidies and excise taxes on imported raw materials had been used to nullify the effect of tariff reductions. The power of review given the bipartisan tariff board to investigate any reduction which might

injure a domestic industry crippled the potentiality of the Reciprocal Trade Agreements act. While there was evidence of growing support in big business and banking circles for free trade, there was widespread opposition from groups, including farm organizations, which feared import competition in the home market.

The United States had taken the lead, however, in negotiating new bilateral treaties of commerce and development, designed to replace the older treaties of commerce and navigation. "National treatment" was worked out in regard to investment, transfer of profits, taxation, employment policies and other modern issues. The number of treaties negotiated along these lines grew slowly, primarily because it was difficult to reconcile the viewpoints of the developing countries with those of the creditor countries. Double taxation treaties were even more difficult to negotiate since no government likes to exempt its citizens from taxes even on income earned abroad and likes still less to exempt resident aliens from taxes on income earned in its own territory. The attempts made to negotiate such treaties, however, indicated that the nature of trade in the second half of the 20th century would be different from the 19th-century trade based on treaties of commerce and navigation. Large corporations rather than individual traders, complex manufacturing operations rather than simple mechanical processes, heavy capital investments rather than mercantile offices had created relations which were not foreseen by the earlier treaties.

Return to Protection.—The leaders of the 19th-century British free-trade movement insisted that, whatever other countries might do, unilateral free trade would benefit Britain. They believed that other countries would realize this and follow the British example. The belief was not unreasonable in the first flush of success. There was a spurt of production and overseas trade in the 1850s, aided by rising price levels after the California (1848) and Australian (1851) gold discoveries. The competition of imported foodstuffs, mainly wheat from the United States, did not become serious until the extension of railroads and steam shipping poured a flood of cheap grain into European ports in the 1870s. This coincided with the collapse of inflationary price levels following the Civil War in the United States and the German wars in Europe—Denmark (1864), Austria (1866) and France (1870). During the 1860s there had been a widespread movement toward free trade among European countries. The proclamation of the German empire at Versailles in 1871 disturbed the European balance of power and checked this movement. The increasing volume of cheap American grain endangered agricultural stability and reinforced the demand for a return to protection in France and most other European countries. Britain sacrificed its agriculture and concentrated on manufacturing for export. The freedom of the London money market and the great volume of commerce and finance cleared through London made it the commercial capital of the world, where transactions were financed and cleared. As Germany, the United States and Japan challenged British manufactured exports in world markets, these commercial and financing functions became more important to the British economy. Only a few small western European countries to which trade was important—Belgium, Denmark, the Netherlands and Switzerland—followed the British free-trade example.

Until World War I the main challenge to British supremacy in world trade came from Germany. Manufacturing capacity of the United States expanded rapidly but was mainly absorbed by the domestic market. During the Civil War high tariffs to countervail the multiplicity of direct taxes imposed by the North to finance the war were maintained after domestic controls and taxes were abolished. Support for free trade had been concentrated in the cotton-exporting South, which lost its political influence after the war. But neither the United States nor the self-governing British colonies competed seriously with British manufactures in export markets. Japan built its manufactures with government aid behind a protective tariff and was beginning to compete particularly in the markets for cheap textiles, but did not establish its shipping and trade on a world basis until after World War I.

There had been a strong free-trade movement in Prussia after the Napoleonic Wars. The Prussian tariff of 1818, under the influence of Smithianism, reduced duties heavily. A combination of this free-trade movement with German nationalism led in 1834 to the formation of the most famous of all customs unions, the Zollverein. All trade restrictions were abolished, so that there was complete free trade among the German states. The British free-traders applauded this development and opposed Lord Palmerston's maneuvers designed to prevent or delay the customs union. Externally, also, the Zollverein pursued a low-tariff policy, which was continued in the first years of the German empire. Both the industrialists of the Rhineland and the large landholders (*Junkers*) of eastern Germany, who exported grains mainly to Britain, supported free trade. However, when France reverted to protection after 1870 and the free-trade movement in Europe was checked, Bismarck negotiated in 1879 a new political agreement upon a basis of protection both for industry and for agriculture. This was known as the compact of iron and rye. By this time American grain exports had conquered the British market and were landing in German ports. After 1879 Germany pursued an active policy of state encouragement to industry and agriculture behind a high protective tariff. State aid was also given to the drive for world trade, shipping and investment in the form of consular services, language training, subsidies and credit facilities. The applied science and technical training which was a feature of German universities and industrial laboratories gave leadership in the new chemical and electrical industries as well as metallurgy and dyes. German world trade and investment were expanding and the mark was becoming a world currency competing with sterling, when resort to arms in 1914 resulted in complete defeat.

German experience threw light upon the possibility that regional customs unions might be used as an approach to world-wide free trade. A customs union eliminates duties within the union. The price is usually adoption by all parties of the tariff of one protectionist participating country. This was the case with the United States, which based its first tariff on Pennsylvania's. The German Zollverein had a low-tariff policy for more than 40 years, but when it adopted protection it was a formidable cause of protectionism elsewhere. There is no assurance that the regional route to free trade (or peace) will not end in creating larger units of economic warfare. The only promising route is by unilateral tariff reduction on the part of the great trading and creditor countries.

After World War I Britain's position had been weakened and its vulnerability demonstrated. Other countries continued the reinforced protective policies adopted during the war. In 1925 Britain returned to a gold basis for sterling at the prewar parity and was involved in deflation at home and intensified competition in export markets. When the great depression was signaled by the collapse of the New York stock market in Nov. 1929, financial difficulties in Europe led to the depreciation of sterling in Sept. 1931. At this point Britain reverted to a protectionist tariff and simultaneously adopted both imperial preference, with lower duties on empire goods, and protective tariffs in the dependent colonies.

Later Methods of Trade Regulation.—After the breakdown of the international gold standard and Britain's reversion to protection in the great depression of 1929–33, a new array of protective trade restrictions was developed. At first these were emergency devices to check swollen imports from depressed national markets, prevent panic flights of capital and safeguard national currency systems from inflationary risks resulting from unbalanced external payments. These devices were *ad hoc*. Each country in the panic of 1931 dealt with its own trading unbalance as best it could. The methods fell mainly into two groups—direct restrictions on the quantities of particular imports, and restrictions on the use of foreign exchange, however acquired. After years of experiment and negotiation it became clear before the outbreak of World War II that exchange control had become the effective overriding technique of trade regulation. Import quotas, price controls and bilateral commodity agreements in various forms were supplementary techniques. The ultimate control was the power of a government to centralize dealings which resulted in its citizens' acquiring or losing purchasing power in other countries. Such dealings might be in the form of trade, exporting goods for sale or importing precious metals or other valuables to hoard; or they might be monetary and speculative. Once embarked on the regula-

tion of external transactions, governments were forced to extend their control over all payments entering and leaving the country.

War financing, together with the organization of economic warfare, increased the effectiveness of these systems of state regulation, gearing the external with the internal controls over national economies. When the war ended in 1945 there had been something approaching a codification of these restrictive trade and monetary practices, together with an evolution and rationalization of bargaining procedures in a succession of bilateral and multilateral conferences. A generation of officials and businessmen had grown up with no experience of free competitive trading on the basis of stable convertible currencies. A generation of economic theorists had come to regard restrictive trade practices as normal. From 1914 through 1955 there had been an approximation of exchange stability and free trading for only four years—between 1925 when Britain and many other countries returned to the gold standard and 1929 when the stock market crashed in New York.

The Bretton Woods agreements, negotiated among the western Allies in 1944, were intended to set up funds adequate to provide exchange reserves that could be drawn upon by countries which needed temporary support when their external payments were freely resumed on a basis of competitive trade. It was recognized that exchange controls and their supplementary devices could not be abolished immediately. A transitional period was envisaged. But the countries which agreed to set up the International Monetary Fund (*q.v.*) and the International Bank for Reconstruction and Development did so with the understanding that after this transitional period exchange controls and quantitative import restrictions would be abolished. (*See* BANK FOR RECONSTRUCTION AND DEVELOPMENT, INTERNATIONAL.) The final act of the Bretton Woods conference urged national governments to create "in the field of international economic relations conditions necessary for the attainment of the purposes of the Fund and of the broader primary objectives of economic policy." Earlier, in the financial agreements providing for lend-lease aid, each of these governments had pledged itself "to the elimination of all forms of discriminatory treatment in international commerce, and to the reduction of tariffs and other trade barriers."

Nevertheless, the discriminatory and restrictive practices of exchange control were extended and consolidated after the war ended. Greater emphasis was placed by most governments, and particularly by the British government, upon the principle of full employment. This had also been written into the master lend-lease agreements, into the charter of the United Nations and into many other international agreements. Conflict developed between the attainment of domestic stability at full employment on the one hand and external stability on the other. There was a considerable liberalization of trade between the western European countries, members of the European Payments union created in 1950.

Until the late 1950s most countries still employed import quotas and exchange restrictions, but in 1959 currency convertibility was restored by the United Kingdom and most other large trading countries. Exchange restrictions were retained mainly by countries undergoing rapid economic development. Import quotas, mainly on agricultural products, were retained by some of the developed industrial countries.

Multilateral Tariff Negotiations.—Economic nationalism after the 1930s made bilateral negotiations less effective. Tariff duties became less important as compared with other kinds of government intervention. Most-favoured-nation treatment had been applied in tested detail to tariff duties but no formula could be found to assure it in respect of exchange and quota allocations, government purchases and price controls. Moreover, trade and payments are not bilateral. The transactions between two countries affect other countries, so that there is a chain of payments among all trading countries. When World War II ended in 1945, it became clear that multilateral action was necessary both to restore the treaty basis and to attack the new discriminatory obstacles to trade, such as quotas and exchange control.

The United States in 1944 initiated negotiations aiming at creating an International Trade organization (ITO) as a United Nations agency comparable with the International Monetary Fund. The charter of the ITO was designed as a pledged statement of the rules for freer trade. In successive conferences at London (1946), Geneva (1947) and Havana (1947–48), the charter was elaborated with so many exceptions and escape clauses that Pres. Harry S. Truman decided not to submit it to congress for ratification. It therefore did not become operative.

At the Geneva conference, however, a group of 23 nations signed a General Agreement on Tariffs and Trade, incorporating the substance of the charter as originally proposed by the United States. The secretariat of G.A.T.T. called successive conferences and secured new adherents. At each conference further tariff reductions were negotiated multilaterally.

In 1962 the U.S. congress passed the Trade Expansion act to stimulate nondiscriminatory trading among the western nations. It was the most important U.S. tariff act since the Reciprocal Trade Agreements act of 1934 and was designed to enable the United States to negotiate on favourable terms with the European Economic community (E.E.C.), assuming Great Britain would be admitted to E.E.C. The act granted authority to the president for a five-year period to reduce existing U.S. tariffs by as much as 50% in exchange for tariff reductions by other countries, and to eliminate tariffs altogether on certain classes of products. At the same time, members of the E.E.C. and other regional groups continued along the road toward freer trade among themselves and with other nations.

See TRADE, INTERNATIONAL; SUBSIDY; TARIFF; ECONOMIC UNION; INTERNATIONAL PAYMENTS; MOST-FAVOURED-NATION TREATMENT. *See* also references under "Free Trade" in the Index volume.

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(J. B. CE.)

FREE VERSE is a prosodic term used in so many ways that it has almost lost any useful meaning, but it was originally a literal translation of the French *vers libre*. When Francis Vielé-Griffin declared in his preface to *Joies* (1888–89), "Le vers est libre," he gave a name to a kind of poem being written in France in the 1880s on novel prosodic principles. The French language does not have accent or stress on fixed syllables as in English, and until about 1880 metrists believed that the number of syllables was the basic principle of French versification, which used mainly the alexandrine (*see* ALEXANDRINE VERSE). Victor Hugo began the loosening up of the rigid alexandrine and the Symbolist poets continued the process. Gustave Kahn, an early vers libre poet, believed that the French language as actually spoken has accent, its position being dependent upon the meaning of the phrase and the emotion of the speaker, the intervals constituting the rhythm of the verse. This belief was confirmed by phoneticians in scientific laboratory experiments. Vers libre theory, therefore, called for the disregarding of number of syllables and observance only of the musical cadence. The prosodic unit was the phrase, not the foot or the line, and the complete sentence became the strophe. Rhyme was optional. Kahn, Francis Jammes and André Spire developed controlled techniques for handling this new verse form.

The first English poets to be influenced by vers libre were close students of French poetry. The most important were T. E. Hulme, F. S. Flint, Richard Aldington, Ezra Pound and T. S. Eliot. The movement called Imagism, started in England in 1912 by Aldington, Pound, Flint and Hilda Doolittle ("H.D."), was concerned with more than versification, but one of its principles was "to compose in sequence of the musical phrase, not in sequence of the metronome." But almost from the beginning the free-verse movement split into two separate groups, a formal one led by Pound, and a popular and confused one led by Amy Lowell. Eliot's early verse was influenced by the disintegrating blank verse of 17th-

century English dramatists and by the vers libre of Jules Laforgue, but by 1920 he turned back to formal metrics, though henceforth the iambic metre was to be used in the English language with more variety and subtlety. By mid-20th century most of the younger poets had followed the example of Eliot, and even Pound had become more metrical, but some of the older poets, especially Carl Sandburg, William Carlos Williams, Marianne Moore and Wallace Stevens, continued to write some variety of "free verse." The versification of Williams and Moore most closely resembled the techniques of the vers libre poets of France.

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(G. W. A.)

FREE WILL. The problem of free will, or of the freedom of the will, is complicated for various reasons. In the first place, the traditional formulation of the problem, its very name, is misleading. To ask whether the will is free assumes that there is such a thing as a will, which may or may not be free in its activities. This is a relic of the old and generally discredited faculty psychology (*q.v.*). Will is really a general term describing certain sorts of events (volitions) and not the name of an agent which performs them. As John Locke said, "We may as properly say that the singing faculty sings and the dancing faculty dances as that the will chooses" (*Essay on the Human Understanding*, book 2, ch. xxi, 17). It would be better to speak of the freedom of the self, that is of the person, than of an abstract will. But the term free will is too well established to be dislodged. Moreover the expression freedom of the self (or personal freedom) might suggest the problems of political liberty rather than the philosophical and psychological problems traditionally associated with the term free will.

The problem is complicated too because of the various points of view from which it may be approached. The psychologist and the epistemologist are mainly interested in the apparent conflict between freedom of choice and the usual scientific assumption that all things, including mental events, are subject to law and necessity. The moral philosopher is primarily interested in free will as a postulate of the moral life. For if a man is compelled by past circumstances to do what he does and no alternative action is open to him, how can we say he ought to have done otherwise or blame him for what he did? "I could not help it" is a complete defense. The jurist is concerned with the relations between free will and responsibility. Can punishment be justified if the criminal had no choice but to commit the crime? Lastly, the theologian has an interest in the problem, since free will seems to involve the denial of God's omniscience and omnipotence or of his justice. For if men are truly free to choose then God cannot foreknow their actions or control their choice; but if men are not free then God cannot be justified in punishing or rewarding them for their deeds.

The central problems were accurately formulated by Henry Sidgwick:

> Is my voluntary action at any moment completely determined by (1) my character as it has been partly inherited partly formed by my past actions and feelings, and (2) my circumstances, or the external influences acting on me at the moment? or not? Could the volition I am just about to originate be certainly calculated by anyone who knew my character at this moment and the forces acting upon me? Or is there a strictly incalculable element in it? (*Methods of Ethics*, p. 46).

The Scientific Problem.—By the beginning of the 19th century there had developed a sharp opposition between science and free will. No scientist indeed would defend the crude fatalistic theory that my action, or my fate, is determined by forces wholly independent of me, so that it is bound to come no matter what I do to prevent it. Nowhere in nature is the fate of any object determined wholly by factors independent of the object itself. Its own nature must always contribute to the result.

But scientists had worked for three centuries on the assumption that all observable events can be brought under the law of universal causation. Their triumphs had been continuous and unchecked. Could it be possible then that the behaviour of a single species on a minor planet in one of the countless solar systems should escape a type of determination which had been found to apply to the smallest particles of matter and the largest and most distant heavenly bodies? Everywhere nature showed itself to be the playground of irresistible forces and subject to complete and exact scientific prediction. To explain an event was to give the causes whose conjunction rendered it inevitable. It was true that until 1850 these claims had been justified only in the world of inanimate matter. But Charles Darwin in biology, Karl Marx in sociology, and Ivan Pavlov and Sigmund Freud in psychology were now to advance causal explanation across the frontiers of life and mind. It could surely be only a matter of time before life was synthesized in a laboratory and human action was predicted and thus controlled by the same techniques as had tamed the elements. Some scientists continued to make these claims for science and many ordinary men to think of science as presenting this solid front against free will.

From the beginning of the 20th century, however, the scientific atmosphere completely changed. There came to be little talk of irresistible forces in science or indeed of any forces at all. To say that a magnet attracts iron filings is unscientific, for this attraction is completely unobservable. What can be verified and therefore should be said is that, in the vicinity of a magnet, iron filings move in certain paths or arrange themselves in certain patterns. There is no compulsion here. What is observed is regular conjunction and no more. Again, in this regularity there is no observable necessity. Scientists no longer claimed to explain why events occur. They describe how they occur. And since no one can see why events are conjoined as they are, the only evidence for such a conjunction is repeated observation of its occurrence. Moreover the predictions based on such observations are only probable, just as the measurements which the observations involve are only approximate. No scientist will claim to say *why* any event happens; no scientist will even claim to predict with certainty *that* it will happen. Finally, it was shown that scientific laws cannot be applied with complete exactness to the behaviour of the electrons which are the ultimate constituents of matter. It has been well said that this "principle of indeterminacy" is not a "principle of indeterminism." It says that the position and motion of an electron cannot be precisely determined (discovered by measurement or predicted). But this does not mean that the position or motion is not determined (*i.e.*, correlated with pre-existing conditions of the electron and its environment according to a set of laws). In particular it does not justify us in attributing to the electron anything corresponding to free will or to talk of it as suddenly deciding, for no special reason, to jump from one orbit to another. Nevertheless, if it is true that certain facts about electrons cannot be discovered by measurement or predicted from no matter what evidence, this underlines the conclusion that all scientific prediction is based on observed statistical regularities and can never yield more than a probable result.

Even if these admissions were all that science would make, they would suffice to render free will possible. For, as will be argued below, no free will theory need claim that a man can choose in complete independence of his past and his environment, nor deny that decisions of a certain kind are probable,—for example, that a man who has resisted a certain temptation frequently will probably resist it next time.

There are, however, some special features of human conduct which make even the milder claims of modern science doubtful when applied here. There are three features of scientific method which seem essential for any close approximation to accurate prediction. The first is measurement. There are always differences between the specimen whose behaviour is to be predicted and those other specimens on whose observed behaviour the law was based—differences of mass, of distance from other bodies, of proportions of elements, etc. When the scientific law is applied to the new specimen, these differences have to be represented by

giving quantitative values to the variables in the law. For example, in order to predict from the law of gravity how much body x will attract body y we must insert the distance between them as a quantity in our calculations. Now the psychological phenomena from which human conduct would have to be predicted are not measurable. While it makes sense to say that I am in greater pain or less angry than I was, it does not make sense to ask whether my pain has trebled or my anger been reduced by 9%. The only hope of measuring psychological phenomena is to measure their physiological accompaniments. But to predict conduct wholly from physiological conditions results in denying either the existence or the causal relevance of psychological states. The former denial (that involved in materialism or behaviourism) became generally discredited. The view of psychological states as "epiphenomena" —events accompanying but not making any difference to physiological processes—is difficult to reconcile with evolutionary theory. For such epiphenomenal states would be useless to the organisms which manifested them and should therefore have atrophied and disappeared long ago, instead of increasing in number and complexity as they clearly have.

If these psychological phenomena are not quantitatively measurable, prediction is impossible. For example, a psychologist may establish that a child who is shut up in a dark cupboard will subsequently tend to fear the dark. But he cannot give any quantitative value to this fear and can therefore do nothing to predict whether, in a particular case, the rival forces will defeat this fear if it appears in conscious form or be able to repress it altogether so that it shows itself only in dreams.

The other two features of scientific method which may make it inapplicable in full rigour to human conduct are analysis and repetition. By analysis is meant the power to concentrate on certain features of an object—*e.g.*, its mass and motion, or its chemical constitution, or its spectroscopic behaviour—and to regard others of its features as irrelevant. Not that every one of its features can be dealt with in isolation; for mass and motion are both involved in the laws of physics, and chemical constitution is found to be connected with spectroscopic behaviour. But if *no* feature of a substance could be excluded as irrelevant to the establishment of a law concerning its behaviour then no such laws could be established. Two bodies may have the same mass and different acceleration, the same chemical constitution and different shape or size or weight. If this were not so, no experimental work would be possible in science. Now there are good grounds for holding that this kind of abstraction is impossible (or possible only for very general classes of events and in a very rough and ready fashion) in regard to human beings and their psychological states. The traits of a man's character are so interwoven that none of them would be what it is without the others; and these traits correspond to the force or features which determine the behaviour of a scientific object. His quick temper helps to determine his kind of courage, his wit gives his quick temper its peculiar edge, his intelligence lightens his wit, his sensitivity broadens his intelligence, his imagination extends his sensitivity; and so on. Similarly his psychological state at a given moment defies analysis into anger plus fear plus shame plus jealousy, etc. The unity of the self and of its psychological states makes the attempt to study one motive or element in isolation from the others a falsification of the facts. Such dissection spells death.

The third feature of scientific prediction is repetition. By this is meant the assumption that the set of factors isolated by analysis can be trusted to recur in other specimens, and that most differences between the specimens will be irrelevant, while those that are relevant can be expressed as quantitative values of the variables in the scientific law in question. But each human personality is unique. Study of a number of pieces of sodium provides good evidence for the behaviour of the next piece of sodium. But study of the behaviour of Smith, Jones and Brown is poor evidence for the behaviour of Robinson. It is just this irruption of uniqueness of personality which has made authorities on aesthetics, on textual criticism, on strategy and on education deny that these studies can ever be adequately dealt with by scientific method or ever achieve scientific standards of predictive accuracy.

There is also one special difficulty in regarding human conduct as completely determined and completely predictable. Human thought is part of human conduct; and the scientific or philosophical views of any man would have to be regarded as predictable consequences of his causal situation. While this kind of explanation is welcomed by any thinker as accounting for the errors of his opponents, he can never accept it as applicable to the truth of his own view. A Marxist maintains that all human conduct is determined by economic processes, by the class structure of society. A man may think he is deciding on a course of conduct because it is right. This is an illusion; all his decisions are determined by class interest. What he calls morality is that set of rules which enables the class in power in his society to preserve its domination. The Benthamite laissez-faire theory of economics has no rational validity; it merely reflects the interests of the bourgeois industrialists among whom it arose. But, if so, Marxist economic determinism itself has no rational validity. It also is an illusion, a mere by-product of local and temporary class interests, bound to be superseded as history develops. It was bound to be believed by 19th-century working men, but there is no need for any other people at any other time to accept it. Its claim to truth is as much an illusion as the moral values it tries to undermine, the religious dogmas it opposes, or the rival economic doctrines it attacks.

It may be said that any attempt to shut off an area as impervious to scientific treatment is a counsel of despair. Whenever this has been tried before it has failed. Science has swept in and conquered. The area of human conduct, too, is an insignificant one on a world scale. Why in this remote corner should laws not hold and prediction fail? Perhaps an answer is that only in this remote corner, so far as we know, can such questions even be asked. Knowledge of the universe is already so astonishing an exception to the general pattern that it would be surprising indeed if other special features did not distinguish man's life. It is surrender to sheer size that tempts men to think the spiral nebulae a more impressive wonder than the minds of Sir Isaac Newton and Albert Einstein.

Moreover the argument so far does not shut off any area from scientific inquiry. Psychology, sociology and economics are entitled to try any methods they like. All that is said is that their predictions will have a lower probability than predictions in other fields. They will succeed so far as quantitative physiological behaviour is found to provide an accurate clue to psychological processes, so far as elements in the self have a nature of their own in isolation from the rest, so far as men resemble each other in the characteristics relevant to the inquiry and so far as their differences do not seriously affect the result. There is good reason to believe that in all the parts of human conduct which matter most to man (parts other than blinks and knee-jerks) these conditions are largely unfulfilled. Nevertheless for large-scale statistical purposes, such as insurance or advertising, prediction may yield a result both generally informative and practically useful.

The Ethical Problem.—So far the argument has concerned the second half of the problem as posed by Sidgwick in the passage quoted near the beginning of this article: "Could the volition I am about to originate be certainly calculated?" It may be said, however, that determinism does not require predictability. A man's act may be completely determined by his character and circumstances even if his character is so unified as to be unanalyzable and so unique that no one else resembles him; so that prediction remains impossible. The first half of Sidgwick's question is still to be answered: "Is my voluntary action completely determined by my character and my circumstances?"

It was previously supposed that nothing could stand against the deterministic march of science except our direct awareness of free choice and the fact that free choice is required for moral responsibility. Various attempts have been made to show that moral responsibility, far from requiring indeterminism or free will, really requires determinism. For when we praise or blame an action we praise or blame a man *for* his action; that is, we commend the self or character from which the action issues. But then it must issue from the self or character. If it were the case that, given my self as it is now, two alternative actions were possible (a brave and a

cowardly one) then neither could issue from my self, nor be connected with anything else. Choice is equivalent to chance, caprice or chaos. If I give a reason why I acted (that I admire Bach or that I was hungry) this cannot be the reason; for, given exactly that degree of hunger or admiration, I could still have acted otherwise. Mental life for the indeterminist is a mere sequence of isolated decisions.

Now the determinism which these criticisms invoke is something different from determinism as understood by science. Historically the first and most influential of such theories was propounded by Immanuel Kant. Kant held that, if science could give a complete causal account of human conduct, moral experience would be inexplicable. The scientist must go ahead with his determinist assumptions and his causal explanations. But the whole sequence of causes and effects which he unfolds is merely appearance. Human conduct must also be regarded as determined by moral laws. Man, as appearance, is subject to causal law; man, as reality, is subject to moral law. Moral law is the command of man's reason and in obeying this law man is free. Now this view is unsatisfactory as an account of freedom. It leads to the view that good or dutiful actions are determined (non-causally) by moral law and that bad actions are determined (causally) by scientific law, and that only the good actions are free. But it is essential for moral responsibility that bad actions should be free just as much as good actions. It is also essential for morals that man as a moral agent should be "under" or "obliged by" moral law but not *determined* by it. For the meaning of "ought" excludes "must."

From this Kantian view of freedom many related theories developed. A man was held to be free only when his higher or rational self, or his ideal personality, determined his action. Thus, in politics law and liberty could be reconciled, and a man could be forced to be free when the law of his state imposed on him actions which his higher self would approve, but which desire would otherwise have compelled him to shirk. Or again, a good chess player will see alternative moves which an inferior player confronted with the same position does not see. And one is tempted to say that the skilled player has more freedom than the unskilled and thus to link freedom with intelligence. These tendencies often arise from the demand that some *positive sense* should be given to freedom. The self which is free must be of a different kind from the unfree self. So we hear of "the true self," "the real self," "my real will" and, in the prayer, the phrase "whose service is perfect freedom." Freedom and service are of course compatible provided that the service is chosen, and the right and reasonable action may be freely done. But these identifications are fatal to responsibility. It is essential to maintain the compatibility of freedom with desire and with the primrose path. Service of the devil must be perfect freedom too.

There is a different version of self-determinism, which allows both good and bad acts to issue from the self. I have various *motives* and among these are desires and the sense of duty. When I do my duty this shows that the motive called sense of duty is stronger than alternative motives (desires). The process called "deliberation" is how the conflict of motives appears to the agent at the stages when no one motive is yet strong enough to win in the face of all the rest. "Choice" is the appearance to the agent of the final swing-over by which duty (or desire) defeats its rivals.

Now in addition to the difficulty of analyzing the self into motives (noted above) there are two special difficulties about this account. Firstly, the term motive was required because desire and duty are so different in character. It is an abuse of language to say that there is a desire to do one's duty and then to maintain that the strongest desire always wins. We are too well aware of cases where we know we ought to sacrifice what we most desire. But the term motive has its own difficulties. Suppose I want to see a play and am also comfortable by the fire and am aware of a conflict; but finally I go off to the play. It would be absurd to call this a conflict of motives; for then desire for warmth and comfort would have been one of my motives; and if on my way to the theatre I had been asked what my motives had been I should have had to say I had two, a desire to see the play and a desire to stay by the fire. We only call anything a motive if in fact it did lead to action. So to say that any motive whatever wins the day is a tautology. If to avoid this we coin a new name to cover all the competitors, say "psychode," we may now say that the strongest among the psychodes will win. But the only evidence I can possibly have that this psychode was the strongest is that it did win. So here again is a tautology which does nothing to assist determination, just as the fact that the candidate with most votes is the winner does nothing to inhibit the freedom of the electors.

The failure of any such analysis of the self may lead to another version of determinism, according to which the self-as-a-whole is the cause of its actions. Such a view (represented in English by F. H. Bradley) will refuse to dissect the self or treat it as a case under a general law. Yet it will maintain that unless the self is the cause of its acts, these acts are contingent, capricious, irrational and irresponsible. There are two independent routes to this goal. One starts from the facts of praise and blame, reward and punishment, which are supposed to require freedom of will. The difficulty is to find any criterion of freedom of will to distinguish acts for which we hold a man responsible from acts for which we do not, so that we can determine, before we praise or blame or punish, whether we are entitled to do these things. The argument starts from punishment. It is admitted that there still lingers in the minds of many people a retributive attitude to punishment, the idea that a man should be made to pay for his sin. But it is held that this attitude is retrograde and barbaric and is anyhow on the decline. It has been almost entirely replaced by the view that punishment is deterrent and reformative. This latter view is utilitarian and justifies punishment by its consequences. If we now ask which acts we are justified in punishing they are those from which men can be deterred by punishment. And here is one criterion for responsibility. A man is responsible for a theft if punishment would have deterred him from doing it and will deter him from doing it again. We do not punish the kleptomaniac because punishment will not deter him. We say he was not free or responsible for his action. But this is not an additional reason for not punishing him. It is the same reason over again. To say he was not responsible is to say punishment would not have deterred him. The same theory is applied to praise and blame. The *only* justification for praising or blaming anyone is to encourage or discourage him and others in that course of action. That the man has freely done the thing for which he is praised or blamed is not *another* justification for praise or blame. It is only another way of saying this is an action which praise and blame could have affected. Now this is obviously a determinist theory of conduct. For the distinction it draws between free and unfree action is not a distinction between uncaused and caused action but a distinction between actions whose causes can include praise, blame, reward, and punishment and those whose causes exclude these. (Similarly deterrence and reform theories of punishment imply a determinist view of human conduct.)

Now this ingenious theory seems to miss an essential feature in punishment and blame. A deterrence or reform theory of punishment is quite compatible with punishing a man for something he did not do. And this is felt by most people to be the worst fault in any punishment. That this is no retrograde or barbaric survival, "on the way out" in modern times, is shown by the ever-increasing care that guilt should be confirmed beyond question, that *mens rea* should be established, and also by our repugnance to the "framed case" or the "confession trial," whose objects are indubitably (and perhaps very successfully) deterrent.

The second line of argument which maintains a necessary connection between self-determinism and responsibility is that mentioned earlier in this article. When we praise an action, we praise a man for the action. "That is a brave deed" and "That is the deed of a brave man" are equivalent, and the latter expresses more explicitly what we want to say. But if so the act must issue from the self and give a clue to its nature. If, given my self as it is now and the circumstances as they are now, two or more alternative actions are possible, then none of them can be said to be caused by the self as it is now or give a clue to its nature. Further, it is said,

this determinism does not offend our natural dignity as human beings. If anyone predicts my action on the grounds that budget estimates show conclusively how much beer or tobacco I shall consume in the coming year, I laugh at him. If he says: "I know what you will do because I have calculated the strength of the rival forces: your desire for praise, your love of your family, your passion for bridge; and the answer comes out as follows," I laugh louder still. Or he says: "I know what you will do, because I know what people of your class and profession do when put in this kind of position"; and I am offended. But suppose he says: "I *knew you* well enough to know you could not have done that"; or, "You are one of our most reliable members; I was sure, *knowing you*, that you would be here." I accept and welcome this prediction because it is based not on statistics, not on comparisons or on abstractions, but on knowledge of me.

Now it seems true that this theory is the only one of all determinist theories which comes within sight of doing justice both to the nature of human personality and to the demands of moral experience. Yet it too has serious difficulties. It claims that a prediction of my action based on knowledge of my character is both legitimate and acceptable to any self-respecting person. But it is acceptable only if the action predicted is a good one. If a man says: "I knew you well enough to know you would not have done that—you are too afraid of unpopularity"; or, "You are one of our most reliable members; I was sure, knowing you, that you would keep us all waiting," I shall not be likely to accept or welcome such predictions. When I accepted and welcomed those other predictions I was confusing prediction based on character with praise for a good choice and approval of a good character. It was these I welcomed. Moreover prediction from character has its own pitfalls as a rational process. It implies that character cannot be changed by action. But it is obvious that all a man does makes a difference to him. There can be no adequate evidence from others what this difference will be nor what the new self will do, as it will have been in the making right up to the moment of action. Winston Churchill described how the German ambassador to London was recalled for not having foreseen David Lloyd George's Mansion house speech of 1911. Churchill comments: "How could he know what Mr. Lloyd George was going to do? Until a few hours before, his own colleagues did not know. Working with him in close association, I did not know. Until his mind was definitely made up, he did not know himself." Nevertheless the self-determinist theory has a very strong case in demanding a connection between the self and its acts even if prediction is still held to be impossible, even on the basis of the agent's own character as deduced from his previous actions.

Indeterminism on the other hand need not deny all connection between character and actions. The free choice it defends must be a choice between *presented* alternatives; and the alternatives that occur to a man will obviously reflect his character and his desires. Indeterminism need not reject probability. It is indeed improbable that a drunkard will resist temptation, for the possibility of yielding to it will present itself to him with great attractiveness. Some indeterminists find the only evidence for free will in choices which go against the strongest desire, choices which require an effort of will. While these cases certainly provide the strongest evidence for free will, it seems unwise to maintain that only in these cases is free will exercised. For a man must be free to put forth or to refrain from such efforts, and the drunkard must be as free when he succumbs as when he resists. It is once more the search for some positive sense of freedom and for a link between freedom and moral goodness which has tended to conceal this requirement.

Here perhaps is the place to refer to the evidence for freedom gained from direct experience. It is possible to hold that we might be directly aware of the efficiency of our will; we might see directly that our volition was a cause or part-cause of our thoughts or images. This is doubtful, but even if granted it is not enough. What free will requires is that our volition should be uncaused; and it is hard to see how we could directly experience an event as uncaused. It is true that we have an ineradicable belief in our own freedom and in open alternatives for our choice. This might be an illusion, for its survival could well be a tribute to its biological utility. As Sir David Ross said, a man is more likely to work for an examination and therefore to pass it if he thinks it is uncertain whether he will pass or fail. If he thought either was certain he might well slacken his efforts. Yet we also saddle ourselves with burdens of guilt and remorse and these beliefs would seem to hinder effective action and to be useless illusions and therefore biologically puzzling.

The arguments for self-determinism (without prediction) and for indeterminism both seem powerful and neither can wholly answer the other or wholly satisfy the demands of moral experience. In such a situation no quick and easy solution is to be expected. Most philosophers who have given full and careful consideration to free will describe it as the most difficult problem in philosophy and themselves show dissatisfaction with their own tentative solutions. But when two opposing cases seem equally strong and yet both seem open to fatal objections it might be that something was wrong with the question to which both were answers. The question was "Given my self as it is now and the circumstances as they are now, is only one action possible or are alternative actions open to me?" Now what may be wrong here is the absence of any indication of the time of the action or actions in question. There are two possibilities. The problem may be "Given. . . . etc., is only one action possible for me *now?*" or "Given. . . . etc., is only one action possible for me at some future time?" Careful scrutiny of the passage from Sidgwick quoted near the beginning of this article will show that in the first sentence Sidgwick adopts the first alternative ("My action *at any moment*" . . . . "influence acting on me *at the moment*") and in the second sentence the second alternative ("the volition I am *just about* to originate" . . . "character *at this moment*"). Let us take the first alternative "Given my self as it is *now*, is only one action possible *now?*" Yes, because the action in question is the volition (and not any physical movement) and the volition *is* the state of myself now. If I see a man frowning and ask him to describe his self "as it is *now*" he may say: "I am trying to understand this article on free will." If I ask him what action he is performing *now*, he will reply: "Trying to understand this article on free will." So the question cannot be put in the first form without becoming a tautology. We pass to the second alternative. "Given myself as it is *now*, is only one action possible *at some future time?*" No, because what my self will do and accordingly how it will change in the time intervening between "now" and the "future time" is not specified and, unless it is, alternatives cannot be eliminated. An attempt may be made to meet this difficulty by shortening the interval between the date of the "given self" and the date of the "action." But so long as there is any interval the objection holds and when the interval completely disappears we are back with the first solution and its tautology.

This emphasis on the time factor finds support in more careful analysis of the one strong argument for self-determinism. When we praise an action we praise the self whose action it is; and we are therefore committed to a necessary connection between the self and the action, and this is determinism. But what self do we praise? Not his *past* self; not even his very recently past self. We praise a man's character—his courage, his integrity, his sense of humour. Now these are dispositions. Elasticity is a disposition of rubber. We say: "It is elastic so it will stretch or compress." But it is not because the rubber *was* elastic that it *now* stretches. Those who have built on these facts about praise and blame a determinist theory have confused the relation between a cause and its effect with the relation between a disposition and its manifestations. It is not the courage of a man in the immediate past which explains his present prowess. If it were, there would be time (however short a time) for it to dwindle. The connection between the self and its action is more like that between the hammer and its weight; the hammer is not the cause of the weight. But this removes the one remaining argument for determinism, and free will seems to hold the field.

The Juridical Problem.—It was mentioned above that the deterrence and reform theories commonly accepted as best explaining punishment imply a determinist view of human conduct; but, on the other hand, the one essential feature of punishment is that only

the guilty should be punished and this implies responsibility and freedom of will. This raises the other juristic problem in this field, that of deciding when a man is responsible. The difficulties arise over the plea of insanity. Though they cannot be fully dealt with here, it may be said, in relation to the central problem, that no jurist would propose to abolish altogether the distinction between responsibility and insanity. A man will be held responsible unless there is special evidence that rebuts this assumption and indicates that the impulse to action was irresistible. But on the determinist theory of action, every impulse from which a man does in fact act is irresistible. Thus, though the difficulties of deciding which acts are free are serious, their existence is an argument for and not against free will. (J. D. M.)

The Theological Problem.—The theological problem of free will arises out of the contrast between the fact that freedom is obviously one of the higher attributes of man, while at the same time it is generally understood to involve the possibility of preferring evil to good. Thus, together with the problem of reconciling free will with predestination (*q.v.*), there arises the further question whether, if free will is thus imperfect, it can be predicated of God.

No account of God could make him appear free in the delight that he takes in contemplating his own essence; this is an act of will, though it is not free. The fault of Narcissus, in classical mythology, was that, while no more than human, he tried to do what God alone can reasonably and must of necessity do. God understands fully his own being: it is supremely good; he must take delight in it. Creation, however, has always been understood in Christian thought to be a free act of God. In this the Christian philosophers broke ground on which the Greeks had not entered before them. Creation cannot add any perfection to God, nor is he in lack of anything that he should seek by creating to supply; and if the created universe were in any way necessary to God, he would not be infinite. Even if it is claimed that some creative activity, though not the making of this particular universe, is a necessity for God, he is thereby bated of his infinity.

Analogous to the twofold activity of God, the internal activity being necessary and the outward-looking one being free, there is to be distinguished in man, according to Christian thought, the necessary adoption of a goal of life (happiness) from the free choice of the means thereto. These means will, of course, differ widely according to the different ideas of happiness current and the different degrees of alertness in the will choosing. Free will in man is thus seen not to be an imperfection due to his lack of knowledge (as many Platonists have thought) but to be an imitation of the free creative activity of God.

The difficulty raised by the Christian idea of freedom is that one is tempted to project back into God's creative activity something like the evil choices that men make. The answer to this, elaborated above all by St. Augustine against the Manichaeans, is that God is more glorified by the willing praise and service of men than by the automatic adoration of a robot. In his choosing to create men who resemble himself by having free will, God permits (but does not command) that men may abuse their freedom. Before God could be condemned at the bar of reason for his action, it would have to be assessed according to the moral principles that govern an action which has two effects. The principle of the "double effect," which applies in a complex moral situation, requires that where an act is morally lawful in itself but has two effects, one good and one evil, (1) the good effect must be sought, the evil one merely permitted to happen; (2) the good effect should not arise through the bad; and (3) there should be a reasonable proportion between the good and evil effects. Now since God in creating free men wills the good effect of his act and does not seek that men should praise him through evil means, the only element open to question in this analysis is the third, namely the proportion between good and evil effects. Human intelligence cannot strike a balance between the good and the evil involved in creation, but God can. Thus while there is a mystery involved in human free will, it is not a mystery which affronts reason. If it be urged that God's infinite wisdom should have been able to find a way round this "double effect" situation, the answer that a Christian would give is that the request falls back precisely into the originally rejected assumption that the praise of God by a robot must be more valuable to him than that of a free man. If human free will were exempt from all tares, this would imply that man is as perfect as God is in mind and will; man's free choices in the search for happiness would all have a clarity of prevision and an alertness of decision beyond what a creature could claim. A Christian would go on to point out that the scales have been tipped in the direction of evil since the original planning, but he would not argue this from principles of reason, as the idea of original sin is a matter for revelation.

The ethic of the scholastic nominalists deemed acts to be morally good when they conformed with God's command rather than with any eternal law (*see* NOMINALISM). Martin Luther, who followed William Ockham in philosophy, regarded all natural virtue as false: pagan heroes, such as Regulus, must have been athirst for glory and thus evil by intent. Championing the bondage of the will against Erasmus' defense of its freedom, Luther urged that God is all-powerful and foresees all things; hence "there is no such thing as free-will." Luther's view implied that the inerrancy of God's foreknowledge must derive from the fixity of its object (man's destiny) and could not be due simply to the power of penetration of the divine intellect. It also required that God reprobate some as he saved others.

John Calvin held the Lutheran view of free will, but not as a truth of reason: he based it on the ground of Scripture, which declares what God has done rather than what he could do (*see* CALVIN, JOHN: *Theology*). Calvin allowed that Adam possessed freedom of choice, but to look for this in later generations was to confuse philosophy with revelation; men did not work *in vacuo*, but with or against Christ. The only morally good acts were those which the triumphant grace of God performed in the elect. The rigour of this view aroused much opposition (*see* ARMINIANISM; ARMINIUS, JACOBUS). It substituted, as Karl Barth saw, an analogy of action between God and man for the analogy of being which was traditional. Man's free will was not like God's, and the only link between divine and human planes was when the Spirit wrought justice in us even in spite of ourselves. The position of Christ is the key to this difficulty.

The concern of God with the balance of good and evil in the world is held by some theologians (chiefly the followers of St. Thomas Aquinas) to be the ultimate motive of the incarnation; thus God could be said to have seen to it that for the destiny of the world "in the end all shall be very well," as the mystics have claimed. Others (the followers of John Duns Scotus), holding that it would be unworthy for God to be as it were beholden to sin for such an achievement, consider that the incarnation was willed by God so that Christ could be the crown of all creation, without regard to the sinfulness of the world. For them the only difference made to the plan by the weight of evil in the world is that Christ came with a body that could suffer, whereas otherwise he would have had a glorified or impassible body. Both groups alike have to face the problem of free will in Christ. When divine and human natures are present in the one person, as all Western and many Eastern Christians believe them to be in Christ, the human problem of free will is heightened, for now in close conjunction there are the divine will and a human will which, to be human at all, must remain free. Some suppressed the problem by denying the duality of natures (*see* MONOPHYSITES), while later the Monothelites (*q.v.*) held that only one will, the divine, operated in Christ.

The terms of the problem were set by Scripture. The full humanity of Christ was taught in Heb. iv. 15; his willing human obedience to a divine command appears in John vi. 38, and xiv. 31; the apparent reluctance of the agony is emphasized in the Synoptic Gospels (Matt. xxvi. 39; Luke xxii. 42). Christ's redemption of mankind has to be free to be meritorious, but if his intellect were fully illuminated by divine knowledge, it would be in immediate contact with its own true happiness and no more free than any human being who was in that state. Joy and sorrow are contraries, argued Aquinas against himself, and the soul of Christ was altogether sorrowful at the time of the passion; it could not therefore at the time be wholly joyous. The answer to this is a theory

of suspension within the soul of Christ. The higher part of the soul was still possessed by the delight of the vision of God, but this delight did not overflow and pervade the whole soul. Thus the soul, being united with a body that was suffering pain, could share in that pain and freely choose to go on suffering. The joy and the sorrow would not then be direct contraries but would be two vectors of a tension in the soul. Another approach to the mystery of Christ's free will might be made by a comparison of it with the inspiration of a prophet by God; here (although two persons are involved) there is an overmastering message from God and yet somehow the language is stamped with the personality, crude, brusque or impetuous, of the human prophet. If the techniques of psychology have made this mysterious conjunction a little more intelligible to the theologian, it may be that by analogy some light could be cast from it on the deeper mystery.

While the close conjunction of Christ's humanity with the divine nature did not take away free will, that conjunction was not so far relaxed as to make that human will capable of sin. The fact of sinlessness in Christ is vouched for by early theological statements in the New Testament (Heb. iv, 15; II Cor. v, 21; I Pet. ii, 22); that Christ could not have sinned was argued by the whole of Christian antiquity. From time to time there have been attempts to introduce some element of sinfulness into Christ's human nature, for the sake of making that nature appear more genuine, its free will more like ours, or even its virtue more triumphant, but always the theological difficulties implied in these attempts have proved greater than their advantages. Against them the comparison made by Origen of the human nature of Christ and the sword in the furnace proves apt enough: while it stays in the furnace it is red-hot, if it were drawn out it would eventually become cold steel, but it never is drawn out. Such varied thinkers as Marsilius of Padua, the Lutheran Gottfried Thomasius and the so-called "kenoticists" who followed the Anglican bishop Charles Gore have all played with the idea that somehow Christ "emptied out" his divine knowledge and power, so that his free will was not only in nature but also in its functioning exactly like ours.

Now while it has been acknowledged above that God may permit evil as a by-end of human activity, such tolerance extends only to those who come under God's general providence for the world. Where the godhead is intimately united with the human nature of the man Jesus, such tolerance must give place to the overmastering holiness of God; otherwise the very reality of the union would be in question and a Nestorian division of Christ would have to be postulated. Nor does this overmastering have the result that Christ becomes in his human nature an automaton. Harmony of passions to reason in man (which is itself productive of greater freedom of the will rather than less) depends on the higher harmony of the whole soul with God. Christ, in whom this higher harmony is perfect, must therefore in his human life have possessed supremely that "reach" or alacrity of will or active indifference (to give it its technical name) after which other human beings strive in painful efforts at self-mastery. *See* DETERMINISM; *see* also references under "Free Will" in the Index volume.

(J. H. CN.)

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(J. D. M.)

FREEZING (HOME): *see* FOOD PRESERVATION (IN THE HOME); HOME EQUIPMENT.

FREGATIDAE, a family (order Pelecaniformes) of large sea birds comprising the genus *Fregata*, the frigate birds (*q.v.*).

FREGE, GOTTLOB (1848–1925), German mathematician and logician, was born at Wismar. After attending the *Gymnasium* there he studied in the universities of Jena and Göttingen, and then taught mathematics at Jena as *Privatdozent* (1874), associate professor (1879) and titular professor (1896). Not content with what had been achieved in the arithmetization of analysis, he made it his life's work to exhibit arithmetic as a development of logic.

In his *Begriffsschrift* (1879) Frege began by expounding a new *calculus philosophicus et ratiocinator* such as Leibniz had projected, and gave the first clear account of a propositional function, the first set of axioms sufficient for the restricted calculus of propositional functions and the first definition of the so-called ancestral relation. Discouraged by the poor reception of this effort toward logical rigour, he then tried to win favour for his main thesis by writing *Die Grundlagen der Arithmetik* (1884) in plain German. Apart from criticisms of rival views, this contains a definition of natural numbers by use of the notion of one-to-one correlation between the objects falling under various concepts. But in his *Grundgesetze der Arithmetik* (1893 and 1903) he returned to his ideal of rigour. Though this work employs the same logical symbolism as the *Begriffsschrift*, it contains new doctrines about meaning first expounded in his three papers *Funktion und Begriff* (1891), *Begriff und Gegenstand* (1892) and *Sinn und Bedeutung* (1892). At this period he wrote also *Über die Zahlen des Herrn H. Schubert* (1899).

One of the few readers of the first volume of the *Grundgesetze* was Bertrand Russell, and in an appendix to the second volume Frege ruefully admitted that this young philosopher had derived from his system a paradox about the class of all classes which are not members of themselves, but he said that he was still convinced of the possibility of deriving arithmetic from logic, and he made some suggestions for evading the difficulty. After this he wrote a few papers on logic, but did not contribute further to the controversy about the foundations of arithmetic. The importance of his achievements in mathematical logic was not fully recognized until some time after his death, probably because his symbolism had been superseded by that of Giuseppe Peano, A. N. Whitehead and Bertrand Russell.

The *Grundlagen* was translated by J. L. Austin as *The Foundations of Arithmetic* (1950), and there are also *Translations From the Philosophical Writings of Gottlob Frege* by P. Geach and M. Black (1952).

(W. C. K.)

FREGELLAE, an ancient town of Latium on the Via Latina, 11 mi. W.N.W. of Aquinum, near the left bank of the Liris (Liri) river. It is said originally to have been occupied by Opici and Volsci and later to have been destroyed by Samnites. In 328 B.C. a Latin colony was established there. Captured by the Samnites in 320 but recaptured by Rome in 313 or 312, it remained loyal to Rome during the Pyrrhic and Hannibalic wars, hampering Hannibal in 211 and leading the loyal colonies in 209. It flourished because of its command of the crossing of the Liris and its fertile territory. In 125 it revolted against Rome, but was captured by treachery and destroyed. In 124 B.C. Fabrateria Nova was founded 3 mi. S.E. and a post station Fregellanum (modern Ceprano) grew up across the Liris; Fregellae itself, however, continued to exist as a village even under the empire. The site is about half a mile east of Ceprano, but the remains are very scanty.

See G. Colasanti, "Fregellae," in *Biblioteca di geografia storica*, vol. i (1906).

FREIBERG, a town of Saxony, Ger., in Karl-Marx-Stadt *Bezirk* (district), which after the partition of the nation following World War II was included in the German Democratic Republic, lies at the northern foot of the Ore mountains 20 mi. S.W. of Dresden. Pop. (1961 est.) 47,376. It owes its origin to the discovery of silver ores in 1168. The town was founded as a mining settlement between 1186 and 1190 and its name is derived from the extensive mining rights which then belonged to the "free miner." In the 12th–13th centuries there was a struggle with the landowners over surface mining rights: the *Bergschöppenstuhl* ("a mining tribunal") was set up in 1255 for the granting of mining franchises, and a mining law was made in 1350. The first mineworkers' strike took place in the 15th century. In 1946 the mines became public property. The Reformation was introduced in 1536 by Henry the Pious, who resided there.

The town suffered severely during the Thirty Years' War and again during the French occupation from 1806 to 1814. In the centre of the old town is the upper market with the 15th- 16th-century town hall and houses. Parts of the old wall, including Donat tower (1445), remain. The castle of Freudenstein, parts

of which date from the 12th century, is now used as a warehouse. The cathedral (1484, Late Gothic) replaced the burned-out Marienkirche (1200); the romanesque carved "golden portal" survives. Freiberg's Mining academy, opened in 1765, included such distinguished professors as Abraham Gottlob Werner (*q.v.*) and Clemens Alexander Winkler, the discoverer of the element germanium. Alexander Humboldt and Karl Theodor Körner were among the students. There are a research institute for nonferrous metals and state fuel and leather institutes. To the west are the Culture and Pioneer parks, and in the northwest a new quarter with an *annexe* of the Mining academy, technical institutes and residential quarters. Freiberg is on the main railway and road from Dresden to Karl-Marx-Stadt. There is mining for lead ore, pyrites and zinc blende, and manufacture of machinery, industrial leather, textiles, porcelain and instruments.

FREIBURG IM BREISGAU, a city of Germany, which after partition of the nation following World War II was included in the *Land* (state) of Baden-Württemberg, is the chief town of the Black Forest and the seat (since 1827) of the archbishop of the province of the Upper Rhine. It lies in a magnificent position at the foot of the Schlossberg and the Schönberg where the river Dreisam flows into the Rhine valley. The administrative area is nearly 31 sq.mi., about half of which consists of oak and pine forest, a quarter of farm land and park land and a quarter of residential area. There is a difference of 1,000 m. (3,280 ft.) between the highest and lowest parts of the district. Pop. (1961) 145,016.

The Basler Hof, the former residence of the chapter of Basle cathedral, is now the administrative offices. The Haus zum Walfisch, now the municipal savings bank, is said to have been built in 1516 for Emperor Maximilian I. In the Town Hall square is the "new" town hall with Renaissance gables and richly carved balconies and opposite is the rebuilt Church of St. Martin, originally a Franciscan monastery, built in the 13th century with Gothic arched cloisters. The Gothic münster, begun in the 13th century and completed during the middle ages, was the only German cathedral to be completed during that time. Its main entrance is richly decorated and the tower, 380½ ft. high, contains one of the oldest German bells, the "Hosanna," which weighs five tons. Superb stained glass in the side aisles and the great triptych on the high altar by Hans Baldung Grien are among the special treasures of the münster. In the Salzstrasse is the former church of the Augustinian monastery, now the Augustinermuseum containing valuable works of art by medieval masters from the district of the upper Rhine, particularly tapestries, goldsmiths' work and stained glass.

Opposite the Jesuit church is the Albert Ludwig university of Freiburg (founded in 1457 by Albrecht VI) and the central offices of the German Roman Catholic relief organization, Caritas. Departments of the university include the Fraunhofer Institute for Solar Research and the Institute for the Study of Micromolecular Chemistry. There is close co-operation between the university institutes and manufacturers' laboratories, for example in the field of artificial fibres.

The Black Forest is a rich source of wood for use in the local paper-making and furniture industries and wood-working machinery is also manufactured. Freiburg is a noted tourist and conference centre. There is an airport and access to the *Autobahn*.

Freiburg was founded in 1120 by Duke Konrad of Zähringen as a free market town (hence its name) at the junction of the trade routes between the North sea and the Mediterranean, and the Rhine and the Danube. In 1218 it passed to the counts of Urach, who took the title of counts of Freiburg. In 1368 it put itself under Austrian rule, and from 1648 to 1805 it was the administrative headquarters for the outlying Austrian possessions. It was besieged and captured in 1525 by the Bauernbund (Peasants' and Farmers' league); in 1632 and 1638 by the Swedes; in 1644 during the Thirty Years' War by the Bavarians, when it was the scene of a series of engagements between the French and the Bavarians and Austrians; in 1677, 1713 and later by the French, who made a fortress of it at the end of the 17th century. In 1806 the city, together with the Breisgau and Ortenau areas, returned to the ruling house of Baden. In World War II it was bombed many times and on Nov. 27, 1944, almost the whole of the old part (the medieval Innenstadt) was completely destroyed. (F. Kf.)

FREIDANK, German didactic poet of the first half of the 13th century whose work became regarded as a standard repository of moral precepts. It cannot be definitely established whether Freidank is a family name or an agnomen denoting what his age saw as the salient quality of his work. The nearly contemporary Seifrid Helbling calls him Bernart Fridanc; but Rudolf von Ems (about 1240) speaks of "meister Frîgedanc," that is, a poet of a free, uncompromising expression of ideas. The poet was a wandering minstrel of burgher origin, born probably in Alemannic or Swabian territory, and took part in the crusade of Frederick II in 1228–29; several of the impressions left by these experiences are recorded in the one work by which he is known and which one may therefore assume to have been written about 1230. This work, which has been preserved in many manuscripts, has the title *Bescheidenheit*, "the distinction of right from wrong," and consists of a large collection of didactic strophes and rhymed aphorisms on religion, ethics and all manner of human problems. The fables, proverbs and other sources on which Freidank drew were common property, but his lack of originality mattered little either to his own or to succeeding generations, and the book retained its authority in German-speaking lands until Renaissance times.

Bibliography.—The most useful edition of the *Bescheidenheit* is by H. E. Bezzenberger (1872). A summary account of Freidank and his work with a full bibliography is given by G. Ehrismann in pp. 316–322 of *Geschichte der deutschen Literatur bis zum Ausgang des Mittelalters, Schlussband* (1935). (Rd. J. T.)

FREIGHT, MARITIME: *see* Affreightment.

FREILIGRATH, (HERMANN) FERDINAND (1810–1876), the outstanding German political poet of the 19th century, was born at Detmold, Westphalia, on June 17, 1810. He was apprenticed to an uncle who was a merchant at Soest and from 1831 to 1839 worked in a bank at Amsterdam and then in a business house at Barmen. His *Gedichte* (1838) were so successful that he abandoned commerce for literature and in 1842 he received a pension of 300 talers a year from Frederick William IV. In the next few years, however, his views became increasingly radical, and in 1844 he bravely renounced the pension on the publication of his collection of poems *Ein Glaubensbekenntnis*. He was forced to leave Germany for Belgium and Switzerland, and from there he made his way to England. His poems in *Ça ira* (1846) had a sharper tone and the *Neuere politische und soziale Gedichte* (1849 and 1851), celebrating the 1848 revolution which had brought him back to Germany, were even more wholeheartedly socialist and antimonarchical. The poem *Die Toten an die Lebenden* (1848) had resulted in his arrest but he had been acquitted by a jury and continued to live in Düsseldorf and, for a while, in Cologne, where with Karl Marx he edited the *Neue Rheinische Zeitung*. In 1851 he and his family returned to England to escape further political persecution. From 1856 to 1865 he was London manager of the General Bank of Switzerland but a public subscription of 60,000 talers raised in Germany enabled him to return in 1868. He died in Canstatt on March 18, 1876.

Freiligrath's poetry has worn better than that of the other political writers of his day; passionate conviction finds pictorial as well as rhetorical expression. Vivid imaginative evocations of exotic scenes and technical virtuosity characterize his earlier poems, which have echoes of Victor Hugo and Alfred de Musset. He did much to familiarize the German public with these authors and with Burns, Scott, Longfellow (with whom he corresponded), Thomas Moore and others.

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FREISING, a town of Germany, *Land* (state) of Bavaria, which became part of the Federal Republic of Germany, after

partition of the nation following World War II, lies on the Isar 32 km. (20 mi.) by road N.N.E. of Munich. Pop. (1961) 27,562. The cathedral hill dominates the town with its 12th-century cathedral, St. John's church (1319–21) and the Benedict church (*c.* 1350). Other important buildings are St. George's church (*c.* 1440), the former Benedictine abbey of Weihenstephan (now a college of agriculture and brewing) and Weihenstephan brewery (founded 1040), one of the oldest in the world. The church of Neustift Premonstratensian abbey lies on the road to Landshut. Freising is on the railway from Munich to Regensburg, and industries include motor engineering (diesels, tractors), brewing and the manufacture of hosiery and fabric gloves. Freising had a castle in the 8th century. The missionary bishop Korbinian came there in 724. St. Boniface established the bishopric in 739, and Freising became the spiritual and secular heart of old Bavaria. The abbey was secularized in 1803 and the bishopric transferred to Munich in 1821. (N. Bo.)

FRELINGHUYSEN, FREDERICK THEODORE (1817–1885), U.S. lawyer, senator and secretary of state, was born of a prominent family of Dutch descent at Millstone, N.J., on Aug. 4, 1817. His grandfather, Frederick Frelinghuysen (1753–1804), was a soldier in the American Revolution, served in the continental congress and was a U.S. senator from 1793 to 1796. His uncle, Theodore Frelinghuysen (1787–1862), was a U.S. senator (1829–35), chancellor of the University of the City of New York (1839–50), nominee for vice-president in 1844 on the Whig ticket with Henry Clay and president of Rutgers college (1850–62). Frederick Theodore, left an orphan at the age of three, was adopted by this uncle. He graduated from Rutgers college in 1836, studied law in his uncle's law office and succeeded to the latter's large practice in 1839. He was city attorney for Newark in 1849 and became counsel for several large corporations. He was one of the founders of the Republican party in New Jersey.

From 1861 until 1866 Frelinghuysen was attorney general of New Jersey. In 1866 he was appointed to the U.S. senate to fill a vacancy and was elected the following year to fill the unexpired term. Defeated for the senate in 1869, he was elected for a full six-year term beginning in 1871. He was one of the senate's ablest debaters and did important work as chairman of the committee on foreign affairs during the negotiations over the "Alabama" claims. Pres. Chester A. Arthur appointed Frelinghuysen as secretary of state in 1881 to succeed James G. Blaine. Patient and firm in his handling of diplomatic affairs, he favoured closer commercial relations with Latin America and negotiated a change in the treaty with Hawaii to give the United States a naval base at Pearl Harbor. He also opened treaty relations with Korea (1882) and mediated several international disputes. He died in Newark on May 20, 1885. (G. C. O.)

FREMANTLE, a city and the principal port of Western Australia, lies at the mouth of the Swan river, 10 mi. S.W. of Perth by road. Pop. (1961) 24,343. Commonwealth and state departments are located in the city, and there are gardens and recreation reserves, ocean and river beaches, health clinics, denominational schools, a high school and a technical school as well as a modern library. The chief industries are those connected with the port and fishing harbour, export of processed crayfish being especially significant. There are also wool warehouses, oil refineries, steel roller mills and engineering works. An industrial estate lying three miles from the city is one of the most important industrial centres in Western Australia and has attracted industries from overseas and from the eastern states of Australia. Inland is an area of about 1,800 ac. devoted to market gardening.

Fremantle is the first Australian port of call for ships from Europe and is related to the South African, Asian and European trade routes. It handles four-fifths of the state's imports and exports, and harbour facilities include more than 650,000 sq.ft. of covered storage space. The port comprises an outer and an inner harbour, which are afforded primary protection by islands and reefs. The outer harbour, 73 sq.mi. in extent, is approached by a channel with a low-water depth of 38 ft. and bottom width of 500 ft. The inner harbour is constructed within the mouth of the river, the banks of which have been projected seaward to form protecting breakwaters. About 11,000 linear feet of deep-water quayage is available, providing berths for ships up to 45,000 gross tons. The port is connected by rail with the state's chief wheat- and wool-producing areas and is the terminus of the Australian Trans-Continental railway. (N. J. C. M.)

FRÉMIET, EMMANUEL (1824–1910), French sculptor who devoted himself chiefly to animal sculpture and to equestrian statues in armour, was born in Paris on Dec. 6, 1824. Though he was a nephew and pupil of Jean François Rude, the detailed naturalism of his sculpture was closer to the art of Antoine Louis Barye, whom he succeeded as professor of animal drawing at the Natural History museum of Paris. Frémiet's first employment was making lithographs of comparative anatomy for a painter of natural history. After initial success with his animal studies, he won a medal of honour at the 1887 salon with the representation, in bronze, of a gorilla carrying off a Negro woman (Nantes).

In imposing equestrian statues, with accoutrements carefully rendered, Frémiet achieved convincing portrayals of warriors such as "Jeanne d' Arc" (second version, 1899; Place des Pyramides, Paris) and "Du Guesclin" (1902; Dinan). For Mount Vernon square, Baltimore, he made "Colonel Howard" (1903) and for Bogotá, Colombia, "Bolívar" (1910). Frémiet ascended the ladder of honours to membership in the Académie des Beaux-Arts in 1892, but his fame did not withstand the later shift of taste away from his chosen subject matter, despite his acknowledged mastery there. He died in Paris on Sept. 10, 1910. (J. W. F.)

FRÉMONT, JOHN CHARLES (1813–1890), U.S. explorer, army officer and political leader, was born in Savannah, Ga., on Jan. 21, 1813. His father, a French *émigré*, died when the boy was six and his mother moved to Charleston, S.C., where Frémont spent his youth. In 1829 he entered the College of Charleston where he displayed marked ability, especially in mathematics. His degree was withheld because of irregular attendance but finally conferred in 1836. Joel R. Poinsett, prominent in South Carolina politics, secured his appointment in 1833 as a teacher of mathematics aboard the sloop of war "Natchez" on a cruise along the South American coast for two and a half years. After resigning from the navy Frémont served as assistant engineer on a railroad survey from Charleston to Cincinnati. In 1838 Poinsett secured him an appointment as second lieutenant of topographical engineers in the U.S. army. For the following three years he was an assistant to Jean Nicholas Nicollet, employed by the war department to map the region between the upper Mississippi and Missouri rivers. In 1841 Frémont headed an expedition to survey the Des Moines river for Nicollet. These instructive years under the French explorer kindled in him a desire for further wilderness adventures. Upon his return he married Jessie Benton, daughter of Sen. Thomas Hart Benton of Missouri. Benton's expansionist interest in the west and his influence in government enabled Frémont to accomplish within the next few years the mapping of much of the territory between the Mississippi valley and the Pacific ocean.

When emigration to the Oregon country became important in 1842, Frémont was sent by Secretary of War Poinsett to survey the route beyond the Mississippi as far as South pass in Wyoming. This was his most significant expedition to date and one that produced descriptions that aided later emigrants. He ascended to the summit of the second highest point of the Wind River mountains, since known as Frémont's peak (13,730 ft.). In 1843 he completed another even more important survey to the mouth of the Columbia river. His guide on this trip, as well as on the previous expedition, was the picturesque Christopher ("Kit") Carson (*q.v.*). From Fort Hall Frémont proceeded down the Snake river to Ft. Boise, on to the Dalles and down the Columbia to Ft. Vancouver. Frémont next turned south and east via Klamath lake, his intention being to search for a "lake called Mary's, at some day's journey in the Great Basin; and thence still on southeast to the reputed Buenaventura River." Moving into northwestern Nevada, Frémont continued to the Truckee and Carson rivers. This portion of the journey added significantly to his geographical knowledge. Frémont originally had no plans to cross the Sierra Nevada into California but suddenly took his entire expedition on an extremely

difficult, indeed rash, midwinter crossing of these mountains. In early March, after surviving appalling difficulties, the party crossed the Sierra near Lake Tahoe to Sutter's Fort on the Sacramento river—an exploit which added greatly to his fame. His return was via the San Joaquin river to the King's river, traversing Techachapi pass around the southern end of the Sierra Nevada and across to Great Salt Lake along parts of the old Spanish trail. He reached Washington, D.C., where, with the aid of his wife, he prepared a detailed report of his exploration. Thousands of copies of this report were printed and eagerly read. While Frémont's entrance into California may be regarded as almost accidental, its importance in relation to later events is obvious.

War with Mexico over annexation of Texas seemed imminent and in the spring of 1845 Frémont headed a third expedition for the professed purpose of further exploring the Great Basin and Pacific coast, but with secret instructions for action in case of war with Mexico. His armed party of 62, including 6 Delaware Indians, reached California in Dec. 1845. The Mexican authorities became suspicious and ordered Frémont out of the province. Frémont refused to leave at once and retired to Gavilan (or Hawk) peak which he fortified and where he raised the American flag. Later he thought better of this indiscreet action and led his party toward the Oregon border. He was overtaken on May 8 by a U.S. marine corps lieutenant, Archibald H. Gillespie, a confidential messenger from Washington, and led his force back into California. The nature of the orders that Gillespie relayed to Frémont is still unknown. After a small group of dissident Americans near Sonoma started a revolt against Mexican authority and created the Bear Flag republic, Frémont gave this unofficial uprising his support. When news of the declaration of war with Mexico reached California, Frémont was appointed by Commodore Robert F. Stockton as major of a battalion made up mainly of American volunteers; he and Stockton completed the "conquest" of the future state.

Gen. Stephen W. Kearny, in the meantime, entered California from the southeast with similar orders to conquer the region and establish a government. This led to a conflict of authority into which Frémont injected himself, after accepting California's capitulation from Mexican officials at Cahuenga pass near Los Angeles. Stockton had appointed him governor of California but Kearny would not recognize the appointment. Frémont disregarded Kearny's orders, acting as governor for two months before being arrested by Kearny, who had received confirmation of his authority. Frémont was tried by court-martial in Washington, found guilty in Jan. 1848 of mutiny, disobedience and conduct prejudicial to military discipline and sentenced to be dismissed from the army. Pres. James K. Polk approved the verdict except as to mutiny, but remitted the penalty. Frémont, in a bitter mood, resigned.

He next decided to establish his home on a 40,000-ac. estate he had purchased near Mariposa, along the Sierra foothills, and on his way to California in midwinter 1848–49 led, at his own and Senator Benton's expense, a fourth expedition to survey passes for a Pacific railroad. Frémont employed the eccentric William ("Old Bill") Williams as guide and the party unwisely tried to penetrate the massive San Juan range in December. Williams led them astray into a high, unknown pass where they were caught by a blizzard. After weeks of intense cold and following the loss of 11 men, the exhausted party retreated to the first settlements on the upper Rio Grande. Frémont continued to California and was greeted with news of the discovery of gold. Rich ore veins were found on his estate and he spent the next few years developing mines which made him a multimillionaire. He was elected for a short term as one of the first two senators from California.

In 1851 he was defeated for re-election by the proslavery party. His opposition to slavery, however, and his popularity in the conquest of California, plus the publicity of a fifth expedition into central Utah during 1853–54, led to his nomination for the presidency of the United States in 1856 by the new Republican party. In the election he was defeated by James Buchanan.

After the Civil War began, Frémont, as a major general, was placed in command of the western department with headquarters at St. Louis, Mo. The organizing of an effective army with insufficient supplies and a few thousand untrained men in a slave state produced political and military enemies who made the most of Frémont's failures, and he was blamed for several distressing defeats. On Aug. 30, 1861, he was about to confiscate the property of Missourians in rebellion and to emancipate their slaves, a premature act which Pres. Abraham Lincoln feared would alienate various border states whose loyalty he hoped to retain. This led to his removal by the president. In 1862 Republican "radicals" who backed Frémont got him command of the mountain department of western Virginia, Kentucky and Tennessee but he proved ineffective against the rapid maneuvers of "Stonewall" Jackson, his Confederate opponent. When Frémont's army was placed under an old enemy in Missouri, Gen. John Pope, Frémont indignantly resigned from military service a second time. He was still popular enough to be considered for the presidency in 1864 by the radical wing of the Republican party; when, however, he realized that he would split the party and thereby defeat Lincoln, he retired from public life to devote himself to various railroad projects in the west. In 1878, after Frémont had lost his fortune, he welcomed appointment as governor of Arizona territory until 1883. He died in New York city on July 13, 1890.

Historians by no means agree concerning the significance of Frémont's western expeditions, for which he is most often remembered. Whether he was a "pathfinder," a "pathmarker" or simply the follower of other men's trails under government auspices is the point at issue. Earlier trappers had long before traveled where he followed, but he first surveyed, mapped and described their routes. He will remain noted for this, as well as for his flair for the dramatic. His controversial conduct at Hawk's peak, his support of the Bear Flag rebellion, his acceptance of the Cahuenga capitulations and his disagreements with Stockton, Kearny and Lincoln all involved Frémont's sensing of the historic and the controversial as determinant factors in his uneven and stormy career. *See* also references under "Frémont, John Charles" in the Index volume.

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FREMONT, a city of California, U.S., in Alameda county on the southeastern shore of San Francisco bay, 25 mi. S. of Oakland and a part of the San Francisco-Oakland standard metropolitan statistical area. Incorporated Jan. 10, 1956, and named in honour of John Charles Frémont, the city was formed by joining the five communities of Centerville, Irvington, Niles, Mission San Jose and Warm Springs. The Nimitz freeway, extending from Oakland to San Jose through Fremont, was important in helping to transform Fremont from an agricultural area into one of varied industries. In the city is Mission San José de Guadalupe, founded in 1797; it was 14th in the chain of the 21 California missions. For comparative population figures *see* table in CALIFORNIA: *Population*. (H. B. Me.)

FRÉMY, EDMOND (1814–1894), French chemist, made important contributions in a wide range of areas. He was born at Versailles on Feb. 28, 1814. He entered Joseph Louis Gay-Lussac's laboratory in 1831 and became *préparateur* at the École Polytechnique in 1834 and at the Collège de France in 1837; he was *répétiteur* at the École Polytechnique, where in 1846 he became professor. In 1850 he succeeded Gay-Lussac in the chair of chemistry at the Muséum d'Histoire Naturelle, of which he was director, in succession to M. E. Chevreul, from 1879 to 1891. He died at Paris on Feb. 3, 1894. His work included investigations of osmic acid, of the ferrates, stannates, plumbates, etc., and of ozone; at-

tempts to obtain free fluorine by the electrolysis of fused fluorides; and the discovery of anhydrous hydrofluoric acid and of a series of salts (*e.g.*, potassium bifluoride), the precise nature of which long remained a matter of discussion.

He also studied the colouring matters of leaves and flowers, the composition of bone, cerebral matter and other animal substances, and the processes of fermentation, in regard to the nature of which he was an opponent of Pasteur's views. In the field of technical chemistry he contributed to the knowledge of the manufacture of iron and steel, sulfuric acid, glass and paper, and in particular worked at the saponification of fats with sulfuric acid and the utilization of palmitic acid for candlemaking.

In the later years of his life he applied himself to the problem of obtaining alumina in the crystalline form and succeeded in making rubies identical with the natural gem not merely in chemical composition but also in physical properties.

He wrote a *Traité de chimie générale* in six volumes.

FRENCH, DANIEL CHESTER (1850–1931), U.S. sculptor whose work is more profoundly American than that of any of his contemporaries, was born at Exeter, N.H., April 20, 1850. His father, Judge Henry Flagg French, was assistant secretary of the treasury through three presidential administrations. French studied anatomy with William Rimmer in Boston, worked for one month with J. Q. A. Ward in New York city, and then two years under Thomas Ball in Italy.

His first important commission came when he was 22, from the town of Concord, Mass., where he lived, for the statue of "The Minute Man." Unveiled by Ralph Waldo Emerson at the Old North bridge on the centennial of the Concord fight, April 19, 1875, it later became the symbol for defense bonds, stamps and posters of World War II, and copies of the statue may be seen in many New England towns. This commission launched the artist on a career unparalleled in American sculpture. Fifty years later, in 1922, he witnessed the dedication of his great marble—the seated Lincoln in the Lincoln memorial in Washington, D.C.

Between these two triumphs there poured from his studio a constant stream of sculpture. Among his better-known works are "Death and the Sculptor," Forest Hills cemetery, Boston, 1893; the equestrian statues of Gen. U. S. Grant, Philadelphia, 1898, and General Washington, Paris, 1900; three pairs of bronze doors for the Boston Public library, 1902; the groups of the "Four Continents" for the New York customhouse, 1907; the "Standing Lincoln," Lincoln, Neb., 1912; the statue of Emerson in the public library, Concord, 1914; the "Alma Mater" at Columbia university, 1915; and the 1st division memorial, Washington, D.C., 1924.

French died in Stockbridge, Mass., on Oct. 7, 1931.

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(M. F. Cn.)

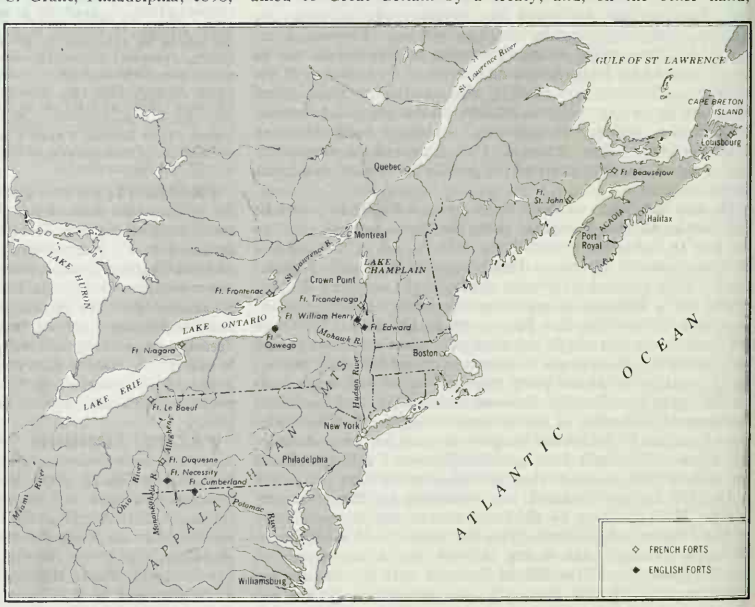
FRENCH, THOMAS VALPY (1825–1891), first Anglican bishop of Lahore, India, a missionary chiefly concerned in preaching the gospel to non-Christians, was born at Burton-upon-Trent, Jan. 1, 1825, and educated at Rugby school and University college, Oxford, of which he became a fellow in 1848. In 1850 he was accepted by the Church Missionary society and sent to Agra, India, where he founded St. John's college. A good scholar, master of many eastern and western languages and a forceful preacher, he tended at all times to overdrive himself; in consequence his health was uncertain, and his periods of service in India alternated with incumbencies, usually of short duration, in England. In 1877 he was appointed first bishop of Lahore, an immense diocese that included the whole of the Punjab and northwestern India. The example of his humble and saintly life was at all times an inspiration to the Christians of his diocese, though his skill as an administrator was less outstanding than that he showed in other directions. In 1887 he resigned his see. In 1890, being deeply concerned about the almost total lack of Christian witness in Arabia, he decided to go at his own charge as a pioneer missionary to Muscat. His mission lasted little more than three months; unable to stand the rigours of the climate, he died on May 14, 1891. One of French's daughters married E. A. Knox, and Ronald Knox, the translator of the Bible, was one of their children.

See H. A. Birks, *The Life and Correspondence of T. V. French* (1895).

(S. C. N.)

FRENCH AND INDIAN WAR. This war was the American phase of a world-wide, nine years' war that was waged between 1754 and 1763. It was called by contemporary writers the "Maritime War" or the "Great War," the "Late Glorious War" or simply the "Late War," but it is most accurately termed the "Great War for the Empire." It involved at first only the empires of Great Britain and France. Later the electorate of Hanover, of which the king of England was head, and two other western German states, Brunswick and Hesse-Cassel, closely associated with Hanover, were drawn into it when France attacked Hanover.

Spain and Portugal became participants when in 1762 Spain, allied to France, invaded Portugal, allied to Great Britain. This is to be distinguished from the Seven Years' War (*q.v.*) that began in central Germany in 1756 over issues having nothing to do with those that precipitated the war already in progress. The participants in the Seven Years' War were, on the one hand, Prussia, allied to Great Britain by a treaty, and, on the other hand,



LOCATION OF ENGLISH AND FRENCH FORTS IN THE AREA OF NORTH AMERICA WHERE MAJOR FIGHTING OCCURRED DURING THE NINE-YEAR CONFLICT

STATE HISTORICAL SOCIETY OF WISCONSIN

"BRADDOCK'S DEFEAT" WHILE APPROACHING FT. DUQUESNE ON JULY 9, 1755. PAINTING BY EDWIN WILLARD DEMING, 1903

Austria, Russia, Sweden and most of the southern German states, all of whom were allied to France by treaties but with none of whom Great Britain was at war. The two wars were, moreover, terminated by distinct treaties, one at Paris and the other at Hubertusburg, Ger., and no nation was a signatory of both.

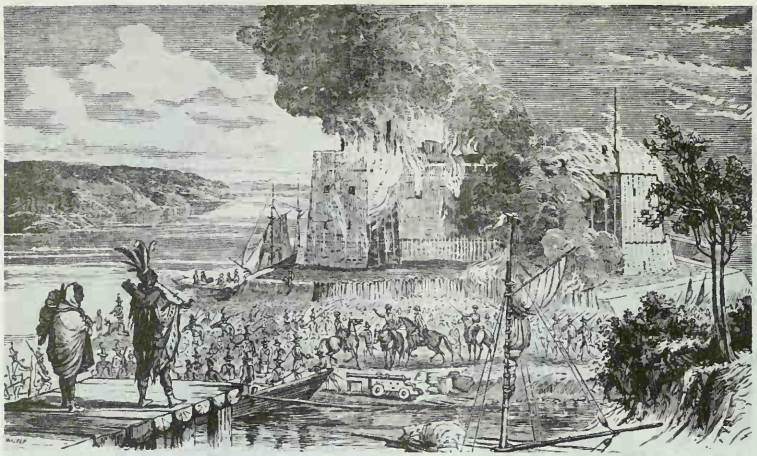
Conflicting British and French Claims.—The Great War for the Empire began over the specific issue as to whether the upper Ohio valley was a part of the British empire and therefore open for trade and settlement on the part of the inhabitants of Pennsylvania and Virginia, or whether it was part of the French empire. But behind this issue loomed an infinitely greater one—nothing less than the question of which nation with its peculiar civilization, including language, forms of government and social mores, was to dominate the heart of the continent of North America.

British territorial claims rested upon the John and Sebastian Cabot discovery of the North American continent in the latter part of the 15th century and the grant by English royal charter in the early part of the 17th century, to both the Virginia company and the Grand Council for New England, of all the land within certain limits between the Atlantic and Pacific oceans. Further, in 1663 there was created to the south of Virginia the province of Carolina that also received a sea-to-sea grant and out of which were later formed North Carolina, South Carolina and Georgia. Thus all the lands to the south of French Canada and to the north of Spanish Florida stretching from sea to sea were claimed by England. In conflict with this was the claim of France to the whole of the Mississippi valley, including the Ohio valley, based upon the discoveries of René Robert Cavalier, sieur de la Salle, who, starting from Canada, moved through the Great Lakes and then, after descending the Mississippi river in 1682, took possession in the name of the king of France of all lands drained by this river and its tributaries.

For about 60 years the issue over which nation had the better right to the lands in the great Mississippi basin was to remain in abeyance. The English gradually settled all along the Atlantic seaboard to the south of the Gulf of St. Lawrence where about 14 colonies—including British Nova Scotia, founded in 1749—came into existence and flourished. The inhabitants of these colonies in the course of time pushed westward from the tidewater to establish themselves in the piedmont country. By the middle of the 18th century the small cabins of the Virginians were to be found even to the west of the Appalachians on the upper waters of such streams as the New and the Holston. By that period hundreds of Pennsylvania traders had likewise settled in the villages of Indian tribes of the upper Ohio valley with whom Great Britain was in alliance.

On the other hand, the French, firmly in control of Canada from the early 17th century, gradually began, through trade, the exploitation of the Great Lakes region. They established permanent settlements at Detroit, in the so-called Illinois country, at the mouth of the Mississippi and at Biloxi and Mobile bay. By 1750 they had, in addition, many trading posts among those Indian tribes with whom they were in alliance. The French, interested more in fur trade than in agriculture, enjoyed the friendship of the Indians, whose way of life was threatened by the British colonists.

Beginning of Hostilities.—A conflict between the two nations over their rival North American claims was doubtless inevitable, but it might have been delayed for many years, since their areas of trade exploitation were widely separated, had not the governor general of New France forced the issue. Although the French had developed no trade relations in the neighbourhood of the Allegheny river and the upper Ohio where Pennsylvania traders were concentrated, the governor general ordered Pierre Joseph Céloron de Blainville in 1749 to go into this region and compel the traders to lower the British flag flying over their trading houses and, as trespassers on the king of France's lands, to retreat to the eastern slopes of the Appalachians. Since this move did not have the desired effect, force was applied in 1752 when the important British



FROM C. R. TUTTLE, "POPULAR HISTORY OF THE DOMINION OF CANADA"; MONTREAL, 1877; PHOTOGRAPH, BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

"EVACUATION OF FT. DUQUESNE, 1758," AFTER IT FELL TO THE TROOPS OF JOHN FORBES AND HENRY BOUQUET

colonial trading centre at Pickawillany on the upper Great Miami river was destroyed. This was followed by the plundering, capture or killing of every English-speaking trader in the upper Ohio valley that the French and their Indian allies could find. These actions not only struck directly at the people of Pennsylvania but at those of Virginia as well.

In fact, the government of Virginia took the position that the lands of the upper Ohio were clearly included in the charter grant of 1609 to that colony. This grant gave Virginia a claim to the western lands that was more valid than New France's claim, which was based upon La Salle's much later journey down the Mississippi. In harmony with this point of view the governor and council of Virginia had by the end of 1752 granted conditionally about 1,500,000 ac. of Ohio valley land with the result that almost every important Virginia family, including members of the Washington, Lee and Randolph families, was vitally interested in the fate of the Ohio area. When, therefore, the news reached Williamsburg, the capital of the colony, that the French were not only driving out the English traders but were building forts on the headwaters of the Allegheny river in order to consolidate their positions, it was determined late in 1753 to send young George Washington to the French Ft. Le Boeuf, located near the upper waters of the Allegheny, to warn the garrison there that it was occupying lands that belonged to Virginia. After that daring mission had failed, the Ohio company of Virginia, which had received, under certain stipulations a special royal grant of upper Ohio valley land, was encouraged to build Fort Prince George at the forks of that river —that is, at the place where the Allegheny and Monongahela rivers join to create the Ohio river and where Pittsburgh now stands— with the understanding that Virginia troops would support the undertaking.

The French, however, were too quick. Descending the Allegheny river in large numbers in the spring of 1754, their troops, under the command of French regular officers, overwhelmed the little force of woodcutters and carpenters busy constructing the palisaded log fort before the Virginia troops and the company of South Carolina Independents coming to their support under Col. Joshua Fry and Lieutenant Colonel Washington could arrive. Upon the death of Fry, Washington took command and, in view of the strength of the French at the forks, decided to entrench himself at Ft. Necessity. There he was attacked and, in the face of great odds, compelled to surrender.

While hostilities between the two nations had preceded the action at Ft. Necessity, it was this clash between British and French armed forces that precipitated the Great War for the Empire. Ultimately the war was to spread from the Ohio valley to every part of the world where either of the two nations had territorial interests.

The government of Virginia appealed to the king for assistance, particularly for two British regiments so that regulars could be pitted against regulars in this wilderness contest. Fearing the outbreak of a new war with France, after having as recently as 1748 made peace with the latter, George II at first stubbornly refused to consider the request, agreeing with the position taken by his minister, the duke of Newcastle, who said: "Let Americans fight Americans" in distant new-world clashes. But when it became clear from further reports sent by the government of Virginia that raw Virginia militia could not be expected to make headway against seasoned French regulars, George finally agreed to order Gen. Edward Braddock to go to Virginia with a force to clear the forks of the Ohio of the French invaders. Moreover, Adm. Edward Boscawen was sent into the region of the Gulf of St. Lawrence with a powerful fleet to prevent further reinforcements of French troops from arriving in Canada.

The war thus begun to defend British territorial claims in the Ohio valley spread like wildfire to other parts of the world. It became a contest between the two greatest maritime powers. France, however, was far superior to Great Britain in land forces. This superiority was soon used against King George's electorate, Hanover, which as a German state was not interested in Anglo-French rivalry in the new world. The war thereupon presented two facets: one a struggle for empire in North America, the West Indies, the African coast and India; the other an effort on the part of the British to prevent Hanover's being used as a pawn in this territorial rivalry.

Early French Successes.—During the first four years of the fighting the over-all advantage was with the French, especially in North America. It seemed to most contemporaries that they would succeed in enclosing the British colonials firmly to the east of the Appalachian mountains, like modern Chile with a long coast line and a narrowly restricted interior. In those years the British regulars and American colonials suffered one stunning reverse after another.

Braddock's army was defeated and scattered in 1755 when approaching the new Ft. Duquesne that the French had erected at the forks of the Ohio. In 1756 the defenders of Ft. Oswego on Lake Ontario were obliged to surrender, as were the defenders of Ft. William Henry near Lake Champlain in 1757. Lord Loudoun's amphibious expedition from New York city against the great French fortress Louisbourg on Cape Breton Island ended in that year in dismal failure, and Gen. James Abercrombie, attacking the French Ft. Ticonderoga in 1758, had his army almost destroyed. Moreover, the frontier settlements in what is now central New York, central Pennsylvania, western Maryland and western Virginia were deserted while thousands of families fled eastward in panic from the torch, sword and tomahawk carried by the French and their Indian allies.

During these years of defeat the only notable success scored by the British and New England forces was the capture in 1755 of the well-fortified Ft. Beauséjour. The French had built the fort in 1749 on the narrow isthmus connecting the peninsula of Nova Scotia with the mainland—a region held by British authorities to be a part of Nova Scotia, ceded by France in 1713 in the treaty of Utrecht—chiefly for the purpose of reviving the loyalty

to the king of France of the French-speaking Acadians in Nova Scotia. This design so far succeeded that these numerous, hardy people not only steadfastly refused to take an oath of loyalty to the British crown but provided the Beauséjour garrison with provisions and a large labour force to aid it in consolidating its foothold on the isthmus.

Since no large contingent of British soldiers was available to hold in awe the Acadians, who had thrown off their former attitude of neutrality as between the British and the French, the British authorities at Halifax decided to disperse them as a war measure. In line with this resolve, transports were provided and most of the Acadians were carried away from their villages in western Nova Scotia and distributed among the inhabitants of the British colonies to the southward.

British Advantages.—In a conflict of this character, which involved such a tremendous stake as the future of a continent, factors other than the series of early French victories were to play a decisive role. First of all, there was William Pitt at the head of the British ministry. He saw correctly that, despite the spread of the Anglo-French war to other parts of the world, the winning of it in North America was the supreme task in hand. With almost fanatical zeal he dedicated himself to that end. He found in such men as Jeffrey, Lord Amherst, James Wolfe and John Forbes first-class military officers.

Pitt recruited new regiments of regulars to replace or to reinforce the old shattered ones, drawing heavily upon that martial people, the Highland Scots; he persuaded parliament to grant him almost unlimited funds; he promised the colonies a liberal reimbursement of their expenses, were they to do their part in the effort by furnishing men for the colonial line; finally, every important detail with respect to operations in North America came under his personal scrutiny so as to guard against further fiascoes. Pitt, in a very true sense, was the organizer of victory in the Great War for the Empire.

In Pitt's favour were other factors that were destined to permit him to overwhelm his opponents. One was the growing superiority of the British navy which slowly but relentlessly swept not only French merchantmen but also French ships of war and troop transports from the seas, thus shutting off the means of bringing reinforcements of troops and munitions from France to Canada. In this connection two great naval battles must be mentioned. The destruction, as a fighting unit, of the French Mediterranean fleet under Admiral de la Clue was accomplished by Boscawen off Lagos in Portugal in 1759, as the French sought to gain the seaport of Brest. The virtual annihilation of the main French fleet brought about later that same year in the decisive battle of Quiberon bay, when Adm. Sir Edward Hawke's fleet bore down upon it with devastating effect.

Moreover, there were available in Great Britain vastly greater financial and industrial resources than in France, which before the end of the struggle was faced with national bankruptcy and economic paralysis. The British colonies also had great quantities of food supplies of all sorts for provisioning the armed forces in the new world, while the inhabitants of French Canada faced almost famine conditions when the blockades off the coasts of France and in the Gulf of St. Lawrence made it virtually impossible to secure food from outside. Nor could the soldiers fighting under the fleur-de-lis in North America be supplied any more easily with vitally needed munitions.

Finally, both British regulars and the American colonial line became seasoned wilderness fighters. It should at the same time be pointed out that the Indian or bushranger method of waging

BY COURTESY OF THE PUBLIC ARCHIVES OF CANADA

ENTRY OF THE BRITISH TROOPS INTO MONTREAL, 1760. PAINTING BY A. S. SCOTT

war, most successfully employed by the French, brought no great decisions in the desperate contest. In the main, both sides tended to observe well-established principles of strategy and tactics. The war, in other words, witnessed the transfer to America of European methods of fighting, modified, of course, to meet peculiar local conditions. Thus, the domination of the high seas by the British royal navy and the capacity, therefore, to provide the field forces in America with an inexhaustible supply of munitions and provisions, together with growing morale and capacity for achievement of the battle-seasoned soldiers, both British and American, fighting there, were factors of the utmost importance in determining the outcome of the war.

British Victory.—Under these circumstances the French tide in North America reached its crest by the end of 1757. In 1758 Amherst captured Louisbourg. Soon afterward John Bradstreet compelled the garrison of Ft. Frontenac to capitulate and the same year Forbes and Henry Bouquet brought about the fall of Ft. Duquesne. The following year Sir William Johnson forced the surrender of Ft. Niagara. Amherst pushed the French out of Ft. Ticonderoga and Crown Point. Further, Wolfe won the vastly important battle of the heights of Abraham that led to the surrender of Quebec. Faced by hopeless odds, the governor general, the marquis de Vaudreuil, was obliged on Sept. 8, 1760, to surrender not only his last stronghold, Montreal, but all of Canada. Thus the North American phase of the Great War for the Empire came to a close. The capture of Spanish Havana, Cuba, by British and American colonial forces in 1762 must, however, also be mentioned because of its implications.

Peace Treaty of 1763.—France and Spain, faced with disastrous defeats in the new world, were ready by 1763 to negotiate a treaty of peace. The signing took place in Paris on Feb. 10. By the treaty France was compelled to cede Canada to Great Britain and relinquish to it all claims to the lands lying east of the Mississippi, outside of the environs of New Orleans. Spain, in order to recover Havana, was obliged to give up Florida, for which loss France compensated Spain by the cession to it of Louisiana, including New Orleans. Thus France, which at the beginning of the war and during the first four years held a dominating position over most of North America, had disappeared from that continent as a political and military power. In contrast, all along the Atlantic seaboard from the northern reaches of Hudson bay to the Keys of Florida the British had no rival.

American Colonial Reactions.—On the surface it seemed that, with the triumphant outcome of the war, the British empire would for generations determine the future of North America. However, the very magnitude of the victory of British arms undoubtedly played a major part in undermining the loyalty of the American colonials to the British crown. Before the war the value of their connection with Great Britain was obvious. With its conclusion this no longer was true—it now seemed that a continued dependence upon the mother country, instead of bringing benefits, would involve most onerous obligations. When the Americans—by reason of the outcome of the Great War for the Empire—no longer had to live in fear of powerful enemy neighbours on their borders, they understandably sought to narrow as much as possible the range of authority exercised over them by king and parliament. When there was resistance to this—especially when an attempt was made by parliament to require them to contribute through taxation to the defense of the new North American acquisitions—friction developed and reached a white heat in 1775 at the outbreak of the American Revolution. *See* also UNITED STATES (OF AMERICA): *History.*

See F. Parkman, *Montcalm and Wolfe* (1884); H. L. Osgood, *The American Colonies in the 18th Century* (1926); L. H. Gipson, *The British Empire Before the American Revolution,* 10 vol. (1936–61).
(L. H. G.)

FRENCH ANTILLES (ANTILLES FRANÇAISES), Caribbean islands in the Lesser Antilles, comprise two overseas *départements* of France: Guadeloupe and Martinique. Guadeloupe (*q.v.*) is in the Leeward Islands and lies between Montserrat and Dominica. Its dependencies include the nearby islands of Marie-Galante, La Désirade, Îles des Saintes and Îles de la Petite Terre to the southeast and, about 135 mi. N.W., Île St. Barthélemy and the French part of St. Martin. Martinique (*q.v.*), in the Windward Islands, lies between Dominica and St. Lucia. Total area 1,118 sq.mi.; pop. (1960 est.) 542,000. (D. R. H.)

FRENCH BROAD RIVER, western North Carolina and eastern Tennessee, U.S., drains nearly two-thirds of the high southern Appalachians in North Carolina. Rising in the Blue Ridge mountains of southwestern North Carolina, near the South Carolina border, it flows generally north through the upland Asheville basin. Turning northwestward at Asheville and descending 714 ft. in 14 mi., it continues to the Tennessee state line. From there it turns westward to Knoxville where it unites with the Holston to form the Tennessee river (*q.v.*). Total length 210 mi. Principal tributaries include the Pigeon and Nolichucky rivers. Douglas dam of the Tennessee Valley authority forms Douglas Lake reservoir about 30 mi. above the river's mouth. Originally navigable for about 50 mi. upstream, the river was used only by sand dredges on its lower reaches by the second half of the 20th century.
(L. DD.)

FRENCH COMMUNITY, an association of states known in French simply as the COMMUNAUTÉ. In 1958 it replaced the French union, itself the successor of the former French colonial empire.

History.—The first French colonial empire, created in the 17th century, comprised Canada, Louisiana (the whole Mississippi valley), St. Domingue (Haiti) and most of the Lesser Antilles, Guiana, two agencies of Senegal, five agencies in India with zones of influence, the Mascarene Islands (Réunion, Mauritius and Rodrigues) and the Seychelles. Between 1763 and 1815, France lost most of this empire, retaining only Martinique, Guadeloupe, Guiana, the agencies of Senegal and India (deprived of their hinterlands) and Réunion Island.

In the course of a century France formed a second colonial empire, which in 1919 consisted of the following lands (1) in north Africa: Algeria, Tunisia and Morocco (protectorates); (2) in west-central Africa: two colonial federations, French West Africa and French Equatorial Africa and two territories mandated by the League of Nations, Togo and Cameroon; (3) in the Indian ocean: French Somaliland, Madagascar and its dependencies (Comoro and the Southern Lands), the five agencies in India (Pondicherry, Chandernagore, Yanaon, Karikal and Mahé) and Réunion Island; (4) in the Pacific ocean: French Indochina (the colony of Cochin China and the protectorates of Tongking, Annam, Cambodia and Laos), New Caledonia and the French *établissements* of Oceania (all eastern Polynesia); (5) in America: St. Pierre and Miquelon, Martinique, Guadeloupe and French Guiana; (6) in the Levant: the two mandated territories of Syria and Lebanon, which were autonomous republics. The inhabitants of the countries acquired before 1815 were French citizens and elected their representatives to the French parliament. Elsewhere the colonial peoples were subjects without political rights, and the chiefs were subordinate, in law or in fact, to the French governors.

After World War II the Levantine states gained their independence. In 1944 a conference held at Brazzaville (capital of the former French Equatorial Africa) accepted the right of the colonies to be represented in parliament. The constitution of 1946 created the French union, composed of associated states (the former protectorates) and of the French republic which consisted, in addition to France, of the overseas *départements* (Algeria, Antilles and Réunion), the overseas territories (the former colonies) and the associated territories (Cameroon and Togo). All the inhabitants were citizens and represented in the French parliament. The territories and Algeria were also granted a local assembly. The union had a president (who was that of the French republic) and a high council and an assembly which were purely consultative.

Developments within this system were somewhat rapid. In 1952 the Indian agencies were transferred to the government of India. The war in Indochina, launched by Communist Vietminh, resulted, in 1954, in the independence of the four states, North Vietnam, South Vietnam, Cambodia and Laos. Tunisia and Morocco gained their independence in 1956. The territories received in 1957, under the "cadre-law," governing councils elected by their assemblies. In

Algeria the revolt of certain Muslims who demanded independence, and the determination of the 1,000,000 French colonists to oppose separation, prevented the working out of a constitution. On May 13, 1958, the colonists formed a "committee of public safety"; parliament yielded and called to power Gen. Charles de Gaulle. Algeria gained independence on July 3, 1962. The constitution of Oct. 5, 1958, ratified by the vote of all the territories (except Guinea, who thus broke with France), created the French Community.

Constitution.—The principle of the community is that of "free determination." The constitution was ratified by universal suffrage, this vote being considered as adherence on the part of each territory. The local assemblies then had to choose between the status of a territory and that of a state. Only the smallest territories chose the status quo. The status of the territories can be modified and every state can become independent.

The French Republic comprises: (1) European France; (2) the overseas *départements*, their administration and legislation being in principle those of the metropolis, but each of which can receive an individual constitution; (3) the overseas territories, which have their own individual organization with a territorial assembly elected by universal suffrage; the assembly appoints a governing council, its president being the governor appointed by the central power.

The republic is "one and indivisible"; all the inhabitants are French citizens; those citizens who have a special civil status (in respect, for example, of the Muslim faith or of local customs) retain the benefit of this. All citizens take part in the election of the president of the republic and of the French parliament.

The States do not form part of the French republic; they are independent and work out their own constitution. They may create unions among themselves.

The Community is the association formed between the French republic and the other states. There is only one "citizenship of the community." The community's sphere of competence includes foreign policy, defense, currency and common economic and financial policy.

The President of the Community is the president of the French republic and the states take part in his election. He has a representative (high commissioner) in each state. President de Gaulle received in 1958 an absolute majority in all the states.

The Executive Council of the Community meets several times a year, in one or other of the capitals, on the summons of the president who assumes the chair. It is composed of the chiefs of the governments of the different states and the ministers responsible for common affairs.

The Senate of the Community is composed of members of the local assemblies designated by them in numbers proportional to the population of the state. After holding two sessions it was abolished in March 1961.

A Community Court of Arbitration, composed of seven judges nominated by the president, gives decisions in disputes between member states.

Agreements of Association may be made by the community with other states.

There are no longer any associated territories, since Togo and Cameroon have, at the instance of France, had their mandatory status terminated by the United Nations, their independence dating from 1960.

The French Republic.—The French republic consists of the following countries (each of which, as well as the other states, is the subject of a separate article):

(1) European France, including Corsica.

(2) The overseas *départements*, former colonies that were part of the first French colonial empire. The inhabitants are white, black or of mixed race and all are French citizens, subject to French law. These lands are organized in the same way as the *départements* of France, with a *préfet* (the agent of the central government) and an elected general council. Their budget is that of the metropolis and individual dispositions in certain respects may be made by law with regard to them. They are, in the West Indies: Martinique, Guadeloupe and its dependencies; in South America: French Guiana; and in the Indian ocean, Réunion.

(3) The overseas territories. These are small and very scattered countries which, while participating in the institutions of the republic, enjoy a certain autonomy and have their own budget. They comprise the following in North America: the islands of St. Pierre and Miquelon, remnants of French Canada; in east Africa: French Somaliland; in the Indian ocean: the Comoro Islands, and the Southern (Kerguelen and other islands) and Antarctic territories, administered directly from Paris; in the Pacific ocean: New Caledonia, Wallis and Futuna Islands and French Polynesia. France also has, with Great Britain, the condominium of the New Hebrides, which has no representative institution and does not form part of the republic.

Other Member States.—These were the following, by geographical distribution:

(1) In west Africa (formerly l'Afrique Occidentale Française, less Guinea): the republics of Senegal, Mali, Mauritania, Upper Volta, Dahomey, Ivory Coast and Niger. Senegal and the Sudanese republic in 1959 united to form the short-lived Federation of Mali, which in 1960 divided to form two republics, Senegal and Mali. Ivory Coast, Upper Volta, Dahomey and Niger have created the Sahel-Benin entente. All the states agreed to form a customs union. (2) In equatorial Africa (formerly l'Afrique Equatoriale Française): Central African Republic and the republics of Gabon, Congo (former Middle Congo) and Chad.

(3) The Malagasy (in French Malgache) Republic (Madagascar).

Evolution.—The system set up overseas by the constitution of 1958 survived only in Algeria, the Sahara, the overseas *départements* and the overseas territories. Among the states the community functioned only during 1959 when six sessions of the executive council were held in various capitals. Immediately after the sixth session, held in December at Dakar, President de Gaulle agreed to Mali's claim for national sovereignty.

In 1960 the powers of the community were transferred to the various republics. In April agreements were signed between France and Mali and France and Madagascar, recognizing the independence of those two countries. At the same time they made agreements to receive military, economic and cultural aid from France. In July the Ivory Coast, Upper Volta, Niger and Dahomey received their independence and so did the four republics of the former French Equatorial Africa. A similar agreement was made with Mauritania in October. By 1963 only Senegal, Gabon, Congo, the Central African Republic, Chad and the Malagasy Republic still belonged to the community. The constitutional bodies, however, no longer continued to function and the relations between these member states and France showed no difference from the relations between France and the other formerly French states.

This new system is based purely on contractual agreements. The states are fully independent, with their own flags, their own national anthems, their own representation abroad and their own armed forces. They were admitted as members of the United Nations in Sept. 1960 (except for Mauritania, whose independence came slightly later and was admitted to the UN in 1961). Their new constitutions, for the most part, tended to give increased executive power to the presidents. In the African republics, where dialects are numerous, French remains the official language. The Malagasy Republic allows French alongside Malagasy.

In Sept. 1960, when Senegal broke away from the Federation of Mali, the Sudanese republic took the name of Mali, and declared its previous agreements with France void. The two states, Senegal and Mali, were admitted separately to the United Nations.

Some of the overseas territories demanded a constitution that would give them greater autonomy. A cease-fire agreement ending the Algerian war was announced on March 18, 1962, and De Gaulle's program for an independent Algeria was given overwhelming support by the French people in a referendum held on April 8, 1962. Independence, including permanent collaboration with France, was approved by the Algerians in the referendum of July 1, 1962. (*See* ALGERIA: *History.*)

Economy.—All the states of the former community, as constituted in 1958, with the exception of French Somaliland but with the addition of Tunisia, Togo and Cameroon, form the "franc

area" (*zone franc*) inside which currencies are freely transferable and which is recognized as a monetary unit by the world. European France sends about 35% of its exports to the other countries of the franc area and receives from them 24% of its imports. Of the exports of these countries 75% is absorbed by France, who supplies 74% of their imports.

Algeria is the principal customer of France and its third supplier. France has more trade with west Africa than with Great Britain. The economic ties that are created by the franc area, by customs tariffs and by French enterprises therefore have considerable importance.

The countries of the 1958 community have a surplus of soft wheat, barley, bananas, cocoa, wine, iron, nickel, lead, phosphates and potash. They can normally supply their own requirements of soft wheat, peanuts, rice, citrus fruits, coffee, vegetable oil and sugar. They have to import in quantity cotton, wool, coal and petroleum, though production of the last-named item in the Sahara would limit the necessity for its importation. The commercial exchanges are largely carried in French ships and aircraft. The franc area and the agreed preferences for the products of the community assure the sale of these goods and, in the case of certain products, at rates higher than world prices. European France, for its part, finds an assured market for its manufactured goods in the other countries of the community. The trade balances of the overseas countries, almost everywhere in deficit, are stabilized by the common funds of the franc area.

Furthermore, the still rudimentary economy of most of the overseas countries is stimulated by the investments of European France. These exceed $1,000,000,000 a year, more than three-quarters of which is supplied by French public funds. More than one-half is devoted to the construction of railways, roads, ports, etc., the rest is divided between the improvement of production (agriculture, irrigation, etc.), and social services (health, education). A fund for aid and co-operation (F.A.C.) and a central treasury for economic co-operation (C.C.C.E.), as well as a special ministry for community relations assure the implementation by France of the necessary technical assistance. Another ministry is responsible for the overseas *départements* and territories.

Algeria was the object of a special effort (the Constantine plan) to meet the serious problems arising from the rapid increase of the population in a country of limited resources. France also absorbed a considerable part of the surplus of Algerian workers.

French aid to the newly independent states and the solidarity of the franc area constitute an effective formula for co-operation and assistance to the underdeveloped countries.

See H. Deschamps, *The French Union* (1956); F. Luchaire, *Droit d'outremer* (1959). (Hu. De.)

FRENCH CONGO, the official name (Congo Français) borne by the French possessions in equatorial Africa from 1897 until 1910, when they were renamed Afrique Equatoriale Française, abbreviated A.E.F. (*see* French Equatorial Africa). In 1960 these territories became fully independent states as the Central African Republic and the Republics of Chad, Congo and Gabon (*qq.v.*) but continued as members of the French Community (*q.v.*).

FRENCH EQUATORIAL AFRICA (Afrique Equatoriale Française, or A.E.F.) was, until 1959, a federation uniting four territories in west-central Africa under French rule. In 1960 the territories (formerly colonies) became independent republics as follows: Central African Republic (the former Ubangi-Shari); Republic of Chad; Congo Republic (the former Middle Congo); and the Gabon Republic (*qq.v.*). Together they had a population (1960 est.) of 5,145,000 and an area of 969,112 sq.mi.

The area has neither geographical nor ethnic unity. In the south it is inhabited by Bantu-speaking Negroes of Guinean race, with several Pygmy groups in the forests. Along the Ubangi and Shari rivers dwell Negroes of tall stature; in the Lake Chad area is a mosaic of Negro tribes and of "Chad Arabs" who have acquired Negro blood; and in the northern desert are found the Tebu (Tubu), who are Negroes with Europoid features.

History.—The Tebu have occupied the desert since antiquity. In the 8th century A.D. was founded the sultanate of Kanem north of Lake Chad and in the 9th century the state of Bornu; in the 16th century two other sultanates, Baguirmi and Wadai, were established. All these were Muslim. The pagan tribes (Sara, Fertit) to the south were weakened by slave traders from Wadai and Sudan. In 1892–93 one of these traders, Rabah Zobeir, overthrew and laid waste the sultanates of Baguirmi and Bornu, but along the Ubangi several tribes, such as the Azande and Mandjia, resisted the slave traders.

Dispersed through the forests of Gabon a number of small tribes (particularly the M'pangwe and Bakota) were in mid-19th century pushed back by the pressure of the Fang from the north. All these peoples were famous for their wood carvings. Along the Lower Congo and on the nearby coast, the Bakongo tribes in about the 15th century had founded the kingdoms of Loango, Congo and Kakongo. Stanley pool, the site of modern Brazzaville and Léopoldville, was part of the Bateke state of Anzico. In the late 15th century the Portuguese discovered the coast, which soon became a flourishing centre of the slave trade, with the coastal inhabitants as middlemen. In 1839–43 Capt. L. E. Bouet-Willaumez took possession for France of the Gabon estuary, where a refuge for freed slaves was founded and called Libreville (*q.v.*). After the Franco-German War, France took an increasing interest in Africa and in 1876 Pierre Savorgnan de Brazza ascended the Ogooué river in Gabon. Following H. M. Stanley's discovery of the course of the Congo in 1874–77, Brazza signed treaties with chiefs in the interior (notably in 1880 with Makoko, king of the Bateke), placing them under French protection. Between 1885 and 1891 most of Middle Congo and Gabon was secured and by 1896 Victor Liotard had penetrated up the Ubangi to the Bahr El Ghazal area. Penetration farther eastward by J. B. Marchand, who in 1898 reached Fashoda on the White Nile, met with British objections.

Expansion was then directed toward the Chad region, whose conquest took several decades. Émile Gentil in 1897 reached Lake Chad and established a French protectorate over Baguirmi. There followed bloody fighting with Rabah Zobeir, who was finally defeated and slain in an encounter with three French columns at the battle of Kousseri (modern Fort-Foureau) in 1900. Wadai and Borku were subjugated between 1911 and 1913 by expeditions led by Col. V. E. Largeau. This northward extension, by establishing a junction with the Niger colony in French West Africa, secured a continuous French empire from the Mediterranean to the Congo. In 1910 the colonies of Gabon, Middle Congo and Ubangi-Shari-Chad were federated under the name French Equatorial Africa (Chad was reorganized in 1920 to form a fourth colony). The government recovered a large part of the vast concessions leased to commercial concessionaires, which had led to some abuses. The federation needed large subsidies from the French exchequer but its development was assisted by the completion in 1930 of the railway between the port of Pointe-Noire and Brazzaville.

In World War II the governor of Chad, Félix Eboué, gave the lead to the other territories in supporting Free France. By the constitution of 1946 all the indigenous peoples of A.E.F. became French citizens and the colonies oversea territories of the French republic. In 1959 they became autonomous states and in 1960 each obtained full independence within the French Community. *See* also references under "French Equatorial Africa" in the Index volume. (Hu. De.)

FRENCH GUIANA (Guyane Française): *see* Guiana: *French Guiana.*

FRENCH INDOCHINA (Indochine Française) the territory in southeast Asia which, apart from Japanese partial occupation during World War II, was until 1954 held by France and included the countries now known as Cambodia, Laos, North Vietnam and South Vietnam. The French, from their capital at Saigon, dealt with the so-called Union of Indochina in four separate political units: Cochin China, a directly administered colony now forming the greater part of South Vietnam; the empire of Annam (which included the province of Tongking), indirectly administered as a protectorate and now largely included in Communist North Vietnam; and the two kingdoms of Cambodia and Laos, also

protectorates, which are now again independent territories under their own names. The territory of Kuang-Chou Wan (*q.v.*), on the east of the Luichow peninsula, leased to France by China for 99 years in 1898–99 and now the municipality of Chan-Chiang (*q.v.*), was returned to China in 1945. *See* INDOCHINA; VIETNAM; CAMBODIA; and LAOS. (E. H. G. D.)

FRENCH LANGUAGE. French is one of the Romance languages (*q.v.*). In particular, the name refers to the standard literary language that is taught to natives and foreigners and that is understood and used, albeit with unequal efficiency, by all speakers of French. French also subsumes a number of dialects. These have, however, been losing currency and prestige ever since the middle ages and are now mere local patois.

French uses the same (Latin) alphabet as English, but some letters may be provided with diacritic marks. The vowels may bear an acute accent (*é*), a grave accent (*è, à*) or a circumflex accent (*â, ê, î, ô, û*). The spelling *é* indicates a so-called close pronunciation (as in English "bait," but without the diphthongal, gliding effect), *è* and *ê* an open pronunciation (as in English "bet"). Other accent marks do not significantly change vowel pronunciation, except that some speakers have a tendency to lengthen circumflexed vowels. The *c*, which is pronounced *k* before vowels other than *e* and *i* (where it is pronounced *s*), may by means of a cedilla, written *ç*, be converted into an *s* sound. French orthography is not entirely phonetic; pronunciation is not certain from spelling alone, as it is in Spanish, Italian, Russian and other languages, but it is almost so. French orthography is not nearly so unpredictable as English.

French is the native language of about 45,000,000 persons in metropolitan France. About 2,500,000 more speakers (native and non-native) are naturalized French citizens and resident foreigners, and approximately 500,000 Frenchmen reside abroad. Of about 42,000,000 persons inhabiting French possessions, about 13% speak French, the percentages varying from 2% in French possessions in western Africa to 95% in Martinique. About one-fourth of Canada's inhabitants, mainly in the province of Quebec, speak French. In the U.S. at mid-20th century, there were more than 100,000 French-born persons. American native speakers of French, mostly bilingual, were mainly located in Maine and Louisiana, but their number was diminishing.

French is also one of the official languages of Belgium (*see* BELGIUM: *Population*) and of Switzerland (*see* SWITZERLAND: *Population and Social Conditions*).

HISTORY

The homeland of French (in the wider sense) is the Roman province of *Gallia* (Gaul), conquered by Caesar in the middle of the 1st century B.C. (except the Provincia, now Provence, which became Roman in 122 B.C.); it corresponds largely to modern France. Before its latinization the country was mainly of Celtic speech, although there is some evidence that in Aquitania (the modern Gascogne) and along some stretches of the Riviera other languages were spoken, by some scholars called Iberian and Ligurian, respectively. But Iberian is virtually unknown, unless Modern Basque, which cannot with confidence be historically or structurally connected with any other known language, is a continuation of Iberian; and Ligurian is little more than a geographical name. The Greeks also had settlements along the Mediterranean coast in Gaul before the Romans; linguistic evidence for this can be found in local names of the Riviera: Nice < Nicaea (Greek Nikeia); Antibes < Antipolis; Port-Vendres < Portus Veneris, a Latin translation of the earlier Greek name Aphrodisias. Otherwise this Greek substratum left no traces. The linguistic inheritance from Celtic, however, extends not only to local names in France (Lyon < Lugdunum; Verdun < Virodunum; names ending in *-ac, -ai, -i*) but also to a number of words, of which some (about 180) are typical of Gaulish Latin and French only. The Celtic of Gaul (Gaulish), poorly attested, was not a uniform language but was spoken in several dialects (surely more than three corresponding to the *partes tres* into which Caesar divided Gaul). Latinization was speedy and thorough (although the Romans made no concerted effort to impose their language), and Celtic dialects were not long continued and were rarely written: Latin enjoyed all the psychological and material advantages of the idiom of the stronger and politically and economically more advanced conquerors. (The Breton language of Brittany, now dying out owing to the social and cultural pressure exerted by the national French language, is Celtic imported in the early middle ages from Britain, not a native speech of Gaul.)

Although the evidence is defective, it can be safely presumed that, outside the spoken and written Latin lingua franca of the Roman empire, the spoken Latin of the various regions of Gaul continued the dialectal diversities of the Celtic substrata. These were the bases of the emerging Romance dialects. (For the relation between spoken and written Latin *see* ROMANCE LANGUAGES.)

After a period of peace and prosperity, Gaul was, like the rest of the weakening Roman empire, subject to foreign invasions, particularly by Germanic tribes. In the course of the 5th century the Visigoths settled in the south, the Burgundians in the Rhône valley area, the Saxons along the channel and the Atlantic coast, whence they soon moved to Britain. But the most important contingent was the Franks who, in 486, under their king Clovis, liquidated the kingdom of Syagrius, the Roman governor who was autocratically holding a Roman province in the north, isolated from the empire by the invaders. The Franks moved south, defeated the Visigoths (507) and absorbed the Burgundian kingdom (534). Clovis had himself baptized; the Franks became Christians and acquired Latin as their new language. They bequeathed about 200 Germanic words to the Latin vocabulary, and it is claimed that their habits of articulation caused certain changes typical for the Romance of Gaul (especially the diphthongization of vowels—*see* below). On the whole, their linguistic influence, though larger than that of other Germans in Gaul, was small. But France (Francia) owes to them its name.

The dynasty of Clovis, the Merovingians, divided the state among the heirs according to Germanic custom, thus producing progressive fragmentation of the land and weakening the monarchy. From the 7th century, the *maior domus* ("mayor of the palace"), originally the first official of the royal household, began usurping something like the duties and powers of a prime minister or regent of the realm, until one of them, Charles Martel, having saved the state from Muslim conquest (in the battle of Poitiers, 732), became the virtual ruler. His son, Pepin the Short, actually came to the throne in 751 and established the dynasty of the Carolingians, among whom Charlemagne (768–814) was the most eminent. Under him occurred what is generally called, somewhat exaggeratedly, the Carolingian renaissance, which included a premature and largely ephemeral attempt, for political and ecclesiastical ends, to revive classical Latin. Charlemagne himself was crowned "Roman" emperor in 800. But the Latin of Cicero had passed away and could not be resuscitated by monarchic fiat. In fact, a return to classical standards estranged Latin even more from the common man, whose Latin had actually become, owing to the passage of time and the influence of Celtic substrata and Germanic superstrata, quite a different language. It could be called Latin at this point only in deference to its earlier form. The church, recognizing this, permitted through the Council of Tours (813) the use of the "rustic" and "vulgar" native tongues for preaching so that everyone could really understand what the priests (many of whom were poor Latinists in any event) were saying.

The new language, thus attaining some prestige and being soon reduced to writing, though not for learned matters, may be called Old French. The oldest available text is that of the oaths of Strasbourg (842), an agreement uniting Louis the German and Charles the Bald, two of Charlemagne's grandsons, against the third, Lothair, in a quarrel over the division of the empire. These oaths, preserved by the historian Nithard, were pronounced in both German and French so that anyone concerned on either side could fully understand their wording. This first written source does not, of course, mark in any sense the birth of French: it had been preceded by a continuous unrecorded development of the speech of Gaul.

The subsequent Old French texts are all literary: the *Cantilène de sainte Eulalie* (880), the *Passion de Christ*, a *Vie de Saint Léger*

and a fragment of a homily on the prophet Jonas (all of the 10th century), followed by a great flowering of literature in various dialects. The most famous work of the age is the *Chanson de Roland*, of the middle of the 11th century, narrating the battle of Charlemagne's nephew (or so he is identified in the *Chanson*) Roland against the Muslims and his death at Roncesvalles.

In the 9th and 10th centuries, marauding Vikings plagued the northwest of France. They were eventually pacified and their energies usefully employed when land (which they had already conquered) was assigned to them, and they became romanized forthwith. These Northmen, or Normans, gave their name to the province of Normandy. Invading England in 1066 and carrying their language there, they became responsible, if not for the romanization of England, at least for the bulk of the more than 50% of the English vocabulary that is of Romance origin.

After the death of the last Carolingian in 987, Hugh Capet came to the throne. Under him and his successors, although monarchic power was restored in the Île-de-France, the decentralization of the administration of France as a whole and the breaking up of the country into many quasi-independent units, which had commenced after Charlemagne's death, continued. Feudalism came to full flowering. The linguistic consequence was a commensurate linguistic fragmentation and the development of literature in a number of dialects. On their evidence, supported by knowledge of later and current patois, the dialects may be classified thus: (1) eastern—Bourguignon, Franc-Comtois, Lorrain, Champenois; (2) northeastern—Picard, Wallon; (3) northwestern—Normand; (4) western—Poitevin, Angevin, Saintongeais; (4) north-central (Île-de-France)—Francien.

In the southeast, approximately covering the former Burgundian kingdom, exists an idiom called Franco-Provençal, which some claim to be sufficiently distinct from the others to warrant calling it a separate language. It is so named because in many respects it takes a position intermediate between French and the various southern dialects subsumed under the title Provençal language (*q.v.*), which are spoken in the remainder of France.

From all these, Francien was to emerge as the standard language of France, with the other idioms becoming gradually substandard patois. This favoured position of Francien, eventually called Français, was not due to any intrinsic excellence (all dialects are potentially equal) but to historic and cultural circumstances. In large part these were provided by the resumption, during the 13th and 14th centuries, of the reins of state by stronger monarchs, residing in Paris, the core of the Francien-speaking region, who managed to concentrate once more in their own hands the power which had eluded their predecessors. Paris became also the artistic, religious and intellectual centre of the realm (the University of Paris was founded in the middle of the 13th century). The catastrophe of the Hundred Years' War (1337–1453), though leaving France prostrate, contributed to the prestige of the throne, produced a national French conscience even among the ordinary people and thus helped the establishment of a national language fashioned after the speech of Paris.

From the 13th century, Romance dialects gradually supplanted Latin not only in literature but also in nonliterary documents. It was inevitable that Francien should be favoured, first in official papers of national concern, eventually also in those of local importance. The treaty of Paris, ratified in 1259, was the first document of its type in Francien, or French.

Thanks to great literary productivity, the language of France also acquired extensive renown abroad, especially in Italy. Brunetto Latini, Dante's teacher, wrote (*c.* 1260) his *Trésor*, a kind of medieval encyclopaedia, in French; and Marco Polo dictated his memoirs in French (1298). Again this was due not so much to an intrinsic superiority of French over other European languages (although Brunetto Latini and many others ascribed their predilection for French to this), but rather to the fact that France led other European countries in developing something of a standardized, supraregional, national literary language.

The terms Middle French (15th and 16th centuries) and Modern French (from the 17th century on) refer customarily to the developing Francien dialect. The other dialects of France, including Provençal, once the carrier of a brilliant and influential literature, were henceforth in continued retreat. Jean Froissart (1338–1410?) was the last important author to use a language other than Francien.

The Renaissance, the greatest phenomenon in the cultural history of France of the late 15th and 16th centuries, implies in linguistic history the adoption of Latin and Greek words and expressions, and also, more ephemerally, the cultivation of a somewhat ponderous, solemn, rhetorical latinizing style whose long periods ill fitted the grammatical structure of Neo-Latin. Many of the words then borrowed from Greek and Latin, though at first the property of the learned few, have over the centuries become common property; only linguistic analysis uncovers their origins.

The influence of Italy had much to do with the return to Latin sources. In 1494 Charles VIII set out to conquer Italy. He returned beaten, but he introduced Italy and, above all, the Italian Renaissance to France. In 1533 Prince Henry (later Henry II) married, at the age of 14, Catherine de Médicis, who brought into France Italians, Italian mores and Italian culture. All these imports, however, were adapted and absorbed, and, regardless of the influence of Latin and Italian (there are about 1,000 words of Italian origin in the French lexicon), the French language remained essentially the same.

Under Francis I, the ordinance of Villers-Cotterêts (1539) banished Latin from its last stronghold in royal jurisdiction. And Calvin's own French translation (*Institution de la religion chrétienne*, 1541) of his Latin *Institutio christianae religionis* (1536) brought French into theology. But the Roman Catholic Church now opposed the popularization of the Scriptures; it was, this time, initiated by Protestants and was therefore violently and bloodily combated. The Sorbonne was on the side of the church, and soon the schools of France found themselves involved, paradoxically, in an anti-French movement. But French did become the language of the Protestant church.

Calvin, although he was not, like his German counterpart Luther, instrumental in the establishment of the national standard language, was a master of prose and therefore influential in the development of literary French. The style of his works and those of his so dissimilar contemporary, Rabelais (1495–1553), served later authors as a model. Rabelais is memorable for the luxuriance of his vocabulary. He not only introduced into the French language neologisms of his own making but also, more importantly, enriched the somewhat formalized and conservative standard language by numerous technical terms and dialectal expressions which had hitherto been shunned as vulgar. There was no word that Rabelais would not use or, indeed, make up, if it fitted his context.

In the domain of poetry, the authors of the Pléiade maintained that if French was not already as good as any other language, it could surely become so if properly cultivated and enriched through borrowing from the classical languages. They issued their manifesto, *La Défense et illustration de la langue française*, written by Joachim du Bellay, in 1549. Grammarians, generally much more interested in Latin than in its modern "corruptions," now also turned their attention to French. The French language was emancipating itself practically and theoretically from the tutelage of Latin. It did so, however, with an *élan* and an exuberance which was soon to call forth, in a new, more sedate and less Rabelaisian cultural climate, a reaction.

In the 17th century, after the freedom, fullness and licence of Renaissance life, and after the upheavals of religious warfare, France entered upon an era of order, rule, restraint and *raison*, of political centralization and autocracy, culminating in the persons of Louis XIII, Louis XIV, Richelieu and Mazarin. In language also, this was a period of contraction and pruning. The riotous growths of Renaissance language were to be weeded out. François de Malherbe battled successfully against archaism, regionalism and neologism in poetry, extolling the norm, restraint and *le bon usage* as practised by the upper classes. In prose, Jean Louis Guez de Balzac advanced similar views. And Claude Favre, Seigneur de Vaugelas was the contemporary grammarian who made usage the proper guide for speaking and writing—albeit the usage of the court and the *honnêtes gens*. In 1635, Richelieu, the se-

vere exponent of monarchic autocracy, officially established the seat of French linguistic autocracy, the Académie Française, which had the task of watching over the French language and preventing its corruption. The first edition of the dictionary of the Académie appeared in 1694 (the eighth in 1932–35); its purpose was normative rather than descriptive. But arresting the natural development of a language and adding frills known only to a small minority always comport dangers of mummification. French escaped this fate, perhaps because of the very excesses of the fashion and its concomitant restriction to a thin layer of society. Molière (1622–73) lampooned it (in the *Femmes savantes*, for example), and his dialogue shows how little the common people were affected, no matter how the learned, the ladies, the young fops and the old fools strained to abide by the rules. This was, moreover, an age in which the court, the aristocracy and high society not only talked themselves but also lived themselves out of contact with the rest of the people, a willful isolation for which the privileged classes paid during the Revolution.

La raison, reason as expounded in the philosophy of Descartes (1596–1650), was about to become the watchword of the time; and orderliness and reason, and immutability were the bonds with which some proposed to fetter the literary language. The great classical authors, above all the dramatists Corneille (1606–84) and Racine (1639–99), with their regular Alexandrine metre, their *trois unités* (the three unities of time, place and action, which, in the name of reasonableness and verisimilitude, did not allow the drama to occupy more than one day's time or greater space than was encompassed by the presentation on the stage), their classical plots and their restricted vocabulary, partly renounced their linguistic freedom.

Paradoxically, the real and considered enthronement of reason actually brought about liberation from some of the linguistic and literary canons rashly and falsely imposed in its name. For the awakening scientific studies of the 18th century, exemplified by the *Encyclopédie* and its founders and writers, by Diderot (1713–84) and by Voltaire (1694–1778), could not develop freely under the restrictions imposed upon the written language in the preceding century. Scientific discourse about new things and new thoughts required new technical terms; localisms and popular words from farm and workshop were employed if they served a purpose. At the same time, the church, the aristocracy and the court, despite the external splendor of Louis XIV's establishment, had lost confidence and prestige among the people. Hence the main pillars of *le bon usage* were cracking, and the *honnêtes gens* were losing influence. Voltaire and Rousseau (1712–78), both masters of prose and both severe critics of contemporary society, though altogether different in ideas and manners, were alike in rejecting the authority and restraints upon linguistic usage, which the 17th century had favoured.

The French Revolution (beginning in 1789), which attempted to gather the strength of the whole nation for nationalistic effort, spoke out against patois and "foreignism" in language. But this phase was soon countered by the literary movements of the 19th century, romanticism, realism and naturalism, whose very names suggest hospitality toward the exotic, the historic and the realistic, and enmity against the traditional, the hidebound and the artificial.

These changes and veerings of fashion concerned mainly vocabulary and style. The structure of the French language was scarcely affected; it remained essentially the same from the Middle French period.

At the present time, linguistic currents and fashions are the same in French as, *mutatis mutandis*, in other languages. The literary standard language spreads continually at the expense of local dialects, leaving only local peculiarities of pronunciation; the process is immeasurably speeded by increased literacy and the penetration of the press, radio and television into regions that were until recently isolated. There is also a spread of an international scientific and technological vocabulary, which is virtually intruding into the nursery. Finally, there is the slow gain, under the impact of linguistic studies of the past century, of an attitude that considers language more a social instrument than a national monument.

INTERNAL DEVELOPMENT

Phonology.—The stressed vowels of late spoken Latin, distinguished from one another by quality and not, as in classical Latin, by quality and quantity (*i ę ę a ǫ ǫ u*: the dot indicates close, the semicircle open, pronunciation) developed in Old French according to their quality and position within the word. The *e* (continuing both classical Latin *ē* and *ĭ*) *ę ǫ* (continuing both classical Latin *ō* and *ŭ*) *o*, when standing at the end of a syllable, in free position, became diphthongs; when within a syllable, in checked position, they remained unchanged. Some think that the free position lengthened the vowels and thus prepared for diphthongization; but this assumption is not essential (*tela* > *teile* [Mod. Fr. *toile*]; *pędem* > *pied; florem* > *flaur* [Mod. Fr. *fleur*]; *cǫrem* > *cuer* [Mod. Fr. *coeur*]; *virga* > *verge; cęruum* > *cerf; rǫpta* > *rote* [Mod. Fr. *route*]; *pǫrtam* > *porte*). Generally *i* remained unaltered (Latin infinitives in *-ire* > French *-ir*); *u* always became *ü*, pronounced like the umlaut in German and spelled *u* (*luna* > *lune*), regardless of position. Free *a* became *e;* checked *a* remained (*mare* > *mer; partem* > *part*).

Old French also had diphthongs *ai, ei, oi, ui*, originating from a combination of *a, e, o* or *u* with a primary or a secondary *i;* the latter having developed, for example, from a palatal or palatalized consonant (*factum* > *fait; tectum* > *teit* [Mod. Fr. *toit*]; *gaudium* > *joie; fructum* > *fruit*) or sometimes from an earlier triphthong (*noctem* > *nueit* > *nuit;* but *iei* is monophthongized: *lectum* > *lieit* > *lit*). When combined with the *u* resulting from the vocalization of *l* before a consonant, *a, ę* and *o* also appeared as diphthongs (*altum* > *aut* [Mod. Fr. *haut*]; *feltrum* > *feutre; multum* > *mout*); and *ę* appeared as a triphthong (*bellus* > *bels* > *beaus* [Mod. Fr. *beau*]). The pronunciation of these was diphthongal in Old French, whereas Modern French has reduced most of them to monophthongs while retaining the older spelling.

All these developments, however, may be neutralized or altered in certain phonemic surroundings. The nasalization of vowels before *m* and *n*, with eventual absorption of the consonant, should be noted (*pontem* > *pont; manum* > *main*). Many inconsistencies with the rules here outlined, as well as with those to be mentioned for the consonants, are due to analogical reformation, whereby the sound appearing in a word conforms not to the rules of regular phonemic substitution but to the leveling influence of a paradigm (*finire* became *fenir*, but then developed into *finir* in analogy with forms in which the first *i* is accented and therefore stable; *amo* with stressed free *a* regularly gives *aime*, but *amare*, where the same *a* is unstressed, should become *amer* and not *aimer*, which is due to analogy).

Nonstressed vowels developed according to their position in the word. They were never diphthongized. The completely unstressed posttonic vowel of a proparoxytone (word accented on the third-from-last syllable) was invariably dropped in French (*populum* > *peuple*). All final unstressed vowels were also dropped (*quando* > *quant* [Mod. Fr. *quand*]), with the exception of *a*, which evolved into the so-called silent *e*. It is not always silent but may be pronounced as the schwa sound, which is phonetically transcribed *ə* (*luna* > *lune*). Other final vowels were also retained if they were needed to support a preceding consonant cluster which cannot terminate a French word (*populum* > *peuple; febrem* > *fièvre*); in Modern French such words sometimes, when the speaker does not pronounce the final *-ə*, also lose the sound of the preceding consonant (*peup'; fièv'*).

The vowel of the pretonic syllable behaved like that of the final; hence it is sometimes called counterfinal (*ornamentum* > *ornement; liberare* > *livrer*). The vowel of the initial syllable was generally weakened when unstressed (in particular, *a* > *ə*); when bearing the secondary stress it remained unchanged.

The development of the consonants was determined more by their position (initial, intervocalic, final or part of a cluster) and their phonetic surroundings than by their quality. The most pervasive phenomenon was palatalization of consonants, by which the sounds *k, g, yod* (the first sound in "yes") and *d* plus *yod*, if followed by *e, i* or *yod*, became *s, ts, sh, dz* and *zh* (*cęruum* > *cerf; civitatem* > *citet* [Mod. Fr. *cité*]; *gentem* > *gent; iungere* > *joindre; diurnum* > *jorn* [Mod. Fr. *jour*]). In French alone of

all the Romance languages, *k* and *g* became *sh* and *zh* also before *a*, which, if stressed, became *ie* (*caballum* > *cheval; caput* > *chief* [Mod. Fr. *chef*, borrowed into English while in its O. F. form]). Initial *qu*, although unchanged in spelling, lost the *u* element (*quando* > *quand*) becoming *k* in sound. Initial *s* followed by another consonant got a prothetic *e*, which remained while the *s* was dropped (*stella* > *esteile* > *étoile*).

In intervocalic position, voiceless consonants (produced without accompanying vibrations of the vocal cords) generally became voiced (produced with accompanying vibrations of the vocal cords) in late spoken Latin. In Old French they, as also the original voiced consonants, tended to become fricatives or to be dropped (*videre* > *veeir* [Mod. Fr. *voir*]; *vita* > *vie; faba* > *fève; ripa* > *rive; plaga* > *plaie; securum* > *seür* [Mod. Fr. *sûr*]; *placere* > *plaisir*). Double medial consonants except *ss* and *rr* became simple, although in Modern French the etymological spelling may be resumed without effect upon the pronunciation (*cappa* > *chape; gutta* > *gote* [Mod. Fr. *goutte*]; *belle* > *bele* [Mod. Fr. *belle*]; *flamma* > *flame* [Mod. Fr. *flamme*]; *terra* > *terre; missa* > *messe*). The cluster *mn* became *m* (*dom(i)na* > *dame*).

Final consonants were largely retained in Old French but were dropped later in pronunciation, though not necessarily in spelling. Final *m* was dropped early in Latin speech, except in monosyllables, where in French it appeared as *n* (*rem* > *rien*). Final *s* lasted through the Old French period. Voiced finals tended to become unvoiced and eventually were lost, together with the original ones; for example, *quand(o)* > *quant*, then the *t* was dropped. Modern French *quand* shows restoration of the etymological *d* in spelling but not in pronunciation.

Morphology.—The most important consonantal phonemic signals in the Latin declensional system, that is, the so-called case endings, are *m* and *s*. Final *-m* disappeared early. Also the vocalic declensional signals lost their significance, because of the loss or blurring of older quantitative and qualitative distinctions in the unstressed vowels. With many cases thus bereft of significant markers, the whole paradigmatic system was doomed. But as long as Old French retained the final *s*, the cases ending in *s* (mostly nominative singular and accusative plural) could be distinguished from others without *s*. According to this new paradigm, *s* was often added by analogy even to forms that had none in Latin, and was dropped from forms where it had become disturbing. The new device, however, was capable of continuing not six cases, as in Latin, but only a two-case declension—one subject and one nonsubject case. When the latter fulfilled other than direct object (accusative) functions, it was generally preceded by a preposition. Once final *s* also had become silent, the majority of the subject-nonsubject distinctions could no longer be formally signaled. Prepositional phrases became indispensable, except for the subject-direct object relation, in which rigid word order (subject—verb—direct object) became the rule.

It is difficult, however, to be sure exactly which came first, the phonetic decay of case endings or their functional replacement by these other devices. The two tendencies probably occurred together and reinforced one another. In general (but there are exceptions) Modern French continues the nonsubject case in both singular and plural. Acoustically, the difference between singular and plural, though shown in spelling, resides in most cases in the accompanying article (*la table—les tables; une table—des tables*). Only pronouns retain audible vestiges of case distinctions (*le, lui, les, leur, je, me, tu, te*, etc.). The three genders of Latin were reduced to two, neuters being transferred into either of the other genders (the plural in *-a* often becoming a French feminine singular). Not all nouns retained their Latin gender.

Adjectives developed in a manner similar to nouns as regards cases and genders. The comparison of adjectives and the formation of the adverb were accomplished through composition rather than inflection: *calidum, calidius, calidissimum, calide* appear as *chaud, plus chaud, le plus chaud, chaudement* < *calida mente* (literally "with a warm mind"). There are few remnants of older ways in Modern French, more in Old French (*meliorem* > *meilleur; peius* > *pis; maiorem* > *majeur; fortiorem* > O. F. *forzor; pessimum* > O. F. *pesme*).

The morphology of the verb partook of all changes that the conjugational system underwent in late spoken Latin (*see* ROMANCE LANGUAGES). The most striking of them and of later ones in French itself were (1) replacement of several simple tense forms by compositions (some forms still being felt as compounds: *il a donné;* others again as simple forms: *donare habeo* > *donare aio* > *je donnerai;* colloquially often replaced by a new compound: *je vais donner*); (2) the loss of all simple passive forms (*amatur* > *il est aimé*); (3) the reduction of subjunctive forms in number and frequency of use; (4) the formation of a conditional mood (*donare habebat* > *il donnerait*).

Of the four Latin conjugational types (infinitives in *-are, -ēre, -ĕre, -ire*) only three remain (but four infinitives *-er, -oir, -re, -ir*); not all verbs, however, stay in their original classes (*rire* < *ridēre; choir* < *cadēre* not *cadĕre*). Some irregular Latin infinitives become regular on the analogy of the main types (*pouvoir* < *potere* for *posse, vouloir* < *volēre* for *velle, être* < *essere* for *esse*). But such analogical leveling, which pervades the whole verbal system, is capricious; it can be described and classified, but not predicted.

Syntax.—Many of the changes from Latin to French syntax are explained through phonological and morphological history. French is not as highly inflected as Latin, and, therefore, certain functions of Latin inflection must be expressed by other means in French: prepositional phrase, word order, subject pronoun (*chante, chantes, chante, chantent* sound alike without pronoun). In Old French, with vestiges of Latin inflection still remaining, word order was freer, and the use of the subject pronoun was optional. Also, the grammatical rules of Latin were applied with laxness while the new language had not yet been rigidly codified. Hence one gets the impression of irregularity and lawlessness, but in truth there were just different rules. It must not be claimed that the syntactical development from Latin to French implies either improvement (greater logic, economy or orderliness) or deterioration (greater rigidity of word order, reduction of distinctions or loss of wealth of inflections). There is merely change, each stage of the language using the material available.

The most important changes of the Middle and Modern French periods have already been indicated in the preceding sections: monophthongization of diphthongs; end of the two-case system; regularization of word order; regularization of the use of definite, indefinite and partitive articles (derived from the Latin demonstrative pronoun, the numeral "one," and the preposition *de* plus the demonstrative pronoun, respectively); obligatory use of the subject pronoun; codification and stabilization of grammar. By the beginning of the 17th century the language had essentially attained its modern stage in structure, and the literature of the period can be read easily by one who knows Modern French.

In conclusion, a few words may be said on the often vaunted logic, clarity and general superiority of French over other languages. This idea was expressed as early as the 13th century by Brunetto Latini; it was dogmatized and enshrined by Rivarol in his *Discours sur l'universalité de la langue française* (1784); and it has since been endlessly reiterated (even in some books cited in the bibliography below). "What is not clear is not French; what is not clear is still English, Italian, Greek, or Latin," says Rivarol. What is not clear is not good French, true, nor is it good anything else. Clarity, logic, skill and all other linguistic excellence reside not in the language but in the user. Language is a mere instrument which can be employed in such a way as to fulfill any linguistic task at the bidding of the user, and he can use it well or ill. Statements on linguistic quality almost invariably refer to style and not to language structure. Style is the individual linguistic behavior of the user superimposed upon the systematic pattern of language. Viewing the performance of the many excellent practitioners of French who have produced over many centuries a great literature, linguistically uninformed persons have ascribed some of this excellence to the language itself (thereby unwittingly detracting from the authors' own merits). If French was, for a long time, the vehicle of international diplomacy and of elegant discourse among international society, this was due not to the excellence of the language, but to the intellectual and political role which

Frenchmen played in these domains, and to the skill (learned in school) with which they employed their own language. That French has lost some of its international currency to English and Russian is no more due to a deterioration of the language than its ascendancy was due to an intrinsic superiority; it is, rather, the consequence of new political, cultural and economic alignments.

See also references under "French Language" in the Index volume.

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(E. PM.)

FRENCH LAW. French law is based mainly on various codes enacted by the emperor Napoleon I at the beginning of the 19th century. The prior legal experience upon which these codes were based was twofold and consisted of the traditions of the *ancien régime* and of the achievements of the French Revolution; the drafters of the civil code (*Code Civil*) tried to keep the best features of both. Codification did not, of course, prevent French law from changing considerably in the 19th and 20th centuries.

BEFORE THE REVOLUTION (1789)

Origins: the Meeting of the Roman and Germanic Traditions.—When in the 5th century A.D. Gaul was invaded by several waves of Germanic peoples, their primitive, clan-centred law clashed with the elaborate Roman system which had become less form-ridden and evolved toward greater freedom of the individual.

In the new Germanic kingdoms of Gaul, the rulers did not try to impose their own laws upon the Gallo-Roman population, who continued to live under Roman law. When in the 6th century the Franks extended their domination over the whole territory, they observed the same principle of "personality of laws." In the Frankish kingdom, up to the 10th century, each individual lived under the law of his own community. However, the capitularies of the kings or emperors applied to everybody, and they became numerous in the second half of the 8th century.

The church was a bond between the different peoples. Its undisputed authority on moral questions gradually influenced all fields of the law. Canon law was elaborated on a scriptural basis by the councils and the popes. Its sanctions were solely spiritual (ranging from penances to excommunication), but very effective. Moreover, royal capitularies often adopted decisions of the church councils.

French Medieval Law: 10th Century to Mid-15th Century.—By the end of the 10th century, the legal system had already undergone a deep transformation through the mingling of populations. Gallo-Romans, Franks and Visigoths as such disappeared, and with them the now superfluous personality of laws. Local customs took over.

When the royal power vanished for two centuries (*see* FRANCE: *History*), its place was taken by feudalism, a hierarchy of lands, or rights in land, tied to a parallel hierarchy of persons.

Land was mostly held as fief (*q.v.*) by a lord from his suzerain, who held it from a higher one, the king being at the top of this pyramid. The vassal owed personal allegiance and help to his suzerain. Some estates were allods, whose owners (generally the church) had an absolute right over them ("held them directly from God"). The land was cultivated and inhabited either by free *roturiers* (commoners) under censive tenure who owed various services and taxes to their lord, or by serfs attached to it. (Most serfs were freed toward the end of the 14th century, though a few remained until the Revolution.)

As to social organization and rights in land, feudalism made a strong imprint on the old law of France. In family law, the influence of canon law was overwhelming.

Customs.—At first, each seigneury had its own customs, its own justice, rendered by the seigneur, and its own weights and measures. After 1300 customs became more uniform within large areas such as Brittany, Normandy and Champagne. By 1400 the boundaries of such areas mostly coincided with those of judicial circuits.

In the early 12th century Justinian's code was rediscovered in Bologna, Italy, and aroused such interest in Roman law that in the south of France it displaced local customs. In the northern half of the country (above a line running roughly from the Île d'Oléron to the Lake of Geneva), too, it was studied but the customs remained in force. This difference lasted until the end of the *ancien régime*. The areas where Roman law was applied were called "written-law provinces" (although it merely followed local custom, which might defeat it in some fields); the other districts were called "customary-law provinces."

During the 13th and 14th centuries, legal scholars recorded the customs of their provinces in books called *coutumiers*. These private compilations were of great help, then as now, for the knowledge of the customs. The best known is *Les Coutumes de Clermont en Beauvaisis*, written about 1280 by Philippe de Remi Beaumanoir.

The King's Statutes.—The feudal lords had to maintain peace on their territory. They dispensed justice and organized policing and administration, but did not touch civil matters. The king ruled his own domain in the same way. From the end of the 9th century to the middle of the 12th, the monarch did not make any general statutes for his whole kingdom: the crown was too weak to enforce them. After the mid-12th century, however, the king succeeded in imposing his authority and his peace over all the country, but left civil matters to customary law, while yet having the power and duty to abolish "bad customs." He also granted privileges to communities such as towns and abbeys, or even to individuals, which exempted them from certain customary duties.

Canon Law.—Canon law developed under the influence of the popes, who enacted numerous decretals, and of famous scholars such as St. Yves (1035–1116), bishop of Chartres, and the 12th-century Italian monk Gratian (*q.v.*). Only canon law was taught in universities until Roman law appeared in the 12th century. Canon law regulated the clergy and all matters relating to the sacraments, especially that of marriage. But even for other matters, for instance ordinary contracts, people often went to the *officialité* of the bishop when they did not trust the lay lords' justice.

The Last Centuries of the Ancien Régime (1453–1789).—After the Hundred Years' War, from which the royal power emerged with new strength, a new period began. The king soon succeeded in establishing absolute power over the country. Internal peace brought great social changes. The evolution of the law was slower, owing mainly to the opposition of the privileged classes and of the *parlements;* a strong desire for change was one of the causes of the Revolution. However, remarkably written works had prepared the path for the adaptation and codification of French law.

The Customs: Compilations and Commentaries.—Exact knowledge of the customs was difficult; proof of them was uncertain and took time. The people were dissatisfied with this; it was suggested early that the law should be written in clear and simple terms so that everybody could know his rights. To satisfy this popular desire, the king ordered in 1453 that compilations be made of all customs. The organization of an efficient procedure took some time and, for most of the customs, compilations were achieved only by the beginning of the 16th century. The criticisms of this first version by some legal writers, among them Charles Dumoulin (for the customary law of Paris) and Bertrand d'Argentré (for that of Brittany) led to a revision of most of these compilations in the following 50 or 60 years.

These records did not stop custom from evolving, while in the north they strengthened that of Paris (usually consulted when local custom was inconclusive) at the expense of Roman law.

Gradually, after 1650, the idea arose that in all these customs there resided a common law of France. The remarkable books written from this point of view were of great help to those who later drafted the civil code. The best-known of them are Jean Domat's *Les lois civiles dans leur ordre naturel* (1694) and the

treatises (about 1761) of R. J. Pothier (*q.v.*). In 1679 professors were appointed by Louis XIV to teach "general principles of French law" in the universities.

Roman Law.—Roman law was still influential in the country: knowledge of it as well as of canon law was part of a lawyer's equipment. During the Renaissance period the teaching of Roman law was renewed by the brilliant Jacques Cujas (*q.v.;* 1522–90). In the written-law provinces this renewal brought a better understanding of certain Roman rules (especially in the field of successions); the customary-law provinces were thus set even farther apart. However, the law of the southern provinces was far from uniform; on a number of points Roman law was not interpreted in the same way by the several *parlements.*

Canon Law.—Canon law applied, as in the middle ages, to the clergy and to the transaction of marriage. However, after the Council of Trent (1563), the *parlements* gradually made serious encroachments upon it (*see* below). The influence of the Catholic Church remained strong in society, but was no longer what it had been in the medieval period.

The King's "Ordonnances."—A prudent but remarkable step toward unifying the law came with the Great Ordinances of Louis XIV and J. B. Colbert (*q.v.*). These did not deal with private law, which was traditionally left to custom; but they restated the law of procedure (1667), criminal law (1670), commercial law (1673), admiralty (1681) and other secondary matters. These ordinances were drafted by a commission appointed by the king, who personally attended some of its meetings. They largely inspired certain of the Napoleonic codes.

In the 18th century the chancellor H. F. d'Aguesseau undertook a complete codification of the law and, between 1731 and 1747, obtained from the king three important ordinances on donations, successions and substitutions. However, the *parlements* regarded this beginning as an encroachment upon their functions and privileges; he, therefore, could not extend the scope of his work.

The Law at the End of the Ancien Régime.—The feudal system of rights in land remained, though the social hierarchy was no longer tied to it: *roturiers* could hold fiefs, and nobles could hold censive tenures. In the southern provinces, where the Roman idea of absolute ownership was most influential, land was considered allodial unless it was proved to be in fee. The contrary was true in the customary-law provinces. Personal duties of the vassal to the suzerain had practically vanished. The only important right of the suzerain was that of receiving a fee when the fief was conveyed. As to the *roturier* censive holdings, their tenants had to pay to the lord an annual *cens* which had become merely symbolic with the devaluation of the currency (except where it was paid in corn). Here, too, the landlord's one important right was to receive a fee (according to most customs, 8% of the price) when the censive land was sold.

Family Law.—The family, united under the authority of the husband, was a strong institution.

Up to the end of the *ancien régime,* marriage was governed by canon law, which had developed in the early medieval period. It was based on consensualism, to wit, the consent of both spouses and the consummation of their union. It was strictly indissoluble; at most, separation from bed and board was allowed in a limited number of cases. Celebration in church was recommended but not compulsory: thus, secret marriages and marriages of children without their parents' consent were valid, and this was criticized by public opinion in the 16th century. In 1563 the Council of Trent, recognizing that secret marriages could be disregarded by the parties too easily, decided that the presence of witnesses (among them the parish priest) should be required for the validity of marriages; but it refused to require the parents' consent. This caused bitter disappointment in France. The *parlements* as well as the royal power cautiously but persistently strove to separate the contract in marriage from the sacrament, proposing themselves to regulate the former while leaving the latter to the church. All was ready for the secularization of marriage by the eve of the Revolution. The *parlements* had decided that marriages against their parents' will of sons under 30 years of age and of daughters under 25 were to be void of civil effect; even after these ages a marriage could not be performed without the consent of the parents unless they had been notified by two "respectful summonses." The canonical theory of putative marriage was applied to give civil effect to marriages of Protestants which no priest had witnessed. Finally an act of 1787 organized civil marriage for non-Catholics.

As to the property relations of the spouses, customs varied: a dotal, or dowry, regime borrowed from Roman law was applied in the southern provinces. In customary-law provinces, various systems of community had been elaborated about the 13th century. Throughout the country, great freedom was left to families to make their own marriage settlements.

Successions and Wills.—There was a great difference between the customary-law provinces and the written-law provinces as regards the law of successions.

According to northern provincial customs, three kinds of property were distinguished in the estate and were subject to particular rules. The *fiefs et alleux nobles* (fiefs and allods of nobility) were conveyed according to noble customs, which usually gave a large place to the right of primogeniture; the *propres* (personal belongings) included the landed property which had come to the testator from his paternal or maternal family (if there were no children, the *propres* had to go back to the same branch—*lignage*—of the testator's family whence they came); and the *meubles et acquêts* (movable properties and properties bought by the spouses during marriage) were divided equally between the testator's heirs.

The similar customs of the written-law provinces completely disappeared during the 16th century under the influence of Roman legal principles. All property was treated alike, and the whole estate was conveyed according to the Roman rules: to the children and grandchildren; to the parents and grandparents; to the brothers and sisters; to the nearest relatives thereafter.

Wills were possible and often were made. They had disappeared in the Frankish period and had been reintroduced about the 12th century under the influence of the church and of Roman law. However, the testator could not disinherit his family, whom both customary and Roman law protected by various devices. Rules as to the forms of wills were unified by Daguesseau in 1735.

Contracts.—The law of contract was largely the same throughout the country. Its technique was that of Roman law, but it was dominated by Christian principles, among them that of good faith. Formalism had been abandoned for consensualism around the 14th century; and the courts had wide powers to void contracts which were unfair to one party.

THE REVOLUTION

The Revolutionary period was one of tremendous legislative activity: long-desired changes were enthusiastically introduced into the laws. A new conception of law appeared in France: statute was deemed a superior source of law. Customs remained only as long as they could not be replaced by a code, and the *parlements* were dismissed in 1790. They were replaced by a unified system of courts which were supposed merely to apply the law and never to lay down general rules.

The main ideas embodied in the Revolutionary legislation are to be found in the Revolution's motto (which is still that of the French republic), *Liberté, Égalité, Fraternité.* The passionate desire for liberty and equality aroused by the 18th-century philosophers brought about the changes that took place.

The feudal system was hated by the peasants for the vexatious labours it imposed on them, by the *bourgeoisie* for the superior contempt of the nobles to which it exposed them, and by both, above all, for the privileges, especially that exempting the nobles and clergy from taxation. Privileges were abolished during the famous night of Aug. 4, 1789. Nobility was abolished in 1790. All landlords' rights were divided into two categories: "vexatious" ones (unpaid labour, tolls, etc.), which were merely abolished; and "contractual" ones, such as rents, which could be redeemed. An act of July 17, 1793, abolished without compensation all rights which remained unredeemed.

The revolutionaries also detested the corporations, which commanded compulsory membership and regulated every profession.

These were suppressed (March 2, 1791) and freedom of commerce was established. But this mistrust was extended to all organized groups of any kind, for it was thought that only one authority should exist over the citizens: that of the state. The *loi Le Chapelier* (June 14, 1791) forbade any form of association for the defense of professional interests. Universities were dissolved (1793); and in the same spirit the property of the Catholic Church was secularized and the priests and bishops were made state employees, a situation which most of them did not accept (July 12, 1790).

Family relations were deeply transformed according to the principles of liberty and equality. Marriage was organized as a merely civil act (Sept. 20, 1792); divorce was permitted (1792); paternal authority was limited and parents' consent was not required for marriages of children over 21 years of age. A short experiment was made with "family courts" which were to overrule paternal decisions; and the wife was declared equal to her husband.

As regards successions, equal parts were given to all children, even bastards. Wills were distrusted and the testator's right to dispose of his property was strictly limited in order to prevent the re-establishment of inequalities by this device.

Throughout the Revolutionary period, successive governments were committed to drawing up a code. Drafts were made; but time and authority were lacking and none was enacted.

THE CIVIL CODE (1804)

Napoleon Bonaparte took over the task of codification as early as 1800, when he was only first consul. He appointed a commission of four (F. D. Tronchet, F. J. J. Bigot de Préameneu, J. E. M. Portalis (*q.v.*) and Jacques de Malleville) to prepare a first draft, which was made within a few months. This draft was sent for comment to the courts and was then discussed in legislative commissions which Bonaparte himself often led. Finally, to obtain the legislature's vote, Bonaparte displayed a clever mixture of force and diplomacy; and his civil code was promulgated as a whole on March 21, 1804. Several other codes followed: a code of civil procedure in 1806; a commercial code in 1807 (which established special rules and courts for commercial cases); a *Code d'Instruction Criminelle*, regulating procedure and evidence in criminal cases, in 1808; and a penal code in 1810.

The Concept of Codification.—From a practical point of view, the code achieved unification of French civil law. However, this was not the only concern of its drafters. They shared with most of their contemporaries and with most modern French lawyers the belief that the law should be written, in clear language, so that it might be accessible to every citizen. This was implied in article 4 of the Declaration of Rights of 1791: "Freedom consists in doing those things that do not harm others; therefore the exercise of the natural rights of each man has no limits other than those that ensure to other members of society enjoyment of those same rights. These limits can be determined only by statute."

On such a view a code must be complete in its field, setting forth general rules and arranging them logically. Finally it must be based on experience. The views taken on these points by those who drafted the Napoleonic code are well set out in Portalis' *Discours Préliminaire*.

The Civil Code's Provision of General Rules.—The code's whole range is covered in 2,281 short articles. Portalis gave two fundamental reasons for this technique: first, that the legislator cannot pretend to foresee all circumstances that may arise in life; and second, that only conciseness can make the code flexible enough to adapt old principles to new circumstances.

This approach to law may seem unrealistic; but it corresponds to the daily experience of all civil lawyers. Many general rules have been applied to concrete circumstances without any difficulty. When interpretation is required, it is the responsibility of the courts to give it, taking into consideration the "spirit" of the code in order to apply to each case the solution that would have been desired by the legislator. In balancing the respective tasks of court and legislator, Portalis emphasized that the courts were to "fill in year by year the gaps" of the code by creating a secondary body of law which should develop "side by side with the sacrosanct statutes and under the control of the legislator."

Logical Arrangement of the Code.—Whenever a case does not fall squarely under a rule set forth by the code, its satisfactory solution will require consistency between the various rules of the code. A code should not be a mere collection of unconnected rules. The drafters of the civil code strove toward inner consistency in their work, so that reliance on logic might ensure satisfactory application of it. They saw no contradiction between logic and experience. In fact, from the time of Descartes, French minds were unable to help seeking logic everywhere: logic was as inherent in the French approach to law as to life in general. For this reason articles of the code are not regarded as mere rulings: more general principles may be inferred from them. If no one article is found to apply exactly to a given situation, it is proper to consider several and to draw from them a more general rule which can be either itself applied to the case or combined with others to reach a solution.

The Code's Foundation on Experience.—Though the code is a work of logic, it relies mainly on experience. Its drafters were exceptionally well qualified in this respect: they had lived the first half of their lives under the laws of ancient France and then had known the Revolution; and they were not prejudiced for or against any of the principles of either regime. Their purpose was not to create new law but merely to restate existing law, subject to choice when Revolutionary enactments varied from previous ones. They were ready to adopt any rules which they might deem best suited to the French people on the basis of experience. They had learned that "it would be absurd to indulge in absolute ideas of perfection in matters capable of relative value only"; as Portalis recognized: "Laws are not pure acts of will; they are acts of wisdom, of justice and of reason. The legislator does not so much exercise a power as fulfill a sacred trust. One ought never to forget that laws are made for men, not men for laws; that they must be adapted to the character, to the habits, to the situation of the people for whom they are drafted."

The Content of the Code.—This pragmatic approach explains why in some matters the drafters took over traditional principles while in others they supported Revolutionary views or, very often, worked out a compromise between the two systems.

The code contains first a few introductory articles stating some basic principles regarding law and its application and then is divided into three parts. The first deals with persons; the second with goods considered in themselves; and the third with the means of acquiring rights in goods, whether by succession or gift or by contract or matrimonial arrangement. Torts and quasi contracts are the subject of a few articles immediately following those on contracts. Some of the most common types of contracts are dealt with separately after the general rules regarding this subject. The end of the last part is devoted to legal and conventional mortgages and finally to limitations.

Establishment of Records of Births, Marriages, Divorces and Deaths.—Under the *ancien régime*, records were kept by the Catholic Church. Under the Revolution, it was decided that official evidence of births, marriages, divorces and deaths should be recorded only by the mayor of each city or by one of his assistants. In view of the variety of attitudes toward religion in France, the drafters of the code decided to maintain this system of secular registration.

Marriage.—The formulators of the code were familiar with the social problems involved in the regulation of marriages: they knew the history of marriage during the *ancien régime*, and they had seen the changes wrought by the Revolution. The idea of marriage had never been challenged at that time, but its importance as an institution had been diminished by secularization. The elimination of the need for parental approval over 21 years of age and the introduction of divorce had further weakened it.

The drafters of the code regarded marriage as the basic institution of a civilized society. Taking into account, again, the variety of religious attitudes in France, they decided that only marriage ceremonies celebrated before secular officials should be held legally valid. This did not deprive ministers of the various faiths of the right to celebrate religious marriage ceremonies, but

these were held void of any legal effect and had to take place after the official secular ceremony in order to avoid any risk of confusion.

The code at least partially restored parental control over children's marriages: it again became impossible for sons and daughters to marry without their parents' consent if they were under 25 and 21 years old, respectively. Over these age limits, parents had to be notified in "respectful and formal acts" for the marriage to be valid. Statutes of 1907, 1922, 1927 and 1933 gradually re-established the Revolutionary rule that when the parties were over 21 years of age consultation of the parents was no longer necessary.

Husband and Wife.—French tradition in this field was consistent. Under the *ancien régime,* the family had been centred upon the husband, whose strong authority and powers were inherited from the Roman *pater familias.* Although the Revolution proclaimed women to be equal in rights with men, it did little to implement this view in law. The drafters of the code saw no reason to modify the traditional situation, and Napoleon himself was actually very much in favour of maintaining subordination of the wife to her husband. The code expressly stated that she owed him obedience. In principle she had no legal capacity to act, a rule with very few exceptions. Without the written consent of her husband the wife could not sell, give, mortgage, buy or even receive property through donation or succession. Only in 1938 and 1942 was this situation changed by statute. The law still lays down that the husband is the head of the family, but it also provides that he must exercise his authority in the interest of his family. If he is unable for any reason to make the necessary decisions, the wife is empowered to replace him. Moreover the principle of her incapacity has been abandoned. She has full capacity to act, except in cases where the law or matrimonial arrangements give specific power to her husband.

Property relationship between the spouses may be regulated in marriage contracts within the limits of the code. If no particular contract has been made, the code provides for a statutory regime under which all chattels and earnings of the spouses fall into a community property to be shared equally between them (or their heirs) at the dissolution of marriage. In any case the code began by vesting in the husband all active powers, even over his wife's property. The wife enjoyed merely passive rights and protection against mismanagement. This was partly changed in 1938 and 1942, when legal capacity to act was given to married women: under some contractual matrimonial regimes, they are now free to manage their own property and even to dispose of it.

Divorce.—Divorce was first introduced into France by the Revolution. It was made very easy, and was even allowed by mutual agreement. Abuses quickly followed.

The drafters of the code decided that since many persons were not prevented by religious conviction from seeking divorce, it was not for the legislator to oblige unhappy spouses to live together for life or even, if parted, to live alone unable to contract a more fortunate union. Divorce, therefore, was allowed, but within strict limits, so that "the most sacred of contracts should not become the toy of caprice." The only grounds for divorce were adultery; condemnation to an "infamous" punishment (punishments for the most serious crimes were so called); excesses; cruel treatment or serious insult. Mutual agreement was added under the personal pressure of Napoleon (already intent on divorcing his first wife, by whom he had no child). But the procedure of divorce by mutual agreement was extremely long, complicated and costly; and no second marriage could take place within six years thereafter.

Divorce was repealed in 1816 under the Restoration, but reintroduced in 1884, when much of the original legislation of 1804 was utilized. Divorce by mutual agreement, however, was dropped as being too complicated and costly.

Property.—The intricate system inherited by the *ancien régime* from feudalism had been rejected by the Revolution, which restored the clear and simple concepts of Roman law.

The formulators of the code completely supported the approach of the Revolution: no trace of feudalism appears in the code. The only classification of goods is the basic one of immovables (which are defined) and movables (which include all goods that are not immovables). The normal relationship between persons and things is ownership, which is defined as a complete, absolute, free and simple right. Mere usufructs or servitudes are possible. But rights in an estate never involve for those who are vested with them the personal duty of doing anything. The code states that a servitude "is a charge laid on an estate for the use and utility of another estate belonging to another owner" (art. 637); and it emphasizes that "servitudes do not establish any pre-eminence of one estate over another" (art. 638).

Though maintaining the achievements of the Revolution, the drafters of the code failed to take over the excellent revolutionary law which had set up a system of publicity for all transfers of land and for real estate mortgages. The code's substitute for this was not comprehensive enough and had to be modified in 1855, 1935 and 1955.

Succession and Gifts.—Here, too, the code adopted many of the ideas of the Revolution. But its formulators tempered them with exceptions and combined them with ideas borrowed from the *ancien régime.*

The Revolutionary law on intestate succession had relied upon two basic principles: (1) that no distinctions be made within the estate of the deceased: land and chattels were treated in the same way and no account was taken of the origin of landed property (the customary rule *paterna paternis, materna maternis* being dropped); (2) that equal parts be given to all heirs of the same degree of kindred (the advantages accruing through some customs to the first-born or to male children being abolished).

The code took over these two principles and provided that an estate should devolve first of all upon children and other direct descendants. If certain heirs of one degree predeceased others of the same degree and left children, representation applied. In other cases distribution was made per capita. Illegitimate children might inherit from their parents, but received less than legitimate children and could not cut out either the deceased's own parents or his brothers and sisters (the share allowed to illegitimate children was increased in 1896). In the second place the parents, brothers and sisters inherited; thirdly the grandparents and fourthly the next of kin up to the 12th degree (a statute of 1917 stopped inheritance at the sixth degree).

In the last three cases the rule of *fente* applies: half of the estate goes to the paternal relatives and half to the maternal. If there are no relatives on one side, an act of 1930 provides that the second half shall go to the spouse; in default of spouse the whole estate goes to the closest relative in degree.

According to the code the spouse could not succeed unless there were no relatives up to the 12th degree. A surviving wife was, thus, in a very bad position if no gift or legacy had been made to her, though under the statutory matrimonial regime she received half of the community property into which all chattels of both spouses fell. The law was changed in 1891, 1917, 1925, 1930, 1957 and 1958. This finally entitled the surviving spouse to at least the usufruct of one-quarter of the property left by the deceased. The survivor also inherits half of the estate if there are no children and if there are relatives on only one side of the deceased's family.

Wills are possible and may be formal or informal. Holographic wills are valid, provided that they are written throughout, and dated and signed by the testator's own hand (art. 970). Wills are self-effective and need no probation.

Freedom to dispose of property by will or by gift is limited, in order to protect children and other descendants as well as parents and grandparents, who have to be allowed a certain proportion.

Contracts, Quasi Contracts and Torts.—The Revolution brought no changes into the law in this nonpolitical field. The drafters of the code merely restated the law which had developed in the course of centuries and which authors already had analyzed. The basic principles of contract law are informality and freedom, which has no other limits than those arising from public policy. This is implied in the striking formula of art. 1134: "agreements legally

entered into have the effect of laws on those who make them." The whole matter of torts is dealt with in five short articles. The general basis for liability is given in art. 1382: "if anybody causes a damage by his own fault, there is a legal obligation upon him to repair it." The subsequent articles regulate liability for damages caused by things, animals, children and employees. It was left to the courts to work out a complete system based on these few articles.

Legal and Conventional Mortgages.—This part was one of the weakest in the code. An excellent statute of the Revolution (1798) had set up a system of registration for all transfers of land titles and real estate mortgages. A buyer of land could ascertain whether he was buying from a regular owner and whether the land was mortgaged; and if it were, he could clear his title by offering the price to the mortgagee.

The drafters of the code maintained compulsory registration, but only for gifts and for contractual mortgages. Sales of real estate and a number of legal mortgages were not subject to registration. This gap left prospective creditors or buyers with insufficient information. Reforms were made in 1855, 1935 and 1955, after which there was a comprehensive system of publicity for mortgages and conveyances of immovable property.

Limitations.—The drafters of the code clarified the law of limitations. Actions at law are limited to 30 years (or to shorter periods by special provisions). Title in land may be acquired by adverse possession within 30 years or even within 10 to 20 years if the possessor believed in good faith that he was the real owner. Furthermore the bona fide purchaser of movable property immediately becomes its owner and nobody can prove a better title against him unless the property has been lost or stolen.

EVOLUTION AFTER THE CIVIL CODE

No important changes were made in the civil code from 1804 to 1880, except the repeal of divorce in 1816, when a Catholic monarchy was restored. The political and legislative power was held by the *bourgeoisie;* and they were entirely satisfied with the basic principles of the code, which favoured individualism and free will. In fact from 1804 until the establishment of the third republic in 1875 the civil code remained the fundamental law of France, whatever the changes of political regime. Jurisprudence was centred upon it; in both teaching and writing, scholars used to discuss it article by article.

The courts fulfilled the role that Portalis had stressed for them: imbued with the spirit of the code, they applied its general rules to particular cases. To meet difficulties, they consulted the code's internal logic, using induction to discover the general principles implied in its provisions and then deducing solutions to the particular problems. The provisions of the code were considered not only as rules but as actual sources of law.

The social atmosphere changed during the third republic, when universal suffrage gave the labouring class an influence on legislation. Faith in liberalism was shaken, and the idea grew that the state should intervene to protect the weak. Statutes slowly increased in number. This movement was accentuated by World Wars I and II: a mass of emergency regulations then had to be passed, and the power of the state to encroach on private interests for the sake of the community was increased.

Subsequent amendments to the code (already briefly mentioned in discussion of the relevant enactments above) reveal two trends: first, greater individualism in family law; second, qualification of individual rights for the sake of social interests—what has been called "socialization" of the law.

As to the first, divorce was restored in 1884 in its original civil-code form, except for mutual consent. Various subsequent measures made it easier until a statute of 1941 (partly upheld in 1945) narrowed the grounds for it and slowed down procedure. After 1900 the formalities of marriage were made easier and parental control over it curtailed. The authority of the husband over his wife was diminished (1938, 1942) and bastards were granted much broader rights than in the code for proving their filiation and succeeding to their parents. Control over paternal authority was increased.

The trend toward socialization of the law involved diminution of the absolute rights of an owner over his property, which was the rule of the civil code. A great number of exceptions to this rule were enacted, especially for landed property: in towns as well as in the country, very strong rights were granted to the state, to the various organs of the community and even to the tenants. Freedom of contracts was also diminished by a number of regulations.

Adaptation of the law to new social needs was not made only by statute. The courts to a certain extent adjusted the law to modern circumstances. They did this, however, in the consciousness of their subordinate position. They recognized that any important change was the province of the legislature and not of the judge, though this did not prevent them from gradually adapting the law to modern conditions of life. With certain articles they took great liberties, recognizing, for example, the general validity of stipulations on behalf of a third party, notwithstanding the restrictive language of art. 1121. When, in the difficult matter of liability for damages "caused by a thing," the legislature failed to respond to the general wish for a new law, the courts used a few words from art. 1384 as a platform from which to launch a completely new set of rules.

Jurisprudence, also, had a role. A number of important statutes were drafted by commissions including judges, professors and lawyers; and authors often suggested to the courts new developments in the application of rules of law (the first example of such an influence was that of Joseph Émile Labbé's comments on the decisions of the court of cassation between 1870 and 1895).

Most of the statutes passed during the 19th and 20th centuries were left outside the code. This situation is not so unfortunate as it might be, for one publisher (Librairie Dalloz) presents in a single volume the texts both of the code and of the relevant private statutes. In fact this *Code Civil* is a very satisfactory working tool.

However, the task of giving a clear and complete statement of the law should not be left to publishers; it is the duty of the legislature itself. Many authors feel that the code should be revised. This task was entrusted to a commission (1945), which by the early 1960s had made much headway.

Further changes were expected: the development of European institutions seemed likely to require readjustments on a broader scale, especially in the field of commercial law and perhaps even in that of contract law. *See* also CODE NAPOLÉON; FRANCE: *Administration and Social Conditions;* CIVIL LAW.

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FRENCH LICK, a resort town of Orange county, in southern Indiana, U.S., 50 mi. W.N.W. of Louisville, Ky. Natural resources and agricultural products include coal, sandstone, mineral water, corn and livestock. A buffalo trail which passed the mineral springs in the present town was used by early travelers, including George Rogers Clark in 1786. Evidence indicates that he named the area French Lick for land by that name in Tennessee. In 1845 William A. Bowles built the first hotel and in 1857 he platted the town. Thomas Taggart (1856–1929), later chairman of the Democratic national committee, purchased the hotel in 1901. Through his efforts French Lick became a popular year-round health resort and convention centre. The resident population in the 1960s was about 2,000. (R. W. HA.)

FRENCH LITERATURE. This article deals with literature in French from the 10th century, when literature first began to be written in the vernacular, into the second half of the 20th century. For earlier literature by writers in Latin, the reader should consult LATIN LITERATURE: *Medieval and Renaissance;* and for the literature of areas of France with their own dialect or language, BRETON LITERATURE and PROVENÇAL LITERATURE. For literature in Anglo-Norman, *see* ANGLO-NORMAN LITERATURE. There are also sections in the articles on BELGIAN LITERATURE and SWISS LITERATURE on writers of those nationalities whose native or literary language was French. *See* also the general articles on

AUTOBIOGRAPHY, BIOGRAPHY, DRAMA, NOVEL, THEATRE, etc., as well as those to which reference is made in the text—*e.g.*, ARTHURIAN LEGEND; ROMANTICISM; SYMBOLISTS, THE; etc., and articles on most of the literary figures mentioned.

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I. THE 10TH TO THE 15TH CENTURY

The earliest writings in France in the vernacular were saints' lives: the *Sequence of Saint Eulalia* (*c.* 900), the *Vie de St. Léger* (*c.* 1000), the *Vie de St. Alexis*, copied in the 12th-century St. Albans psalter which belonged to the recluse Christina of Markyate. The first real monument of French literature, however, was the *Chanson de Roland* (*c.* 1100), which remains its best-known achievement until the Renaissance. It is the masterpiece of a flourishing type of epic poetry, the *chanson de geste,* of which about 80 specimens are extant.

1. Chansons de Geste and Romances.—These deal with subjects of legendary French history. The line generally used is of 10 syllables, and in later poems of 12; there is a regular caesura. The lines are arranged in *laisses* or *tirades* (assonating stanzas) of very irregular numbers. The earlier poems are assonanced, only the vowel sound of the last syllables being identical. Later the poems are rhymed in a regular manner. In subject matter there are three chief groups: one dealing with Charlemagne and the 12 peers (*see* also CHARLEMAGNE LEGENDS); another with the family of Guillaume d'Orange (*q.v.*); a third with the rebellious barons of the Carolingian epoch—Renaud de Montauban, Ogier the Dane (*qq.v.*), Girart de Roussillon, Isembard the renegade and Raoul de Cambrai.

The earliest extant versions alone of the various poems amount to more than 300,000 lines. The successive development of the *chansons de geste* may be illustrated by the fortunes of *Huon de Bordeaux* (*q.v.*), one of the most lively, varied and romantic of the older epics and one which is interesting from the use made of it by Shakespeare in *A Midsummer Night's Dream* and by Christoph Wieland and Carl Maria von Weber in their versions of *Oberon.* In its oldest form this may have been a legend of the Carolingian ruler Charles Martel and his relations with the underworld, but in the earliest extant poem (*c.* 1200) it has turned into a pleasant burlesque where we meet with the sprite Oberon, king of faery. A later poet amplified the legend to 30,000 alexandrine lines. When this point had been reached *Huon* began to be turned into prose, being, with many of its fellows, published and republished during the subsequent centuries and sinking to the level of chapbook literature.

But the best period of the *chanson de geste* was during the 11th and 12th centuries. The *Chanson de Roland* (*q.v.*) is the earliest extant *chanson de geste* and belongs in its present form to the 12th century. The *chansons de geste* were composed, memorized, orally delivered, handed down and continually reshaped by the *jongleurs,* who traveled to baronial halls, to markets, fairs and wakes, and sang them, intermixing frequent appeals to their audience for silence, declarations of the novelty and the strict copyright character of the *chanson,* revilings of rival minstrels and frequent requests for money in plain words.

The existing manuscripts are mainly composite, or cyclic, collections of the 13th and 14th centuries. The names of the authors are known only in a few cases, the names of copyists, continuators and mere owners of manuscripts having often been mistaken for them.

The characters of a *chanson* in the cyclic manuscripts are somewhat uniform. There is the hero who is unjustly suspected of guilt or sore beset by Saracens, the heroine who falls in love with him, the traitor who accuses him or delays help. There is Charlemagne, in several of the *chansons* an incapable and venal dotard, in others still the great emperor; and, with Charlemagne, the duke Naimes of Bavaria, invariably wise, brave, loyal and generous. In the *Chanson de Roland* there is no "romance" in the modern sense of the word except in the incident of Aude's death when she hears of Roland's fall. Even in the later *chansons* the element of "romance" is of minor concern. Fighting, counsels and religion hold the field. In a few *chansons* there appears a very interesting type; the man of low birth or condition who rescues the high-born hero from his enemies—Rainoart in *Aliscans,* Gautier in *Gaydon,* Robastre in *Gaufrey,* etc. The series of *Le Chevalier au Cygne* deals with the first crusaders, and a remarkable group, of which Guillaume d'Orange is the central figure, deals with the defense of the south of France against Muslim invasion. (*See* also CHANSONS DE GESTE.)

Arthurian Romances.—The second class of early French narrative poems consists of the Arthurian cycle (*see* ARTHURIAN LEGEND). The earliest-known compositions of the cycle are at least a century later than the earliest *chanson de geste,* but it soon succeeded the *chansons* in popular favour and its influence was both wider and more enduring. It is not easy to conceive a greater contrast in form, style, subject and sentiment than is presented by the two classes. In both religious sentiment is prominent, but the religion of the *chansons* is of the simplest, not to say of the most savage, character. To pray to God and to kill his enemies constitutes the whole duty of man. In the romances the mystical element becomes prominent and furnishes, in the development of the theme of the Holy Grail (*q.v.*), one of the most important features. In the Carolingian knight the courtesy and clemency which are associated with chivalry are almost entirely absent. The *gentix ber* contradicts, jeers at and execrates his sovereign and his fellows with the utmost freedom. He thinks nothing of striking his *cortoise moullier* so that the blood runs down her *cler vis.* If a servant or even an equal offends him, he will throw the offender into the fire, knock his brains out or set his whiskers ablaze. The Arthurian knight is far more of the "modern" chivalric hero, but his chief difference from his predecessor is undoubtedly in his amorous devotion to his beloved. Herein the romances reflect the courtly conception of "love-service" which was the main inspiration of the troubadour lyric of southern France (*see* also TROUBADOURS; COURTLY LOVE).

The starting point of much Arthurian romance was the *Historia*

regum Britanniae (*c.* 1135) of Geoffrey of Monmouth which was imitated by Wace in the French *Roman de Brut* (1155) and by Layamon in English. The legend of Tristan (*q.v.*) and Iseult is of independent Celtic origin: it was handled first as a grandiose tragic narrative of ill-fated and obsessive love by an unknown French poet, whose work survives in the German poem by Eilhart von Oberge, then by the Anglo-Norman poet Thomas. Chrétien de Troyes left much-elaborated versions of the tales which were preserved in more concise form at the end of the *Mabinogion* (*q.v.; see* also WELSH LITERATURE): his *Yvain* (or *Le Chevalier au lion*), *Erec* and *Perceval* (or *Le Conte del graal*) correspond to the Welsh *The Lady of the Fountain, Gereint Son of Erbin* and *Peredur Son of Efrawg* respectively. In Chrétien's *Perceval* the "grail" is not yet the Holy Grail but a mysterious dish or platter accompanied by a bleeding lance which appears to the hero in the grail castle; his adventures are already interwoven with those of Gawain (*q.v.; see* also PERCEVAL). Chrétien left his poem unfinished, and there are numerous continuations of it. Likewise unfinished was his famous poem of Lancelot and Guinevere (*qq.v.*) (*Le Chevalier de la charrette*), begun at the behest of the countess Marie de Champagne and finished by Godefroy de Laigny. The simpler tales underlying the work of Chrétien and his courtly contemporaries survived not only in Welsh prose but in the sagas of Iceland: the poems of Chrétien and Thomas were soon imitated by the poets of southern Germany and it is through the *Parzival* of Wolfram von Eschenbach and the *Tristan und Isolde* of Gottfried von Strassburg that these romantic themes became known to Wagner.

The octosyllabic couplet, the vehicle of all this early romance literature, was abandoned in the 13th century in favour of prose; and a huge cycle of romances arose, the prose *Lancelot* (or Vulgate cycle), in which the gallant and amorous adventures of Lancelot and Tristan were fused with the "high history of the Grail" and with the final disasters which overtook the kingdom of Logres and the chivalry of the Round Table. The matter of this cycle is best known to English readers in Sir Thomas Malory's *Morte Darthur*, which, though far later than the originals, conveys a reasonably good impression of the characteristics of the prose romances. Indeed, the Arthurian knight, his character and adventures are so much better known than the heroes of the Carolingian *chansons* that there is less need to dwell upon them.

The *lais* of Marie de France are closely associated with Arthurian romance; they are not *lais* in the musical sense of the term (*see* TROUVÈRE) but short stories in verse on romantic and magical themes which had perhaps inspired musical lays at some remoter period. *Lanval*, on the theme of the poor knight who wins a fairy mistress, was twice imitated in English; *Elidue*, on the theme of the man with two wives, is the perfect medieval *nouvelle*. *Chèvrefoil* ("The Honeysuckle") is a mere anecdote from the Tristan cycle; *Laustic* ("The Nightingale"), though scarcely longer (160 lines), expresses the nostalgic yearning of romantic love by a symbolism which resembles that of Pirandello's *Il Lume dell' altra casa*.

Romances of Antiquity.—There is a third class of early narrative poems, differing from the former two in subject but agreeing, sometimes with one, sometimes with the other, in form. These are the classical romances, which are not much later than those of Charlemagne and Arthur. The chief subjects were the conquests of Alexander and the siege of Troy, though other classical stories were included. The most remarkable is the romance of *Alexandre* by Lambert le Tort and Alexandre de Paris. Alexander is in many respects a prototype of Charlemagne: he is regularly knighted, he has 12 peers, he holds tournaments. He has relations with Arthur and comes in contact with fairies; he takes flight in the air, dives in the sea and so forth. The principal Greco-Latin epic cycles were transmuted into the three great romances, Thèbes, Troie and Eneas (the second is attributed to Benoît de Sainte-Maure). (*See* also ALEXANDER ROMANCES; TROY.)

The *chansons de geste* had shown the creative power and independent character of French literature. There is, at least about the earlier ones, nothing borrowed, traditional or scholarly. They smack of the soil, and they rank France among the very few countries which, in this matter of indigenous growth, have yielded more than folksongs and fireside tales. The Arthurian romances, less independent in origin, exhibit a wider range of view, a greater knowledge of human nature and a more extensive command of the sources of poetical and romantic interest. The classical epics superadd the only ingredient necessary to an accomplished literature: the knowledge of what has already been achieved by other peoples and other literatures and the readiness to take advantage of the materials thus supplied.

2. Romans d'Aventures.—There remain to be mentioned a considerable number of narrative poems written in the 12th or 13th century that cannot be brought into any one of the three previous categories. As literary taste spread, *romans* were written about any possible subject and in many various forms. Thus *Guillaume de Palerme* deals with the adventures of a Sicilian prince who is befriended by a werewolf; *L'Escoufle*, by Jean Renart, with a heroine whose ring is carried off by a sparrow hawk; *Gui de Warewic*, *Meraugis de Portlesguez* by Raoul de Houdenc, *Cléomadés* by Adenet le Roi, *Partenopeus de Blois* and *Floire et Blanchefleur* are among the best known. To this category may be added a number of early romances and fictions in prose. *Aucassin et Nicolette* (*q.v.*) is written partly in prose and partly in verse and is called a *chantefable*.

Such was the literature produced for the enjoyment of the higher classes in the late 12th and 13th centuries. The habit of private wars and of insurrection against the sovereign supply the motives of the *chanson de geste*, the love of gallantry, adventure and foreign travel those of the romances, Arthurian and miscellaneous. On the other hand, the gradual spread of learning, inaccurate and ill-digested perhaps but still learning, not only opened up new classes of subjects but opened them to new classes of persons.

Hence there arose two new classes of literature. The first consisted of the embodiment of learning of one kind or other in the vulgar tongue. The other produced the second indigenous literary growth of which France can boast, namely, the fabliaux, and the almost more remarkable work which is an immense conglomerate of fabliaux, the great beast epic of the *Roman de Renart*.

3. Fabliaux.—There are few literary products which have more originality and at the same time more diversity than the fabliau (*q.v.*). The epic and the drama, even when they are independently produced, are similar in their main characteristics all the world over, but there is nothing in previous literature which exactly corresponds to the fabliau. The story is the first thing; the moral is secondary and is never allowed to interfere with the story. These observations apply only to the fabliaux, properly so called, but the term has been used with considerable looseness. The 18th- and 19th-century editors included in their collections several miscellaneous pieces such as *dits* (didactic and descriptive poems containing witty social satire and observation, *e.g.*, the *Dit du hardi cheval* listing all possible defects of a horse, the *Dit des cris de Paris*) and *débats* (discussions between two persons or contrasts of the attributes of two things). Not that the fable proper was neglected. Marie de France—mentioned above for her romantic *lais*—is the most literary of the many writers who composed what were often named *Ysopets*, after the mysterious original poet. Phaedrus and the medieval Latin *Romulus* were imitated in the vernacular by this class of writer, and several of the best known of "fablers" date from this time. The fabliau, on the other hand, according to the best definition of it yet achieved, is "the recital, generally comic, of a real or possible incident occurring in ordinary human life." The comedy, it may be added, is usually of a satiric kind and occupies itself with every class and rank of men, from the king to the villein. There is no limit to the variety of these lively verse tales, which are mainly written in octosyllabic rhymed couplets. In one the subject is the misadventure of two Englishmen whose ignorance of the French language makes them confuse donkey and lamb; in others it is the fortunes of an exceedingly foolish knight who has an amiable and ingenious mother-in-law, the deserved sufferings of an avaricious or ill-behaved priest, the bringing of an ungrateful son to a better mind by the wisdom of babes and sucklings.

Not a few of the *Canterbury Tales* are taken directly from fabliaux; indeed, Chaucer, who also imitated the *Roman de Renart,* is the nearest approach to a fabliau writer in England. The prose novels of Boccaccio and other Italian taletellers are also based largely upon fabliaux. But their influence in their own country was the greatest. They were the first expression of the spirit which thereafter animated the most national and popular developments of French literature. Simple and unpretending as they are in form, the fabliaux announce not only the *Heptaméron* of Marguerite de Navarre but also foreshadow the cruel jests of Le Sage, Voltaire and Maupassant. Their wry heroes and heroines behave with the cynical aplomb of a "Boule de Suif," the destructive verve of a Panurge or a Zazie.

The special period of fabliau composition appears to have been the 13th century. It signifies the growth of a lighter and more sportive spirit than had yet prevailed in the literature, the rise in importance of the clerical and mercantile classes at the expense of the baronial and monastic, and also the consciousness on the part of these lower orders of the defects of the two privileged classes and of the shortcomings of the system of polity under which these classes enjoyed their privileges. There is, however, in the fabliau proper not very much direct satire, this being indeed excluded by the definition given above and by the thoroughly artistic spirit in which that definition is observed. The fabliaux are so numerous and so various that it is difficult to select any as specially representative. The following may be mentioned, however, both as good examples and as interesting from their subsequent history: *Le Vair palefroi* by Huon le Roi, treated in English by Leigh Hunt and by Thomas Love Peacock; *Le Vilain Mire,* the original consciously or unconsciously followed in Molière's *Le Médecin malgré lui; Le Roi d'Angleterre et le jongleur d'Éli; La Housse partie; Le Sot chevalier,* an indecorous but extremely amusing story; *Les Deux Bordeors ribaus,* a dialogue between two *jongleurs,* of great literary interest as it contains allusions to the *chansons de geste* and romances most in vogue; and *Le Vilain qui conquist paradis par plait.*

4. Roman de Renart.—If the fabliaux are not remarkable for direct satire, that element is supplied in more than compensating quantity by an extraordinary composition which is closely related to them. *Le Roman de Renart* (*History of Reynard the Fox*) is a poem, or rather series of poems, which, from the end of the 12th century to the middle of the 14th, served the citizen poets of northern France not merely as an outlet for literary expression but also as a vehicle of satirical comment—now on the general vices and weaknesses of humanity, now on the usual corruptions in church and state, now on the various historical events which occupied public attention. The enormous popularity of the subject is shown by its long vogue and by its influence over generations of writers who differed widely in style and temper. Nothing can be farther from the allegorical erudition, the political diatribes and the sermonizing moralities of the authors of *Renart le contrefait* than the sly naïveté of the writers of the earlier branches of the cycle. Yet these and a long and unknown series of intermediate bards the fox-king pressed into his service, and it is scarcely too much to say that during the two centuries of his reign there was hardly a thought in the popular mind which, as it rose to the surface, did not find expression in an addition to the huge cycle of *Renart.*

The extant French poems on the subject amount in all to nearly 100,000 lines (omitting mere variations but including the different versions of *Renart le contrefait*). The separate branches are the work of different authors, hardly any of whom are known, and, but for their community of subject and to some extent of treatment, might be regarded as separate poems. The history of Renart, his victories over Isengrim the wolf, Bruin the bear and his other unfortunate rivals, his family affection, his outwittings of King Noble the Lion and all the rest are well known. It is perhaps in the subsequent poems, though they are less well-known and less amusing, that the hold which the idea of Renart had obtained on the mind of northern France and the ingenious uses to which it was put, are best shown. The first of these is *Le Couronnement de Renart,* a poem of between 3,000 and 4,000 lines, describing how the hero, by his ingenuity, got himself crowned king. This poem already shows signs of direct moral application and generalizing. These are still more apparent in *Renart le nouvel,* a composition of about 8,000 lines finished in the year 1288 by the Fleming Jacquemart Gelée. Here personification first becomes evident. Instead of, or at least besides, the lively personal Renart who used to steal sausages, set Isengrim fishing with his tail or make use of Chanticleer's comb for a purpose for which it was certainly never intended, there is *Renardie,* an abstraction of guile and hypocrisy, triumphantly prevailing over other and better qualities. Lastly, there is the great miscellany of *Renart le contrefait* (1322–28), which even in its existing versions extends to 50,000 lines. Besides floods of miscellaneous erudition and discourse it contains political argument of the most direct and important kind. The wrongs of the lower orders are bitterly urged. (*See* also REYNARD THE FOX; BELGIAN LITERATURE: *Flemish;* DUTCH LITERATURE.)

5. Early Lyrics.—The song literature of medieval France is both abundant and beautiful. From the 12th century to the 15th it received constant accessions, several signed, several anonymous, several purely popular in their character, several the work of more learned writers, others again produced by members of the aristocracy. Of the latter class it may fairly be said that the catalogue of royal and noble authors boasts few if any names superior to those of Thibaut IV of Champagne, king of Navarre at the beginning of the 13th century, and Charles d'Orléans, the father of Louis XII, at the beginning of the 15th. The popular origins of northern French lyric forms have been a matter for controversy ever since Alfred Jeanroy's thesis, *Les Origines de la poésie lyrique en France au moyen-âge* (1889), was discussed by the two greatest scholars in the Old French field: Gaston Paris and Joseph Bédier. The fact that a theme or genre is found again in popular songs of a later date is not decisive proof of popular origins, although the possibility can never be ruled out entirely. It was the poetic imagination of the *trouvères* which gave final shape to the *chanson de toile* and the *pastourelle,* the former being usually the celebration of the loves of a noble knight and maiden and recounting how Belle Doette or Eglantine or Oriour sat at her windows or in the tourney gallery or embroidered silk and samite in her chamber, with her thoughts on Gerard or Guy or Henry; the latter somewhat monotonous but naïve and often picturesque recitals, very often in the first person, of the meeting of an errant knight or minstrel with a shepherdess and his cavalier but not always successful wooing. With these, several of which date from the 12th century, may be contrasted, at the other end of the medieval period, the more varied and popular collection dating in their present form from the 15th century and published in 1875 by Gaston Paris, and their modern counterparts studied by Julien Tiersot in 1889 (*Histoire de la chanson populaire en France*) and Théodore Gérold in 1913 (*Chansons populaires de XVe et XVIe siècles avec leurs mélodies*). In both alike, making allowance for the difference of their age and the state of the language, may be noticed a charming lyrical faculty and great skill in the elaboration of light and suitable metres. Especially remarkable is the abundance of refrains of an admirably melodious kind. Indeed the publication of the musical manuscripts in facsimile between 1892 and 1938 altered the whole approach to the *trouvère* tradition, since it was then realized that the *trouvères* did not merely write poems which could be sung but composed songs which were meant to be sung and were also poems.

The famous figures in *trouvère* poetry were Huon d'Oisy, Conon de Béthune, the châtelain de Coucy, Gace Brulé and Colin Muset, while many writers mentioned elsewhere—Guyot de Provins, Adam de la Halle, Jehan Bodel and others—were also lyrists. But none of them can compare with Thibaut IV of Champagne, who by his possessions and ancestry had a connection with the north and the south and who employed the methods of both regions but used the language of the north only. Thibaut was supposed to be the lover of Blanche of Castille, the mother of St. Louis.

But while knights and nobles were thus employing lyric poetry in courtly and sentimental verse, lyric forms were being freely employed by others, of both high and low birth, for more general purposes. Blanche and Thibaut themselves came in for contemporary lampoons, and both at this time and in the times immediately

following a number of writers composed light verse, sometimes of a lyric, sometimes of a narrative kind, and sometimes in a mixture of both. By far the most remarkable of these is Rutebeuf, who is among the earliest of French writers to tell their personal history and make personal appeals. But he does not confine himself to these. He discusses the history of his times, he composes pious poetry, and in at least one poem takes care to distinguish between the church which he venerates and the corrupt churchmen whom he lampoons. Besides Rutebeuf the most characteristic figure of his class and time (about the middle of the 13th century) is Adam de la Halle (or Adam le Bossu) of Arras. He was not only the culminating figure in the *trouvère* tradition, who first composed polyphonic music on vernacular words, but the creator of the *pastourelle dramatique*, the *Jeu de Robin et de Marion* (1282–88) and the satirical revue in the urban setting of medieval Arras, the *Jeu de la feuillée* (1276–77). (See *The Beginnings of Drama* below.)

6. Roman de la Rose.—A work of very different importance from all these though with seeming touches of the same spirit, a work which deserves to take rank among the most important of the middle ages, is the *Roman de la rose*. The author of the earlier part was Guillaume de Lorris, who lived in the first half of the 13th century; the author of the later part was Jean de Meun, who was born about the middle of that century and whose part in the *Roman* dates from *c.* 1280. This great poem exhibits in its two parts very different characteristics which yet go to make up a harmonious whole. It is a love poem, and yet it is satire. But both gallantry and raillery are treated in an entirely allegorical spirit. The early part, which belongs to Guillaume de Lorris, is remarkable for its gracious and fanciful descriptions: like Pilgrim on a different quest, the lover in his pursuit of the Rose meets with an allegorical giant, *Danger* (his beloved's lofty unyielding demeanour), and is befriended by another abstract figure, *Bel-Accueil* ("Fair Welcome"). Forty years after Lorris' death, Jean de Meun completed the poem in an entirely different spirit. He keeps the allegorical form, and indeed introduces two new personages of importance, *Nature* and *Faux-semblant*. In the mouths of these personages and of another, *Raison*, he puts the most extraordinary mixture of erudition and satire. At one time we have the history of classical heroes, at another theories against the hoarding of money, about astronomy and about the duty of mankind to increase and multiply. Accounts of the origin of royalty that would have cost the poet his head at some periods of history and even communistic ideas are also to be found here. *Faux-semblant* is a real creation of the theatrical hypocrite. All this miscellaneous and apparently incongruous material in fact explains the success of the poem. There are to be found in the *Roman de la rose* the characteristics of the later middle age, its gallantry, its mysticism, its economic and social troubles and problems, its scholastic methods of thought, its naïve acceptance as science of everything that is written, and at the same time its shrewd and embracing criticism of much that the age of criticism has accepted without doubt or question. The *Roman de la rose*, as might be supposed, set the example for an immense literature of allegorical poetry, which flourished more and more until the Renaissance. (*See* also ROMAN DE LA ROSE.)

7. Satiric and Didactic Work.—Direct satire began early in the 13th century with Guyot de Provins and Hugues de Berzé. Travesties of the romances of chivalry were written in which the chief heroes and situations were mercilessly parodied. The disputes of Philippe le Bel with the pope and the prosecution of the Templars had an immense literary influence, partly in the concluding portions of the *Renart*, partly in the *Roman de la rose* and partly in other satiric allegories of which the chief is the romance of *Fauvel*, attributed to Gervais du Bus. The hero of this is an allegorical personage, half man and half horse, signifying the union of bestial degradation with human ingenuity and cunning. Fauvel (the name, it may be worthwhile to recall, occurs in William Langland) is a divinity in his way. All the personages of state, from kings and popes to mendicant friars, pay their court to him. The abuse of usury at the time and the exactions of the Jews and Lombards were severely felt, and Money itself, as personified, figures largely in the popular literature.

An example of early didactic verse is the *Bestiary* of Philippe de Thaün, a Norman versifier who lived and wrote in England during the reign of Henry I (*see* also BESTIARY). Besides the *Bestiary*, which from its dedication to Queen Adeliza has been conjectured to belong to the third decade of the 12th century, Philippe wrote a calendar and a lapidary, all three being translated from the Latin. These works of mystical and apocryphal physics and zoology became extremely popular in the succeeding centuries and were frequently imitated. A moralizing turn was also given to them that was much helped by the importation of several miscellanies of oriental origin, partly tales, partly didactic in character, the most celebrated of which is the *Roman des sept sages*, which, under that title and the variant of *Dolopathos*, received repeated treatment from French writers both in prose and verse. The arts, too, as well as science, soon demanded exposition in verse. The favourite pastime of the chase was repeatedly dealt with, notably in the *Roi modus* (1354–77), mixed prose and verse; *La chasse* (1387) of Gaston Phoebus, comte de Foix, prose; and the *Trésor de vénerie* of Hardouin de Fontaine Guérin (1394), verse.

Didactic verse soon became used for exposition of all the arts and sciences. Vegetius and his military precepts had found a home in French octosyllables as early as the 13th century; the end of the same age saw the ceremonies of knighthood solemnly versified, and *mappemondes*, primitive gazeteers describing the provinces and countries of the whole world, were also turned into French. In 1246–47 Gautier (or Gossouin) of Metz composed in French verse a sort of encyclopaedia, *L'Image du monde;* another, the *Livre du trésor*, was written in French by Brunetto Latini, the master of Dante. Profane knowledge was not the only subject which occupied didactic poets at this time. Religious handbooks and commentaries on the Scriptures were common in the 13th and following centuries, and under the titles of *chastoiements, enseignements* and *doctrinaux* moral treatises became common. The most famous of these, the *Chastoiement d'un père à son fils*, falls under the class of works attributable to oriental influence, being derived from the Indian *Panchatantra*.

In the 14th century the influence of the *Roman de la rose* helped to render moral verse common and popular. The same century, moreover, which witnessed these developments of well-intentioned if not always judicious erudition witnessed also a considerable change in lyrical poetry, corresponding to the development of the *Ars nova* (*q.v.*) in music. In this age arose the forms that were long used by French poets—the ballade, the rondeau (*q.v.*), the virelay, the triolet, the *chant royal* (*q.v.*) and others. These received considerable alterations as time went on. There are many early *Artes poeticae*, from the *Art de dictier* of Eustache Deschamps to the *Art poétique françois* of Thomas Sibilet (1548), the immediate forerunner of Du Bellay's famous manifesto, *Défense et illustration de la langue française* (1549). The earliest poets who appear to have practised these rules extensively were born at the close of the 13th century and the beginning of the 14th. Of these, Guillaume de Machaut (*c.* 1300–77) is the earliest. He left about 80,000 verses. Deschamps (1346?–1406?) was nearly as prolific. Jean Froissart the historian (1338–*c.* 1404) was also an agreeable and prolific poet. Less known but not less noteworthy, and perhaps the earliest of all, is Jehannot de l'Escurel, whose personality is obscure and most of whose works are lost but whose fragments are full of grace. Froissart appears to have had many countrymen in Hainaut and Brabant who devoted themselves to the art of versification, and the *Livre des cent ballades* of Jean le Sénéchal and his friends (*c.* 1390) shows that the French gentleman of the 14th century was as apt at the ballade as his Elizabethan peer in England was at the sonnet.

(G. SA.; D. S.; C. A. RN.)

8. The Beginnings of Drama.—The earliest drama in France, as elsewhere, consisted of liturgical plays (*see* also DRAMA: *Medieval Drama*). These are of various types, but the best known are *mystères* (meaning originally "ceremonial act," but by the 14th century "dramatic performance"), which used traditional biblical material, and *miracles*, based on nonbiblical legends concerning the saints. The *Sponsus* (partly French, partly Latin), which dramatized the parable of the Wise and Foolish Virgins, the Beauvais *Daniel* (in Latin, but with a few refrains in French) and the

Mystère d'Adam (entirely in French except for Latin stage directions and liturgical readings) are anonymous *mystères* of the 12th century. Two professional writers were the authors of the earliest surviving French *miracles:* the *Jeu de Saint Nicolas* (*c.* 1200) by Bodel and the *Miracle de Théophile* (*c.* 1261) by Rutebeuf are remarkable examples of the genre, particularly the former with its comic scenes of low life. The later moralities, *sotties* and farces may have developed from the simpler and earlier forms of the fabliau and of the *jeu parti,* a debate in lyric form. Even short romances, such as *Aucassin et Nicolette,* could have become dramatic when recited by skilled *jongleurs,* whose contribution to the development of early drama must have been significant. Typical of the earliest secular theatre are the short pieces *Courtois d'Arras* (before 1228 and attributed by some to Bodel), a lively dramatization in a contemporary setting of the parable of the Prodigal Son, and *Le Garçon et l'aveugle* (second half of the 13th century). But the first comedy of any real worth and substance is the *Jeu de la feuillée* (1276–77) by Adam de la Halle, an amusing mixture of satire and fantasy. Set in Adam's own town of Arras, the play pokes fun at the author's family, his friends and fellow citizens while also making use of such characters from folklore as the three fairies who appear in so many traditional stories. Adam's *Jeu de Robin et Marion* (*c.* 1282–88) is really a *pastourelle dramatique* enlivened with songs and dances. Modern critics have seen in these two plays the origin in the one case of comedy proper, in the other of comic opera.

For a long time, however, the *mystères* and *miracles* remained the mainstay of drama, and until the 13th century actors and singers were usually taken from the ranks of the clergy. It has, indeed, been rightly pointed out that the offices of the church were themselves dramatic performances and required little more than development at the hands of writers of *mystères.* The occasional revels of the lower clergy, such as the Feast of Fools celebrated at Christmas and New Year, no doubt helped in this development. The variety of *mystères* and *miracles* was very great. Two small folio manuscripts contain 40 *Miracles de Nostre Dame,* written for a Paris guild in the latter half of the 14th century, that are extremely varied in plot, character and length.

A very popular poem on the Passion was widely circulated by the *jongleurs* in France and England at the beginning of the 13th century. But the oldest extant French play on the subject, the Palatine Passion (so-called after the manuscript in the Vatican library), dates from the beginning of the 14th century. To the same period belong the only surviving French play dealing with Antichrist and the Last Judgment, the *Jour de Jugement* (*c.* 1330?), the Chantilly collection of *Mystères et moralités* comprising Nativity scenes and three moralities, and the 16 pieces contained in a Bibliothèque Ste. Geneviève manuscript, this last a veritable repository of *mystères* and *miracles* with one farce for good measure. But the great period for the Passion play was the 15th century. The *Passion de Semur* (the unique manuscript is dated 1488) is characteristic of the genre as it appeared in France, in that it consists of nearly 10,000 lines, takes two days to perform and extends the action from the Creation to the Ascension. The authors of many of the other surviving 15th-century Passion plays are known, which clearly indicates the success of this genre. Eustache Mercadé's *Passion d'Arras* (before 1440) deals solely with the life of Jesus but contains 25,000 lines and takes four days to perform; Arnoul Gréban's *Mystère de la passion* (*c.* 1451) was also played in four days but contains more than 30,000 lines. Other longer arrangements of these texts survive, notably one by Jean Michel played with great pomp at Angers in 1486. Outside this tradition are two extremely lengthy compilations belonging to the second half of the 15th century, the *Actes des apôtres* by Simon Gréban and the *Mystère du Viel Testament,* a collection of plays from the Old Testament which served as source for a great number of popular performances.

But these performances, though they held their ground until the middle of the 16th century and extended their range of subject from sacred to profane history—legendary as in Jacques Milet's *Destruction de Troie* (1450–52) and contemporary as in the anonymous *Mystère du siège d'Orléans* (*c.* 1470?)—were soon rivaled by the more profane performances of moralities, farces and *sotties,* three types of comedy which are often difficult to differentiate. The heyday of all three is the 15th century, while the Confrérie de la Passion, the special performers of the sacred drama, itself obtained the licence constituting it only by an ordinance of Charles VI in 1402. In order to take in the whole of the medieval theatre at a glance, however, we may anticipate a little. The confraternity at this period was not itself concerned with the profaner kind of dramatic performance. This latter was the preserve of two other bodies, the clerks of the Basoche and the *Enfants sans souci.* As the confraternity was chiefly composed of tradesmen and persons very similar to Peter Quince and his associates in *A Midsummer Night's Dream,* so the clerks of the Basoche were members of the legal profession of Paris and the *Enfants sans souci* were mostly young men of good family. The morality was the speciality of the first body, the *sottie,* of the second. But as the moralities were sometimes decidedly tedious plays and by no means brief, they were varied by the introduction of farces. (*See* also THEATRE.)

The morality was the natural result on the stage of the immense literary popularity of allegory in the *Roman de la rose* and its imitations. It could be serious or comic but always showed a didactic intention. The *sottie,* essentially a comedy played by *sots, i.e.,* fools in characteristic costume, was directly satirical and assumed the guise of folly only as a stalking-horse for shooting wit. It was more Aristophanic than any other modern form of comedy and, like its predecessor, it perished as a result of political application. Encouraged at the beginning of the 16th century as a political weapon—as for example the *Prince des sots* (1512) by Pierre Gringore, aimed at Pope Julius II—it was soon forbidden and replaced in one direction by the prose pamphlet, in another by forms of comic satire more general in their scope.

The farce, on the other hand, having neither moral purpose nor political intention, was a purer work of art, enjoyed a wider range of subject and was in no danger of any permanent extinction. Farcical interludes were interpolated in the *mystères* themselves; short farces introduced and rendered palatable the moralities, and the *sottie* itself was but a variety of farce; all the kinds were sometimes combined in a sort of tetralogy. It was a short composition, 500 lines being considered sufficient, whereas the morality might run to at least 1,000 lines, the *miracle* to double that number and the *mystère* to 50,000.

Of the farces performed only that of *Maître Pierre Pathelin* (*c.* 1465), is now much known; however, many are almost equally amusing. *Pathelin* itself has many versions and editions. Other farces are too numerous to attempt to classify; yet they bear in subject as in manner a remarkable resemblance to the fabliaux, their probable source. Unfaithful wives or husbands, unpleasant mothers-in-law, shifty or clumsy valets and chambermaids, philandering priests, the abuses of relics and pardons, the extortion, violence and sometimes cowardice of the seigneur and the soldiery, and the corruption of justice, its delays and its pompous apparatus supply the subjects. The treatment is narrative rather than dramatic, particularly in the monologue type of farce (often a mock sermon) but makes up by the liveliness of the dialogue for the deficiency of elaborately planned action and interest. All these forms, it will be observed, are directly or indirectly comic.

Tragedy in the middle ages is represented only by the religious drama, except for a brief period toward the decline of that form when the "profane" mysteries referred to above came to be performed. These were, however, "histories" in the Elizabethan sense rather than tragedies proper.

9. History.—The early historians, such as Wace in his *Roman de Brut* (1155) and Benoit in his *Chroniques des ducs de Normandie* (*c.* 1170), contented themselves with French verse adaptations of Latin chronicles. These, after a fashion universal in medieval times, began from fabulous or merely literary origins; thus just as Andrew of Wyntoun later carried back the history of Scotland to the terrestrial paradise, Wace begins that of Britain from the siege of Troy. But soon prose chronicles, first translated, then original, became common. Then came French selections and versions from the great series of historical compositions

undertaken by the monks of St. Denis, the so-called *Grandes Chroniques de France*, dating from 1274 when they first took form in the hands of a monk named Primat to the reign of Charles V, when they assumed the title given. But the first really remarkable author who used French prose as a vehicle of historical expression was Geoffroy de Villehardouin, marshal of Champagne, who was born before 1152 and died in Greece in 1213. Under the title of *Conquête de Constantinople* Villehardouin has left a history of the fourth crusade. The work has been well called a *chanson de geste* in prose; indeed, in the surprising nature of the feats it celebrates, in the abundance of details and in the vivid and picturesque poetry of the narration it equals the very best of the verse epics. But it is now felt that Villehardouin was putting up a specious plea for one of the worst misdeeds of the middle ages, the wrecking of the Byzantine empire, and that he was one of the chief criminals.

The rhymed *Chronicle* of Philippe Mousket and the prose *Récits d'un ménestrel de Reims* belong to the second half of the 13th century. They are more fiction than history, though the latter is witty and vivid in style. The *Chroniques de Hainaut*, commissioned in 1278 by Baudouin d'Avesnes, are an example of an attempt at serious history written directly in French prose. Jean de Joinville, whose special subject is the life of St. Louis, is shrewd and practical, has political ideas, is curious about the past and gives descriptions which are often very creditable pieces of deliberate literature.

What Villehardouin is to the 12th and Joinville to the 13th century, Froissart is to the 14th. His description of events is the most famous as it is the most varied of the three, but it has special drawbacks as well as special merits. Society is still to him all knights and ladies, tournaments, skirmishes and feasts. Unlike Joinville and still less like Villehardouin, he depicts these events not as a sharer in them but with the facile and picturesque pen of a sympathizing literary onlooker. As the comparison of the *Conquête de Constantinople* with a *chanson de geste* is inevitable, so is that of Froissart's *Chroniques* with a *roman d'aventure*. (*See* also CHRONICLE.)

10. Poetry in the 15th Century.—Christine de Pisan, the daughter of an Italian astrologer who was patronized by Charles V, was born in Italy but brought up in France and enriched the literature of her adopted country with much learning, good sense and patriotism. She wrote history, devotional works and poetry; though her literary merit is not of the highest, it should not be underestimated. But in the opinion of his contemporaries the greatest poet of the age was undoubtedly Alain Chartier. His best-known poem, *La Belle Dame sans merci* (1424), was widely read, discussed and imitated. A very different person is Charles d'Orléans, one of the greatest of *grands seigneurs*, for he was the father of a king and heir to the duchies of Orléans and Milan. Charles was an admirable poet. He is the best-known and perhaps the best writer of the graceful poems in which an artificial versification is strictly observed and helps, by its recurrent lines and modulated rhymes, to give to poetry something of a musical accompaniment even without the addition of music properly so-called. His ballades are certainly inferior to those of François Villon but his rondels are unequaled.

Villon is universally recognized as the most important single figure of French literature before the Renaissance. His main work consists of two compositions, the *Testament* and the *Lais* or *Petit Testament*, written in stanzas of eight lines of eight syllables each, with lyrical compositions in ballade and rondeau form interspersed. There is little in Old French literature to compare with the best of these, such as the "Ballade des dames du temps jadis" (*see* BALLADE), the "Ballade pour sa mère," the "Ballade de la Grosse Margot," "Les Regrets de la belle Heaulmière," and others, while the whole composition is full of poetical traits of the most extraordinary vigour, picturesqueness and pathos. "L'Épitaphe Villon" deserves special notice. The output of poetry in the *formes fixes* already mentioned, and others less beautiful, grew greatly toward the end of the century, leading to the emergence of the school known as the *grands rhétoriqueurs*.

11. 15th-Century Prose.—This period produced no great prose writer except Philippe de Commynes, but many writers attempted serious prose composition. Christine de Pisan and Chartier were at least as much prose writers as poets, and the latter, like Jean Gerson, the famous preacher who attacked the *Roman de la rose*, dealt much with the reform of the church, urging the end of all its sufferings and evils in forceful language in his *Quadrilogue invectif* (1422). Though verse was, in the centuries before the 15th, the favourite medium for literary composition, moral and educational treatises already existed in prose form. Certain household books (*livres de raison*) have been preserved that date as far back as the 13th century and contain not only accounts but family chronicles, receipts and the like.

Accounts of travel, especially to the Holy Land, culminated in the famous *Voyage* of Sir John Mandeville, which, though it has never been of as much importance in French as in English literature, was first written in French. In the 14th century there are the *Livre du Chevalier de la Tour Landry*, composed for the education of his daughters, and the *Ménagier de Paris*, intended for the instruction of a young wife, and a large number of miscellaneous treatises of art, science and morality, while private letters exist in considerable numbers and are generally of a moralizing character; books of devotion, too, are naturally frequent.

Froissart had been followed as a chronicler by Enguerrand de Monstrelet and by the historiographers of the Burgundian court, Georges Chastellain, Olivier de la Marche and Jean Molinet, the last three chiefly admired in their own day as poets of the *grands rhétoriqueurs* school mentioned above. Jean Jouvenel des Ursins, author of the *Chronique du règne de Charles VI*, may be mentioned as presenting the minute observation which has distinguished the class ever since. Jean Le Maire de Belges wrote the extremely popular *Illustrations de Gaule*, a kind of historical novel in prose and verse which traces the royal ancestry back to Francus, son of Hector. But Commynes has a distinctive style that owes nothing to Froissart. The last of the quartet of great French medieval historians, he does not yield to any of his three predecessors in originality or merit, but he is very different from them. He represents the passion of the time for statecraft, and his *Mémoires* has long ranked with Machiavelli's *Il Principe* as a manual of the art, though he has not the absolute amoral character of the Italian. The *Mémoires*, considered purely as literature, show a style well suited to their purport—not, indeed, brilliant or picturesque, but clear, terse and well suited to the expression of the acuteness, observation and common sense of their author.

The best prose of the century, the nearest yet to being an acceptable literary medium, was employed for the telling of romances in miniature. The *Quinze Joyes de mariage* is undoubtedly the first work of prose belles-lettres in French. Its themes are those of the fabliau and the farce. The novelty is in the application of prose to such purpose and in the crispness, the fluency and elegance of the prose used. These tales have been attributed, without conclusive proof, to Antoine de la Sale. La Sale's one acknowledged work is the story of *Petit Jehan de Saintré* (*c.* 1456), a short romance exhibiting great command of character and abundance of delicate draughtmanship. Another work of the period, the *Cent Nouvelles nouvelles* (an anonymous collection written between 1450 and 1462 and not to be confused with the 16th-century collection with the same title), is the first of a long and remarkable class of literature, the short prose tale of a comic character.

(J. H. WA.)

II. THE 16TH CENTURY

The 16th century is one of France's most rich and varied literary periods. By comparison with the same era in Italy, Spain, Germany and England, it is quite outstanding. François Rabelais, Pierre de Ronsard and Michel de Montaigne—these three authors tower above a host of others who are minor only by comparison with them. This is the century which saw the passing of the middle ages, the birth of the Renaissance, and its growth into full and splendid maturity. It is also the century in which the movement for religious reform, at first closely connected with the rebirth in learning, parted company from it and finally came into conflict with it. The bitterness of religious and political strife of the last decades of the century is reflected in a wide range of literature.

1. Drama.—The break with the middle ages is most marked in drama, but this is perhaps one of the least rewarding aspects of the period from the reader's point of view. The religious *mystères* and *miracles* died out by the middle of the 16th century, partly because they were generally less good than their 15th-century predecessors, and partly because they irritated both parliament and clergy by their licence. Gringore was by far the most remarkable writer of this type of play. His *Prince des sots* and *Mystère de St. Louis* are among the best of their kind. An enormous volume of religious plays was produced between 1500 and 1550. One morality alone, *L'Homme juste et l'homme mondain,* contains about 36,000 lines. But the decline of the religious play is shown by the fact that to play sacred subjects was, in 1548, expressly refused to the Confrérie de la Passion, the most famous of the confraternities formed in the 14th and 15th centuries to perform the cycles of *mystères.* A new note in religious drama was struck in 1550 by Théodore Beza with his *Abraham sacrifiant,* but this is still too far removed from the classical model to be considered the first modern French tragedy. Moralities and *sotties* dragged on under difficulties till the end of the century, and the farce, which is immortal, continually affected comedy. But the effect of the Renaissance was to sweep away all other vestiges of the medieval drama, at least in Paris. An entirely new class of subjects, entirely new modes of treatment and a different kind of performers were introduced.

The change came from Italy. In the close relationship between the two countries during the early years of the century, Italian translations of the classical masterpieces were easily imported. New French translations were made of the *Electra,* the *Hecuba,* the *Iphigenia in Aulis,* and the French humanists hastened to write original tragedies on the classical model, especially as exhibited in Seneca. Basing his work on classical models, Étienne Jodelle wrote the first modern tragedy, *Cléopâtre captive,* and the first modern comedy, *Eugène* (both 1552). These have the reputation of being unactable and unreadable, but in their day they were very successful and set a new example which for two and a half centuries the French were to regard as the peak of literary ambition. The chief tragic playwright of the period, however, is Robert Garnier, who chose his subjects from classical, sacred and medieval literature. His most famous play is *Les Juives* (1583), a biblical tragedy; he wrote the first French tragicomedy, *Bradamante* (1582), using one of the Charlemagne legends, based in part on Ariosto's *Orlando Furioso.* Garnier's best plays are lyrical, eloquent and moving. The chief comic playwright of the century is Pierre Larivey or Guinta, a Florentine by birth. His best play is, perhaps, *Les Esprits* (1579). He was not very often performed but was much read, especially by 17th-century French playwrights. Minor playwrights of the 16th century are Jacques Grévin, Antoine de Montchrestien, Jacques and Jean de la Taille, all of whom wrote mostly tragedies; and Odet de Turnèbe, author of comedies.

2. Poetry.—There is an enormous variety and wealth of poetry in this period, and modern scholarship has rediscovered and re-established several minor poets, especially from the second half of the century. The first important poet was Clément Marot, in whom are to be found both forms and themes typical of the middle ages and the Renaissance, though a medieval flavour predominates. Marot first composed much allegorical and mythological poetry which he collected in *L'Adolescence Clémentine* (1532). He composed epistles, epigrams, *ballades, rondeaux, blasons* (descendants of the medieval *dits*) and *coqs-à-l'âne,* all remarkable for their easy and polished style, their light and graceful wit and an elegance new in French literature. He excels in the epistle, in which he often treats a delicate subject rather boldly and with remarkable, subtle good humour. Marot's patroness, Marguerite de Navarre (d'Angoulême), was herself a poet who wrote in a religious as well as an amorous vein, her chief work being *Les Marguerites de la Marguerite* (1547). An early contemporary of Marot's worthy of note is Le Maire de Belges, whose poems savour of the *Grands Rhétoriqueurs* but prepare the way for Marot himself and even Ronsard. Mention must also be made of Mellin de Saint Gelais (1487–1558), a court poet who wrote some attractive short pieces, *rondeaux, huitains* and *dizains,* and Victor Brodeau who wrote many *rondeaux* in the manner of Marot.

At Lyons there flourished a group of able poets the chief of whom was Maurice Scève, mainly famous for his long series of *dizains* which sing his love for *Délie* (1544). His style is beautiful but often obscure. Délie may well have been Pernette du Guillet, a talented Lyonese lady whose brief poetic works were published shortly after her death (in 1545). A much more talented poet was Louise Labé, sometimes called Charly, whose three elegies and 24 sonnets (1555) tell a passionate love story in accents of purest poetry. Three minor poets often associated with Lyons are Antoine Héroët, author of a delicate, graceful, Neoplatonic love poem called *La Parfaite Amie;* Charles Fontaine and Hugues Salel.

The principal poet of the period is, of course, Ronsard. His chief studies were carried out under the humanist and poet Jean Dorat. These two, together with five others, Joachim du Bellay, Jean Antoine de Baïf, Rémy Belleau, Pontus de Tyard and Jodelle, made up the famous group of writers known as the *Pléiade* (*q.v.*). Their object was to create a French literature to rival that of Renaissance Italy, first by bringing the French language on a level with the classical tongues by imitating and borrowing from them and, secondly, by reproducing in French regular tragedy, the Pindaric and Horatian ode, the Virgilian epic, the Petrarchian sonnet, etc. The *Pléiade's* manifesto, in which the group stated its objects and methods, was written by Du Bellay and called the *Défence et illustration de la langue française* (1549). Wisely, caution and attention to the genius and the tradition of French were insisted upon. Being men of the highest talent, they achieved much that they designed; even when they failed to achieve it, they often produced results as important as and more beneficial than those which they intended. They occasionally went too far and thus were responsible, to some extent, for the reaction led by François de Malherbe at the beginning of the 17th century. Ronsard, a prince among poets, wrote an enormous amount—sonnets, odes, *odelettes,* songs, elegies, philosophical and reflective poems and even the beginning of an epic. His odes and sonnet sequences are particularly fine, and he produced excellent poetry from the late 1540s to the early 1580s. Next to him in stature but much narrower in range, though still a major poet, comes Du Bellay, whose sonnets are written with consummate skill, especially those in the sequence, *Les Regrets* (1558), where his mood varies between the profoundly elegaic and the pungently satirical. Belleau is no mean poet, polished, light and gracious, sometimes compared with Théophile Gautier. He wrote much, notably a vast *Bergerie* (1572) which includes his famous "Avril." Baïf is a minor poet, rather pedantic but interesting, whose chief work remains a sonnet sequence, *Les Amours de Méline* (1552). Jodelle is a thoughtful, vigorous lyric poet of uneven strength, while Tyard, more even, is gracious for the most part, but occasionally obscure. He was at first associated with the Lyonese poets and published his main lyric work, *Les Erreurs amoureuses* (1549) before his future colleagues of the *Pléiade* had published anything more than the occasional poem.

The poets of the *Pléiade,* in particular Ronsard, had many imitators. Jacques Peletier du Mans (1517–82) was, however, like Tyard, something of a precursor of the *Pléiade,* for he much influenced Ronsard and Du Bellay, whom he knew well, by his knowledge and love of Latin and Greek poetry; he championed the theories of the *Pléiade* and himself wrote several worthy lyric poems in a Ronsardian manner. His *Oeuvres poétiques* (1547) contain Ronsard's own first published poem. Under the obvious influence of Ronsard, Jacques Tahureau wrote his *Sonnets de l'Admirée,* Olivier de Magny his *Soupirs* and *Gayetez,* and Nicolas Denisot his *Noëls.* More minor still are the *ronsardisants* Louis le Caron, Amadis Jamyn and, as poets, the three playwrights who occasionally wrote lyric verse, Jacques Grévin and Jean and Jacques de la Taille. More noteworthy *ronsardisants* are Jean Vauquelin de la Fresnaye, who wrote several graceful pastoral poems (*Idillies et foresteries,* 1555), several poor satires and a fine *Art poétique,* not published till 1603; and Philippe Desportes, a favourite court poet, seen as a successor to Ronsard by his contemporaries, who wrote *bergeries,* elegies, mascarades, sonnets, etc., but only occasionally produced a really good poem, like his sonnet

about Icarus or his villanelle to Rosette. Mathurin Régnier, famed for his satires, is a descendant of both the school of Ronsard by his erudition, his command of language and his scholarship and of the older Gallic spirit of Villon and Marot by his consummate acuteness, terseness and wit.

The second half of the 16th century was the scene of bitter civil strife and many poets gave vent to religious passion and vehement political feeling. Perhaps the chief is Théodore Agrippa d'Aubigné, whose main work, *Les Tragiques*, was begun in 1577 but not published till 1616. D'Aubigné is both a religious (Calvinist) and a violently satirical poet, and *Les Tragiques* is a kind of moral and religious last will and testament in epic form, rich in invective and biblical references, often morbid, of uneven quality, but here and there containing several of the most beautiful pages in French literature. Guillaume du Bartas, also a Protestant, achieved great fame for his epic work *La Semaine* (1578) in which he set out to describe the whole process and product of the Creation. Ronsard considered him an equal but posterity has reduced him considerably in rank. In spite of obvious stylistic faults, *La Semaine* remains a curious and fascinating poem. Jean de Sponde, who has been rediscovered by 20th-century scholars, was a Protestant who became converted to Catholicism. His *Essai de quelques poèmes chrétiens* (1588) is written in an impassioned and ornamental style. Jean Baptiste Chassignet, a minor poet whose sonnet-sequence *Mépris de la vie et consolation contre la mort* (1594) contains several remarkable comparisons and metaphors, is another modern rediscovery, as is Jean de la Ceppède, a devout Catholic who composed a long sonnet-sequence, *Théorèmes Spirituels*, mostly written between 1613 and 1621. Jacques du Perron wrote several good religious poems; so did Gabrielle de Coignard whose *Oeuvres* were published after his death (in 1594). Other minor poets of this period are Guy du Pibrac, who wrote *Cinquante Quatrains moraux contenant préceptes et enseignements utiles pour la vie de l'homme;* Nicolas Rapin, who experimented with rhythmic and quantitative verse; and Clovis Hesteau de Nuysement, whose *Visions hermétiques* contain several strangely beautiful stanzas.

3. Prose.—In quantity, 16th-century prose fiction is not very considerable, but its quality is enhanced by one of the most outstanding French writers of all time—François Rabelais. His great work was written in several parts—*Pantagruel* (1532), *Gargantua* (1534), the *Tiers Livre* (1546), the *Quart Livre* (1552) and a fifth and final book published posthumously (1564). The last three books concern Pantagruel. With an immense erudition representing almost every aspect of contemporary knowledge, with an untiring faculty of invention, with the judgment of a philosopher and the common sense of a man of the world, with an observation that let no characteristic of the time pass unobserved and with a tenfold portion of the special Gallic gift of good-humoured satire, Rabelais reaches a height of speculation and depth of insight, and a vein of poetical imagination, rarely found in any writer but almost unique when combined with his other gifts. His work has been taken for an exercise of transcendental philosophy, for a concealed theological polemic, for an allegorical history of this and that personage, for an exercise in literary invention and for an attempt to tickle the popular ear and taste. It is all of these and it is none—all of them in part, none of them by deliberate and exclusive intention. It may perhaps be called the exposition and commentary of all the thoughts, feelings, aspirations and knowledge of a particular time and nation put forth in attractive literary form by a man who was unusual in combining the practical and the literary spirit, the power of knowledge and the power of expression.

Other storytellers of the 16th century worthy of note are Philippe de Vigneulles, author of *Les Cent Nouvelles nouvelles*, written between 1505 and 1515; Nicolas de Troyes, whose main work, *Le Grand Parangon des Nouvelles nouvelles*, was written between 1535 and 1537; Marguerite de Navarre, whose *Heptaméron* was published posthumously in 1558; Bonaventure des Périers, whose *Nouvelles Récréations et joyeux devis* were also published posthumously in 1558; Noël du Fail, who wrote three collections of short stories—*Les Propos rustiques* (1547), *Les Baliverneries* (1548) and *Les Contes et discours d'Eutrapel* (1585); and, finally, Guillaume Bouchet, who composed *Les Serées* (1584). Of these, the *Heptaméron* is probably the most justly famous. It is modeled on Boccaccio, but its tone and character are entirely different, and it has a very individual charm. Des Périers' tales are shorter, simpler and more homely; there is more wit in them and less refinement. Vigneulles and Troyes are the least lively and original of this group and for the most part tell only short, comic anecdotes. Du Fail is one of the more original storytellers. His *Propos rustiques* reveal much direct observation of peasants and their way of life, as do his *Baliverneries*, while the tales in his final collection are a strange mixture of anecdotes, reflections, satirical comments and political, social and religious theories. Bouchet's tales are for the most part rather clumsy and pedantic; only very occasionally are the conversations they reproduce light and lifelike. In many ways the *Moyen de parvenir* (1612) by Béroalde de Verville belongs to the 16th-century tradition of storytelling, being a collection of conversations at a banquet attended by the oddest mixture of guests—writers, soldiers, humanists, philosophers, artists and utterly fantastic characters who tell tales, mainly about shameless wives and foolish husbands.

As literary artists the historians and memorialists of the 16th century hardly compare with those of the middle ages. However, there are five authors of this period whose histories exceed all others in interest and importance. These are the one who called himself the *Loyal Serviteur* (probably Jacques de Mailles), author of the *Histoire du chevalier de Bayard* (*c.* 1524); François de la Noue, author of the *Discours politiques et militaires* (1587); Blaise de Monluc, author of the *Commentaires*, which were not published till 1592; Pierre Brantôme, whose memoirs were not published till the late 17th century; and D'Aubigné, whose *Histoire universelle* was published in parts between 1616 and 1620. Brantôme is perhaps the best known of these, particularly for his *Vies des dames illustres* and *Vies des hommes illustres et des grands capitaines . . .*, shrewd and cynical, charming and light, free from any particular religious or political prepossessions. La Noue expresses a moderate view in political matters in a language both harmonious and sturdy; Monluc deals exclusively with military matters, writing in a most straightforward and vivid manner. D'Aubigné gives the extreme Huguenot side as opposed to the royalist partisanship of Monluc and the *via media* of La Noue, and his style is the most uneven of all, ranging from pedantic clumsiness to poetic brilliance.

Political writers are numerous, but few may be considered as literary artists. The chief is Jean Bodin, who in the protracted argument between the royalists and the reformers takes the royalist side in his *République* (1576), arguing in favour of unlimited monarchy. Perhaps the most able writer supporting the opposite view is Étienne de la Boétie, who protested against the monarchial theory in his *Contr'un* or *Discours de la servitude volontaire* (*c.* 1549), a brilliant essay. Other political writers on the royalist side include Michel de l'Hospital and Guillaume Postel; on the opposite side is, notably, François Hotman. Guillaume du Vair wrote on the need to establish peace with a strong and just government. Religion is, of course, closely linked to politics at this time, and this is particularly evident in the famous *Satire Ménippée* (1594), the foremost work against the Holy League, the political party of the Catholics. From the literary point of view this is one of the more remarkable of political books. The *Ménippée* was the joint effort of Pierre Leroy, Jacques Gillot, Florent Chrétien, Rapin and Pierre Pithou. Jean Passerat and Gilles Durand assisted in writing part of the verse in this prose-and-verse satire which is extraordinarily strong yet perfectly good-humoured. The section which is most outstanding from the literary point of view is attributed to Pithou.

Theological writers are many and several are literary artists of considerable distinction. The great textbook of the French Reformation is the *Institution chrétienne* by John Calvin. This book is remarkable in matter, form, circumstance and result. It is the first really great composition in argumentative French prose. Its severe logic and careful arrangement had as much influence on the manner of future thought, both in France and the other regions

where its widespread popularity carried it, as its style had on the expression of such thought. It was the work of a man of only 27, when hardly any models of French prose existed except tales and chronicles which required and exhibited totally different qualities of style. It is indeed probable that if the *Institution* had not been first written by its author in Latin and later translated by him it might have had less dignity and vigour; however, it must at the same time be remembered that this process of composition was at least equally likely, in the hands of any but a great genius, to produce a heavy and pedantic style neither French nor Latin in character. Even before the *Institution,* Jacques Lefèvre d'Etaples and Guillaume Farel saw the importance of the use of the vernacular. Calvin was much helped by Pierre Viret, who wrote a large number of small theological and moral dialogues designed to captivate as well as to instruct the lower orders. Mention must be made here of the brilliantly written *Cymbalum Mundi* (1538) by Des Périers in which he violently attacks Christianity. Beza wrote chiefly in Latin, but he composed in French an ecclesiastical history of the Reformed churches and several translations of the psalms. Marnix de Sainte Aldegonde followed Viret as a satirical pamphleteer on the Protestant side. Toward the end of the century a wider outlook was achieved by Philippe du Plessis-Mornay, on the Protestant side, whose work is at least as much directed against freethinkers and enemies of Christianity in general as against the dogmas and discipline of Rome. His adversary, the redoubtable Du Perron who, originally a Calvinist, went over to the other side, employed French most vigorously on controversial works, chiefly with reference to the Eucharist. Du Perron was celebrated as the first controversialist of the time and obtained dialectical victories over all comers. At the same time, the bishop of Geneva, Saint Francis of Sales, supported the Catholic side, partly by controversial works but still more by his devotional writings, the chief of which is his *Introduction à la vie dévote* (1608), still a popular classic. Finally under this head one might mention Pierre Charron, who published *Les Trois Vérités* in 1593, in which he wrote on the existence of God, the excellence of Christianity and the superiority of Catholicism. His chief work is, however, a fine essay entitled *Traité de la sagesse* (1601).

Writers of scientific and learned works whose style and command of language earn them a high place among the literary artists of the 16th century are fairly numerous. Three are outstanding: Jacques Amyot, Henri Estienne and Étienne Pasquier. Amyot, bishop of Auxerre, takes rank as a French classic by his translations of Plutarch, Longus and Heliodorus. The admiration which Amyot excited in his own time was immense. Montaigne declares that it was due to him that his contemporaries knew how to write and speak, and the Académie Française, founded in the 17th century, though not much inclined to honour its predecessors, ranked him as a model. His *Vies des hommes illustres* (first published 1559), had great influence at the time and coloured perhaps more than any classic the thoughts and writings of the 16th century. It is considered his masterpiece. Estienne (sometimes called Stephanus) wrote several pungent and eloquent treatises on the French language—*Traité de la conformité du langage français avec le Grec* (1565); *Dialogues du nouveau langage français italianisé* (1578); *Précellence du langage français* (1579) and a curious *Apologue pour Hérodote* (1566). Pasquier is one of the first great literary critics to write in French, and his *Recherches de la France,* which he took 25 years to compose, is a masterpiece of balanced criticism and good French. Minor writers under this head worthy of note are Claude Fauchet, François de la Croix du Maine, Antoine Duverdier, Bernard Palissy and Ambroise Paré.

The essayist Michel de Montaigne stands alone. Literature received one of its greatest accessions in his famous books of *Essais* (1580–88). It would be a mistake to imagine the existence of any skeptical propaganda in his charming and popular work. Its principle is not skepticism but egotism, and, the author being by nature skeptical, this quality appears naturally rather than intentionally. It expresses the mental attitude of the latter part of the century as completely as Rabelais expresses that of the early part. Inquiry and protest have given way to a placid conviction that there is not much to be found out and that it does not much matter; the erudition though abundant is less indiscriminate; exuberant drollery is replaced by quiet irony; though neither business nor pleasure is decried, both are regarded rather as useful pastimes incidental to the life of a man than with the eager appetite of the Renaissance. From the purely literary point of view, the style is remarkable for its absence of pedantry in construction and yet for its rich vocabulary and picturesque brilliance. It is one of the best-loved books in the French language throughout the world; its mood and contents are in tune with the minds of civilized persons in all ages. Montaigne is an infinite source of pleasure, to be read at leisure, by large or small sections, to be put down and taken up again at will.

At the hands of this host of writers, and aided by its first real grammarians, the French language in the 16th century began to develop into a rumbustious creature in need of careful discipline (*see* FRENCH LANGUAGE). This discipline was to be exerted by the first important writer of the next age, François de Malherbe.

(K. V.)

III. THE 17TH CENTURY

For most readers the 17th century is still the central and supreme period of French literary expression, but modern research has not made it easier to define the period as a whole or describe the complex and baffling movement of literature within it. There would seem to be no reasons for beginning the story in 1600 or concluding it in 1700. The death of one great king (Henry IV) in 1610, and of another (Louis XIV) in 1715 provide possible halting places where the critic may notice changes and distinguish tendencies. But it was not the kings who were the decisive influences in creative writings, or even in establishing the sort of society in which people wrote and read. Court encouragement was one among many influences; others were economic prosperity, the leisure of a rising middle class, fashion in reading and, perhaps most of all, the absence of civil and foreign war. Literary production throughout the century was abundant and apparently haphazard. The works which are called "classical" are a tiny part of that production. A survey such as this cannot deal with the ephemeral, yet it would suggest a false picture if it were forgotten that for those who lived in the century the ephemeral, by its very quantity, engulfed what later generations have thought admirable.

1. The First Half of the Century—*Poetry and Prose.*—Society in the 17th century had not achieved stability; it was energetic and unregulated, and death and personal violence were intrusive. The polish and elegance of poems and novels were not so much a reflection of society as an escape from the remembrance of anarchy—a desire for stability in a world of change. This is especially true of the early years of the century. The virtual end of civil war in 1598 and the return to peaceful conditions was shown by the appearance of collections of verse in which the old favourites, Ronsard and Desportes, tended to be replaced by verse that was more chiseled and restrained. This tendency, as so often happens in French literary history, was embodied in an individual: Malherbe, who from 1605 worked in Paris, enjoyed royal support and became increasingly appreciated. Boileau's famous lines:

> "Enfin Malherbe vint et, le premier en France,
> Fit sentir dans les vers une juste cadence . . ."

rejoicing that there had "at last" appeared a French poet who satisfied the modern taste for regular and smooth verse, give a fair picture of what most Frenchmen in the 17th century thought Malherbe had accomplished. A *Recueil de beaux vers* of 1627 includes 60 of his poems. The same decade saw the work of his chief disciples, François Maynard and Honorat de Racan, and also that of his chief opponent, Régnier, whose satire *Macette* had appeared in 1609. The generation born around 1590 produced poets of distinction: Théophile de Viau, François Boisrobert and Girard de Saint-Amant, all of whom inclined to free thought. The last of these went on writing throughout the 1630s, when the most popular name was Vincent Voiture, who seems to modern taste more versifier than poet but who, for his contemporaries, was an incomparable virtuoso.

The poetic landscape of 1630 was probably in fact much more

varied and interesting than it now seems. It even had its Metaphysicals. The poetry of Sponde and of La Ceppède provided the initiated reader with verse of very different quality from that of Voiture. It described the human condition with a personal force rarely found in classical poetry:

> Tout s'enfle contre moy, tout m'assaut, tout me tente,
> Et le Monde, et la Chair, et L'Ange révolté
>
> ("All things rise against me, lay siege to me, lay traps for me: the world, the flesh, Lucifer . . .")

Satire flourished: Régnier was not the lone figure he now appears; the vigorous verse of Sigogne and Vauquelin should be remembered alongside the work of De Lingendes and De Viau.

The new poetry appealed to a smaller circle than did the new fiction, especially when a brilliant writer emerged in Honoré d'Urfé, whose *Astrée*, published in a long series of volumes from 1610, was more than just a fashionable success. By his gifts of invention and style he contrived to satisfy tastes as diverse as love of adventure, the simple life, the code of courtesy and the Platonic ideal. Céladon, Sylvandre and Hylas were for many generations what the characters of Scott and Dickens were for the Victorian age. D'Urfé's novel outshone the host of fictions inspired, in great part, by his work: the Latin stories of John Barclay, the translations from Mateo Alemán and other Spaniards, the *Polexandre* of Gomberville and the novels of Jean Pierre Camus, bishop of Bellay. More realistic and closer to the medieval tradition were Charles Sorel's *Histoire comique de Francion* (published 1623, more than 20 editions before 1700) and Paul Scarron's *Le Roman comique* (1651–59).

The Academies.—The literary activity of the time was not confined to the production of verse and novels: under Louis XIII small groups of people, spoken of as Academies, developed a taste for literary discussion. One of these, taken over by Cardinal Richelieu in 1634 and formally constituted the following year, took the now famous title of Académie Française. The moving spirits seem to have been Valentin Conrart, who wrote little but of whom his contemporaries speak as having a passion for good writing, and Jean Chapelain, mocked by some for his heavy poetry and his concern for the rules of composition, but whose essays and prefaces (collected by A. C. Hunter, 1936) show a remarkable critical mind. Unattached to this group was Guez de Balzac, a keen critic and a master of expression, whose letters and literary quarrels gave him a great reputation; his letters appeared in print from 1624 and those to Conrart were collected in 1659. Some of these assemblies were as much social as literary, notably those of the Hôtel de Rambouillet, founded by Catherine de Vivonne, one of the remarkable women of the age, who for 20 years (1620–1640) provided a friendly meeting ground for upper-class persons interested in talk and manners. Another critic, Claude Favre, Seigneur de Vaugelas, acquired great authority in discussions of language; his *Remarques sur la langue française* (1647) became famous as a plea for intelligent usage. Most of these critics were in touch with Malherbe and together they represent a remarkable literary phenomenon. They were possibly more successful than they knew in creating a standard of literary taste and in making the French language a supple instrument of expression.

These literary coteries should not be thought of as isolated. Their prototypes occurred under Henry III; they continued in various forms through the centuries and their successors are part of the intellectual energy of modern Paris. Nor did they discuss only style. Several undertook scientific research, notably the group under Pierre Mersenne to which Pascal's father belonged, and the circle of the brothers Pierre and Jacques Dupuy, known as the Académie Putéane, which included François de la Mothe le Vayer, Gabriel Naudé and Pierre Gassendi. (On all these *see* R. Pintard, *Le Libertinage érudit dans la première moitié du XVII siècle*, 1945). René Descartes, though attached to one of these groups, seems to have been in touch with them all and discussed by all. (*See* also CARTESIANS.)

The influence of Descartes seems to have pervaded his entire century. All the brighter spirits react to him and because of him: Pascal, Arnauld, Bossuet, Malebranche. No doubt a host of minor figures were affected by his Method. It is not that he imposed doctrines or ideas: his views on vortices, doubt, innate ideas, proofs of God, etc., were not, it would seem, accepted widely or for very long. It seems rather to have been his cast of mind and temper, which suggested a new attack on old problems, a new way of thinking and arguing. His vision of science leading to mastery of nature, which found expression in the final section of the *Discours de la Méthode* (1637), is seen at work in his disciple Bernard le Bovier de Fontenelle who in the *Disgression sur les Anciens et les Modernes* (1688) wrote his best epitaph: "Avant M. Descartes on raisonnait plus commodément, les siècles passés sont heureux de n'avoir pas eu cet homme-là" ("Before Descartes reasoning was easier; past ages are fortunate not to have known him").

The Theatre.—Another prominent feature in the first half of the century is the rise in prestige of the Parisian theatre. Compared with the drama to be seen in London, that of Paris, at the time of Shakespeare's death, was undistinguished; 60 years later French drama was the admiration and envy of Europe. It is hard to say where the new vigour and skill came from. As in the creation of Versailles, it was due to "teamwork." In 1625 there was still only one licensed theatre in Paris: the Hôtel de Bourgogne, home of the *mystères*, where nearly all Racine's plays were to be performed. A dramatist of talent, Alexandre Hardy, wrote about 600 plays which offered both Renaissance pathos and real dramatic suspense. Gradually the whole public attitude to the theatre changed; it became a polite entertainment and, as in so many other social habits, this was partly caused by the active encouragement of Richelieu. The enthusiastic reception given to the *Pyrame et Tisbé* of De Viau, probably in 1623, was a foretaste of things to come. A new generation of authors appeared: Racan, Jean Mairet, Jean de Rotrou who supplied plays of intellectual interest and coherent plot. Mairet was to go farthest and to achieve most. His *Sylvanire* (1631) was the first successful "new" play using the Italian invention of the unities and thereby concentrating action within strict limits. Other young writers showed how the new fashion could admit the picaresque adventures that the public wanted: Pierre Corneille in *Clitandre* (1631); Boisrobert in *Pyrande et Zisimène* (1633). Others clearly resisted the new style: Schélandre in *Tyre et Sidon*, Georges de Scudéry, in *Lygdamon et Lydias* and other plays, seemed to scorn the limits of time and place. But new talent appeared in Rotrou's *Hercule mourant* and Tristan l'Hermite's *Mariamne* and Mairet's *Sophonisbe* (all produced in 1634 and 1635). Corneille's *Le Cid* was therefore part of a movement and at first indistinguishable from the rest. One document couples *Le Cid* and *Mariamne* as the two novelties of Paris, both containing "de ravissantes choses."

The great success of *Le Cid* and the famous polemic connected with it (which used to be attributed to the jealousy of Richelieu but seems rather to have been caused by the vanity of Corneille) have caused the play to be seen in a false perspective. *Le Cid* is not the solitary emergence of French classicism; it is simply a brilliant play. Its attractive characters, its dramatic encounters, its rhetorical interchanges proved irresistible to a public avid for great drama and fine style. In a sense it was what followed that demonstrated its greatness. Corneille took three years over his next play, *Horace*, a work of great dramatic power. With this piece the connoisseurs might well feel that a truly national drama had been evolved. Corneille used Livy's famous story of the Horatii and the Curiatii to enforce the tragic split within a family (and this at a time of national emergency, 1640) between patriot and pacifist. With incredible inventiveness he produced three plays of similar brilliance within three years: *Cinna*, a drama of political conspiracy; *Polyeucte*, the social tragedy of a Christian martyr; and *Rodogune*, a powerful study of a virago. Thus, by supplying a body of plays which were treated within a generation as classics, compelling the respect of Dryden no less than the enthusiasm of the public, Corneille almost single-handedly created the French classical theatre. Had he written no more his reputation might well stand higher than it does. But even in the creative period of his career he was not alone. Rotrou wrote in *Saint Genest* a martyr play as interesting as *Polyeucte* and in *Venceslas* a tragedy of politics; he adapted Plautus in *Les Deux Sosies* and

Lope de Vega in *Laure Persecutée*. Thus at the death of Richelieu France seemed to be in full literary revival, with an abundance of talent, a new public and a rapidly forming tradition.

2. The Classical Period.—The civil war known as the Fronde (*q.v.*; 1648–52) cuts the century in two, sociologically no less than by date. There is no clear evolution from the best literature of the 1640s—pre-classicism as it is often called—to the classicism of the 1660s. Certain features persist, but there is a change of attitude. The war left its mark on the middle classes, which supplied the authors and most of the reading public; it left the writers, and no doubt their readers, more sophisticated, more cynical, less inclined for heroics. It should be remembered that there was no recognized profession of letters; writers lived by patronage, and the Fronde produced a new type of patron. Both Boileau and Molière started their careers as hack writers for Fouquet, and it was Fouquet who induced Corneille to return to the theatre and attempt a version of the chief tragic theme of antiquity, the Oedipus story. Corneille's first play since *Pertharite* (1652) was played in 1659.

The greatest mind of the age, Blaise Pascal, wrote within the orbit of the new puritan movement, which, after the civil war, gathered round Antoine Arnauld and the community of Port Royal—a movement which never succeeded in overcoming the king's suspicion that it was subversive. This new spirit is clearly to be seen in the series of pamphlets (written by Pascal under a pseudonym) known as *Les Lettres provinciales*, which appeared at irregular intervals throughout the summer and winter of 1656 and 1657. Here, used to brilliant effect, were all the novelties of Guez de Balzac, with a relevance, a force and a polemic gift that he could not command. Pascal himself was so impressed by the vigorous and confident reasoning of those who had no use for religion that he devoted the last energies of his short life to planning an apology for the Christian religion. It got no further than the plan and a mass of partly arranged fragments, but, known as the *Pensées*, these form the most profound work of French classicism. They have influenced later thinkers even more than they impressed the first readers of 1670. Left in note form, and with the vigour, even violence, of expression that seems to have been natural to Pascal, this is the only French classical work to have survived in its primitive state—a marvel of compression and annotation.

The new realism appears in the plays of Scarron and the later volumes of such novels as *Le Grand Cyrus* of Mlle Madeleine de Scudéry; what threatened to become a tedious fiction was transformed into a social diary by the introduction of contemporary and scarcely veiled portraits. The existence of a public alive to intellectual subtleties allowed Molière to bring his theatrical company back to Paris and to introduce to a royal audience in the guardroom of the Louvre on Oct. 24, 1658, after a performance of Corneille's tragedy *Nicomède*, a *divertissement* of his own that was a prelude to 15 years of intense dramatic activity, the results of which are now called classical comedy.

It is the same spirit which animates a great work unpublished during the 17th century: the *Mémoires* (publ. 1717) of Jean François de Gondi, Cardinal de Retz. One of the chief participants in the Fronde, he embodied its spirit in these caustic and brilliant pages. He had already shown his quality as a writer in his rewriting of an Italian tract on the conspiracy of Fieschi, later useful to Schiller. Retz is not an admirable character but he can brilliantly convey an awareness of things and an uninhibited attitude to human behaviour. It was this quality, perhaps, which was the chief element in the immediate public success of a collection of epigrams, known as the *Maximes*, published in 1664 (first acknowledged edition 1665) by François, duc de la Rochefoucauld. These mordant and brilliant epigrams, written in the late 1650s, partly as a society game, are the chief literary legacy of the Fronde. They offer, within a severely classical form, a pitiless analysis of its self-seeking *sauve-qui-peut* attitude to morality, its cynical pessimism and its discovery of what is now called the subconscious. They attack individualism ("c'est une grande folie de vouloir être sage . . . tout seul"—"it is folly to want to be wise . . . alone"), idealism, stoicism and intellectualism with a wit and force that compelled the admiration of modern writers such as André Gide.

Classical Works of the 1660s.—These years have some claim to be thought of as the most creative decade in the history of French literature; a body of work was produced which is superior to that of either the 1820s or the 1860s. Molière's first attempt at a five-act comedy, *L'École des Femmes*, played on Dec. 26, 1662, aroused a controversy as animated as that of *Le Cid*. Boileau's first satires and the *Maximes* circulated about the same time. Jean Racine's first masterpiece, *Andromaque*, appeared in 1667 and Jean de la Fontaine's first collection of *Fables* in 1668. All these are distinguished by a new sense of the dignity of the language, by powerful imagination devising new forms for literary communication, and by an intellectual ability to renew the commonplace and the ordinary. These qualities, rather than any doctrinal agreement on the nature and function of reason or the rules of writing seem to animate the greatest works of French classicism. Of their appeal to the French of their own and later times there is no doubt. Many who have no special interest in literature know, for example, La Rochefoucauld's comparison of death and the sun, Bossuet's words on the youth of St. Bernard and the death of Madame, M. Jourdain's discovery that he had been speaking prose all his life, La Fontaine's description of the uprooted oak, Hermione's distracted question "Qui te l'a dit?" and even Boileau's "J'appelle un chat un chat et Rolet un fripon." When such things enter the popular mind it is a proof that a national literature exists.

There was apparently no intention to create "classical" works and very little collusion among the creators. The emergence of this body of great writing after 1660 has never been explained. It is possible to trace the course of a slow apprenticeship in each of the writers, but they did not belong to a single generation: Molière and La Fontaine were born within a year of each other; Racine and Boileau were nearly 20 years younger. The most impressive talent to watch at work in the 1660s is probably that of Molière. He is not to be imagined as a philosopher or as a dramatist who is experimenting with various kinds of comedy for their own sake. Modern research has shown that he was, in fact, fighting to keep a dramatic company on its feet and that when he began writing his main concern was to fill the blanks in its repertory; it was only when the public unmistakably favoured his own pieces that he assumed his full creative role. It seems that he succeeded best with his occasional shorter plays: *Sganarelle*, *Le Médecin malgré lui*, *Psyché*, *Le Bourgeois Gentilhomme*. He spent much time on *Dom Garcie de Navarre* and *Dom Juan*, both of which failed, on *Le Misanthrope* and *L'Avare*, where the success was short-lived, and on *Tartuffe*, which took him five years to put on the stage. But to watch, in retrospect, the way his plays mount in range and intensity gives one some idea of what it meant at that time to run a Paris theatre and supply it with plays. In the season of 1666 Molière wrote five new plays for his company; six years later, in 1671, the company put on 15 of his plays, three of which were new. Fame came to him fairly soon; by 1666 he was perhaps the most talked-of author of the day. But he appears to have had neither leisure to write nor freedom from financial worry; as late as 1669 the company was saved from collapse only by the fantastic success of *Tartuffe*. It is surprising that critics have discussed deeper meanings or heterodox views in a body of work about which the only things known for certain are that it was hurriedly composed to please a discriminating public, and that to seek a pulpit for questionable opinions was the last thing its creator was likely to have risked. The abiding impression is that of a creative talent of such power that even the hurried sketch is firm, the suggestion poetic, the chief character convincing. Molière works like a Daumier, not like a Flaubert. Yet this haste devised characters of astonishing comic force: Tartuffe, Alceste, Harpagon, Chrysale. Compared with such creations all previous French comedy looks fumbling and feeble. As Voltaire said: "Molière a tiré la comédie du chaos" ("Molière has rescued comedy from chaos").

One of the neglected features of French classical literature is its poetry. Lyrical outpourings are not to be found; satire and a gift for the picturesque are characteristic of Nicolas Boileau-Despréaux. To say no more than this would be unjust to Boileau,

whose contemporaries and successors thought more highly of him than do modern readers. His famous *Art poétique* of 1674 has been so ruined by school use that it has been forgotten that it was a success in the salons, since it is a witty book. Boileau, there and in his epistles and satires, handles certain styles with entire mastery: puns, rhymes, paradox, topical allusion, all are easily and forcefully expressed. Each of his works was an experiment and there can be few poets who have exercised influence in such different directions as he did. He worked out in *Le Lutrin* a new kind of burlesque, which became very popular in the 18th century; his *Art poétique* was taken up as the classical code more seriously than he probably intended; with *Le Traité du sublime* he presented the pre-Romantics with one of their main arguments.

La Fontaine commands a greater range than Boileau, both of irony and fantasy. Steeped in the ancient poets, he recovers for French verse the majesty of the Virgilian line (as in the end of *Le Chêne et le roseau*) and is able to suggest reverie of a kind usually claimed as Romantic: "Loin du monde et du bruit, goûter l'ombre et le frais." The delight given by the *Fables* cannot be accounted for otherwise than by their poetic renewal of the details of common life and by the relationship of the author to such material. This poet can write of gods and animals, of dignitaries and peasants, in the same tone of serene and unclouded discernment.

Apart from these two poets the real achievements of classical poetry in these years was in tragedy. What Racine achieved was no doubt due to the competition of many authors now forgotten—not only, as is so often claimed, to that of Corneille. They, no less than he, attempted to recover the ancient Greek themes in ballet, opera and tragedy. At least three contemporaries wrote on the Phaedra story before he took it up. But Racine's recoveries of the ancient tragic suspense and emotion were impressive, not least by their frequency. Seven times within his short dramatic career of ten years did he perform the miracle of animating a truly tragic situation. Several good judges think that his first success, *Andromaque* in 1667, was never surpassed. Paul Claudel and Jean Giraudoux have declared their admiration for *Britannicus* (1669). The limits of concentration would seem to have been reached in *Bérénice*, only one year later, which confines the tragic subject to the farewell of a queen to two lovers and to the poignant opposition of public and private interests. Yet in 1672 Racine produced a profound study of primitive violence in *Bajazet*, to be followed a year later by *Mithridate*, where an equally violent character was opposed by one of great integrity. *Iphigénie* (1674) and *Phèdre* (1677) show, perhaps, an intentional return to themes where gods and men, as in La Fontaine, form a more complex symbolism. In the supreme achievement of *Phèdre* many have seen the classic 17th-century statement of the tragic gulf between passion and purity. Some of these plays gave offense, partly owing to the irascible character of the author, but this should not blur the lasting impression of the greatest of the French poets, as some think him, writing his plays for a small audience in the rhetorical tradition of the Hôtel de Bourgogne. The final irony of this unique career is that after a silence of 20 years he wrote for a girls' school two biblical plays which have evoked as much admiration as any of the others (*Esther*, 1688, *Athalie*, 1691).

Writings of Churchmen.—The role of the church in 17th-century life was immense; its contribution to literature is limited to one or two individuals. Many writers indeed were churchmen—among them Pierre Gassendi, Nicolas Malebranche, Retz, Jean Mabillon—but the fact is incidental to their writing. Other churchmen wrote works that belong to scholarship rather than to letters, Tillemont, for example, or Fleury. The greatest religious writer of the age, Pascal, was a layman. Such a movement as that associated with Port Royal, while explaining, as Sainte-Beuve has taught, the deepest conflicts of the time, produced little of what would be called literature. A. Thibaudet once remarked that he would rather have Sainte-Beuve's book on Port Royal than any work produced by Port Royal. Some would make an exception for the famous *Logique ou l'art de penser* (1662) but its great influence was not strictly literary.

No fair account of 17th-century writing can omit two great ecclesiastical figures who were both friends and enemies, and colourful, contrasting personalities, Jacques Bénigne Bossuet and François de Salignac de la Mothe Fénelon. Bossuet, older than Fénelon by 24 years, is the finest type of bishop of the *ancien régime*—a man of integrity, intelligence and fabulous industry. His writings were all occasional and are as varied and voluminous as his correspondence. But whether he is writing polemic or piety, preaching in a convent retreat or before the king, he is always readable, always direct, forceful and capable at any moment of sustained beauty of language. His funeral orations (the most famous being those on Henrietta Maria in 1669, on her daughter Henriette d'Orléans in 1670 and on Condé in 1687) have been unjustly called "false masterpieces"; Bossuet recovers for the church what in ancient times was the distinction of statesmen and lawyers —the power to express in noble language the praise of the dead, and within a Christian setting this is something of a contradiction. In Bossuet the Christian preacher is rarely hidden by the man of this world. His attempts to show the plan of universal history, or to refute the Protestants and Quietists, are now seen to be the weakest part of his work. He was so wedded to the hierarchical and orthodox view of things that he condemned all independent thought and even once defined a heretic as "celui qui a une opinion" ("anyone who holds an opinion"). But his expositions of religion are unsurpassed and it would be unfair to remember him by his letter against the theatre rather than by his treatise on Concupiscence, or the even finer "Discours de la vie cachée en Dieu."

It was unfortunate that such a man should have to meet in open discussion so comparable a figure as Fénelon—the temperamental opposite of Bossuet, equally learned and eloquent, but sinuous, of Newmanlike subtlety, able to see both sides and to convince each that he was of their view. The very fact of their quarrel has made Fénelon appear more modern than he really was. His *Télémaque* was an intellectual guidebook for succeeding generations (and figured even at Victorian prize days), but with all his wide vision he was a man of his age and not a "*Moderne*." (The famous quarrel between *Anciens* and *Modernes*, formerly considered a single incident, is now regarded as a series of encounters on literary taste, the reputation of Homer, the notion of progress in literature and ideas; *see* ANCIENS ET DES MODERNES, QUERELLE DES.)

Feminism.—The term was not used, but one mark of this period was the success of women in the literary world, both in fostering the discussion of literature and as writers, though as the latter they had to use pseudonyms. Mlle de Scudéry published under her brother's name and Mme Louise de la Fayette anonymously. The greatest woman writer of the time did not use any name at all: the Marquise de Sévigné published nothing. It was the chance of her daughter's residence in Provence that provoked the long series of letters later collected (and after many vicissitudes correctly transcribed: Bibliothèque de la Pléiade, edited by Gérard-Gailly, 3 volumes, 1953–57). The *Lettres* have made her one of the great names of French culture. Intelligence, wit, imagination, argument, temper—here all the French qualities are displayed, as in Pascal's notes, with an abandon that intended publication would have ruined. She conveys aspects of her time that no precise documentary evidence could convey. With all her personal curiosity and vivacity she yet takes for granted the hierarchical presuppositions of her age: she feels the greatness of the great, and she feels no pity for the criminal. Thus she is admirable in recounting what the king said to her after a performance of *Esther*, in retailing the tortures of the sorceress Brinvilliers, the deaths of Turenne and Louvois, the trial of Fouquet.

Her friend Mme de la Fayette, a more careful and a more limited artist, was the author of a single masterpiece, *La Princesse de Clèves* (1678). This novel seems to be a recasting of a court episode from Brantôme, without the Renaissance brilliance of that writer. Its psychology and its restrained pathos make it as impressive to read as a Racinian tragedy. As a discussion of the social issues involved in marriage it should be ranked with *La Nouvelle Héloise*, which perhaps it partly inspired. The way in which the usual fictional tricks of the time are replaced by an early form of the interior monologue is a reminder that it stands in the same tradition of writing as *Adolphe*, *Dominique* and *L'Immoraliste*.

La Bruyère.—Jean de la Bruyère is as lonely a figure in literary history as he was in the house of Condé. Yet he wrote in the popular tradition of satirical moralizing and he is chiefly responsible for the fact that his contemporaries are forgotten—his portraits seem more alive than their models. He sheltered his reflections behind a translation of Theophrastus, but his pen pictures proved such a success that he greatly increased his book in later editions; keys to the characters, claiming to say who was meant by each satiric portrait, were circulated. It was not primarily as satirical portraiture that *Les Caractères ou les moeurs de ce siècle* won the admiration of Flaubert and the Goncourts; they praised La Bruyère as a stylist. His biting sketches of French upper-class immorality, of the effects of money and fashion, of human vanity and social climbing, take many forms, from the epigram to the rudimentary short story. To describe a materialist civilization he uses the technique of a Balzac, impressing actual objects vividly and speedily on the reader. He does comment, but so pungently that he never destroys the sketch and the contour. He works as a *pointilliste* with a brush, accumulating detail, scorning grammatical connections; in his hands the list is as eloquent as the moral judgment. In this way his pictures are unforgettable: the man who lives for his tulips or his birds, the man who knows the latest news, the absent-minded man, the hypocrite as he really is—not Molière's stage figure. These are offset by devastating epigrams such as: "Un dévot est celui qui, sous un roi athée, serait athée" ("The pious man is a man who, under an atheist king, would be an atheist").

La Bruyère is the youngest of a group of writers that modern research has not made easier to describe or sum up. The old conception of them as illustrating Cartesian notions of literature under the chairmanship of Boileau has had to be abandoned, and with it what used to be called "the Decline of the Age of Louis XIV." As the king got older, times certainly got harder; society and, by inference, letters give the impression of decline. But that is not so in kindred fields: in scholarship, in ideas, in science, in polemic. The readers of Bayle and Fontenelle are as intelligent and as well-served as were those of Corneille and Pascal. The artistic vigour of the middle years may seem to have abated, but this is to say no more than that one or two of the supreme artists were now missed. But Saint-Simon was still writing, and, thanks to the secrecy in which he composed his memoirs, we are able to read pages of unexampled vigour and power. (W. G. Me.)

IV. THE 18TH CENTURY

A. Years of Transition: 1685–1715

The 1680s mark a turning point in the history of French literature, and 1685, the year of the revocation of the Edict of Nantes, can with some justice be regarded as the approximate beginning of a new era in French literature, of which the outbreak of the Revolution in 1789 can conveniently be taken as the end. In 1685 Louis XIV had still 30 years to live; his palace at Versailles, regarded by posterity as the characteristic symbol of classical art, was not yet completed. But Molière, Corneille and La Rochefoucauld were dead, Racine had retired from the stage, Bossuet had withdrawn to his diocese, Boileau's productivity had subsided and La Fontaine in his remaining ten years of life was to write nothing of significance. Neither the spirit nor the genius of classicism, however, was yet extinct. La Bruyère published in 1688 his *Les Caractères,* one of the masterpieces of French literature (*see* above). Implicit in it is the notion that there exists a norm of human behaviour that is the same for all ages and all countries, and that divergences from this norm, though they are widely found, are reprehensible. This classical attitude is typical of the 17th century; but the social conscience of La Bruyère, revealed in his compassionate attitude to the indigent peasant and in his insistence on a king's duty to his people, show him to be a precursor of 18th-century philanthropy.

The main preoccupation, meanwhile, of many of the best-known writers had become critical rather than creative. Charles Perrault, remembered for his fairy tales, *Contes de ma mère l'Oye* (1697), which are still reprinted, read to the Académie Française a poem entitled *Le Siècle de Louis le Grand* (1687) in which he attacked the prestige of the ancient world and asserted that in ages to come similar renown would be enjoyed by even such 17th-century authors as Maynard, Jean Ogier de Gombaud and Antoine Godeau. His poem and other writings in which he followed it up were ill-received by many writers: by La Fontaine, by La Bruyère and above all by Boileau. Tempers rose high, and it was only after attempts at mediation had been made by Arnauld, Bossuet and Racine, that a reconciliation of Boileau and Perrault was effected. This was sealed in 1701 when Boileau published a peace-making letter to his opponent. The quarrel had ended, apart from a temporary rekindling in 1714 when the subject was the translation of Homer and the opponents were Antoine Houdar de La Motte and Mme Dacier. Its spokesmen had been guided by passion rather than by reason and the conflict of ideas of which it was a shadowy representation was more important than the quarrel itself (in spite of the prestige of its protagonists).

Posterity was to regard Racine's return to the stage with *Esther* (1689) and especially *Athalie* (1691) as by far the greatest event in the history of tragedy in Louis XIV's last 30 years. His contemporaries' judgment on this reappearance was harsher than on the work of Prosper Jolyot Crébillon, who was carried to the height of fame by his blood-curdling horrific tragedies, of which the best-known, praised by Voltaire and still sometimes read, is *Rhadamiste et Zénobie* (1711), replete with murders, mistaken identities, conversions, a Phèdre situation, an Oedipus situation and an ambassadorial intervention. Comedy could not but decline after Molière, but the decline was severe. Jean François Regnard wrote many plays, gay and lighthearted, but superficial and relying on the techniques of farce. *Le Joueur* (1696) is the best known of these. It is on a theme stolen from Charles Rivière Dufresny, himself a comic writer of some note. Florent Carton d'Ancourt, known as Dancourt, was a careless stylist but a prolific writer of comedies and shows some skill in his realistic portrayal of different social types. A higher standard was reached by Alain René Le Sage, whose first literary successes were on the stage with *Crispin rival de son maître* (1707) and *Turcaret* (1709), both of them bold and vivacious. It is Le Sage who raises comedy out of the mediocrity into which Molière's successors had caused it to fall.

The most important novel of these years was *Les Aventures de Télémaque,* by Fénelon (see *Writings of Churchmen* above). Fénelon was already renowned not only as an ecclesiastic but also, after his *Traité de l'éducation des filles* (1687), as a man of letters and as an innovator. *Télémaque* was written for the duc de Bourgogne, Fénelon's pupil and the heir to the French throne. Clandestinely published in 1699, it was immediately extremely successful. In structure and in theme, if not in aim, it resembles the classical epic. Narrating in engaging prose the travels of Telemachus, son of Ulysses, after the siege of Troy, Fénelon produces many well-written descriptions richly adorned with mythological allusions. He is bold enough also to express in his book many ideas, often advanced ideas, of a political and social character, often involving implicit criticism of the policies of Louis XIV, and proposing as the perfect society a curious blend of medieval feudalism and enlightened despotism as it was to exist in the 18th century. The novel became in his hands an instrument not for vague and conventional moralizing as often in the 17th century but for the spreading of specific and developed ideas.

The other great genre, poetry, relapsed into mediocrity. The Abbé Guillaume Amfrye de Chaulieu wrote occasional pieces, mainly of a trivial character addressed to the fashionable and the prominent. La Motte, more consciously a man of letters, was a literary theorist and a dramatist as well as a poet. He was renowned in his own day, though less so than Jean Baptiste Rousseau, to his contemporaries Rousseau the great, whose verses were polished and not invariably dull.

Although in these years poetry and the theatre had declined, there was no abatement, in either quality or amount, in ecclesiastical literature. Bossuet followed his Augustinian *Discours sur l'histoire universelle* (1681) with his polemical *Histoire des variations des églises protestantes* (1688). His *Politique tirée des propres paroles de l'Écriture sainte,* composed for his pupil the

dauphin *c.* 1678, was published posthumously in 1709. It is a vigorous and uncompromising defense of political absolutism based on divine right.

A retreat from the categorical orthodoxy of Bossuet is shown by other ecclesiastics: by Esprit Fléchier, bishop of Nîmes, a fashionable orator bent on rhetorical effect, by Jean Baptiste Massillon, bishop of Clermont, whose faith began to assume a rationalist aspect, by the Jansenist Pasquier Quesnel, whose *Nouveau Testament en français avec des réflexions morales sur chaque verset* . . . (1693) was the occasion for the Bull *Unigenitus* (1713), and especially by Fénelon. In addition to expressing new political ideas in *Télémaque,* Fénelon became involved in the Quietist movement. His emotional and quasi-mystical *Explications des maximes des saints* (1698) were forthwith condemned by the Holy See. Mention cannot be omitted, among religious writers, of Richard Simon, an Oratorian whose rigorous exegetical methods led him into heterodoxy.

The disintegration of previous absolute standards represented both in the quarrel of ancients and moderns and in the decline of religious orthodoxy is shown in the growth of a spirit of cosmopolitan relativism. This is revealed in the works, and also in the life, of Charles de Saint-Denis de Saint-Évremond, who from 1661 until his death lived in England, with a five-year interval in Holland. An individualist and a *libertin* in all senses, he had an acute and satirical intelligence and made some contribution to the philosophy of history. Relativism was encouraged also by the *Voyages* and *Mémoires* (1703) of Baron de Lahontan (1666–*c.* 1715), by the fictitious *Voyages et aventures de Jacques Massé* (1710) by Simon Tyssot de Patot and by the translation into French of the *Arabian Nights* (1704–1717) by Antoine Galland (1646–1715).

This characteristic of relativism marks most of the work of Fontenelle, whose attractive style and incisive mind won him great renown before 1690. His *Entretiens sur la pluralité des mondes* (1686) are perhaps unequalled as an example of scientific popularization. At the same time they are a vigorous attack on prejudice. Here and in his other works, notably the *Histoire des oracles* (1686), he revealed a critically skeptical mind, unimpressed by religious or by philosophical authority. Such an outlook was not of course unprecedented in France; however, it was now being expressed in works of great popular appeal, published openly and with official approval.

Pierre Bayle, exiled because of his Protestantism, was essentially a controversialist of great erudition. He attacked superstition and discussed the virtues of the atheist in his *Pensées diverses sur la comète* (1682); he vigorously defended liberty of conscience in the *Commentaire philosophique* (1686). His greatest and most influential work was the *Dictionnaire historique et critique* (1697, subsequently expanded). This vast compendium of knowledge, in which the crucially important and the frivolously insignificant stand side by side, is perhaps the greatest mass of erudition ever to have come from the pen of one man. Bayle's personal opinions are usually masked, and there is dispute about them. In the 18th century, when his vogue was great, he was regarded as a skeptical agnostic, but some modern readers impute to him a firm religious sentiment.

Fontenelle and Bayle are the most significant precursors of the movement known as the Enlightenment, but they are not alone. Two political writings, in addition to those of Fénelon, are noteworthy. The anonymous *Les Soupirs de la France esclave* (1689–90) contain denunciations of Louis XIV which would have appeared extreme a hundred years later. More calm and more constructive, if unworldly, is the *Projet de paix perpétuelle* (1713) of the Abbé Castel de Saint-Pierre, who also invented the word *bienfaisance* to describe the concept of philanthropy.

B. 1715–1789

1. Drama, Poetry and the Novel.—From the death of Louis XIV to the outbreak of the Revolution the three principal genres of literature, the drama, the novel and poetry, continued unabated in volume, and in each of them significant developments were to occur. The prestige of tragedy was undiminished. The success of Crébillon tempted the young François Marie Arouet (writing under the pen name Voltaire) to the tragic stage and in 1718 his *Oedipe* was performed, the first of a long series of tragedies from his pen, about 30 in all, of which several attained the most glowing success. Vigorous rhetoric, melodramatic effects often inspired by Shakespeare, whom, to Voltaire's subsequent regret, he introduced to the French, only intermittent respect for the *bienséances* of the previous age, but no serious challenge to the structure of tragedy: these characteristics mark a genre which became for him a weapon in philosophical controversy. The oblivion into which his plays have fallen is not justified in all cases; *Zaïre* (1732) and *Mahomet* (1742) have real merit.

Eighteenth-century tragedy is sometimes identified with the tragedies of Voltaire. Other writers, however, enjoyed great fame in their day. La Motte's *Inès de Castro* (1723) broke all records of financial success: the plays of Buyrette de Belloy (1727–75) were more frequently performed than those of any 18th-century writer except Voltaire; Jean François Ducis produced successful adaptations of Shakespeare.

There are many writers of comedies, of whom Philippe Néricault Destouches, Alexis Piron and Charles Palissot are not contemptible. Destouches wrote comedies of character with a moral aim; *Le Glorieux* (1732) is the best known. Piron's *Métromanie* (1738) satirizes poets; Palissot's *Les Philosophes* (1760) is directed against the Encyclopedists and their friends. There are however two writers of comedies of great talent, Marivaux and Beaumarchais. Pierre Carlet de Chamblain de Marivaux wrote prose comedies of gentle intrigue, in which love is the motive force. His psychological analysis is subtle rather than profound, his style highly polished, his characters sophisticated but introspective. His plays portray and were written for the fashionable Parisian society of the 18th century. In the case of the best of them, for example *Le Jeu de l'amour et du hasard* (1730), the passage of two centuries has not weakened their appeal.

Pierre Augustin Caron de Beaumarchais, a political adventurer and financial intriguer, wrote a number of plays of which *Le Barbier de Séville* (1775) and *Le Mariage de Figaro* (1784) are the greatest and must rank as works of genius. Refinement of wit, brilliant dialogue, bold social criticisms directed against the nobility, and above all the character of Figaro, carefree, crafty, gay, eloquent and unscrupulous, have ensured their lasting success.

The rigidity of the classical distinction between tragedy and comedy was found irksome by several 18th-century writers, and various attempts were made to escape from it. Nivelle de La Chaussée, whose principal plays are *Le Préjugé à la mode* (1735) and *Mélanide* (1741), wrote comedies from which the comic was banished and which represented scenes of domestic crisis and anxiety. They were known as *comédies larmoyantes* and were written in verse. More lasting in importance was the *drame* or *tragédie bourgeoise,* of which Denis Diderot was the architect. Influenced by such English examples as George Lillo's *London Merchant* (1731) and Edward Moore's *Gamester* (1753), which he himself was to translate into French (1760), he devised the theory of a play in which the passions were as elevated as in tragedy, but the characters of a more humble social status. He was inspired by the belief that the traditional genres were exhausted, the high point of perfection having been reached in the previous century, and that literary excellence could now be attained only by new ventures. He regarded the *drame* too as a useful instrument for the inculcation of those social lessons which were dear to the 18th century. He wrote two plays as exemplars of the new genre, *Le Fils naturel* (1757) and *Le Père de famille* (1758), but these were of indifferent quality and are less important than his theoretical writings. Other writers followed Diderot's example, notably Michel Jean Sedaine with *Le Philosophe sans le savoir* (1765), and Louis Sébastien Mercier, who was much influenced by English literature and wrote many *drames* including an adaptation of *Romeo and Juliet* under the title *Les Tombeaux de Vérone* (1782). The new genre was important less intrinsically than because it prepared the way for the romantic drama of the 19th century.

The 18th century's output of poetry is very voluminous and here and there one finds a poem of merit. Several such are among the

odes of Le Franc de Pompignan, the occasional pieces of Paradis de Moncrif, Cardinal de Bernis, Charles Collé and Jean Baptiste Louis Gresset. Louis Racine, son of the great Racine, deserves mention for his poem *La Religion* (1742), with Jansenist sentiments and some Pascalian language, and Charles Pierre Colardeau (1732–76) for his very popular fugitive epistles or *héroïdes*. The principal poetic figure until late in the century is, however, Voltaire, who alone in his age was able to write a successful epic, *La Henriade* (1723), which is not without nobility. Many of his poems are biting satires, while some, like the *Poème sur le désastre de Lisbonne* (1756), contain lofty and compassionate sentiment.

The second half of the century has many authors of odes, epistles and occasional poems. Sometimes there appears a long poem of merit. Jacques Delille translated Milton and Virgil and in 1782 published *Les Jardins*, a poem in four books. Antoine Léonard Thomas wrote an *Ode sur le temps* (1762) which was extensively drawn on by Alphonse de Lamartine. Louis de Fontanes imitated Gray and translated Pope. But greater than any of these was André Marie Chénier, born in Greece, and dying on the guillotine, whose poems show personal emotion and chastened classical beauty. His odes, elegies and *Iambes* (not published until 1819) show him to be a true poet, endowed with a lyric inspiration that had been rare in France since the days of the Pléiade.

The novel in the 18th century was in the ascendant. The preceding tradition was not a rich one; but at the end of the century the novel was about to become the major genre. Le Sage, after *Le Diable boiteux* (1707), a fanciful and satirical tale, published *Gil Blas* in three stages, in 1715, 1724 and 1735. This novel, one of the most successful in all French literature, owes much to Spanish literature and Le Sage was charged with plagiarism. The travels of Gil Blas are described through good and ill fortune across Spain, interpolated tales abound and agreeably satirical portraits are numerous. But when the Abbé Antoine François Prévost d'Exiles, in the seventh volume of his *Mémoires et aventures d'un homme de qualité,* produced the immortal *Manon Lescaut* (1731), the novel had advanced far beyond the semipicaresque rambling of Le Sage. Manon is beauty and treachery incarnate, while her lover Des Grieux, whose conscience, though refined, is always feebler than his passion, represents the heightened emotionalism which was known as *sensibilité*. Compared with this, the novels of Marivaux (*La Vie de Marianne*, 1731–41; *Le Paysan parvenu*, 1735–36) are placid and almost soporific; but their psychological penetration is acute and the mode of narration has the agreeable naïveté of Laurence Sterne. The vigour of Prévost is found also in *La Nouvelle Héloïse* (1761) of Jean Jacques Rousseau, inspired by Samuel Richardson, who had been translated by Prévost. This novel, which is written in epistolary form, enjoyed in its day so great a renown that it was made available in libraries at an hourly charge. The characterization is vivid, the plot (in spite of the novel's length) is at times almost exciting, the descriptions of natural beauty, unusual in the 18th century, are frequent; the work at the same time represents the climax of *sensibilité* and heralds romanticism. This line of development was further marked by the translation into French, published in 1776, of Goethe's *Werther,* and by the publication of the exotic novel *Paul et Virginie* (1787) of Bernardin de Saint-Pierre and of *Les Liaisons dangereuses* (1782), likewise epistolary, of Choderlos de Laclos. To this account of the 18th-century novel in France should be added mention of the novels, sometimes emotional, sometimes satirical, of Diderot, posthumously published, and of the philosophical short story whose most able exponent was Voltaire. *Zadig* (1747) and *Candide* (1759) retain their brilliance after two centuries.

Comparable to the growth of the novel in the 18th century is that of autobiographical memoirs, which now become important historical documents and significant works of literature. Mathieu Marais, Jean Buvat, Edmond Barbier, Charles Hénault, Charles Duclos, the duc de Luynes, the marquis de Dangeau, Jean François Marmontel and the marquis d'Argenson are all authors of important memoirs, for the most part published long after their deaths and useful both to the historian and to the literary historian. Two others are of the greatest importance. The first of these is the duc de Saint-Simon, whose *Mémoires* provide a uniquely valuable source of information about court life and political activity from 1691 to 1723. Well-informed but fascinatingly tendentious, unable to differentiate between the trivial and the significant if it affected his dignity, brilliant if individualistically erratic in style, Saint-Simon as a memorialist is beyond compare. The other important figure is Jean Jacques Rousseau, whose *Confessions* (1781–88) are very unlike Saint-Simon's memoirs. Frankly and almost morbidly introspective, they give an intimate account of their author's life and above all a character analysis that is of rare penetration and set forth with great literary skill. It is their author's aim not to describe the events which he witnessed but to describe himself. It is a new kind of autobiography which many others were subsequently to imitate. It shows Rousseau once again as a preromantic.

2. The Enlightenment.—*1715–1733.*—In spite of the intrinsic excellence of some of its works and the historical importance of others, the 18th century is less remarkable for the history of the conventional genres of literature than for the development of its thought. The most celebrated currents of this thought combine to form what is often known as the Enlightenment (*q.v.*). This phenomenon, though European in scale, received its most effective expression in France. A new orientation, skeptical, relativist and rationalist, had been given to French thought by Fontenelle and Bayle but received for a time no further direct stimulus than that provided by renewed editions of their work, with the exception of several translations, the most important being of John Locke. In the *Lettres persanes* (1721), however, of Charles Louis de Secondat de Montesquieu, are found explicit or lightly veiled advanced ideas, clad in a seductively witty form: the greater importance of morality than of faith; religion viewed primarily as a social phenomenon; religion stripped of its revealed elements and reduced to the light of reason; the desirability of religious toleration; the iniquity of despotism, Louis XIV being compared with the Grand Turk; and simple elements of the philosophy of history. These notions, new to the 18th-century French reader, are hinted at in passing. They are very far from forming a system; however, they stimulated thought and shook prejudice, and the *Lettres persanes* enjoyed great success.

The following decade shows no developed school of advanced thinkers, but there was much intellectual activity, not a little of it clandestine. Many treatises, often but not invariably crude in composition, circulated widely in manuscript and expressed ideas which were sometimes deist and sometimes atheist. The titles are sometimes noncommittal but often eloquent: *La Foi anéantie; Le Ciel ouvert à tous les hommes; Les Trois Imposteurs.* An identified author whose works enjoyed this secret circulation before receiving posthumous publication was Comte Henri de Boulainvilliers (or Boulainviller), astrologer and biographer of Mohammed, who in his *Histoire de l'ancien gouvernement de la France* (1727) and elsewhere argued for the rights of the nobility against the central government and produced a celebrated theory of the Germanic origin of the French state.

Discussion of a more organized type, but on similar political themes, often apparently but deceptively innocuous, occurred in the Club of the Entresol, where nobles and bourgeois met as equals. Established in 1724, it was organized by the Abbé Alary, and those who attended included his close friend Lord Bolingbroke; the comte de Plelo; Andrew Michael Ramsay, who read there part of his philosophical novel *Cyrus;* the Abbé de Saint-Pierre; René Louis, marquis d'Argenson, later for a short time foreign minister; and perhaps, at least once, Montesquieu. Discussions appear to have been uninhibited and the opinions expressed often unorthodox. Certainly they were unpleasing to authority, for the club was dissolved in 1731 by the chief minister, Cardinal Fleury.

1734–1749.—Great developments came in the next 20 years, the first person responsible being Voltaire, in whose *Lettres philosophiques* or *Lettres sur les Anglais* (1734) many hitherto veiled or clandestine ideas burst into public expression. Criticism of the clergy, criticism of the nobility, mockery of out-of-date philosophers, were expressed in the simplest language and in a brilliant mixture of gentle raillery and mordant satire. The work's two

main positive achievements were the presentation of English civilization to the French, as a standard of comparison and even, by inference, as a model to be imitated, and the introduction on a popular level of the philosophy of Locke. After 1734 sensationalism or the notion that all ideas come from the senses is one of the central beliefs of the French Enlightenment. The *Lettres philosophiques* have another significance. The work was condemned by the *parlement* of Paris and ordered to be burned: it was the first of a long series of popular philosophical works to meet that end.

In the same year appeared Montesquieu's *Considérations sur les causes de la grandeur des Romains et de leur décadence*, a serious attempt to study historical causation. The underlying causes, physical, intellectual, military and political, of the greatness and decline of Rome were set forth clearly in a short work of synthesis. Many comments and analogies made the work one of actuality, and it contains serious elements of political theory as well as of historical method. The hatred of despotism shown by Montesquieu both here and in the *Lettres persanes* was expressed also by Fénelon in his *Examen de conscience d'un roi*, first published in 1734, 15 years after his death.

Two years later Alexander Pope's *Essay on Man*, published in England in 1733–34, was translated, and its success in France was enormous. It was printed in French more than 60 times before 1789. The latent deism of Pope found favour with the French deists, while the doctrines of order, harmony and optimism were welcomed by a public already prepared for them by the philosophy of Gottfried Leibniz. Voltaire's seven *Discours en vers sur l'homme* (1734–37) were directly inspired by the *Essay on Man*, while *Zadig*, first published in 1747 under the title *Memnon*, marks the peak of the influence of Pope on Voltaire. It stresses the ever-present influence of a beneficent destiny in men's lives and might well have taken as its motto Pope's line, "All partial evil, universal good."

Vigorous propaganda in favour of the ideas of Locke is the keynote of *La Philosophie du bon sens* (1737) by the marquis d'Argens, a well-written work of persuasive popularization, clearly modeled on Fontenelle's *Entretiens*. The same task, though inevitably in a less popular manner, was meanwhile undertaken for Sir Isaac Newton, first by Pierre Louis Moreau de Maupertuis in his *Discours sur la figure des astres* (1734) and later works and then by Voltaire in his *Eléments de la philosophie de Newton* (1738). The increased receptiveness of public opinion is shown by the publication in 1743 of five treatises of the kind, hitherto circulating only in manuscript, in a tiny volume bearing the significant title *Nouvelles libertés de penser*. The authorship is uncertain. Two of the essays have been attributed to Fontenelle and one of them, the most interesting, entitled *Le Philosophe*, to César Chesneau Dumarsais. *Le Philosophe* is an essay written by a robust mind. It describes the philosopher as a human machine which by means of its mechanical constitution reflects on its movements; he is moved by reason as a Christian is moved by grace. This notion of a *philosophe* as a member of a non-Christian élite, guided by reason, more inclined to doubt than to believe and leaning to materialism, is characteristic of the thought of the French Enlightenment. This is the 18th century's first clear definition of the term.

The next six years saw a great outburst of philosophical works. Luc de Clapiers, marquis de Vauvenargues, was a man independent in his ideas and inclined to embrace conceptions of heroic stoicism. He was nevertheless a friend of Voltaire, a deist and indebted to Locke. His *Introduction à la connaissance de l'esprit humain* (1746) contains elements of utilitarianism and traces of the influence of Shaftesbury. The *Essay Concerning Merit and Virtue* had meanwhile been translated into French in 1745 by the then unknown Diderot, whose next publication was a slim volume of *Pensées philosophiques* (1746), in which he argued clearly and succinctly for deism. It was at once burned by the public executioner. Diderot followed this by a *Lettre sur les aveugles à l'usage de ceux qui voient* (1749), an outspoken examination of the moral consequences of sensationalism which won him imprisonment in the Château de Vincennes. *Les Moeurs* (1748) by François Vincent Toussaint was a bulkier defense of deism. It enjoyed great popularity, and was publicly burned. The more extreme works of Julien Offray de La Mettrie argued for complete materialism, openly denying the existence of the soul, in his *Histoire naturelle de l'âme* (1745) and *L'Homme machine* (1747), the most outspoken works to appear so far. In 1748 there was published a work of a quite different kind yet not less characteristic of the Enlightenment. This was *De l'esprit des lois*, by Montesquieu, one of the greatest monuments of French thought. Disdaining to deal with many of the most vehemently discussed issues of the day, and preferring in relation both to religions and to political systems to explain rather than to judge, Montesquieu nevertheless found himself engaged in bitter controversy. The success of his work was in no way reduced by this. His main legacy to his successors was his theory of constitutional monarchy with separation of the powers on the English pattern, and the theory of the influence of climate on the character of peoples. *De l'esprit des lois* gave to French 18th-century philosophy a political bias which had not previously been at all conspicuous.

Meanwhile, not surprisingly, there had been some antiphilosophical literature. The Swiss writer Jean Pierre de Crousaz had published a refutation of the *Essay on Man* in 1738; the Abbé Jean Baptiste Gaultier sought to prove the impiety of the same poem in 1746 and of the *Lettres persanes* in 1751; Diderot's *Pensées philosophiques* were assailed by *Pensées raisonnables* and *Pensées anti-philosophiques;* many critiques were written of *De l'esprit des lois*. Most of these writings were valueless. The best antiphilosophical work of the first half of the century was written not in French but in Latin. This was the *Anti-Lucretius* (1747) of Cardinal Melchior de Polignac, who endeavoured in dignified Lucretian hexameters to defend the philosophy of Descartes against the growing materialism of his day.

1750–1789.—In the second half of the century the philosophical movement is marked by great achievement and by violent opposition. This is particularly evident in the case of the *Encyclopédie*. The publisher André François Le Breton, having formed the project of translating into French Ephraim Chambers' *Cyclopaedia* (1728), after several false starts assigned the task to Diderot and to Jean le Rond d'Alembert, then well-known as a mathematician and member of the Académie des Sciences. The project soon expanded into the production of an original compendium of knowledge with a theoretical basis of epistemology and cultural history which was outlined by D'Alembert in his *Discours préliminaire* (1751). Many of the articles expressed either openly or by means of easily penetrated devices the new ideas in relation to religion and politics. At two stages in the course of publication the *Encyclopédie* encountered grave difficulties. The first was occasioned by the Sorbonne's censure for heresy of the thesis *Jerusalem caelesti* (1751) of the Abbé Jean Martin de Prades, who was a contributor to the *Encyclopédie;* the second (1758–59) was a result of the coincidence of the publication of some dangerous articles (notably one by D'Alembert on Geneva) with a public crisis provoked by an attempt on the king. Diderot, though deserted by several of his contributors, succeeded with the faithful aid of the chevalier Louis de Jaucourt in bringing the work to completion in 1765. The *Encyclopédie* certainly contributed greatly to the advancement of knowledge (though less than the almost equally monumental *Histoire naturelle*, 1749–89, of George Louis Leclerc, comte de Buffon, which covered the whole range of geology, botany and zoology with remarkable penetration). More significant, however, was its contribution to the theory of progress, which in the second half of the 18th century took enormous strides. The belief in progress is found in most philosophical works of this period; it was the main theme of a celebrated lecture given in the Sorbonne in 1750 by the future minister Anne Robert Jacques Turgot; it inspired utopian writings such as Mercier's *L'An 2440* (1770) and *Le Vrai Système* (published 1939) of the atheist monk Dom Deschamps (1716–74); it received its final expression in a work which sums up all the aspirations of the 18th century, the *Esquisse d'un tableau historique des progrès de l'esprit humain* (1795) of Antoine Nicolas de Condorcet.

An apparent dissenter from this theory of progress was Rousseau

who argued for the natural goodness of man and the corrupting influence of society in his *Discours sur les sciences et les arts* (1750). The theme is developed further in his *Discours sur l'inégalité* (1754), where the institution of property is denounced as the cause of the setting up of the state and the right of insurrection against a tyrant is asserted. This was followed by the first boldly outspoken socialist work in France, *Le Code de la nature* (1755) by Morelly, of whom almost every biographical detail is unknown. He denounces property as the cause of all evil, lays down the principles of good society and even draws up for it a detailed constitution.

Meanwhile more conventional 18th-century doctrines were spreading widely. Étienne de Condillac, who more than most of his contemporaries was a philosopher in the English sense of the term, had published in 1749 his *Traité des systèmes* in which he surveyed previous philosophies and sought a means of avoiding their errors. He laid great stress on the linguistic element in philosophy and compiled a dictionary of synonyms which remained unpublished until 1951. His *Traité des sensations* (1754), with its celebrated device of the imaginary statue endowed initially only with the sense of smell, was the most rigorously sustained expression of the doctrine of sensationalism.

Claude Adrien Helvétius, a wealthy patron and host of the *philosophes*, in his well-written treatise *De l'esprit* (1758) energetically attacked all forms of morality based on religion and set forth the principles of utilitarianism. The publication of *De l'esprit*, which appeared openly and with royal privilege carelessly given, provoked the gravest crisis that the *philosophes* had known Helvétius was made to recant, publication of the *Encyclopédie* was stopped, *De l'esprit* was burned along with various other philosophical works including Voltaire's innocuous *Poème sur la loi naturelle* (1756). At this point—the moment at which Voltaire published *Candide*—the fortunes of the *philosophes* were at their lowest ebb.

They rapidly and surprisingly improved, however, because of the government's hostility, for its own reasons, to the *philosophes'* worst enemy, the Society of Jesus, culminating in 1764 in the suppression of the order in France. The *Encyclopédie* was allowed to resume and the publication of the text was completed in 1765. Meanwhile Rousseau, who after his two discourses had envisaged a sustained treatise on political institutions, published what he had completed of this project under the title *Du contrat social* (1762). In it he declared that primitive man is free from all constraint, that society comes into existence by his free acceptance of the social contract and that in any legitimate society the sovereign power rests in the people. *Du contrat social*, one of the world's most influential books, exercised but little immediate influence and was not greatly noticed on its publication. Two years later appeared another political work, known to Rousseau in manuscript and used by him in *Du contrat social*. This was the posthumously published *Considérations sur le gouvernement ancien et présent de la France* (1764) by the marquis d'Argenson, who, uncharacteristic both of his class and of his times, argues for an extension of democracy within the framework of the French monarchy. The method proposed is to establish in each locality popular magistrates, and he defines in detail their duties and their relationship to the central authority.

Almost simultaneously with *Du contrat social* Rousseau published his *Émile, ou de l'éducation* (1762), which evoked a great storm of criticism. It was closer than Rousseau's other writings to the well-known positions of the *philosophes*, and the *Profession de foi du vicaire savoyard* which it contains is perhaps the century's most eloquent plea for constructive deism.

Meanwhile negative and destructive writings continued. An unknown parish priest from Champagne, Jean Meslier, left behind him a lengthy and impassioned denunciation of all religion and an outspoken advocacy of atheism. Manuscript copies of this *Testament* (published *in extenso* only in 1864) circulated widely during the 18th century, and in 1762 Voltaire published an *Extrait des sentiments de Jean Meslier*, in which, though the positively atheistic part had been pruned, Meslier's hostility to Christianity retained its vigour of expression. Paul Henri Thiry, baron d'Holbach, was about to become the most outspoken participant in anti-religious polemics. He had already published *Le Christianisme dévoilé* (1761); he followed this up with a series of antireligious treatises and a large number of translations (including Lucretius and the *Letters to Serena* of John Toland) and in 1770 published his most famous work, the *Système de la nature*. Here the anti-religious thought of the 18th century reaches its climax. The soul is defined as a false idea, God is denied and absolute necessity is declared to govern all human actions.

From the finality of D'Holbach's views there could be no advance, and in relation to religion and metaphysics it is the Enlightenment's extreme position. Meanwhile, however, Diderot had reached atheism by another route. Such dialogues (unpublished until after his death), as the *Supplément au voyage de Bougainville* and *Le Rêve de d'Alembert*, show materialist doctrine resting not like D'Holbach's on *a priori* conviction but on a personal interpretation of natural science and particularly of biology. With great suppleness of mind Diderot asks more questions than he answers and often, exploiting the dialogue form to the full, gives more than one answer to his questions. His later philosophical writings are richly suggestive.

The social and political thought of the Enlightenment is taken further by the Abbé G. T. Raynal in his *Histoire philosophique et politique des deux Indes* (1770) and by the Abbé Gabriel Bonnot de Mably, whose *De la législation* (1776) expressed some socialistic ideas, while D'Holbach's own *Système social* (1773) is the best French exposition of a utilitarian political philosophy.

After the accession of Louis XVI in 1774 there was little new in French thought for many years. Bernardin de Saint-Pierre in his *Études de la nature* (1784) combined Rousseauistic enthusiasm for nature with philosophical ideas which had seemed out-of-date to Voltaire in *Candide* 25 years before, while Sylvain Maréchal (1750–1803), on the other hand, in many atheistic works culminating in his *Dictionnaire des athées* (1800), shows himself to be simply a disciple of D'Holbach. The *philosophes* had overstated their case; they nevertheless handed on what was to be a permanent acquisition to human thought. (Rt. S.)

V. THE REVOLUTION AND THE 19TH CENTURY

A. The First Period: 1789–1815

The French Revolution was prepared in the minds of the populace by the great writers who did not live to witness it: in 1789 Voltaire and Rousseau had been dead for 11 years, Diderot for 5. The ensuing period of political upheaval, social disturbance and war was unpropitious for the development of literary talent. After the fall of the monarchy the republic was forced to protect itself from the threatening dangers at home and abroad; the demands of the struggle were so exacting that there was little scope for writers save as political journalists and party hacks. Of these, the republican Camille Desmoulins and the royalist Antoine de Rivarol had the force and bite which made them masters of invective. Oratory came into its own once more as the preachers gave way to the politicians, sermons to the political harangue. Mirabeau in the constituent assembly, P. V. Vergniaud in the legislative, stirred their audiences to action by vehement rhetoric; Danton had the fire, Robespierre and Saint-Just that ice, that put the mob in their power and sent their opponents to death. These years of upheaval produced, however, one writer, Chénier, whose gifts were purely poetical. The *Idylles* and *Élégies* had been composed, for the most part, before 1789, but the violent events in which Chénier participated evoked the savage outcries of *Iambes* written in prison while he awaited execution at the order of Robespierre. These poems remained unknown until their publication in 1819 under the Restoration.

The other literature which has survived the first revolutionary years is the literature of eccentrics: those who in a time of anarchy lose their centre. Such were the writings of the monarchist exiles. Such also was the work of fanatical and convinced individualists who attempted to protect their personal freedom from the clamour of faction. Restif de la Bretonne and the marquis de Sade. La Bretonne, with a reputation for lubricity equal to, though dissimilar from that of Sade, was an invaluable witness to the social

transformations in the streets of revolutionary Paris. His autobiographical novel *Monsieur Nicolas* (1794–97) is a vast social panorama of his period as well as an immensely repetitive chronicle of amorous adventure. The marquis de Sade, for whom the Revolution was little more than an interlude in the obsessive notation of his private fantasies, provided several of the scenes for what Mario Praz has called "the romantic agony" of the 19th century. He, too, belongs to his posterity—a posterity which ranges from Baudelaire to the Surrealists; his most notorious work, *Justine, ou les malheurs de la vertu* (1791), has been an acknowledged influence on the eroticism of much French writing since World War II. S. R. N. Chamfort, who preferred suicide to prison, left a collection of maxims and anecdotes which gained him a receptive posterity at the liberation of France in 1945—a breviary for the disillusioned. Only Joseph Joubert, a philosophic moralist, possessed the writer's traditional capacity for detachment; he accepted the full implications of his solitude and filled notebook after notebook with his subtle meditations.

Nor did the period of the consulate and the empire which followed the first republic provide any better conditions for the development of literature. Napoleon, though brought to power by the Revolution, soon whittled away the liberties he had sworn to defend, and bold and original writing was regarded as dangerous. The innocuous production of neoclassical tragedies and traditional comedies, the publication of conventional epics and didactic verse, met with the easy and short-lived success of official art. The best writers went into opposition, working secretly, watched by the police.

The greatest of these was François René de Chateaubriand. His literary, as distinct from his political, career spanned the first 15 years of the century. Of noble family, he emigrated at the Revolution, first to America, then to England. Exile, the sufferings of his family, experience of the revolutionary chaos, precipitated a return to the faith of his childhood. The restoration of the Christian ideal as a principle of social cohesion gave him his writer's vocation, and his work of apologetics, *Le Génie de Christianisme* (1802), was the famous result. Two short novels, *Atala* (1801) and *René* (1802), and his prose epic *Les Martyrs* (1809) are, in effect, illustrations to this apologetic. Chateaubriand's influence on the young men of his time was profound; he knew how to voice their secret aspirations and they gave themselves without reserve to the enchantments of his prose. His hero, René, seduced from prosaic reality by those longings for the infinite which carried him into dream worlds of the imagination, imposed, as did Byron's heroes, the emotion of romantic melancholy on the sensibility of the coming age. Chateaubriand's travels, particularly his first sight of the virgin forests of America, initiated another romantic impulse: exoticism, of which the best example is *Les Natchez*, published in 1826 but written in his youth in London, and of this *Atala* and *René* are detached episodes. But Chateaubriand had only one subject, himself; it was in the *Mémoires d'outre-tombe* (1848–50), where he surrendered himself to the full orchestration of his mature prose, that he left his most enduring work.

The contemporary fashion for the introspective, self-analytic hero was further stimulated by Étienne Pivert de Senancour's *Oberman* (1804) and the *Delphine* and *Corinne* of Madame de Staël. But it was less as a novelist than a critic that Madame de Staël asserted her tempestuous personality; her essays *De La Littérature* (1800) and, especially, *De l'Allemagne* (1810), in which the "romantic" genius of German civilization was first revealed to the French, played a vital role in forming the taste of the period. It was a taste which was beginning to assimilate foreign influences. The classical ideal within the Greco-Latin culture receded before the claims of a new aesthetic. James Macpherson's *Ossian*, Horace Walpole's *Castle of Otranto*, the *romans noirs* of Ann Radcliffe, the early writings of Goethe and the plays of Schiller took the French reading public by storm. The way was open for the literary revolution which coincided with the change of political climate.

B. The Second Period: 1815–1848

The Restoration of 1815 marked the beginning of a constitutional regime guaranteed by the charter which Louis XVIII had "conceded" to his people. An opposition on the extreme right wing soon made itself felt, an opposition which was to stiffen later under Charles X. It was rather ministerial intransigence than the undiminished vitality of liberalism that precipitated the revolution of July 1830 and the change of dynasty. The new king, Louis Philippe, turned to the *bourgeoisie* for support, and for 18 years peace and public order were maintained. During the whole of this period the writers, less rigorously controlled than they had been since the Revolution, were able to write with a freedom in which their particular talents could develop. The result was seen in the astonishing literary achievements of the romantic generation.

Strictly speaking there was no such thing as a French romantic school because French romantic poetry was never forced into the strait jacket of a verse technique which a poetic school exists to propagate. Romanticism is the term used to define a new approach to human experience, a transformation of thought and taste that at this time all Europe shared. Each of the national literatures was a channel for this new sensibility; each came under its influence and each modified it.

Romanticism involved all the arts. Poets, novelists, painters, sculptors, musicians came together for common discussion and the hammering out of new formulas to embody the new ideas. This was particularly the case in France. Thus in 1824 Charles Nodier, the curator of the Bibliothèque de l'Arsenal, established a salon that soon became famous; writers and artists of all kinds met there on Sunday evenings for free debate. Three years later Victor Hugo and Sainte-Beuve founded the Cénacle. This group, which included Alfred de Vigny, Alfred de Musset, Prosper Mérimée, Théophile Gautier, Gérard de Nerval and Alexandre Dumas, was prepared to do battle for its convictions; it was here that the new forces of romanticism worked out their strategy before the performance of Hugo's *Hernani* at the Théâtre Français in March 1830—the evening of catcalls and clamour which ended in the rout of the outdated representatives of classicism.

This literary revolution had already been prepared by vigorous manifestos. Stendhal, in an essay with the significant title *Racine et Shakespeare* (1823), set out to prove that the contemporary audience was more attuned to the turbulence of the Shakespearean drama than to the rigid theatrical formulas of Racine. He identified romanticism with the new direction of taste: "Romanticism is the art which gives the public those literary works which, in its present outlook on life, afford it the greatest possible pleasure. Classicism is the literature of its great grandfathers." Hugo's prefaces to *Cromwell* (1827), *Les Orientales* (1829) and *Hernani* emphasized the ideal of liberty which united all the young writers, and he defined romanticism as "liberalism in literature."

However generalized this definition may seem it does summarize the spirit of the movement. The French romantics opposed the unpredictable demands of the imagination to the rules of art, the gifts of sensibility to the tyrannies of reason; they claimed the right of the individual to place the fulfillment of his own nature above the imperatives of ethical dogma. Such attitudes were confirmed in the 1820s by the translation of Byron's poems, the *romans noirs* of "Monk" Lewis and C. R. Maturin, the historical novels of Walter Scott and Goethe's *Faust;* in the 1830s the *Tales of Hoffmann* had an enormous vogue. Emanuel Swedenborg and the illuminist philosophers on the frontiers of religion gained enthusiastic converts to their doctrines of spiritual initiation. Subjected to such a variety of influences, French romanticism presented diverse and even contradictory aspects: spiritual dejection and sensual delirium, cults of the picturesque and of the fantastic, humanitarianism and mysticism—these are the traits, more or less in evidence according to the individual author's temperament, which may be discerned in the major works of the time. It was a literature which recognized no law save that of liberty.

1. The Poetry of the French Romantics.—Romanticism freed French poetry from the compulsions of its previous history; from then on it was an instrument for the transmission, as if from within, of the affective states experienced by the poet. But although the poets were now at liberty to translate their own sufferings and anguish and ecstasy into verse, not all of them conceived

their vocation in these narrow terms; many believed that the social conscience of the century would find its voice in poetry; this conviction became increasingly accentuated as the period advanced.

The poems of Lamartine are particularly characteristic of this development. He began with a collection of elegiac verse, *Les Méditations* (1820), in which the most moving poems, "Le Lac," "L'Isolement" and "Le Vallon," were the product of an unhappy love affair. These personal themes began to be coloured by religious emotion in *Les Harmonies* (1830), as were the two epic fragments "Jocelyn" and "La Chute d'un ange." But it was only in *Les Recueillements* (1839) that he became passionately concerned with social problems, expressing remorse for his self-pitying egoism, compassion for humanity and faith in its future.

In the same way, Hugo extended his poetic range until he became known as "the sonorous echo" of his time. The technical virtuosity and descriptive charm of the *Odes* (1822), the *Ballades* (1826) and *Orientales* (1829) were followed, after the July revolution, by a deeply felt accession of social emotion. However much the *Feuilles d'automne* (1831), the *Chants du crépuscule* (1835) and the *Voix intérieures* (1837) were an outlet for personal melancholy and heartbreak they gave voice also to the contemporary disquiet. In *Les Rayons et les ombres* (1840) he had reached the conviction that he was the anointed prophet of a better age.

The poems of Vigny appear to be self-communings far-removed from Hugo's abundant, public verse; they are open, nevertheless, to all the vicissitudes of human existence. His *Poèmes antiques et modernes* (1822–37) celebrate some of the significant moments in universal legend and history: the biblical epoch (in "Moïse" and "Eloa"); Greco-Roman civilization; the middle ages; the Wars of Religion; the reign of Louis XIV; the 19th century. The 11 poems of *Destinées*, published in 1864 after his death, transcribe in symbols the long journey from the agonies of doubt to a serene wisdom; the despair of the earlier poems in this collection: "La Mort du loup" (1838), "La Colère de Samson," "Le Mont des Oliviers" give way to the peace of "La Maison du berger" (1844) and find, at last, a humanist optimism in "La Bouteille à la mer" (1847) and "L'Esprit pur." "I have put down what I knew and all I have suffered," he wrote in the *Journal d'un poète*, an essential document for the understanding of his poems.

Among the great poets of this period it was only Musset who stubbornly refused to serve a public cause. His literary and political independence earned him the title of the *enfant terrible* of romanticism, and in fact the verse fantasies of the *Contes d'Espagne et d'Italie* (1830) demonstrated something of the movement's exhibitionist character. After the brilliance of this early appearance before the public he abandoned his fellow poets to follow his own star. His best-known work, the four *Nuits* (1835–37), traced the course of a heartbreaking love affair with a lyricism marred, in places, by his fatal capacity for declamation.

The fame of these poets must not be allowed to obscure the lesser talents of a great period. Lamartine's elegiac muse presided over the mysterious and ardent grace with which Marceline Desbordes-Valmore wrote her poems. Sainte-Beuve in *Joseph Delorme*, Brizeux in *Maria* were romantic *intimistes*—poets whose emotional reticence permitted them only to suggest the deeper regions of the spirit. Such discretion was at the opposite pole from the uninhibited verse of Pétrus Borel and Philothée O'Neddy, the satiric violence of Auguste Barbier and the wit and verve of Pierre Jean de Béranger—a ballad writer whose immense popularity temporarily placed him among the greatest poets in the general esteem. Aloysius Bertrand in *Gaspard de la nuit* and Maurice de Guérin in *Le Centaure*, for all their divergent aims, shared a common preoccupation with the effects to be obtained from the prose poem.

2. The Romantic Theatre.—Romanticism stimulated a revival in the theatre by breaking with the rules that, by tradition, governed dramatic construction. In the famous preface to *Cromwell* (1827) Hugo proposed that the unities of time and place be abandoned and that the tragic and comic be permitted to coexist in the modern poetic play. But neither Hugo nor any other of his fellow playwrights felt constrained by dramatic formulas, even when they had invented them; on the stage, as in poetry, it was the original genius who made his own rules for his own purposes.

Dumas was the first of his generation to achieve success in the theatre; it was because he had all the tricks of the theatrical trade at his finger ends that *Henri III et sa cour* (1829) received such acclaim. Hugo's immense triumph in *Hernani* (1830) and *Ruy Blas* (1838) enhanced the prestige of poetic drama. The three acts of Vigny's *Chatterton*, successfully produced in 1835, were closer, in the severity of their construction and the density of their language, to classical tragedy. On the other hand Musset's *Lorenzaccio*, played in the same year, was a victory for the Shakespearean manner.

Musset was certainly the most happily inspired of these playwrights. He never overindulged the current taste for local colour and the historical picturesque as did Hugo and Dumas. His plays, like his poetry, were acts of self-exploration and self-expression. Something of his own obsessive nature belongs to the debauched hero of *Lorenzaccio*, he identified himself with the central figures of *Les Caprices de Marianne*, *Fantasio* and *On ne badine pas avec l'amour*, and it was his own wit that graced his sophisticated comedies. All these plays were written to satisfy his deepest needs and without caring whether they were brought to stage production. Staged only in the last years of his life, they alone among the plays of the period have retained their freshness and brilliance.

3. The Romantic Novel.—It is to romanticism that the modern novel owes its overwhelming prestige; it was romanticism that determined its growth and form. This rapid efflorescence produced the novel of self-analysis, the historical novel, and, as in the works of Balzac and Stendhal, the novel of contemporary society. Novels of every kind passionately interested an increasingly vast public, even among the workpeople.

René and *Oberman* had many successors for a generation that probed and debated the problems of the inner life. The *Adolphe* (1816) of Benjamin Constant and the *Volupté* of Sainte-Beuve are disguised autobiographies where the love affairs, the moral scruples and torments of a central character, scarcely distinct from its creator, are subjected to the searchlight of a lucid and pitiless self-knowledge. Musset's *Confession d'un enfant du siècle*, Lamartine's *Raphaël* and *Graziella*, and (though this belonged to a later time) Eugène Fromentin's *Dominique* (1863) are further examples of indirect self-portraiture.

It was at this time and as a result of this same impulse toward self-knowledge that several authors began writing their *journaux intimes*. The posthumous publication of these self-disclosing and intimate diaries has brought as much fame to their writers as their strictly literary works. Constant, for the modern reader, is not only the author of *Adolphe*, one of the most acute psychological novels of the century, but also of the *Journal intime*, the *Cahier rouge* and the recently discovered *Cécile*—the ruthless self-analysis of an extraordinary character. Stendhal, by virtue of his autobiographical writings—the *Journal*, the *Souvenirs d'égotisme*, *La Vie d'Henry Brulard*—is now a familiar personality as well as an admired novelist. How much the intimate diary is a by-product of the novelist's art may be measured by the interminable and turgid journal written by Henri Frederic Amiel, a romantic moralist.

The historical novel, like the historical play, satisfied the curiosity of a reading public in love with the colour and movement that the picturesque customs and the heroic adventures of the past seemed able to provide. The romances of Sir Walter Scott, read everywhere in Europe, were slavishly imitated; the French novelists had their own approach to their material. Vigny, in *Cinq-Mars* (1826), related the story of a conspiracy in Richelieu's time, but he made it an apologia for his own class, the nobility, which still remained loyal to its traditions however much it had been humiliated by the absolute monarchy. In *Notre-Dame de Paris* (1831) Hugo brought medieval Paris to life, with its bourgeois, its students and beggars, but he gave the plot certain philosophical implications when, under the shadow of the great cathedral, a mysterious fatality harried his characters to murder and death.

Honoré de Balzac surrendered to the prevailing mode for historical and autobiographical novels: *Les Chouans* (1829) and *Louis Lambert* (1832). But the grand design for his whole *oeuvre*

rapidly took shape in his mind, this was to paint in a vast fresco the society of 19th-century France. Thus *La Comédie humaine*, as he named it, gradually came into being as each of his novels (nearly 100) fitted into place. Some of them describe the secret dramas of provincial life (*Eugénie Grandet*), others the violent and complicated passions of *la vie parisienne* (*Histoire des treize, Illusions perdues, Splendeurs et misères des courtisanes*)—the world over which the modern tyrants, the stock exchange, politics and the press, exercised their unlimited power. Not only was Balzac a novelist of contemporary society, he was also a master of the novel of character; his people possess a timeless reality and he understands the whole mechanism of the human heart—avarice in *Gobseck* (1830) and *Eugénie Grandet* (1833), paternal love in *Le Père Goriot* (1835), sexual love in *Le Lys dans la vallée* (1835), envy in *La Cousine Bette* (1846). But these novels of contemporary life are, in Balzac's eyes, only the foundation for the edifice he planned; they were to be crowned by such "études philosophiques" as *La Peau de chagrin* and *La Recherche de l'absolu*, where man, with his limitations and insensate ambition, confronts, in a desperate struggle, the forces of destiny. The great and unique Balzac is Balzac the visionary.

Stendhal, the pseudonym of Henri Beyle, wrote novels whose subtlety and verve have made them a major influence; the incomprehension of his contemporaries has been succeeded by the devotion of posterity. His young heroes reflect the emotional *brio* of his temperament and his quick, lucid intellect; the melancholy Mme de Rénal, the imperious Mathilde de la Mole and the brilliant Sanseverina are portraits of the women he loved or would have liked to love. The novels of Stendhal, like those of Balzac, are social and political documents of the period. *La Chartreuse de Parme* (1839) is set in the Italy to which he gave his heart and by which, in some sense, he was formed; *Le Rouge et le noir* (1831) transcribes the moral climate of French society at the Restoration and mirrors all the capacity for revolt in his nonconforming nature; *Lucien Leuwen* (unpublished until 1894) pierces the façade of government at the time of the July monarchy. His *De l'Amour*, in which he elaborated his theory of the passions, is an invaluable appendix to the novels, his travel books a fascinating commentary on them. Of all the writers of the romantic movement, Stendhal, with the incomparable vivacity of his thought and style, is the one most sympathetic to 20th-century taste.

The popularity of George Sand was immediate and unreserved. Generosity of feeling and the mastery of her craft, displayed in a love story such as *Lélia* (1833), a novel of humanitarian sentiment such as *Le Compagnon du Tour de France* (1840) and a regional novel such as *La Mare au diable* (1840), earned her a devoted following. Dumas abandoned the theatre for those novels of adventure (*Les Trois Mousquetaires*, 1844; *Monte Cristo*, 1845) which he composed with inexhaustible invention and spirit. Eugène Sue developed the peculiar techniques of the serial story in *Les Mystères de Paris* (1842) and *Le Juif errant* (1845–47) and held a huge concourse of readers in daily suspense.

The novels of the romantics were spoiled by the one fault that seems indigenous in romanticism: shapelessness and overwriting. Yet the period was also the golden age of the short novel and the short story—works of rigour and intensity in which these same novelists renewed the French genius for formal invention. Balzac's *contes philosophiques* such as *Le Chef-d'oeuvre inconnu*, or his pictures of social life such as *La Maison du chat-qui-pelote;* Stendhal's *Chroniques italiennes;* Vigny's *Stello* and *Servitude et grandeur militaires* (short stories grouped on a single theme) are examples, as are the stories of Musset, Gérard de Nerval and Gautier. Two accomplished exponents of the short story gave their whole attention to this genre: Nodier and Mérimée; the former with an artlessness that concealed art conducted the reader into regions of dream (*Trilby*, 1822; *La Fée aux miettes*, 1832); the latter, the finest technician of them all, gave body to romantic mystery (*La Vénus d'Ille*, 1837) and an almost unbearable verisimilitude to the violence of romantic passion (*Colomba*, 1840; *Carmen*, 1845).

4. Historical and Critical Writers of the Romantic Movement.—Romanticism affected the disciplines of historical and critical writing to the point where they became accepted literary genres in their own right.

History, employed by the romantic novelists and playwrights for their own colourful ends, also began to be written by the historians in a way that excited the interest of the general reader. Augustin Thierry, for example, transformed the arid *Chronicles* by the narrative skill with which he manipulated them for his *Récits des temps mérovingiens* (1835). Other historians, such as F. P. G. Guizot in his *Histoire de la révolution d'Angleterre* (1826–27) and Tocqueville in *La Démocratie en Amérique* (1835–40), wrote to prove rather than to relate, and set out to verify their theories by an examination of the facts. Jules Michelet, the greatest of them all, thought of historical writing as an integral resurrection of the life lived in past epochs; his monumental *Histoire de France* (completed 1867), inspired by the principles of democracy and written in magnificent and idiosyncratic prose, evoked the successive moments in which a civilization advanced, with the passing centuries, to the attainment of liberty.

The only literary criticism which has survived from this period is the work of Sainte-Beuve. Unsuccessful as poet and novelist, he turned to the literary essay, devoting his critical attention both to his contemporaries and to the writers of the past. "The critic," he asserted, "is the man who knows how to read and can teach others to read"; his task is one of exhaustive and objective inquiry into the life and times of the great authors as well as into their texts. Sainte-Beuve possessed so lucid a comprehension of the human character behind the written word that his *Portraits littéraires*, painted with all the purity of his style and his gift of vivid metaphor, enlarged the frontiers of criticism. His *Lundis*, weekly articles published from 1850 to 1869 and collected in *Causeries du Lundi* (1851–62), are often models of perspicacity.

5. The Movement of Ideas.—The romantic writers were affected by, as well as themselves affecting, the philosophical and social currents of thought in their period. The freedom to publish a social criticism which was often outspoken and radical would not have been possible without a liberal government in power.

The continuity with 18th-century thought was sustained by the *Idéologues* as they were called, who in the last years of the empire took over, defined and carried to their extreme conclusion the propositions of the *Encyclopédistes*. They were opposed by the transcendentalist thinkers. This transcendentalism, represented by such thinkers as Victor Cousin, was promoted to a semiofficial status at the time of the Restoration and the July monarchy. The positivism of Auguste Comte, a mystique of science and humanity, was more attuned to the mental presuppositions of the century of progress. French literature, even philosophical literature, has more cause to be grateful to a disciple of Comte, Émile Littré, than to Comte himself. Littré diverted his mind from philosophy to philology and from 1863 to 1877 compiled his monumental *Dictionnaire de la langue française*. His precise definitions and his historical grasp of the growth of the French language have made this dictionary an indispensable instrument.

The reaction of throne and altar to Revolutionary dogma had been voiced at the beginning of the century by two royalist critics, Louis Bonald and Joseph de Maistre. The latter's *Du Pape* (1819) was a brilliant piece of special pleading for the Ultramontanism which was to gain its end before the century was out. On the opposing side the powerful pamphleteering of Paul Louis Courier had demanded a progressive loosening of authoritative powers in church and state.

The social structures of the period were subjected to the scrutiny of Saint-Simon and Fourier, economists who became prophets of modern socialism. Under Louis Philippe this social criticism grew more outspoken, especially in the writings of Pierre Joseph Proudhon and Robert de Lamennais. The latter, who suffered papal condemnation for his articles in the liberal *L'Avenir*, attempted in the *Paroles d'un croyant* (1834) to reconcile his Christian faith with republican ideals.

C. The Third Period: 1848–1870

The bourgeois regime of Louis Philippe became increasingly

rigid and intolerant during the ministry of Guizot, both in its principles and in its departmental administration; in Feb. 1848 the people of Paris rose against it and from this democratic revolution the second republic was born. The new regime, however, quickly succumbed to its internal divisions and the *coup d'état* of Dec. 2, 1851, put back the clock for those many writers who had been sustained by humanitarian ideals. The opposition was silenced under Napoleon III and censorship reintroduced; publication was once again under control, though in practice this control was somewhat relaxed after 1860.

Literature suffered from these changes and the self-confidence of romanticism was checked. Positivist thought, more reassuring to the bourgeois determination to consolidate itself, grew in power; scientific method dominated every department of intellectual life. History and criticism became sciences: Fustel de Coulanges, Ernest Renan, and Taine professed a strict determinism and analyzed historical fact and literature with the sole purpose of arriving at an objective truth. Even the traditional literary genres were infected by this new spirit. Romantic idealism survived in the work of a few poets, but many writers, infatuated by this newfound reconciliation of art and science, turned against their heritage from the previous generation. This reaction was known in poetry as the Parnassian movement (*see* PARNASSIANS), in the novel and the drama as realism.

1. The Aftermath of the Romantic Movement.—If the Parnassian school may be considered as a reaction from the romantic movement, it must be remembered that there were important romantic poets still writing. These poets—Hugo in his later work, Gérard de Nerval and Baudelaire—formed a bridge between the first and second phases of romanticism.

Gérard belonged to the early romantic generation, but his finest work was written in his last years. His whole life was a search for the paradise of which his childhood had been an intimation—a paradise from which he was constantly expelled by the pains and deceptions of existence. He suffered recurrent periods of mental breakdown and it is probable that he finally committed suicide. The essential Gérard is distilled in two works of prose, *Sylvie* and *Aurélia*, and in the 12 sonnets called *Les Chimères;* these few pages are the poetic metamorphoses of his haunted life. Gérard was an incarnation of the romantic spirit in its purest form; the bold innovations of his art look forward to the experiments of modern poetry.

It was after 1850, too, that Hugo wrote his greatest verse. Solitude and the sea (he lived in exile from the second empire on Jersey and Guernsey) nurtured his tremendous, surging eloquence. He cast his poems of revenge (*Châtiments*, 1853) in the face of the loathed "usurper," Napoleon III; in his finest lyrical verse (*Les Contemplations*, 1856) he wrote the memoirs of his spirit—the life of a man who had endured, without defeat, 25 years of struggle and suffering; he composed the epic of Humanity (*La Légende des siècles*, 1859) which he set within the vaster epic of Creation; he wrote the novel of human society (*Les Misérables*, 1862) in which he gave free rein to all the longings and hopes of his generous heart. His genius, ripened by experience and exalted by visionary enthusiasm, made him the greatest figure, though not the greatest literary influence, in French literature of the 19th century.

Charles Baudelaire, on the other hand, profoundly influenced the course poetry was to take in the years after his death and, at the deepest level of poetic creation, he influences it still. Baudelaire's melancholia (or "spleen"), his particular obsessions, his pursuit of the Ideal, attached him to the ethos of romanticism; the rigour of his verse, almost Racinian in its control, purged him of the chief romantic fault—the loose rhetoric of generalized emotion. His poems were collected under the title of *Les Fleurs du mal* (1857). Hugo spoke of the "nouveau frisson," the new excitement, that had entered French verse and certainly these poems, with their emotionally charged tensions, explored the forbidden regions of human existence as never before. The *Petits Poèmes en prose*, experimenting with a language where freedom from metrical order served the demands of an inner necessity, discovered the emotional tone of a life beginning to be known as "modern." Baudelaire's translations from Edgar Allan Poe and his literary and art criticism influenced the course of aesthetic speculation for the remainder of the century. His notebook, and particularly that section of it known as *Mon Coeur mis à nu*, survives as an intimate and pathetic reflection of his tortured spirit.

2. The Parnassian Reaction.—The Parnassian poets were united in their determination to rescue French verse from the emotional and verbal imprecision of the romantics. The movement was heralded by Théophile Gautier who, though having shared in all the battles of the romantic avant-garde as a young man, was converted to a religion of art which exacted the unquestioning obedience of its adepts. His *Émaux et camées* (1852), where each poem has been as carefully "worked" as an intaglio, proposed a belief in formal perfection without which, he asserted, no work of art, however sincerely felt, could hope for immortality.

Leconte de Lisle was the acknowledged leader of Parnasse. The deliberate disciplining of his romantic sensibility, his personal reserve, the cult of a frigid Beauty who reigned supreme above the vain agitations of the human race, inhibited the movement of life within his verse; his poems are magnificent but sometimes curiously dead. The *Poèmes antiques* (1852) evoke the splendour of vanished civilizations; the arts of Greece, the wisdom of India, consoled him for the wretchedness of a century against which he could only utter imprecations. The *Poèmes barbares* (1862) voice his longing to escape into the savage grandeur of the past or the untouched regions of the natural world. He kept so tight a hold on the language of his verse that there are moments when a poem seems frozen within its marmoreal form.

The first volume of the *Parnasse contemporain* appeared in 1866 and it was followed by two others. Gautier, Baudelaire, Leconte de Lisle figured in them, as did Théodore de Banville, Sully Prudhomme, François Coppée and José Maria de Heredia; even Verlaine and Mallarmé were contributors, though their development was to be along other lines. All these poets proclaimed their belief in formal perfection and they flattered themselves that they had brought poetry back to the sublime purity of its nature. Heredia is a characteristic exponent of these theories. At the end of the century he collected, in *Les Trophées* (1893), the 118 sonnets he had slowly written through the years.

3. The Realist Novel and the Drama of Social Manners.—The diffusion of the positivist spirit and the development of scientific studies, after 1850, impelled the novelists to base their work on the accurate observation of observed facts. Balzac had already shown the way. Champfleury, the first theorist of realism, demanded that the novelist should choose his subjects from the most ordinary aspects of the human condition and that his novels should be "daguerreotypes" of everyday life.

Gustave Flaubert is considered the master of the realist school, but the complexities of his character, exasperated by nervous illness and the self-imposed solitude of Croisset, lend his work a certain ambiguity. He was a romantic *manqué* who devoted his life to the elaboration of an impersonal, classical art. Whether, as in his historical novels, *La Tentation de Saint-Antoine* and *Salammbô* (1862), he chose a romantic subject, or whether, as in the novels of modern life, *Madame Bovary* (1857) and *L'Éducation sentimentale* (1869), one which seemed to be more in accord with the doctrines of realism, his work was always based on microscopic research and observation. After this preparation had been completed he subjected the novel he was writing to the exact articulation of plot and the demands of an impersonal style. This process was unsatisfactory in the historical novels, where the weight of erudition seems to stifle their inner life, but it made *Madame Bovary* and *L'Éducation sentimentale* two of the great novels of the 19th century. Flaubert's clarity and realism did much to exorcise the sentimental complacencies of the triumphant *bourgeoisie* and the emotional self-indulgence of the "mal du siècle"—two facets of the philistinism which sought to destroy the civilized artist. His unfinished novel *Bouvard et Pécuchet* renewed his attack on the "received ideas" of the age. Flaubert's *Correspondance* is so informative and so moving a witness to the devotion with which he served his art that it cannot be omitted from any consideration of his *oeuvre*.

Jules de Goncourt and his brother Edmond collected documents, took notes of what they saw in the suburbs and slums of Paris, made clinical studies of pathological cases and translated this material into their novels of "real life." *Renée Mauperin* (1864) reconstructs the life of a childhood friend, *Germinie Lacerteux* (1865), that of an old servant; *Charles Demailly* is a frank picture of the literary world, *Manette Salomon* (1867), of that of the stage. Like Flaubert they were conscious prose stylists, reñning their language to an "écriture artiste," as they called it. The same gifts of observation and style were applied to their famous *Journal*.

The theatre of these years participated in the vogue for a realist portrayal of society. In 1843 the failure of Hugo's *Les Burgraves* marked the end of the romantic dream. Émile Augier took the rich *bourgeoisie* for his subject and in *Le Gendre de M. Poirier* (1854) renewed the theme of the *Bourgeois gentilhomme*. Alexandre Dumas *fils* portrayed the social and moral problems of his time in his beautifully constructed plays (*La Dame aux camélias*, 1852; *Le Demi-monde*, 1855). Eugène Labiche turned his genial gaze upon the eccentricities of his generation and, with a gift for farce which be sometimes used to explore the deeper strata of the human character (*Le Voyage de M. Perrichon*, 1860), left a few plays that have become a permanent addition to the repertory of the French theatre.

D. The Fourth Period: 1870–1900

The Franco-German War of 1870, the commune and the institution of the third republic marked a new point in French history, but the literary world showed no signs of being affected by these events. The novelists, with Émile Zola at their head, carried realism a stage further in the service of scientific determinism and formed the Naturalist school. By 1885, however, a vigorous reaction to "scientism" was taking place. The sustained attacks by the critic Ferdinand Brunetière and the philosopher Henri Bergson on the reigning ideology incited a new generation to recover idealism for the novel and the poem.

1. The Naturalist School.—Influenced by Taine and the scientist Claude Bernard, Zola maintained that the novel should serve the same ends as scientific study. Its purpose was to study "the human temperament and the deep modifications of the human organism under the pressures of environment and events." He set out to compose a cycle of 20 novels, *Les Rougon-Macquart*, with the intention that it should become "the natural and social history of a single family during the second empire." Two of these novels stand out for their savage depiction of working-class life: *L'Assommoir* (1877) and *Germinal* (1885).

A collection of short stories, *Les Soirées de Médan*, had signaled in 1880 the birth of the Naturalist school; Zola was among the contributors and Guy de Maupassant made his first public appearance with his masterpiece "Boule de suif." It was as a writer of short stories that Maupassant achieved public fame. With his controlled and powerful art he knew how to place his Norman peasants, Parisian bourgeois, shop assistants, society women and prostitutes in the banal setting of their existence; the approach of his own mental breakdown impelled him to describe, in other stories, cases of hallucination and madness. As well as his 300 short stories he completed six novels, the best-known being *Bel-Ami* (1885) in which he painted the Parisian newspaper world with ruthless realism. Like all the naturalist writers Maupassant served what he believed to be the truth, but naturalism, in fact, is only a selection from truth's many facets.

Several admirable writers adhered to the principles of naturalism: Edmond de Goncourt, who continued to write after his brother's death (*La Fille Élisa*, 1877); Alphonse Daudet, a novelist (*Le Petit Chose*, 1868, *Tartarin de Tarascon*, 1872, *Sapho*, 1884) and a writer of lively and touching short stories (*Lettres de mon moulin* and the *Contes du lundi*); and, though on the fringe of the school, Jules Vallès, with his semiautobiographical trilogy *Jacques Vingtras* (1879–86), containing *L'Enfant*, *Le Bachelier* and *L'Insurgé*. In the theatre, Henri Becque, independent of literary affiliations as he was, displayed in *Les Corbeaux* (1882) many of the naturalist traits. André Antoine founded the Théâtre Libre to support the principles of the movement.

The passing of naturalism—at least as a defined historical literary phase—can be watched in the career of Jules Renard. His novel *Poil de carotte* (1894) has all the naturalist observation, but an observation made to serve a narration and a prose style reduced to the barest essentials. Renard, with his selective eye, is at the opposite extreme from Zola, whose indiscriminating gaze took in everything and put everything down; *L'Écornifleur*, written with wry humour, would have been four times the length if it had come from Zola's hand. Renard's later experiments in literary description (*Histoires naturelles*, 1896) have made him a more important author for some writers of the mid-20th century than he perhaps deserves to be, for they are attempting also to transpose objects into words.

2. The Reaction Against Naturalism.—There were some writers, however, who scorned this literature of exact description; a few claimed the old aristocracy as ancestral background and this was not irrelevant to the extreme virulence with which they opposed the crass materialist philosophy of the democratic age.

Barbey d'Aurevilly wrote of the heroic exploits of the Chouans (*Le Chevalier des Touches*, 1864), and of the sufferings of a religious at the time of the Revolution (*Un Prêtre marié*, 1865); his best-known work, *Les Diaboliques* (1874), is a collection of six short stories written by one "who believes in the devil and his power over the world." The comte de Gobineau related, in his novel *Les Pléiades* (1874), the travels of three young men who thought of themselves as exceptional beings, with a pride of race that justified their scorn of the crowd. Villiers de l'Isle-Adam arraigned, in his *Contes cruels* (1883), the overweening pride of the scientists, the tyranny of finance and the insolent triumphs of mediocrity; the only novel he wrote, *L'Ève future* (1886), veiled with bitter irony his disquieting vision of the future of science.

Joris Karl Huysmans was a disciple of Zola in the first stages of his literary career; *En ménage* (1881) was a novel in the naturalist manner. His increasing nausea and despair at the limitations of naturalist "reality" drove him toward religious faith. But there was a halfway house between naturalism and religion which Huysmans paused to explore: the ivory tower of aestheticism. This provoked his most extraordinary and most famous novel, *À rebours* (1884). His last novels (*Là-bas*, *En route*, *La Cathédrale*, *L'Oblat*, 1891–1903) describe the stages of this journey toward the full, mystical experience of the Christian religion. Léon Bloy, a fervent and fanatical Catholic, wrote two autobiographical novels (*Le Désespéré*, 1886; *La Femme pauvre*, 1897) in which he thundered imprecations against the impious century, dooming it to the fires of hell and announcing the apocalypse that would usher in the final redemption.

Novelists who reacted no less profoundly against their time but with less violence, were Paul Bourget in *Le Disciple* (1889) and Maurice Barrès in *Les Déracinés* (1897). But Barrès' early work is of a more complex nature (*Sous L'Oeil des barbares*, *Un Homme libre*, *Le Jardin de Bérénice*—a series of novels published under the collective title of *Le Culte de moi*, 1888–1901); here he transcribed his philosophy of egoism—a will to personal happiness and a systematic cult of rare, even violent, sense experiences. Pierre Loti, a naval officer, vainly sought the liberations of exotic adventure (*Aziyadé*, 1879; *Le Mariage de Loti*, 1882); these novels analyzed the sensibility of those who seek relief from the perplexities of their nature in distant travel and yet cannot disperse their innate melancholy and despair.

Anatole France began his writer's career as the dilletante who escapes into the dream of pagan beauty and wisdom (*Thaïs*, 1890; *Le Lys rouge*, 1894). But the impact of the Dreyfus affair (the intense dispute which divided France and involved even the most detached men-of-letters in bitter quarrels with their colleagues; *see* Dreyfus, Alfred) transformed his rather shallow temperament, drawing him into the struggle against the right wing for which Bourget and Barrès wrote. The series of novels called *Histoire contemporaine* (1897–1901) bore witness to this evolution in their author's character. The hero, M. Bergeret, first encountered by the reader as a convinced skeptic, is drawn, by a sequence of events, into the political struggle, and compelled to fight for justice and humane government.

3. The Symbolist Movement.—The Parnassian doctrines of impassiveness and objectivity were opposed to the natural impulses of poetry. Indeed the imposition of this poetic orthodoxy was immediately nullified by those considerable poets who still took it for granted that the writing of poetry was a metamorphosis of inner experience. The new movement of symbolism (*see* SYMBOLISTS, THE) was prepared before ever it was named.

Baudelaire himself had shown the path that symbolism was to follow: a line in his famous sonnet *Correspondances*—"Les parfums, les couleurs et les sons se répondent"—served as a preliminary statement of the movement's aesthetic. Natural forms, this doctrine asserted, are the multiple symbols of a single reality and beneath their diversity the poet rediscovers a profound unity, mysterious and intangible.

Arthur Rimbaud moved toward this aesthetic after he had written the early poems which had captured, with precocious brilliance, the disquiet and the rebellion of his youth. He "studied to make himself a visionary," and, as a way of access to the obscure regions of consciousness, he cultivated delirium in all its forms. The history of this experimental initiation into the sources of poetic consciousness is recounted and condemned in *Une Saison en enfer* (1873); not long after, Rimbaud abandoned poetry and departed in 1880 to Abyssinia as trader and gunrunner. Whether the composition of his prose poems (*Les Illuminations*, published without his knowledge in 1886, the heyday of symbolism) was before this renunciation, contemporaneous with it or even after it is difficult to determine, but they witness the urgency with which his whole being strained toward the hidden mystery of existence and the new language with which to utter it. Rimbaud is a meteor whose path has drawn the modern poets in his train.

Others foreshadowed this new poetic consciousness and, though they wrote only on the margin of symbolism and adhered to no literary group, diffused a powerful influence within the developments of later French poetry. Little is known of Lautréamont, pseudonym of Isidore Ducasse; his prose poems *Les Chants de Maldoror* (1869–74) remained for long unperceived. These poems, which appear to celebrate the apotheosis of evil, are composed with a fortuitous juxtaposition of images that made them one of the source books of surrealism. Tristan Corbière, like all these "poètes maudits," was unknown in his lifetime; the poems in his single volume, *Les Amours jaunes* (1873), seethe with explosive, savage images, like the rush and suck of the sea against the Breton shores where Corbière wrote them. Charles Cros (1842–88) is, on the other hand, all Parisian. *Le Coffret de santal* (1873) is composed with the metropolitan bitterness that reduces everything to nothing.

Paul Verlaine, a Parnassian in *Poèmes saturniens* (1866), his first volume, liberated himself rapidly from the precepts of a poetic school which could only constrain his voluptuous sensibility. A dangerous friendship with Rimbaud culminated in an emotional crisis echoed in *Romances sans paroles* (1874) and above all in *Sagesse* (1881), where the verse is infused with Christian repentance and piety. Verlaine had great sincerity and charm; his verbal music composed a prelude to the more elaborate orchestrations of symbolism.

A line of Verlaine's: "Je suis l'Empire à la fin de la décadence," reflects the mood of those who, between 1880 and 1885, were known as the Décadents. To emancipate the self from the restraints of tradition, to live on the exasperated nerves and within the claustrophobia of ennui, as did these poets, was to invite either a vague or a contorted idiom of verse. But the decadence did produce one true poet, Jules Laforgue, whose dislocated verse rhythms perfectly transmitted the diffidence and the impudence of his paradoxical nature.

All these poets were an element in the spiritual climate of which symbolism was a manifestation. It was the climate of Hegelianism, the philosophy of Idealism. Symbolist doctrine was based on the belief that the world transmitted by the senses was a reflection of the spiritual universe. The poets sought a key to open a door into this universe and they thought of the poem as an instrument of metaphysical knowledge. They affirmed that the translation of such spiritual experience called for verbal symbols, and they dissolved the traditional metric in an effort to endow their verse with the power of music to suggest spiritual values. Several of them experimented with a *vers libre* in which, as they hoped, poetry would be liberated from the exigences of rhyme and measure and thus become a more flexible means of expression.

Stéphane Mallarmé was the central figure of this movement: its greatest poet, its theoretician and an influence which went far beyond the group of admirers who met, each Tuesday, to hear the master discourse on the nature of art. The simplicity of his character, his poverty, his selfless devotion to the arduous demands of his aesthetic, made him, in the eyes of his disciples, a saint of literature. He wrote his first poems under the influence of Baudelaire and, however subtle his subsequent explorations into the techniques of verse, he never entirely departed from the alexandrine. With *Hérodiade* and *L'Après-midi d'un faune* he achieved his particular and profound originality: words brought into relationship not only with other words but with the pauses between them —the relationship of music to silence. Each of his poems was the outcome of protracted meditation and he asks an equal patience of the reader to allow the poetic meaning to be disclosed. Mallarmé was an hermetic poet, but he is not impenetrable.

Mallarmé transcends the Symbolist movement. Symbolism failed as a poetic doctrine and a poetic school because it asked more of poetry than it is in its nature to give. Jean Moréas (1856–1910), who was one of the movement's founders, broke with it in 1890, and in the following year issued a manifesto recalling poets to discipline and clarity; he called his countermovement the "École Romane," as if to emphasize a recovery of Mediterranean light after this period of Nordic fog. His *Stances* (1899) have a certain classical sobriety. This reaction bore little but dead fruit, though Paul Valéry, who was Mallarmé's close friend but not his disciple in the making of poems, may have been touched by it as was Charles Maurras at the end of the century.

The year 1900 did not, on the surface, mark any change in literary taste. In literature, as in life, it was a precarious moment of stability. The third republic, after surmounting domestic crises, seemed firmly in the saddle. A certain self-satisfaction, almost a social euphoria, was diffused throughout French life. The pleasures of "la belle époque" were soon to prove a flimsy façade. Literature, like the other arts, was secretly preparing, in the few minds in advance of their time, a revolution as radical as were the coming changes that transformed the old Europe and undermined the accepted conventions of society. (P.-G. CA.)

VI. THE 20TH CENTURY

The 20th century saw many new developments in French literature. Schools and movements followed each other in rapid succession, the two most important being surrealism and existentialism (*q.v.*), but purely literary groupings were often replaced by philosophical or political affiliations. Literature increasingly reflected the problems and uncertainties of the time and many writers were involved in the discussion of conflicting ideologies.

A further characteristic was the widening of horizons brought about by easier travel, and by contacts with foreign literatures, especially those of England, the United States and Russia. A number of well-known authors were of foreign origin or foreign parentage, and others belonged to overseas France. French literature enjoyed a growing reputation in the outside world, and the Nobel prize for literature was awarded ten times to French authors between its foundation in 1901 (Sully Prudhomme) and 1960 (Saint John Perse). Other holders were the provençal poet Frédéric Mistral, Romain Rolland, Anatole France, Henri Bergson, Roger Martin du Gard, André Gide, François Mauriac and Albert Camus. In France itself a great profusion of literary prizes brought talent to light.

During the first part of the century, symbolism became a dominant influence, and there was a general reaction against 19th-century naturalism. Bourget, France and Loti were at first held in high esteem, but declined in reputation from the 1920s onward. Barrès continued to attract many followers, especially in right-wing circles. It seemed characteristic of the age to turn to certain authors for leadership, and various writers in turn established an

ascendancy in different sections of opinion. Maurras dominated right-wing nationalism for many years and Bergson created the philosophic atmosphere in which many writers grew up. Alain (Émile Auguste Chartier) was a critic, essayist and moralist who influenced several generations; Charles Péguy and Antoine Saint-Exupéry, the former killed in 1914, the latter in 1944, provided an ideal for many Frenchmen. In very different ways Gide, André Malraux, Jean Paul Sartre and Camus had an influence extending beyond literature and helped to mold the outlook of their age.

The intellectual curiosity of the time was shown in the founding of many periodicals, expressing almost every shade of opinion. The first of these was Péguy's famous *Cahiers de la quinzaine* (1900–14), in which he waged war against corruption, materialism and injustice. Much of the new writing of the century appeared in the *Nouvelle Revue française* (1909–43), founded by Gide, with Jean Schlumberger and Jacques Copeau. Its editors included Jacques Rivière, Jean Paulhan and Marcel Arland. Other notable periodicals were *Esprit*, founded by Emmanuel Mounier in 1932, as a platform for the progressive Catholic movement, *Personnalisme; La Table ronde*, started by Mauriac in 1948; and *Les Temps modernes* (1945–49) founded by Sartre, the chief organ of the existentialists.

There have been few periods in which autobiographical writings have been so prominent. The journals and memoirs of Renard, Barrès, Gide, Valéry, Mauriac, Julien Green and Paul Léautaud (1872–1956) were particularly enlightening, and so too were several of the many volumes of correspondence (for instance that of Claudel and Gide, or of Rivière and his brother-in-law Alain-Fournier).

Many authors became well known in several different branches of literature. A number were both novelists and dramatists, or writers for the cinema; many novelists also wrote biographies, literary or artistic criticism, essays and other miscellaneous journalistic writings.

1. Fiction.—The range of the novel was greatly extended, but many characteristics were developments of earlier tendencies rather than complete innovations. For some time vast novel cycles were in favour. The generous ideals of Rolland were expressed in *Jean Christophe*, the story of a composer of genius (1906–12); he also wrote lives of Michelangelo, Tolstoi, Gandhi, his friend Péguy, and a major work on Beethoven. Marcel Proust, one of the great novelists of the first half of the 20th century and a major influence on many younger writers, created a world of unforgettable characters in *À la recherche du temps perdu* (1913–27). It is a merciless exposure of fashionable society and of certain anomalies in human nature, but written with a sense of comedy by a novelist who was also a poet. Increasingly an invalid, Proust sought to recapture in this vast work the impressions of his youth before they vanished from his mind.

Martin du Gard wrote an excellent novel, *Jean Barois* (1913), on the effects of the Dreyfus case. His clear-sighted, dispassionate observation is also apparent in *Les Thibault* (1922–40), a family cycle reflecting the social history of France from the late 19th century to World War I.

Georges Duhamel, an army doctor during World War I, stressed the futility and suffering of war in *La Vie des martyrs* (1917) and *Civilisation 1914–17* (1918). He will be remembered particularly for his *Salavin chronicles* (1920–32) and his *Chroniques des Pasquier* (1933–45), which reflect his sympathy and understanding. Earlier, he was closely associated with Jules Romains, the leader of the "unanimist" school, based on the idea that one unifying principle underlies all human activities. This theme is found in Romains' poetry, particularly his *Vie unanime* (1908), and in his novel *Les Hommes de bonne volonté* (1932–47), a vast panorama ranging over many aspects of life in France between 1908 and 1933, in which the volumes dealing with World War I are particularly outstanding. Novel-cycles about French life were also written by René Behaine and Paul Vialar (*La Mort est un commencement*). Henri Troyat, born in Moscow, wrote a cycle about revolutionary Russia from 1888 onward (*Tant que la terre durera*, 1947–50), which, like his earlier novel *L'Araignée*, was widely praised.

The novel of social realism, often militantly left wing, was represented by Charles Plisnier and Louis Aragon, the latter being particularly successful after World War II with his historical novel about Napoleon's return from Elba, entitled *La Semaine sainte* (1958); Jean Richard Bloch wrote . . . *et Cie* (1913), a powerful Jewish story; Louis Ferdinand Céline (Louis Ferdinand Destouches), who later became vehemently anti-Semitic, wrote one of the most controversial novels of the period in *Voyage au bout de la nuit* (1932). This foreshadowed certain aspects of existentialism, as did *Le Sang noir* (1935) by Louis Guilloux.

The lower levels of society were depicted in *La Mère et l'enfant* and *Bubu de Montparnasse* by Charles Louis Philippe. Pierre Hamp (Pierre Bourillon, André Thérive, Léon Lemonnier, Eugène Dabit, Maxence van der Meersch and Jean Prévost described industrial scenes or working-class conditions. Prévost was also an excellent literary critic. Philippe Hériat (Raymond Gérard Payelle); described French middle-class life. Among younger writers, Michel de Saint-Pierre became known with *Les Aristocrates* (1954), and *Les Nouveaux Aristocrates* (1960).

André Maurois (Émile Herzog) has written in many different genres. He gained popularity with lighthearted sketches of British army life in World War I, followed by biographies of Shelley, Byron and Disraeli. His more searching studies of Proust, Alain, George Sand and Victor Hugo added greatly to his reputation, and his gifts as an imaginative writer were well seen in his stories for children. Other excellent writers of children's literature were Jules Supervielle, Marcel Aymé, Saint-Exupéry and René Guillot.

André Chamson began with *Roux le bandit* (1925) as a regional novelist, writing about the Cévennes; later he widened his range to discuss topical issues and difficult moral problems (*L'Année des vaincus*, 1934; *La Neige et la fleur*, 1951; *Adeline Vénéjan*, 1956; *Le Rendez-vous des espérances*, 1961). C. F. Ramuz gave authentic descriptions of Vaud in Switzerland; Jean Giono, first known for his evocations of Provence, later developed a more "Stendhalian" kind of writing (*Un de Beaumugnes*, 1929; *Que ma joie demeure*, 1935; *Le Hussard sur le toit*, 1951).

Many other novelists made their own region part of the literary scene: Alphonse Chateaubriant (Brittany), Jean de la Varende (Normandy), Maurice Genevoix (Sologne), Henri Pourrat (Auvergne), Henri Bosco (Provence), Henri Queffélec (Brittany), and Mauriac (Les Landes). Others found inspiration in distant lands. Louis Hémon's *Maria Chapdelaine* (1916) was a moving story of French Canada, and the setting of most of Camus' novels is Algeria. The restless cosmopolitanism of the 1920s was represented by Valéry Larbaud, Paul Morand and Blaise Cendrars; the brothers Jérôme and Jean Tharaud, writing in partnership, were skilled in descriptive travel fiction; Edouard Peisson and Roger Vercel conveyed the feeling of the sea. Pierre Mille wrote diverting colonial novels, and Henri Duvernois and Francis Carco (Caropino), were essentially Parisian. Gabriel Chevallier's *Clochemerle* (1934) was a riotous skit on village politics, and the sardonic humour of Aymé was seen in *La Jument verte* (1934, Eng. trans. *The Green Mare*), another lively picture of rural life. His disillusioned studies of postwar France (*Le Passe-muraille*, 1943; *Uranus*, 1948) were also notable. Aymé contributed to the revival of the short story or *nouvelle*, with Arland, Jean Cassou, Marc Blancpain, Morand, Supervielle and Camus (*L'Exil et le royaume*, 1957).

Colette (Sidonie Gabrielle Colette) is outstanding among women writers. Her novels are largely concerned with the pleasures and pains of love and the senses. She recalls her childhood in a countryside astir with life in its minutest forms and records her impressions in exact and exquisite prose (*La Vagabonde*, 1910; *Chéri*, 1920; *La Maison de Claudine*, 1923; *La Chatte*, 1933, etc.).

The analytical novel, discussing individual problems and emotional conflicts—traditional themes in French fiction—was prominent throughout the period. Gide was recognized as a leading figure from the 1920s onward. Impatient of constraints in life, he subjected his art to rigorous discipline, attaining a style of classical lucidity (*Les Nourritures terrestres*, 1897; *La Porte étroite*, 1909; *Les Faux-Monnayeurs*, 1925). He influenced Larbaud (*Fermina Marquez*, 1911; *Journal d'A. O. Barnabooth*,

1913) and Schlumberger (*Saint-Saturnin*, 1931).

Analytical novels, in great variety, were also written by Jacques Chardonne, who in novels such as *L'Epithalame* (1921), explored the mediocrity behind many romantic illusions; and by Jacques de Lacretelle, Émile Henriot; and later by Cassou, Claude Aveline, Pierre Bost, Jean Blanzat, Blancpain, José Cabanis, Gilbert Cesbron, Jacques Lemarchand and Roger Peyrefitte. Hervé Bazin became known with *Vipère au poing* (1948), a grimly impressive study of relations between a mother and her son. He showed increasing mastery in his later works, *e.g.*, *Au Nom du fils* (1961). The influence of modern psychology was often apparent; and novelists were also indebted to Stendhal and the 18th-century analysts. Typical was the novel of adolescence, best represented by two masterpieces, *Le Grand Meaulnes* (1913), by Alain-Fournier (Henri Alain Fournier), and *Le Diable au corps* (1923), by Raymond Radiguet. Other works of this type, in addition to those of Gide and Mauriac, included *Simon le pathétique* (1918), by Jean Giraudoux, the creator, both in his novels and his plays, of an exclusive and very personal world of poetic fantasy, realism and humour, and *Les Enfants terribles* (1929) by Jean Cocteau. Two younger writers who won swift acclaim were Françoise Sagan (*Bonjour tristesse*, 1954; *Aimez-vous Brahms*, 1959) and Françoise Mallet-Joris of Belgian parentage (*Le Rempart des béguines*, 1951; *Les Mensonges*, 1956).

The position of the individual in the world of eternal values, and the question of sin and redemption, were constant themes among the Catholic writers, notably Mauriac. He conveys with intensity the oppressive atmosphere in which his characters live out their unhappy, withdrawn existence (*Le Baiser au lépreux*, 1922; *Thérèse Desqueyroux*, 1927; *Le Noeud de vipères*, 1932; *La Pharisienne*, 1941). He became known as a dramatist with *Asmodée* in 1938, and *Les Mal Aimés* in 1945. After World War II he turned increasingly to political journalism, but always with the uncompromising independence that marked his prewar condemnations of fascism.

Georges Bernanos, a visionary, for whom the forces of good and evil were real presences, showed a fierce integrity both in polemical writings (*La Grande Peur des bien-pensants*, 1931, and *Les Grands Cimetières sous la lune*, 1937); and in fiction (*Sous le soleil de Satan*, 1926; and his masterpiece *Journal d'un curé de campagne*, 1936). Julien Green, of Anglo-American parentage, depicted an obsessive and nightmarish world in *Adrienne Mesurat* (1927), *Minuit* (1936) and *Moïra* (1950). Marcel Jouhandeau wrote with great frankness about his private life, and vividly described "Chaminadour," the name given to his native town of Guéret.

Other novelists wrote from a humanistic standpoint, *e.g.*, Henri de Montherlant and Malraux, two of the most important writers of the century. Montherlant, a successor of Barrès, blended exaltation and cynicism in works showing great mastery of language, *Les Bestiaires* (1926), *Les Célibataires* (1934) and *Les Jeunes Filles* (1936–39). Malraux stressed self-sacrifice and community of effort, in novels based on his experience of revolution and civil war: *La Voie royale* (1930) *La Condition humaine* (1933), which is an outstanding work, *Le Temps du mépris* (1935) and *L'Espoir* (1937). After the first volume of *Les Noyers de l'Altenburg* (1943) Malraux embarked on several vast philosophic surveys of art throughout the world, to show that mankind's greatest triumph lies in artistic achievement (*Les Voix du silence*, 1951; *La Métamorphose des Dieux*, 1957–58; etc.).

The struggle for self-realization in a common cause was also the theme of Saint-Exupéry, who found a particular elevation of mind in flying, and admirably conveyed this in *Vol de nuit* (1931), etc. His *Pilote de guerre* (1942) ranks among the best records of World War II. The Resistance movement produced *Lettres à un ami allemand*, by Camus, the short stories of Elsa Triolet and Pierre Courtade, *Le Silence de la mer*, by "Vercors" (Jean Bruller), and *Angleterre*, by "Argonne" (Jacques Debu-Bridel). (*See* below, *Poetry*.)

Albert Camus, sometimes classed with the existentialists, parted from them after publishing his essay *L'Homme révolté* (1951). He emphasized the absurdity of life in an apparently purposeless world—a constant theme in modern times—but also stressed the need for common effort. *L'Étranger* (1942) and *La Peste* (1947) gave him first place among his generation; his plays, which included *Le Malentendu* (1944) and *Les Justes* (1950), were less successful.

From the 1930s, many French novels showed human nature in a singularly unprepossessing light. The cult of the sombre, the violent and the abnormal was accentuated by the influence of the German writer Franz Kafka and the modern American novelists, and traditional values appeared to be sharply challenged, or replaced, by a general moral uncertainty. The writings of the existentialists reflected these dilemmas about the human condition. Two separate streams of thought were represented: Christian existentialism, expounded by Gabriel Marcel (*see* below, *Philosophy*), and atheistic existentialism, led by Jean Paul Sartre. Sartre and his followers used many forms of literature as their instruments. They sought to discover how the individual might work out his own salvation, unfettered by conventional morality or religious doctrine: his decisions must be his own, but he assumes a responsibility to the community through them. At first Sartre's attitude seemed comprised of negation and despair (*La Nausée*, 1938 and *Le Mur*, 1939); a more positive attitude appeared in his unfinished cycle, *Les Chemins de la liberté* (1945–49). Another existentialist writer, Simone de Beauvoir, showed insight in *L'Invitée* (1943) and in her socio-political novel covering the immediate postwar years, *Les Mandarins* (1954). Her speculative essay *Pour une morale de l'ambiguité* (1947), her defense of feminism, *Le Deuxième Sexe* (1949), and her autobiographical *Mémoires d'une jeune fille rangée* (1959), also attracted much attention.

The experiences of World War II and the features of the postwar scene provided material for Francis Ambrière (Charles Letellier), Jean Louis Curtis (*Les Forêts de la nuit*, 1947; *Les Justes Causes*, 1954), Pierre Gascar, Roger Vailland (*Drôle de jeu*, 1945), Emmanuel Roblès, Roger Nimier and many others. Romain Gary, after a notable novel on the Polish resistance movement, developed a singularly original theme in *Les Racines du ciel* (1956); *Le Dernier des justes* (1959), by André Schwartz-Bart, was a deeply moving story of Jewish persecution through the ages.

Experiments in theme, construction or language—sometimes unduly complicated, or pushed too far toward symbolism or fantasy—became typical of the later period. Notable works of this kind were written by several highly individual authors; *i.e.*, Maurice Blanchot; Henri Thomas; Julien Gracq, an important surrealist novelist (*Le Rivage des Syrtes*, 1951); and André Pieyre de Mandiargues. Raymond Queneau, a master of verbal dexterity in poetry and prose, struck a lighter note in *Le Chiendent* (1933) and *Zazie dans le métro* (1959). The desire to break away completely from literary traditions and establish a new level of contact with reality, free from all verbal images, prompted the writers of the "anti-novel" school in the 1950s, notably Nathalie Sarraute, Marguerite Duras and Alain Robbe-Grillet, with Claude Simon and Michel Butor.

The adventure story flourished, with Claude Farrère, Pierre Benoît, Joseph Kessel, Pierre MacOrlan and others. Henri Barbusse and Roland Dorgelès are remembered for their accounts of World War I. Georges Simenon gave a new status to the "thriller" of crime and detection. Pierre Boulle and Jean Hougron showed skill both in narrative and psychological description. The historical novel, early comparatively neglected, reached a high standard in the work of Zoë Oldenburg and Marguerite Yourcenar.

2. The Theatre.—During the first part of the century, the theatre showed its vitality mainly in comedy. Tristan Bernard was a gay humorist, Georges Courteline made more Frenchmen laugh at themselves than anyone since Molière, and Georges Feydeau proved to be the best *vaudevilliste* of modern times. On the other hand many "problem" plays of the early period dated considerably; *e.g.*, those of Paul Hervieu, Eugène Brieux, Henri Bernstein, Georges de Porto-Riche and François de Curel.

New tendencies in serious drama were derived from the Symbolist works of the Belgian poet Maurice Maeterlinck. These led on to the writings of Paul Claudel and other French dramatists. Claudel's first two masterpieces, *L'Annonce faite à Marie* and *L'Otage*, were both performed in 1912, but the works that brought him greatest renown—*Le Soulier de satin* and *Partage de Midi*—

were not performed till 1943 and 1948, although they were written much earlier, in 1919–24 and 1905 respectively.

After the 1920s theatrical productions increased greatly in variety. A group of highly gifted actor-managers, notably Copeau, brought many new plays to the stage and introduced valuable experiments in production and technique. There were comedies of every kind: ephemeral frivolities by Sacha Guitry; *Dr. Knock* (1923), an extremely successful satire on doctoring by Romains; the trilogy *Marius, Fanny* and *César* (1928–31) by Marcel Pagnol and works by F. Crommelynck, Jacques Deval, Duvernois, Édouard Bourdet, Jean Sarment (Jean Bellemère) and Marcel Achard.

In the serious theatre new talents were emerging. Plays relying on implication and suggestion rather than outright statement were written by Charles Vildrac (*Le Paquebot Tenacity*, 1920), and by Jean Jacques Bernard in *Martine* (1922). The action was usually simple, and the characters were those of everyday life. More vehement, often declamatory plays were written by Henri René Lenormand, Steve Passeur and Paul Reynal (*Le Tombeau sous l'Arc de Triomphe*, 1924).

From the 1930s onward there was a remarkable renaissance in tragedy. Religious themes regained a prominence unknown since the days of Racine, and another feature was the use of classical legends, or historical subjects, with a strong bearing on contemporary events. To these developments Claudel, Giraudoux, Cocteau, Jean Anouilh and Montherlant all made distinctive contributions.

Claudel's plays have a transcendental quality which makes them both lyrical and epic. Often unwieldy and difficult to stage, their success was partly due to the skill of Jean Louis Barrault, another of the great actor-producers of the day. Giraudoux and Montherlant both secured a second and greater reputation as playwrights after becoming well-known novelists. Giraudoux's fame mounted steadily with *Amphitryon 38* (1929), *Intermezzo* (1933), *La Guerre de Troie n'aura pas lieu* (1935), and *La Folle de Chaillot* (1946). Montherlant's superb sense of style, and his grasp of dramatic construction, gave singular lustre to *La Reine morte* (1942), *Le Maître de Santiago* (1948), *Port-Royal* (1954), *Le Cardinal d'Espagne* (1960).

Cocteau was preeminently a poet, who made dazzling excursions into many realms of literature and art. He wrote versions of ancient myths (*Antigone, La Machine infernale*, etc.), a remarkable psychological study (*Les Parents terribles*), adaptations of Shakespeare, mime, ballet and films (*La Belle et la bête, Orphée*).

Anouilh, like Armand Salacrou, was primarily a man of the theatre. Now flippant, now sardonic, he took disillusionment and frustration for his themes, in plays which alternated between tragedy and comedy: *Antigone* (1943), *Ardèle* (1948), *La Valse des toréadors* (1951), *L'Alouette* (1953), *Ornifle* (1955), and *Becket* (1959). Salacrou developed increasing mastery in many different kinds of plays, and held a foremost place among postwar dramatists with such plays as *Atlas-Hôtel* (1931), *La Terre est ronde* (1938), *Les Nuits de la colère* (1946), an outstanding play on the resistance, and *L'Archipel Lenoir* (1947).

The leading existentialists were prominent in the theatre. Sartre became famous in 1943 with *Les Mouches* and *Huis-clos*, (1944), *Les Maines sales* (1948), *Le Diable et le Bon Dieu* (1951) and *Les Sequestres d'Altona* (1958), all of which provoked argument by their insistence on controversial or painful themes. Simone de Beauvoir's *Les Bouches inutiles* (1945) was also a notable addition to the existentialist repertoire.

Serious plays predominated after World War II, some of its problems being discussed by Roblès, Maurice Clavel and Thierry Maulnier. *Sud* (1953) and *L'Ennemi* (1954) were two notable psychological studies by Julien Green, striking out on a new career as dramatist. Comedy, however, was not neglected. Aymé, already mentioned as novelist, achieved a success with *Clérambard* (1950), and Félicien Marceay, a well-known novelist of Belgian origin, showed that he could write just as deftly for the stage (*L'Oeuf*, 1956). André Roussin wrote diverting comedies (*La Petite Hutte, Les Oeufs de l'autruche*, etc.), and Jacques Audiberti (1899–) covered philosophic intentions under the guise of comic extravagance (*Quoat—Quoat, Le Mal court*).

There were also serious undertones and moral values in the world of ludicrous fantasy devised by the Rumanian-born Eugène Ionesco, in plays like *Le Rhinocéros* and *Les Chaises*. He was one of the chief exponents of the "anti-theatre," a movement represented on the tragic side by Samuel Beckett, an Irishman whose increasing preoccupation with themes of futility and degradation aroused much discussion at the early performances of *En attendant Godot* (1953) and *Fin de partie* (1957).

These various experiments with new techniques and the persistent determination of French playwrights not to shelve discussion of different problems or insoluble dilemmas, made the French theatre more alive in the latter part of the period than for many years before.

3. Poetry.—French poetry of the 20th century has derived much of its inspiration from late 19th-century authors, notably Baudelaire, Verlaine, Mallarmé, Rimbaud, Gérard and Lautréamont. Poets outside France—Émile Verhaeren, Walt Whitman, Rainer Maria Rilke—also exercised much influence. Modern poetry in France, as elsewhere, often tended to live in a rarefied atmosphere and to be concerned with highly personal forms of self-expression, not always intelligible to the general reader.

Valéry was the chief disciple of Mallarmé in this respect. His philosophical preoccupations and his great gift for intellectual self-analysis were first seen in his two prose essays, *Introduction à la méthode de Léonard de Vinci* (1895) and *Une Soirée avec M. Teste* (1896). He published little for 20 years, then sprang into fame as a poet in 1917, with *La Jeune Parque*. A long poem, "Le Cimetière marin," followed in 1920, and was included in a collection, *Charmes* (1922). Thereafter Valéry reverted to prose, his Socratic dialogue *Eupalinos ou l'architecte* (1923) and five volumes of essays entitled *Variété* (1924–44) being especially memorable. During the first quarter of the century much religious poetry was written, notably by Claudel and Péguy. Claudel was converted to Catholicism by mystical experience in 1886, and his *Cinq grandes odes* (1910) reflect his sense of the supernatural. His writings, often diffuse and obscure, combine lyrical power with an occasional jovial humour. Francis Jammes returned to Catholicism through Claudel's influence. His poetry, with a simplicity not devoid of artifice, is often genuinely moving. Péguy was another poet who returned to Catholicism. His writing has something of the naïveté of medieval legend. Prolix and repetitive, it nevertheless contains many lines of great beauty, especially when dealing with death and sacrifice as in *Le Mystère de la charité de Jeanne d'Arc* (1910), *Le Porche du mystère de la deuxième vertu* (1912) and *Ève* (1913).

Other poets of the early period included the comtesse de Noailles, author of *Le Coeur innombrable* (1901) and *L'Honneur de souffrir* (1927), who expressed her deeply felt themes with a romantic lyricism; Henri de Régnier, son-in-law of Heredia, who was first associated with the Symbolists but later reverted to more classical themes; and P. J. Toulet (1867–1920), who appealed to a discriminating few. Paul Fort (1872–), on the other hand, was a popular poet, drawing much of his material from provincial legend (*Ballades françaises*, 1897–1953), and printing his verse as if it were prose. Prose poetry was popular throughout the period. Claudel showed its resources in *Connaissance de l'est* (1900), and Péguy, Max Jacob, André Breton, Léon Paul Fargue, Henri Michaux and René Char all used it extensively.

Traditional versification was increasingly discarded, with the changeover to "modern" poetry. This began before World War I, and became particularly apparent with the surrealists during the early 1920s. Surrealism often led to extravagance and straining after novelty, but many writers felt its influence. It was partly derived from 19th-century sources, notably the works of Lautréamont, and a fiercely grotesque, antibourgeois farce called *Ubu-Roi* (1896), by Alfred Jarry. It owed much to Guillaume Apollinaire. Keenly interested in the cubist painters, especially Pablo Picasso, he showed a brilliant, often artificial modernity, but his poetry reflects genuine feeling (*Alcools*, 1913; *Calligrammes*, 1918). Two other predecessors were Max Jacob and Blaise Cendrars (Frédéric Sauser). Jacob, an ingenious humorist, wrote moving religious poetry after his conversion to Catholicism; Cendrars, a man of many travels and adventures, poured his exuberant vitality into all his writings.

Surrealism was founded by Breton, with Aragon and Paul Éluard. Breton had become acquainted with Freudian psychoanalysis, and surrealism embodied the new themes of the subconscious —hence its insistence on "automatic" writing. He remained its most dynamic and persistent advocate, producing important manifestos, and *Nadja* (1928), a surrealist novel. Soon, however, other supporters went their separate ways; *e.g.,* Cocteau, Aragon, Éluard, Robert Desnos and Char.

During World War II, Aragon, Éluard and Desnos took part in the resistance and poignantly expressed the pent-up feelings of their compatriots. Aragon wrote *Le Crève-coeur* (1941), and *Les Yeux d'Elsa* (1942; in honour of his wife, Elsa Triolet, herself a poet; a later fine collection, *Elsa,* appeared in 1959). Éluard's idealism and depth of feeling made him outstanding (*Poésie et vérité; Au Rendez-vous allemand;* etc.). Char and Emmanuel were also notable resistance poets, who later deepened their choice of theme.

The outburst of poetic activity during the war made it seem that a revival was near. Temporarily the widening gap between poets and the general reader was bridged by the expression of feelings in which both could share. However, this tendency did not long survive the liberation of France.

Pierre Jean Jouve, a complex, pessimistic writer, strongly affected in turn by unanimism, Freudianism and Catholicism himself, influenced several younger poets, notably Jean Cayrol, Luc Estang (both also novelists), Patrice de la Tour du Pin, and Emmanuel. Michaux wrote of subconscious fears, and a world that seemed dark and menacing; Fargue and Pierre Reverdy were sincere and independent poets whose work led to many later developments; Audiberti and Jacques Prévert were skilled in every device of language. Saint John Perse, an extremely intellectual writer, produced poetry with elements of epic, subtly contrived and rich in imagery. Supervielle was deliberately uncomplicated; his observation, wit and fantasy made his poetry particularly attractive. These qualities were also seen in his plays and fiction and his delightful stories for children.

4. Philosophy, Thought and Scholarship.—Henri Bergson was the foremost French philosopher and aesthete of his day. He emphasized the importance of intuition, and opposed the scientific determinism of the Naturalists. His theory of time as a matter of personal experience rather than physical duration was also influential in literature. His views were contested by the rationalists Léon Braunschvig and Julien Benda, author of *La Trahison des clercs* (1927) and other militant essays challenging modernism and contemporary developments in thought and literature. Sartre's major exposition of existentialism, *L'Être et le néant,* appeared in 1943, and so did Camus' argument against suicide, *Le Mythe de Sisyphe.* Maurice Merleau-Ponty moved from existentialism; he was a formative and deeply thinking writer on behaviourism, the phenomenology of perception, and social and aesthetic problems. Henri Lefebvre studied Marxism, and Gaston Bachelard the philosophy of science, psychology and aesthetics.

Catholic writers included the visionary Léon Bloy; the philosopher Maurice Blondel; Jacques Maritain, interpreter of St. Thomas Aquinas, who is also interested in aesthetic theories and the creative imagination; Étienne Gilson, a world authority on medieval Christian philosophy; the Abbé Henri Bremond, who also wrote a much discussed treatise on "pure" poetry; and Daniel-Rops (Henri Petiot), author of *Jésus en son temps* (1945). Gabriel Marcel introduced Sören Kierkegaard to France and published several of the most substantial metaphysical writing of the age. He also wrote plays (*Le Dard,* 1937), and was a discerning dramatic critic. Pierre Teilhard de Chardin, a Jesuit and an eminent archaeologist, sought to reconcile modern scientific and evolutionary theory with theology in profoundly thoughtful works (*Le Phénomène humain; Le Milieu divin* and other posthumous publications). The philosopher Simone Weil, although she never became a Catholic, was a moving writer of mystical experience and intensely held spiritual convictions whose work mainly appeared after her death.

Political controversies occupied many writers. Maurras had gifts as poet and critic, often overlooked among the animosities which his vehement nationalism provoked. Jean Jaurès voiced the ideals of international socialism. These were given a philosophical content by Léon Blum, also an acute moralist and literary critic. André Siegfried and Raymond Aron brought a searching intelligence to social, economic and political discussions. The experiences of World War II were interpreted by Blum in *À L'Échelle humaine* (1945), and by Marc Bloch, a noted medieval historian, in *L'Étrange défaite* (1946). With his *Mémoires de guerre* (1954–59) and other writings, Gen. Charles de Gaulle ensured his place in literature as well as in history.

The leading historian was Ernest Lavisse, and others included Bainville, Pierre Gaxotte, Charles Seignobos, Élie Halévy and Louis Madelin. The history of art was studied by Émile Mâle, Élie Faure, Henri Focillon, and Marcel Brion; Gide, Valéry, Alain, René Hughe and Malraux did much to develop aesthetic theory. Daniel Mornet and Paul Hazard surveyed the origins and nature of 18th-century thought, in several major works; P. Vidal de la Blache made geography literature; Ferdinand Brunot recorded the history of the French language.

5. Literary History and Criticism.—Gustave Lanson gave a new discipline to literary history. His *Histoire de la littérature française* (1894, rev. by P. Tuffrau, 1953), and his bibliography of modern French literature (revised ed., 1931) remain indispensable. The *Revue d'histoire littéraire de la France,* founded 1894, maintained high standards of scholarship under Mornet and Jean Pommier, both of them leading authorities in several branches of literature. The *Revue de littérature comparée,* founded in 1921 by Fernand Baldensperger and Hazard, became a focus for the growing study of international relationships in matters of literature. Other new periodicals provided information for the general reader about current literary production, the *Nouvelles littéraires* (founded 1922) being particularly well known.

Important contributions to knowledge were made by many scholars concerning the literature of earlier periods, and much valuable work was done in providing accurate biographical information about the great French authors, and reliable editions of their writings. Balzac and Stendhal were two writers who benefited considerably in this way, through the work of Marcel Bouteron and Henri Martineau respectively.

There has been no period in which literary criticism has been practised more widely, and in which a greater diversity of opinion has been expressed. Many traditional assessments were revised, and in the latter part of the period criticism has tended to go ever more intricately into the processes and purposes of literary creation, especially in the light of modern psychological theories or philosophic speculation. It has also been much concerned with interpreting the mood and outlook of the 20th century, as reflected in its literature.

In the first part of the century, Remy de Gourmont and Paul Souday were notable; Albert Thibaudet, somewhat later, took a leading place (*Histoire de la littérature française de 1789 á nos jours,* 1936; *Réflexions,* 1938–41, etc.). Alain became famous for his *Propos,* short essays dealing with a great variety of topics; his longer works (*Avec Balzac,* 1937; etc.), were equally stimulating. Charles du Bos, like Larbaud, did much to make English authors known in France; Edmond Jaloux, Benjamin Crémieux and André Suarès were also gifted interpreters of foreign literature. Henriot, whose articles were collected in a number of volumes entitled *Courrier littéraire,* and Robert Kemp, the foremost dramatic critic of his day, brought wide knowledge and a keen sense of values to their estimates both of earlier literature and contemporary works; André Rousseaux was also notable, but wrote from a more subjective standpoint (*Le Monde classique; Littérature du XXe siècle,* 7 vol., 1938–61).

Other leading critics were Arland (*Lettres de France, Nouvelles lettres de France,* etc.), Gérard Bauer ("Guermantes"), Jacques Boulenger (*Mais l'art est difficile,* etc.), Ramon Fernandez, Léautaud, Marcel Raymond, A. Thérive, Thiébaut and Fernand Vandérem.

In the later period, original and distinctive contributions were made by R. M. Albérès (*La Révolte des écrivains d'aujourd'hui,* (1949), Dominique Aury (*Lecture pour tous*), Albert Béguin, Roland Barthes, A. Blanchet (*La Littérature et le spirituel,* 1959–

60), Blanchot (*Faux-pas*, 1943; *La Part du feu* 1949), Pierre de Boisdeffre (*Métamorphose de la littérature*, 1950–51), Kléber Haedens, Robert Kanters, Claude Mauriac (*L'Alittérature contemporaine*, 1958, dealing with the modern trends in "anti-literature"), Maurice Nadeau (*Histoire du surréalisme*), Gaëtan Picon, Georges Poulet (*Études sur le temps humain*, 1950–52), Claude Roy, Samuel S. de Sacy, editor of the *Mercure de France*, and Pierre Henri Simon, also an analytical novelist (*Témoins de l'homme*, 1951; *L'Esprit et l'histoire*, 1954; etc.).

See also additional references under the entry "French Literature" in the Index volume.

(S. C. Gd.)

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(S. C. Gd.)

FRENCH MOROCCO, the English name given to a region, La Zone Française du Maroc, of northwest Africa between the Atlantic coast and the Sahara, during the maintenance of the French protectorate (1912–56). Its area was 154,054 sq.mi. In 1956 the region was incorporated with the Spanish zone of Morocco and the international zone of Tangier to form the independent kingdom of Morocco. *See* Morocco.

FRENCH POLYNESIA (Polynésie Française), until 1957 known as the Établissements Français de l'Océanie, is an overseas territory of France consisting of the French islands in the central South Pacific ocean, but including also Clipperton Island in the northern hemisphere about 700 mi. from the American mainland (Mexico). These scattered islands have a population (1956) of 73,201 and an area of 1,448 sq.mi. The principal groups are the Society, Marquesas, Tubuai or Austral and Gambier (formerly Mangareva) islands and the Tuamotu archipelago.

A distinction exists between the high and low islands. The former (such as Tahiti, Bora-Bora, Marquesas) consist of ancient volcanic craters with jagged peaks and ridges cut through by valleys and drained by short, straight streams and (except in the Marquesas) with a narrow coastal plain. Usually they have a plentiful tropical growth, especially in the valleys (Tahitian chestnut, banyan, *Barringtonia*, tree ferns, hibiscus, wild banana and citrus) and a markedly heavier rainfall on the windward (eastern) side. The low islands are coral or limestone atolls a few feet above sea level, covered with white coral sand supporting coconut palms and scrub. Both high and low islands usually have extensive lagoons inside a coral barrier reef. The prevailing winds are the easterly trades.

Society Islands: Windward Group (Îles du vent).—These have a total area of 455 sq.mi., the chief island being Tahiti (*q.v.*). The islands of this group are all high except Tetiaroa, an atoll 26 mi. N. of Tahiti. Moorea (10 mi. W. of Tahiti) is a triangular island of 53 sq.mi., whose needle-pointed basalt mountains form a semicircular amphitheatre facing north. The highest peak is Mt. Tohivea (3,960 ft.); the tooth-shaped Mt. Muaputa (2,723 ft.) has a hole completely through it near the top. On the northern side the fiordlike harbours of Papetoai bay and Paopao bay

(Baie de Cook) afford safe anchorages. Mehetia (about 60 mi. E. of Tahiti) is the easternmost of the Society Islands, rising to 1,427 ft. Tubuai-Manu (47 mi. W. of Moorea), has a central hill of 780 ft. dominating a fertile plain.

Society Islands: Leeward Group (Îles sous le vent).—This group, with an area of 161 sq.mi., lies between 100 and 200 mi. N.W. of Tahiti and consists of the high islands Huahine, Raiatea, Bora-Bora and Maupiti and a few atolls. Huahine, divided into two parts that are joined by an isthmus submerged at high tide, rises in the north to 2,195 ft.; Fare is the chief village. Raiatea and Tahaa, 2 mi. apart, lie within the same barrier reef; the principal settlement is Uturoa. Bora-Bora (10 mi. N. of Tahaa) rises centrally in the peaks of Otemanu (2,385 ft.) and Pahia; its harbour of Povai bay (Teavanui) is deep and sheltered; Vaitape is the principal settlement. Maupiti (23 mi. W. of Bora-Bora) is surrounded by a broad lagoon.

Tuamotu Archipelago.—This vast group consists of 78 islands arranged roughly in a double chain east of the Society Islands and stretching northwest-southeast over about 900 mi. Area 345 sq.mi. Except for Makatea, an uplifted coral island rising to 200 ft. about 150 mi. N.N.E. of Tahiti, and the small raised coral island of Tikei in the north of the group, all are low atolls. This and their formerly uncharted profusion caused them to be known as the Dangerous archipelago, although the Tahitians after conquering them named them the Paumotu (Submissive Islands). Some (Rangiroa, Fakarava, Hao) have lagoons of about 100 mi. in circumference. The climate is hot and without pronounced variation; typhoons are not uncommon between December and April. The coral detritus supports coconut and pandanus palms. Apataki atoll (about 250 mi. N.E. of Tahiti) is the administrative centre.

Gambier Islands.—This group, lying about 1,100 mi. S.E. of Tahiti, consists of four inhabited high islands (Magareva, Taravai, Akamaru and Aukena) within a single barrier reef about 40 mi. in circumference. They have razorback centres with secondary ridges descending to high coastal promontories enclosing bays. Magareva in the centre of the lagoon rises centrally to 1,447 ft. in Mt. Duff. The climate is warm and the soil fertile. The principal settlement and port is Rikitea on Magareva.

Tubuai (Austral) Islands.—This group, about 400 mi. S. of the Society Islands, consists of Maria (Hull) atoll in the west and the scattered high islands of Rimatara, Rurutu, Tubuai and Raevavae. They have a mild and temperate climate but are subject to typhoons. Mataura on Tubuai Island is the chief settlement. About 480 mi. S.E. of Tubuai lies Rapa (called Rapaiti by the Polynesians to distinguish it from Rapanui, or Easter Island), a crescent-shaped island. Its main settlement, Ahurei, has a sheltered harbour surrounded by crags rising to 2,077 ft. The island is fertile, with a moist temperate climate. About 70 mi. E. of Rapa lie the four Îlots de Bass, or Marotiri Islands, which are rugged, bare and uninhabited. The total area of the Tubuai group is 55 sq.mi.

Marquesas Islands (Îles Marquises).—These lie about 925 mi. N.E. of Tahiti and consist of ten islands and a few islets. Area 385 sq.mi. The Marquesas are divided into a northern (Washington) group, of which the chief islands are Nuku Hiva (127 sq.mi.), Ua Pu and Ua Huka; and a southern (Mendaña) group, of which the chief islands are Hiva Oa (125 sq.mi.) and Fatu Hiva. Nearly all are high islands, Ua Pu rising to 4,040 ft. The country is picturesque and rugged, with razorback ridges extending from central ranges, their slopes clad with fern and scrub, deep and relatively isolated valleys with luxuriant vegetation, and no coastal plain but high cliffs. The climate is hot (average 78° F. [about 26° C.]) and damp and the annual rainfall 30–100 in. Atuona on Hiva Oa is the chief settlement, and Hakapehi on Taiohae bay is the principal port of Nuku Hiva.

Clipperton Island.—This lonely, unpopulated atoll about 2,000 mi. W. of the Panama canal is 3 mi. across, low lying but rising to a 70-ft. promontory in the northeast. Italian arbitration between French and Mexican claims in 1930 assigned ownership to France. Phosphate deposits were exploited between 1906 and 1917.

People.—The original population of these groups was Polynesian, with local differences in appearance, language and social organization. The diffusion centre is believed to have been Raiatea, which was the ancient religious cradle of Polynesia, although accidental settlement by straying canoes also played a part. The social organization (*see* POLYNESIA), with its graded, centralized system of authority supported by a priesthood and supernatural sanctions, was broken down by European contact, although it has to some extent survived in the remoter islands. The population is still basically Polynesian with considerable admixture of other blood and is deeply influenced by French culture. It is increasing after the catastrophic decline initially caused by European contact.

History.—European discovery of the islands of French Polynesia was gradual. The southern Marquesas were discovered in 1595 by Alvaro de Mendaña; his successor, Pedro de Quiros, in 1606 discovered some of the Tuamotus. The Dutch explorer Jacob Roggeveen in 1722 discovered Makatea, Bora-Bora and Maupiti. Capt. Samuel Wallis in 1767 discovered Tahiti, Moorea and Tubuai-Manu. The Society Islands were named after the Royal society, which sponsored the expedition under James Cook that observed the transit of Venus from Tahiti in 1769. In that year Cook discovered Huahine, Raiatea, Tahaa and also Rurutu in the Tubuai Islands; Tubuai itself was discovered on Cook's last voyage (1777). Rapa was discovered by George Vancouver in 1791, and in the same year Capt. Joseph Ingraham of the U.S. trading vessel "Hope" traversed the Marquesas Islands and discovered their northern group. The Gambier Islands were discovered in 1797 by Capt. James Wilson of the British missionary ship "Duff."

The history of the Society Island groups is virtually that of Tahiti, which was made a French protectorate in 1842 and a colony in 1880. French missionaries went to the Gambier group in 1834, and in 1844 a French protectorate was proclaimed, followed by annexation in 1881. The Tubuai Islands were also evangelized from Tahiti, and as late as 1888 Rimatara and Rurutu sought British protection, which was refused. They were placed under the French protectorate in 1889 and annexed in 1900. The Tuamotus were part of the kingdom of the Pomare family of Tahiti, which came originally from Fakarava. They were claimed as dependencies of Tahiti within the protectorate by France in 1847 and became part of the colony in 1880. In the Marquesas, Nuku Hiva was in 1813 annexed to the United States by Capt. David Porter (*q.v.*) of the frigate "Essex," but the annexation was never ratified. French occupation of the group followed the landing of forces from a French warship, requested by the chief of Tahuata (near Hiva Oa). Soon afterward there was a quarrel with the French and in 1842 the chiefs ceded sovereignty to France.

Administration and Social Conditions.—The islands, ruled initially under the Organic decree of 1885, were after 1957 administered by a governor in Papeete (*q.v.*) assisted by a council of government and a territorial assembly. They send representatives to the national assembly and senate in Paris. They are divided into *circonscriptions* (administrative divisions) as follows: Windward Islands (including Makatea); Leeward Islands; Tuamotu, Tubuai, Gambier and Rapa islands; and Marquesas Islands. Papeete and Uturoa have elected municipal councils. French gendarmes are stationed in each division, which is divided into districts each of which elects a chief and an advisory council. The divisions elect representatives to the territorial assembly. The basic laws are those of France. About 16,000 children attend schools. Outside Tahiti, where the more advanced schools and hospitals are situated, social services tend to be primitive. Most of the people live in villages round the coast of the high islands or concentrated on the main atolls of the low islands.

Economy.—Subsistence agriculture can be maintained without hard work on the high islands, but on the atolls fishing plays a larger part in existence. Some pigs and poultry are kept, and on the plateaus of some of the high islands such as Hiva Oa graze cattle, goats and horses, often wild. Retail trade and activities such as bakeries, slaughterhouses and market gardening are controlled by the Chinese settlers. The chief imports are metalwork,

textiles, gasoline, sugar and flour. The chief exports are phosphates, copra, vanilla and mother-of-pearl, but the balance of trade is generally adverse.

Tahiti has a good coastal road and interisland traffic is carried by a multitude of unscheduled small vessels. Papeete is a port of call for several shipping services and for airliners on the Los Angeles-Sydney route; it is also linked by air services with Honolulu, Fiji, Bora-Bora and Raiatea.

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(F. J. WT.)

FRENCH REPUBLICAN CALENDAR, a calendar adopted in France in 1793, during the Revolution, as a substitute for the Gregorian. Its purpose was not only to show that the establishment of the republic in France marked the beginning of a new epoch for humanity and to substitute a rational and scientific calendar for one less so but also to destroy the Christian associations of the Gregorian system. After 1789 it had become common to add to the Gregorian date the words "Year 1 of Liberty" and, after Sept. 21, 1792, "Year I of Equality" or "of the Republic." On Dec. 20, 1792, the Convention had decreed that its committee of public instruction should submit a project "on the advantages to France of synchronizing her republican era with the vulgar era." Evidently this decree did not envisage the construction of a new calendar, and, moreover, on Jan. 2, 1793, the Convention had decided that that year should be "Year II of the Republic."

Month	Years II, III (1793–95)	Year IV (1795–96)	Years V, VI, VII (1796–99)	Years VIII, IX, X, XI (1799–1803)	Year XII (1803–04)	Years XIII, XIV (1804–05)	Sansculottides (complementary days from 1795)
1 Vendémiaire	Sept. 22	Sept. 23	Sept. 22	Sept. 23	Sept. 24	Sept. 23	Years II–VII
1 Brumaire	Oct. 22	Oct. 23	Oct. 22	Oct. 23	Oct. 24	Oct. 23	
1 Frimaire	Nov. 21	Nov. 22	Nov. 21	Nov. 22	Nov. 23	Nov. 22	
1 Nivôse	Dec. 21	Dec. 22	Dec. 21	Dec. 22	Dec. 23	Dec. 22	1794–99
1 Pluviôse	Jan. 20	Jan. 21	Jan. 20	Jan. 21	Jan. 22	Jan. 21	Sept. 1–17
1 Ventôse	Feb. 19	Feb. 20	Feb. 19	Feb. 20	Feb. 21	Feb. 20	1795 Sept. 6–22
1 Germinal	March 21	March 21	March 21	March 22	March 22	March 22	1799 Sept. 6–22
1 Floréal	April 20	April 20	April 20	April 21	April 21	April 21	
1 Prairial	May 20	May 20	May 20	May 21	May 21	May 21	Years VIII–XIII
1 Messidor	June 19	June 19	June 19	June 20	June 20	June 20	
1 Thermidor	July 19	July 19	July 19	July 20	July 20	July 20	1800–05 Sept. 1–18
1 Fructidor	Aug. 18	Aug. 18	Aug. 18	Aug. 19	Aug. 19	Aug. 19	1803 Sept. 6–23

The committee of public instruction, which consisted of scientists (the chemist A. F. Fourcroy, the astronomer J. J. Le Français de Lalande, the constitutional bishop Joseph Lakanal) and of men of letters (M. J. Chénier, P. F. N. Fabre d'Églantine) well known for their hostility to Christianity, next thought of a rational calendar completely separate from the Gregorian. The idea was already in the air, having been launched as early as 1785; in 1788 Sylvain Maréchal had suggested in the *Almanach des honnêtes gens* a calendar whose year, beginning on March 1, should be divided into 36 decades; in Dec. 1792 it had been requested that the new year be fixed on Sept. 21, the anniversary of the republic's foundation. The chief author of the new calendar was Gilbert Romme, deputy to the Convention for Riom and a former professor of physics; but Lalande, the mathematician Gaspard Monge (not on the committee) and other experts collaborated with him.

On Sept. 19, 1793, Romme read his report to the committee and on Oct. 5 to the Convention. The new plan closely followed Maréchal's pattern as to the division of the year, which consisted of 12 months, each containing three decades of ten days each (*i.e.*, 30 days), with the addition of five supplementary days in ordinary years and six in leap years. It was to begin at the autumn equinox corresponding to the proclamation of the republic, Sept. 22, 1792. The commission had found it difficult to think of names for the months, and the Convention accepted those put forward by Fabre d'Églantine, one of the sponsors of the project, who had a certain poetic gift. He had adapted some names suggested by Maréchal, but those he himself invented seem to have been inspired by an old calendar used in south Germany. Fabre explained that he had tried to take advantage of the harmonies of the French language in the composition and prosody of these new words and of their terminations. The autumn months had a grave sound and a medium measure (Vendémiaire, "vintage"; Brumaire, "mist"; Frimaire, "frost"), the winter months a heavy sound and a long measure (Nivôse, "snow"; Pluviôse, "rain"; Ventôse, "wind"), the spring months a lively sound and a short measure (Germinal, "seed-time"; Floréal, "blossom"; Prairial, "meadow") and the summer months a sonorous sound and a broad measure (Messidor, "harvest"; Thermidor, "heat"; Fructidor, "fruits"). There was one serious drawback to these names—they fitted only the seasons of the northern hemisphere. In the southern hemisphere Thermidor, for example, would have been the coldest month. Hence the nomenclature had no universal validity.

The supplementary days came in a group at the end of the year, and Fabre proposed to call them "Sansculottides," after the most ardent revolutionaries. This was done, but the expression "complementary days" was reinstated when the moderates ousted the *sans-culottes* in 1795. These days were to be devoted to national celebrations.

Individual days were allotted names corresponding to their numerical order in the decade, as follows: *primidi, duodi, tridi* and so on up to *décadi*, which was to be a day of rest and rejoicing. For the saints' names attached to each day in Catholic countries Fabre substituted names of seeds, trees, roots, flowers and fruits. The name of a domestic animal was allotted to each *quintidi* and the name of the tool used during the decade to each *décadi*. Every period of four years was called a *Franciade*.

The Convention adopted this new calendar by the decrees of Oct. 5, 1793, and of 4 Frimaire year II (Nov. 24, 1793), in consequence of which the Sunday rest was abolished and replaced by observance of the *décadi*. The fact that all fair days and payment days had to be altered was a grave blow to traditional customs and above all to the Christian religion. But the revolutionary calendar was followed by few people outside administrative bodies, though the Directory prosecuted those who ignored it.

It was adopted, subject to some modifications of month names, by all the "sister republics" that sprang up outside France between 1795 and 1805: the Batavian, Swiss, Cisalpine, Ligurian, Roman and Neapolitan republics. It was, of course, enforced in the French colonies and annexed territories, such as Belgium, the left bank of the Rhine, the Ionian Islands and Malta. Napoleon, writing to Talleyrand in Aug. 1805, seemed to have no doubt that the calendar would continue in use: "Convey to M. Lezay my displeasure at his dating his letter Aug. 12 and at his not using the *French calendar;* while a law exists it must be obeyed . . ." But a few days later Napoleon himself, setting store by the consolidation of his good relations with the pope and the restoration of the Catholic religion in France, abolished the new calendar. The senatus-consult of 22 Fructidor year XIII (Sept. 9, 1805) fixed the rest day for officials on Sunday and decided that the Gregorian calendar should be restored from Jan. 1, 1806. All the allied or vassal countries affected had already gone back to the Gregorian system by that time.

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(J. Go.)

FRENCH REVOLUTION. The term "French Revolution" is traditionally used to denote the revolutionary movement that shook France between 1787 and 1799 and reached its first climax there in 1789; hence the conventional term "Revolution of 1789," denoting the end of the *ancien régime* in France and serving also to distinguish that event from the later French revolutions

of 1830 and of 1848. Some 20th-century historians, however, notably Robert Palmer in the United States and Jacques Godechot in France, prefer to regard this movement not as a "French Revolution" in the strict sense but as a French phase of a great revolution that began in America with the revolt of the English colonies in the 1770s, spread to the British Isles with the disturbances in England and Ireland (1781–82) and to Europe with the revolt in the United Provinces of the Netherlands (1783–87), the revolt in Belgium (1787–90) and the riots in Geneva (1782), and finally reached France in 1787. This revolution, it is further argued, was then revived in Belgium (1792) and spread to the German Rhineland (1792), to the United Provinces (1795), to Italy (1796) and to Switzerland (1798). According to this view, moreover, the year 1799 did not mark the end of the revolution, for Napoleon consolidated it in France and spread it in Europe; nor did it end with Napoleon's final overthrow in 1815, for it reappeared in 1830 and exploded finally in 1848, when other states no less than France were shaken by it (*see* EUROPE: *History*). The end came only when the general reaction to revolution began in 1849. Thus the French Revolution was only one aspect of a much vaster revolution that affected the west and, in particular, the Atlantic countries and has suggested the description "Western" or "Atlantic" Revolution. Antoine Barnave, one of the first leaders of the Revolution in France, indeed had already claimed in his *Introduction à la Révolution française* that there was not, in the strict sense, a "French Revolution" but a "European revolution which reached its zenith in France." While the present article discusses the Revolution mainly in terms of the characteristics of its phases, the articles FRANCE: *History* and FRENCH REVOLUTIONARY WARS provide detailed accounts of the course of events.

Causes.—The French Revolution had general causes common to all the revolutions of the west at the end of the 18th century and particular causes that explain why it was by far the most violent and the most universally significant of these revolutions.

The first of the general causes was the social structure of the west. The feudal regime had been weakened step by step and had already disappeared in England, in the United States and in northern Italy. The *bourgeoisie* had become numerous and wealthy and was aspiring to political power in those countries where it did not already possess it. The peasants, many of whom owned land, had attained an improved standard of living and education and wanted to get rid of the last vestiges of feudalism, so as to acquire the full rights of landowners and to be free to increase their holdings. Furthermore, from about 1730, higher standards of living had reduced the mortality rate among adults considerably. This, together with other factors, had led to an increase in the population of Europe unprecedented for several centuries: it doubled between 1715 and 1800. Though this was not detrimental to eastern Europe, which had been thinly populated, it had a serious effect on western Europe, which was densely populated and had difficulties in growing enough food. For France, which with 26,000,000 inhabitants in 1789 was the most populated country of Europe, the problem was most acute. This increase in population may well have been the principal reason for the economic transformation of the west in the second half of the 18th century, which saw not only efforts to develop agriculture, to increase the yield of crops and introduce new ones and to improve the breeding of livestock but also the beginnings of the so-called "Industrial Revolution," with new technical inventions and the concentration of certain industries. This in turn was the cause of further social upheavals.

A larger population created a greater demand for food and consumer goods. The discovery of new gold mines in Brazil had led to a general rise in prices throughout the west from about 1730, indicating a prosperous economic situation; but from about 1770 this trend slackened, and economic crises, provoking alarm and even revolt, became frequent. Arguments for social reform began to be advanced. The Philosophes, whose writings inspired these arguments and who concerned themselves more and more with the social problem from 1750, were certainly influenced by

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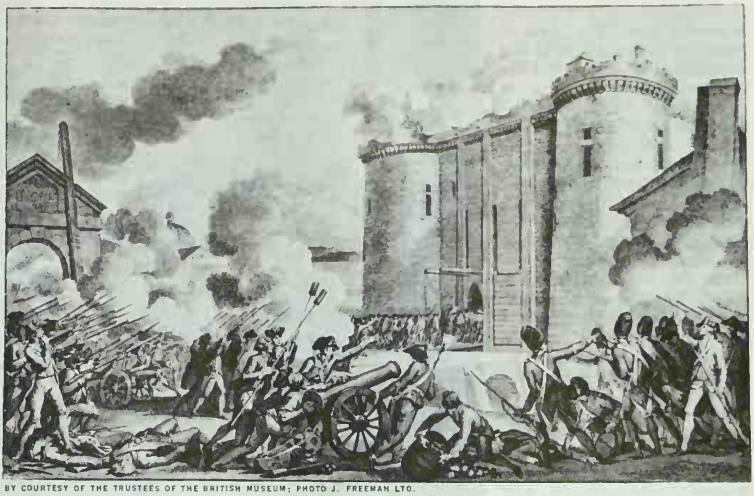
"MEETING OF THE THIRD ESTATE IN A LOCAL TENNIS COURT," VERSAILLES, 1789. PAINTING BY JACQUES LOUIS DAVID, 1790. FROM A COLLECTION IN THE BRITISH MUSEUM

the 17th-century theorists, Descartes, Spinoza and Locke, but they came to very different conclusions about political, social and economic matters. A revolution seemed necessary to apply the ideas of Montesquieu, Voltaire or Rousseau. This Enlightenment (*q.v.*) was spread among the educated classes by the many "societies of thought" that were founded at that time: masonic lodges, agricultural societies and reading rooms.

It is uncertain, however, whether revolution would have come without the added presence of a political crisis. Faced with the heavy expenditure that the wars of the 18th century entailed, the rulers of Europe sought to raise money by taxing the nobles and clergy, who in most countries had hitherto been exempt. To justify this, the rulers likewise invoked the arguments of advanced thinkers, adopting the role of "enlightened despots." This provoked reaction throughout Europe from the privileged bodies, diets, estates (*see* ESTATES-GENERAL) and "sovereign companies" such as the French *parlements*. In North America this reaction caused the American Revolution, which began with the refusal to pay a tax imposed by the king of England. The rulers tried to stop this reaction of the aristocracy; and both the rulers and the privileged classes sought allies among the nonprivileged bourgeois and the peasants. In central Europe the rulers were supported by the third estate, whereas in western Europe, at least in the beginning, the privileged were supported by the *bourgeoisie*.



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"THE FALL OF THE BASTILLE," JULY 14, 1789. DRAWING BY C. MONNET. FROM A COLLECTION IN THE BRITISH MUSEUM

These were the underlying causes of all the revolutions of 1770 to 1789. The French Revolution was to be the most radical and far-reaching of all because (1) France had the largest population in Europe and could not feed it adequately; (2) the rich and expanding *bourgeoisie* was excluded from political power more systematically than in any other country; (3) the peasants were acutely aware of their situation and were less and less inclined to support the anachronistic and burdensome feudal system; (4) the Philosophes had been read more widely in France than elsewhere; and finally (5) French participation in the American Revolutionary War had completed the ruin of the state's finances.

Aristocratic Revolt (1787–89).—The revolt took shape in France when the controller general of finances, C. A. de Calonne, arranged the summoning of an assembly of "notables" (prelates, great noblemen and a few representatives of the *bourgeoisie*) in Feb. 1787 to propose reforms designed to get rid of the deficit in the budget by increasing the taxation of the privileged. The assembly rejected the reforms and demanded the calling of the estates-general, which represented the clergy, the nobility and the third estate and which had not met since 1614. The efforts made by Calonne's successors to enforce reform in spite of resistance led to the so-called revolt of the "aristocratic bodies," notably that of the *parlements* (the most important courts of justice), whose powers had been curtailed by the edict of May 1788. During the spring and summer of 1788 there was unrest in Paris, Grenoble, Dijon, Toulouse, Pau and Rennes. The king, Louis XVI, had to yield; summoning Jacques Necker to the ministry, he promised to convene the estates-general for May 5, 1789. He also, in practice, granted freedom of the press, and France was flooded with pamphlets on projects for the reconstruction of the state. The elections to the estates-general, held between January and April 1789, coincided with further disturbances, as the harvest of 1788 had been a bad one. There were practically no exclusions from the voting; and the electors drew up *cahiers de doléances*, which listed their grievances and hopes. They elected 600 deputies for the third estate, 300 for the nobility and 300 for the clergy.

Revolution of 1789.—The estates-general met at Versailles on May 5, 1789. They were immediately divided over a fundamental issue: should they vote by head, so as to give advantage to the third estate, or by estate, in which case the two privileged ones might outvote the third? In the bitter struggle over this legal issue the deputies of the third estate soon won the support of the parish priests against the privileged, whom the king favoured. The third estate was victorious when, in defiance of the king, it met on June 20 in the *jeu de paume* (tennis) court and swore never to disperse until it had given France a new constitution. The king grudgingly gave in and invited the clergy and nobility to join the third estate and so to form the National Constituent Assembly; but at the same time he began gathering troops to dissolve it.

These two months of prevarication at a time when the problem of maintaining food supplies had reached its climax infuriated the towns and the provinces. Rumours of an "aristocratic conspiracy" by the king and the privileged to overthrow the third estate led to the *grande peur* of July 1789, when the peasants were nearly panic-stricken in fear for their lives. The gathering of troops round Paris and the dismissal of Necker provoked insurrection in Paris. The people on July 14, 1789, seized the Bastille, symbol of royal tyranny. It was no longer a revolt but a revolution. The king had again to yield; visiting Paris, he showed his recognition of the sovereignty of the people by wearing the tricolour cockade.

In the provinces the *grande peur* of July made the peasants rise against their lords. The nobles and the bourgeois now took fright. The National Assembly could see only one way to check the peasants; on the night of Aug. 4, 1789, it decreed the abolition of the feudal regime and of the tithe. Next it followed the example of the American revolutionaries and introduced the *Declaration of the Rights of Man and the Citizen* (Aug. 26), proclaiming liberty, equality, the inviolability of property and the right to resist oppression. The declaration, moreover, was drafted in such terms that it could be applied to any country and by any government, whether monarchical or republican. The bourgeois majority that drafted it, however, was content with equality of rights and said nothing about the social condition of labourers or craftsmen. Even so, the declaration became the creed of a new age.

The decrees of Aug. 4, 1789, and the declaration were such in-

novations that the king refused to sanction them. The people of Paris rose again and on Oct. 5 marched to Versailles. Next day they brought the royal family back to Paris. The assembly followed the court, and in Paris it was to work on the new constitution until the end of Sept. 1791. This constitution brought a social and administrative reorganization that was to remain basically unchanged, though its political regime was only temporary.

The New Regime.—The Constituent Assembly completed the abolition of feudalism, suppressed the old "orders," established civil equality (at least in metropolitan France, since slavery was retained in the colonies) and assured equality of rights in so far as eligibility to public office was concerned. The decision to nationalize the lands of the church in order to pay off the public debt led to a widespread redistribution of property. The *bourgeoisie* and the peasant landowners were undoubtedly the chief beneficiaries, but some farm workers also were able to buy land. Altogether, there was an increase in the number of landowners and an even larger increase in the number of cultivators, and the reform was so radical that no government would be able to undo it. Having deprived the church of its resources, the Constituent Assembly resolved to introduce salaries for the clergy, but first to reorganize the church. Thus it voted the Civil Constitution of the Clergy, which was rejected by the pope and by the majority of the French clergy. This produced a schism which aggravated the violence of the accompanying controversies.

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM. PHOTO J. FREEMAN LTD.

"LOUIS XVI STOPPED IN HIS FLIGHT AT VARENNES" WHILE TRYING TO FLEE THE COUNTRY, JUNE 20–21, 1791. PAINTING BY D. PELLEGRINI. FROM A COLLECTION IN THE BRITISH MUSEUM

The complicated administrative system of the *ancien régime* was swept away by the Constituent Assembly, which substituted a rational system based on the division of France into *départements*, districts, cantons and communes administered by elected assemblies. The principles underlying the administration of justice were also radically changed, and the system was adapted to the new administrative divisions. The judges were to be elected.

The Constituent Assembly tried to create a monarchical regime in which the legislative and executive powers were shared between the king and an assembly elected for two years by the "active citizens"; *i.e.*, by those Frenchmen who paid more than a certain amount in tax. This regime might have worked if the king had really wanted to govern with the new authorities, but Louis XVI was weak and vacillating and was the prisoner of his aristocratic advisers. The Civil Constitution of the Clergy, which he had been forced to promulgate, horrified him. On June 20–21, 1791, he tried to flee the country, but he was stopped at Varennes and brought back to Paris.

Revolution and Counterrevolution in France and in Europe.—The events in France gave new hope to the revolutionaries who had been defeated a few years before in the United Provinces, in Belgium and in Switzerland. Likewise, all who wanted changes in England, in Ireland, in Germany, in the Austrian lands or in Italy viewed the Revolution with sympathy. In all these countries Revolutionary clubs were formed, and there were demonstrations in the streets. The "enlightened despots," alarmed, gave up their programs of reform, rejected the help of the lower classes and made new advances to the aristocrats. The disappointed lower classes therefore lent a ready ear to the news from France. In the mustering of forces in support of the old systems of government it is noteworthy that the most important apologists of counterrevolution were not French subjects: Edmund Burke was an Irishman, Jacques Mallet du Pan a Swiss, and Xavier de Maistre a Savoyard subject of the king of Sardinia. Numbers of the French counterrevolutionaries—nobles, ecclesiastics and some bourgeois—abandoned the struggle in their own country and emigrated. They formed armed groups close to the northeastern frontier of France and sought help from the rulers of Europe. The rulers were at first indifferent to the Revolution but began to worry when the Constituent Assembly proclaimed a revolutionary principle of international law, namely that a people had the right of self-determination. In accordance with this principle the papal territory of Avignon was reunited with France on Sept. 13, 1791. The gulf widened between France and the rest of Europe. The persecution of supporters of the Revolution, collectively described as Jacobins, increased outside France, and finally France declared war on Austria and Prussia on April 20, 1792.

War and Its Consequences.—Warfare was to continue, with very little interruption, until 1815. It ended with a partial victory for the great ideas of the Revolution. The regime of 1790 was consolidated in France and also in some other parts of Europe to which it had subsequently been introduced; and elsewhere hopes of an analogous regime were strengthened. The course of the war, however, produced new upheavals in France and in Europe in general. In the first phase (April–Sept. 1792) France suffered defeats, the Austro-Prussian army crossed the frontier and advanced rapidly toward Paris. Believing that they had been betrayed by the king and the aristocrats, the French revolutionaries rose on Aug. 10, 1792, occupied the Tuileries, where Louis XVI was living, and imprisoned the royal family in the Temple. At the beginning of September, the Parisian crowd broke into the prisons and massacred the nobles and clergy imprisoned there. Meanwhile the volunteers were pouring into the army, as the Revolution had awakened nationalism. In a final effort, the French forces checked the Prussians on Sept. 20, 1792, at Valmy. "This place and day," declared Goethe, who was present at the battle, "marks the beginning of a new era in the history of the world." On the same day a new assembly, the Convention, met. Next day it proclaimed the abolition of the monarchy and the establishment of the republic.

In the second phase of the war (Sept. 1792–April 1793) the

revolutionaries got the better of the enemy. Belgium, the Rhineland, Savoy and the county of Nice were occupied by French armies, which abolished the feudal regime there. In France the Convention was divided between the Girondins (*q.v.*), who would have liked to organize a bourgeois republic in France and to spread the revolution over the whole of Europe, and the Montagnards or men of the Mountain, who, with Robespierre, wanted to give the lower classes a greater share in political and economic power but wanted to restrict their revolutionary activity to France. Despite efforts made by the Girondins, Louis XVI was judged by the Convention, condemned to death for treason and executed on Jan. 21, 1793.

In the spring of 1793 the war entered a third phase, marked by new French defeats. Austria, Prussia and Great Britain formed a coalition, to which most of the rulers of Europe adhered. France lost Belgium and the Rhineland, and invading forces threatened Paris. These reverses, as those of 1792 had done, strengthened the extremists. The Girondin leaders were driven from the Convention, and the Montagnards, who had the support of the *sans-culottes* (workers, craftsmen, shopkeepers, smallholders and agricultural labourers), seized power and kept it until 9 Thermidor year II (July 27, 1794). The Montagnards were bourgeois liberals like the Girondins, but under pressure from the *sans-culottes* and in order to meet the requirements of defense they adopted a radical and advanced economic and social policy. They introduced the *maximum* (government limitation of prices), taxed the rich, brought national assistance to the poor and to the disabled, declared that education should be free and compulsory, ordered the confiscation and sale of the property of *émigrés* and proposed, though did not enforce, the confiscation of suspected persons' property and its free distribution among the poor. These exceptional measures provoked violent reactions: the wars of the Vendée, the "federalist" risings in Normandy and in Provence, the revolts of Lyons and Bordeaux and the insurrection of the Chouans in Brittany. Opposition, however, was broken by the Terror, which entailed the arrest of at least 300,000 suspects, 17,000 of whom were sentenced to death and executed while more died in prisons or were killed without any form of trial. At the same time the revolutionary government raised an army of more than 1,000,000 men.

Thanks to this army, the war entered its fourth phase (from the spring of 1794). A brilliant victory over the Austrians at Fleurus (June 26, 1794) enabled the French to reoccupy Belgium. Victory made the Terror and the economic and social restrictions seem pointless. Robespierre, "the Incorruptible," who had sponsored the restrictions, was overthrown in the Convention on 9 Thermidor year II (July 27, 1794). The *sans-culottes*, whose leaders he had executed in March and April 1794 for refusing to submit to the discipline of the Terror, did nothing to save him. Soon after his fall the *maximum* was abolished, the social laws were no longer applied, and efforts toward economic equality were abandoned. Reaction set in; the Convention began to debate a new constitution; and meanwhile, in the west and in the southeast, a royalist or "white" terror broke out. Royalists even tried to seize power in Paris, but were crushed by the young general Napoleon Bonaparte on 13 Vendémiaire year IV (Oct. 5, 1795). A few days later the Convention dispersed.

Bourgeois Republic and Revolutionary Expansion.—The constitution of the year III, which the Convention had voted, was inspired both by the constitution of 1791 and by that of the United States. The executive power was to be exercised by a Directory of five members, elected for five years, though one of the five seats was to be refilled every year. The legislative power was entrusted to two chambers, elected for three years, with one-third of the membership being replaced every year. The broad outline of the administrative organization created by the Constituent Assembly was retained (only the districts were abolished). This regime, which was that of a bourgeois republic, would have developed smoothly if war had not perpetuated the struggle between revolutionaries and counterrevolutionaries throughout Europe. The war, moreover, embittered existing antagonisms between the Directory and the legislative councils in France and often gave rise to new ones. These disputes were settled by *coups d'état*, chiefly those of 18 Fructidor year V (Sept. 4, 1797), which removed the royalists from the Directory and from the councils, and of 18 Brumaire year VIII (Nov. 9, 1799), which abolished the Directory itself.

After the victory of Fleurus the progress of the French armies in Europe had continued. The Rhineland and Holland were occupied, and in 1795 the Dutch, Tuscany, Prussia and Spain negotiated for peace. When the French army under Bonaparte had entered Italy (1796), Sardinia came quickly to terms. Austria was the last to give in (treaty of Campo Formio, Oct. 1797). Most of the countries occupied by the French were organized as "sister republics," with institutions modeled on those of France. Such were the Batavian republic (Holland), the Cisalpine in Lombardy, and the Ligurian in Genoese territory.

Peace on the continent of Europe did not end revolutionary expansion. The majority of the directors had inherited the Girondin desire to spread the Revolution over Europe and listened to the appeals of Jacobins abroad. Thus French troops in 1798 and 1799 entered Switzerland, the papal states and Naples and set up the Helvetic, Roman and Parthenopean republics. Great Britain, however, remained at war with France. Unable to effect a landing in England, the Directory, on Bonaparte's request, decided to threaten the British in India by occupying Egypt. An expeditionary corps under Bonaparte easily occupied Malta and Egypt, but the squadron that had convoyed it was destroyed by Nelson's fleet at Abu Qir on Aug. 1, 1798. This disaster led to the formation of a second coalition of powers alarmed by the progress of the Revolution. This coalition of Austria, Russia, Turkey and Great Britain won great successes during the spring and summer of 1799 and drove back the French armies to the frontiers. Bonaparte thereupon returned to France, to exploit his own great prestige and the disrepute into which the military reverses had brought the government. His *coup d'état* of 18 Brumaire overthrew the Directory and substituted the consulate. Though Bonaparte proclaimed the end of the Revolution, he himself was to spread it in new forms throughout the world.

See NAPOLEON I.

See also references under "French Revolution" in the Index.

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FRENCH REVOLUTIONARY WARS is the title given to the hostilities of 1792–99 between France and one or more of the European powers. It thus comprises the first seven years of the period of warfare that was continued through the Napoleonic Wars (*q.v.*) until Napoleon's abdication in 1814, with a year of interruption under the peace of Amiens (1802–03). The end of 1799 may be conveniently taken as the dividing point between the Revolutionary and the Napoleonic phases of the conflict, since in that year the consulate of Napoleon Bonaparte was established.

The present article is divided as follows:

1. Nature of the Wars
2. European Situation, up to 1792
3. French Declaration of War
4. Campaign of 1792
5. First Coalition and the Jacobin Regime
6. Campaigns of 1793
7. Campaigns of 1794
8. War at Sea and in the Colonies, to 1795
9. Peace Treaties and the Campaigns of 1795
10. Directory and the Campaigns of 1796–97
11. Coup of 18 Fructidor and the Peace of Campo Formio
12. Great Britain and the War (1796–97)
13. French Expedition to Egypt and Syria (1798–99)

14. Formation of the Second Coalition
15. French Dispositions in 1799
16. Campaigns of 1799

1. Nature of the Wars.—While all warfare is undertaken for political reasons, the French Revolutionary Wars are exceptional for the degree to which they were concerned with political considerations. They are associated above all with the appearance in France, and with the imposition by France on neighbouring states, of fundamental changes in the structure of the state and society. No other European wars have shown such intimacy with, or novelty in, political motives. The Napoleonic Wars, which grew out of those undertaken by the first French republic, were characterized by the extent to which they retained and extended the political and social innovations of Revolutionary France. It will be seen that the political situation in Revolutionary France impelled the new government to make war on neighbouring states and that French Revolutionary doctrines as well as French expansionist policies encouraged these states to oppose France in the field. The course of the French military and foreign policy, furthermore, was greatly influenced by the continuation of an internal political and social revolution during hostilities, and in this too the continual interaction of political and military affairs presents a marked contrast with the Napoleonic Wars. For details of the political background in France, *see* FRANCE: *History;* FRENCH REVOLUTION.

Nevertheless, it would be wrong to lose sight, amid this unfamiliar background to war, of more conventional considerations in the motives and conduct of the belligerent powers. The leaders of the French Revolution took over and expanded traditional objectives of French foreign policy. Conversely, although the restoration of the *ancien régime* in France and its preservation in the rest of Europe was among the motives of the attack by France's enemies, so often and so greatly did they allow this objective to be obscured by the demands of their traditional interests that it must be considered as subsidiary to their fundamental objectives in making war. The British especially, being geographically insulated and having a more liberal constitution than their continental allies, were concerned far less with combating revolutionary ideology than with preventing French attempts to create a continental hegemony. In contracting the series of alliances with the powers of the first coalition in 1793, Great Britain indeed insisted that they abandon their demands for a royalist restoration (virtually, unconditional surrender), so that ultimate war aims were left uncertain. The British sought to uphold a balance of power in Europe that would enable them to affirm their control of the seas, to extend their colonial conquests and to achieve predominance as a trading and manufacturing nation both beyond Europe and on the continent.

The wars of the Revolution and of the first empire were the culmination of an intermittent Franco-British conflict that had begun with the War of the Grand Alliance and the War of the Spanish Succession (*qq.v.*). At its close Great Britain had finally succeeded in preventing France's predominance in Europe and asserted British supremacy overseas. Great Britain, with a population not much more than one-third that of France in 1789, depended for strength on preponderance in commerce and manufactures and so was preoccupied with the sources and maintenance of wealth, which required that military efforts should be concentrated on naval and colonial affairs. This diminished still further Great Britain's ability to mount substantial operations in Europe; for this the continental allies, immediately threatened by invasion and not lacking in military manpower, had to serve. Great Britain, however, saw that if the French could impose peace on their own terms on Europe, they would be free to mobilize their resources against the British at sea and in the colonies and to close the European markets essential to British commerce. Therefore Great Britain, alone of all the coalition powers ranged against France, remained at war for virtually the entire duration of the Revolutionary and Napoleonic Wars, pursuing a strategy dominated by maritime, colonial and economic motives. The divergences in interests and objectives between the British and their European allies explain some of the dissensions which arose in the allied camp and also the hostility that Great Britain was to encounter among the neutral powers. By blockading French-held ports and issuing licences to control trade with the enemy bloc, the British advanced their own interests to the detriment or at least the expense of the neutrals. Thus, broadly speaking, throughout the wars from 1792 to 1815, Great Britain devoted the profits from an increasingly advantageous position in world trade to furthering the struggle with France, while the French, since they could not match British maritime power, were obliged to master Europe if they were to turn the tables on Great Britain strategically and economically.

During the period 1793–99, however, it was by no means certain that France would have to wait until Europe had been pacified before defeating Great Britain. For the first few years of the war the existing strength of the French fleet, if it could gain enough support from other states' navies, seriously threatened to overcome the British naval supremacy. For some time Great Britain's preoccupation with colonial warfare proved costly, comparatively unsuccessful and, eventually, detrimental to the outcome of the war in Europe, where British land forces, if fully mobilized, might have tipped the balance. Only twice in the Revolutionary Wars did small British expeditionary forces fight in Europe, and then only in Holland, in 1794 and 1799, though 60,000 British troops fell by 1796 in the largely indecisive fighting in the West Indies—more than were to be lost during Wellington's campaigns in the Iberian peninsula (1808–14), where they not only were able to reconquer Spain and Portugal but also to tie down far larger numbers of French troops.

The British government was unique in its ability to undertake an enormous debt in order to finance its own war effort and to subsidize that of its allies. The great expansion of the British national income, however, was at that time due far more to unusually favourable terms of trade in conventional goods produced by largely conventional means than to the initiation of the Industrial Revolution—the distinguishing characteristics of which belong to the years after 1815. On the other hand, the wars put obstacles in the way of industrial development and financial organization on the continent, so that Great Britain's lead in these fields seems to have been lengthened still further by the time peace came.

Two factors contributed considerably to the outbreak and to the course of the early years of the French Revolutionary Wars: (1) the weakness of France caused by the Revolution itself, which from the meeting of the estates-general in May 1789 continued with mounting intensity and throughout the first three campaigns (1792, 1793 and 1794); and (2) the second and third partitions of Poland (1793 and 1795), which served to distract the continental powers from their invasion of France.

The unprecedented successes of the French in the Revolutionary Wars were due to their advantages in numbers; to the fact that France, even before the Revolution, was in many respects the most developed nation on the continent; and finally to the often contradictory effects of revolutionary ideals and methods. The first French republic could afford to be prodigiously wasteful of its resources in making war; it could utilize the energies and wealth of the entire population to a degree far beyond the limits of action available to the neighbouring continental governments of the *ancien régime*. These novel developments, however, lay several years ahead, when the continental powers undertook to make war on Revolutionary France. Indeed, in very large part, the most striking characteristics of French Revolutionary warfare, together with the men and the domestic policies of the Jacobin committee of public safety with whom it is associated, owed their appearance to the first successes of the invaders, whose threat to the new regime inspired the Terror, its radical political reforms and the massive mobilization of national resources.

For Great Britain the many complexities of the European scene during the first three years of the French Revolution were problems of secondary importance, since the influence of the chief rival state on the continent had been largely neutralized by internal dissension. Inevitably, Great Britain was less concerned by developments in eastern and central Europe, and less than a year before the outbreak of war with France (Feb. 1793) Pitt reduced the strength of the home army from 17,000 to 13,000. When war came, Pitt, with most of his countrymen, anticipated that it would soon be over.

It may be pointed out that the British, throughout the Revolutionary and Napoleonic Wars, avoided recourse to a system of direct conscription for the army; and even the pressing of men for the navy fell, or was intended to fall, on merchant seamen. The expedients adopted in recruiting land forces during the first years of the war were not particularly efficient. In order to free regular regiments, which were recruited wholly from volunteers, for service overseas, 30,000 militiamen were called up in 1794 for home defense; but since it was permissible to pay a substitute to perform militia service, the recruitment of regular formations suffered in consequence.

2. European Situation, up to 1792.—The last years of the 1780s and the early 1790s had been marked by a general instability in European affairs which considerably affected the position of the continental powers as hostilities with France approached. In Holland (the United Provinces of the Netherlands) the stadholder, William V of Orange, had been assisted by Prussia and by Great Britain in his difficulties with the democratic party supported by France. Frederick William II of Prussia sent his troops into Holland in 1787 and concluded with Great Britain and the stadholder the triple alliance of 1788, intended to oppose French influence in Dutch affairs and Russian and Austrian designs against Poland and Turkey. The entente between Great Britain and Prussia, however, was soon dispelled by the latter's overambitious policy. In 1789 Prussia came close to declaring war on Russia and Austria, having urged Sweden to invade Russia and the Poles to seek the return of Russian annexations. Both Austria and Russia were engaged in war with Turkey. In Dec. 1789 Austria was confronted by a revolt in the Austrian Netherlands (roughly, modern Belgium) against the Holy Roman emperor Joseph II's doctrinaire liberalization of their institutions. Dissatisfied with the course of Prussian policy and desiring to strengthen the Austrian Netherlands against France, Great Britain welcomed the chance of a *rapprochement* with Austria. Despite the growing understanding between Austria and Great Britain, the Prussians concluded an alliance with the Poles in March 1790 and massed their troops near Austria's Bohemian frontier. Leopold II, however, the new Holy Roman emperor and ruler of the Austrian dominions, signed a truce with the Turks, and the Poles refused to cede Torún and Gdánsk to Prussia in return for aid. Dangerously isolated, Prussia came to terms with Austria at Reichenbach (July 27, 1790) and even adumbrated a common front against the French Revolution in which the possibility of annexing some French territory might arise.

Meanwhile the continuation of Russian and Austrian hostilities with Turkey prevented effective action by the continental powers against France. Peace with Turkey was signed finally by Austria on Aug. 4, 1791, and peace preliminaries by Russia on Aug. 11. Next, however, tension grew up in central Europe. At the end of 1791 Catherine the Great had brought a Russian army of 130,000 to the Polish frontier. Though it was prepared to offer Austria and Prussia a share of the spoils should they oppose its designs on Poland, the Russian government declared its enthusiasm for a monarchical alliance against France—both in order to cover its intentions against Poland and in the hope of directing Prussian and Austrian attention to the west. Thus it is clear that France had occupied a secondary place in the minds of European statesmen until mid-1791. Events in France, far from inspiring the powers with the zeal that they professed for a monarchical crusade, had encouraged them to seek advantages in the east while the French were preoccupied with their internal affairs. Later, the very real divisions among the continental powers were to precipitate their defeat by the French armies.

Austria had shown little response to Prussia's suggestions, from the Reichenbach convention onward, for joint action against France with the double purpose of counteracting the Revolution and making territorial gains in the west. The Prussians' own interest in such a policy and the fact that the Polish situation had yet to be regulated were powerful arguments to deter the Austrians from committing themselves in the west while Russia's hands were free in the east. Yet Leopold's concern for the safety of his sister Marie Antoinette and her husband, Louis XVI of France, led him to promise positive action when he heard that they were about to escape from their critical position (the flight to Varennes, June 1791). On Aug. 27 he and the king of Prussia issued the declaration of Pillnitz, appealing to the European sovereigns to use force to strengthen Louis XVI's position.

In Paris the Legislative Assembly, from which members of the former Constituent Assembly were excluded, met on Oct. 1, 1791. The situation which confronted its less experienced and more radically minded deputies continued to deteriorate. There was a worsening financial crisis, right-wing insurrections had arisen in the Vendée in August, and peasant risings were continuing elsewhere. The declaration of Pillnitz, however, instead of intimidating the supporters of the Revolution, served to discredit the moderate Feuillants in the assembly, which grew more disposed to war. In Dec. 1791 the French government called upon the elector of Trier, Clement Wenceslas of Saxony, to disband the armed forces of *émigrés* on his territory, whereupon Leopold retorted that he would defend the elector against aggression. Then, in March 1792, Leopold's son and successor, the Holy Roman emperor Francis I, was informed by Marie Antoinette that the Girondin ministry, which Louis XVI had just accepted, was about to attack the Austrian Netherlands. Austria and Prussia, though their relations were already strained over the actual disposition of their forces in the west and over the steps to be taken in the event of Russian action in Poland, sent a circular to the European powers on April 12, inviting concerted action.

Contradictory motives impelled the new Girondin ministry and its supporters to hostilities, though they had failed to recruit foreign support. War, they hoped, would safeguard and complete the Revolution, exposing the bad faith of the king and his relations with the *émigrés*. La Fayette and the partisans of constitutional monarchy believed that war would strengthen the new regime and Louis's position by distracting popular attention from domestic problems. The Girondins, led by Brissot, gained the support of the Jacobins, for the club ignored the pleas of Robespierre and the extreme left who with reason—as events were to show—opposed a war managed by aristocrats, foreseeing that they might use it against the Revolution.

3. French Declaration of War.—On April 20, 1792, the Girondin ministry's proposal to declare war on Austria (but not on the empire) was ratified by the assembly, which a month later likewise undertook war against Sardinia, which had responded affirmatively to the Austro-Prussian circular of April 12, as did Russia. Dumouriez, the French minister of foreign affairs, like La Fayette and the comte de Narbonne (Louis de Lara), envisaged a short war—defensive on the upper Rhine and, if Spain should attack, in the Pyrenees, offensive in Savoy and in Belgium—from which the victorious army would return to restore the king's power in a stabilized democracy. They discounted the growing crisis in the nation's economic and political life; they ignored the manifold weaknesses of the army which was to carry out this ambitious policy; above all they underrated the army's divisions and hesitations over the political considerations which bulked continually larger in the public mind.

Far from saving the king, the war, naturally enough, soon precipitated the fall of the monarchy, long suspected of plotting to overthrow the new regime. On June 13 Louis dismissed the Girondin ministry in favour of the more moderate Feuillants that it had replaced. A week later there were demonstrations at the Tuileries to demand the restoration of the Girondins. La Fayette on June 28 left his headquarters to appear in the assembly, but returned to the army disappointed in his hopes of checking the advance of popular pressure on the government and the existing constitution. At the end of July he moved his forces to Compiègne, but with no more influence on the course of events in Paris. The new ministry, attacked by the Girondins, resigned on July 10. During the second half of July the Jacobin republican movement in Paris grew fast, attracting widespread support from the provinces. On July 27 Charles William Ferdinand (*q.v.*), duke of Brunswick, commander of the allied army, issued the celebrated manifesto which, by threatening Paris with reprisals if the king and queen were harmed, stimulated French determination to resist.

On Aug. 10, 1792, when the Tuileries palace was sacked by a mob and the king's Swiss guard slaughtered, the revolutionary commune of Paris assumed the powers of the municipality. The Legislative Assembly recognized the insurrectionary commune, suspended the monarchy and resolved that a new national assembly, the Convention, should be elected by universal male suffrage to determine the future form of government. Having failed to raise the northeastern districts and to turn his army against Paris, La Fayette fled across the frontier with Alexandre de Lameth and many of his officers on Aug. 19. Two days later, the peasantry of the Vendée took up arms against Paris. The "second Revolution" that began on Aug. 10 soon wrested control of affairs from the assembly, increasingly the prisoner of the Paris commune. A provisional executive council was nominated, of which Danton was the moving spirit. The multiplication of authorities extended from the capital and government to the army and the frontiers. The assembly dispatched *représentants en mission;* the *conseil exécutif* sent *commissaires*, as did the commune. The commune had made its first arrests on Aug. 10. Less than a month later, the first Terror began with the September massacres.

4. Campaign of 1792.—For his invasion of France, Brunswick had only 29,000 Austrians and 42,000 Prussians available, together with 4,000–5,000 *émigrés*, since 25,000 Austrians had to remain on guard in Belgium and 16,000 on the Rhine.

Small though these numbers may seem for the repulse of the French attack on Belgium and Brunswick's march on Paris, the condition of the numerically superior French forces, not to mention the disorder in France, offered substantial hope of success to the allies. The regular French army was under strength and with 82,000 men (including garrisons) would find it difficult to sustain prolonged hostilities. Morale and efficiency too had suffered grievously from the emigration of more than half the officer corps; the defections to follow and the deepening divisions of the nation as the Revolution went on were to aggravate distrust, uncertainty and indiscipline. The separately brigaded volunteer battalions, on the other hand, enrolled after July 11, 1792, to fight for one campaign, were better paid and, electing their own officers, had enthusiasm for the cause; but they lacked training, equipment, arms and discipline, and their presence provided a further solvent of the morale of the regulars, whom they were frequently to abandon under fire. The reverses of the allies in 1792 were due primarily to the inadequacy of their own strategy and second to the efforts of the old army that the Revolution had inherited from the *ancien régime*.

One reason why Austria, with an estimated total of 223,000 men under arms, and Prussia, with 131,000, withheld so much of their strength from Brunswick's invasion force was their mistrust both of one another and of Russia with regard to Poland. The Russians began their invasion of Poland on May 19, 1792, and had occupied most of the country by the end of July. Only then did Brunswick's army set out from Coblenz. Even so, it suffered from divided counsel: Brunswick urged an overhesitant strategy envisaging a systematic advance with the reduction of the fortresses on the Meuse and reserving a march on Paris for the following spring, while the king of Prussia and Hohenlohe (Friedrich Wilhelm von Hohenlohe-Kirchberg) thought in terms of a military promenade to carry them to Paris by the late summer.

The army crossed the French frontier on Aug. 19, took Longwy on Aug. 23 and Verdun on Sept. 2, crossed the Meuse and reached the Argonne plateau on Sept. 8. Its right, under Clerfayt, then was supposed to watch the French army of Sedan; its left rested on the Verdun-Châlons road a few miles east of Valmy. The army of Sedan, however, which had been falling back from the frontier before Dumouriez took command on Aug. 28, now marched boldly southward across Clerfayt's front (Sept. 1–3), escaped a turning movement by Clerfayt (Sept. 13) and reached Ste. Menehould, east of Valmy, where Dumouriez' 23,000 men were joined by the marquis de Beurnonville (Pierre de Ruel) with 12,000 men from the north. While Dumouriez kept guard against the allied centre's attempt to encircle the French by a southwesterly movement, Kellermann arrived with 18,000 men from the French army of Metz and took up a position facing westward against the left of the allies.

The decisive battle of Valmy (*q.v.*), on Sept. 20, was little more than a prolonged and heavy cannonade in which 40,000 rounds were fired. When the Prussian infantry advanced, the French held firm. Seeing his columns hesitate, Brunswick ordered the retreat. At Valmy 34,000 Prussians had faced 52,000 French, of whom 36,000 were engaged. Total casualties were fewer than 500. The unexpectedness of the reverse, due largely to the staunchness of Dumouriez' regular troops and to his artillery, increased its great moral effect. Militarily it was a victory for the Revolution in that it gave the French a substantial breathing space. The wastage of effectives in Brunswick's army (particularly from dysentery), leaving him only 17,000 fit for campaign, obliged him to retire from the theatre of war and to accept Dumouriez' offer, sanctioned by Paris, to negotiate a suspension of hostilities.

Brunswick's retreat to the Meuse allowed Dumouriez to turn his attention to the northern frontier. Having been held up in an advance on Lille, the Austrian army of the Netherlands had withdrawn toward Mons early in October. On Nov. 6, in the battle of Jemappes (*q.v.*), Dumouriez' heavily superior numbers brought him success in an assault en masse—the most practicable formation for his inexperienced and ill-trained troops—delivered frontally without preliminary maneuver. The battle was typical of the early Revolutionary victories where sheer weight of numbers and *élan* supplied the want of training, discipline and organization. Overrunning Belgium, the French advanced into Germany and took Aachen.

Meanwhile, in September and October, the French army on the Rhine, under Adam Philippe de Custine, was winning successes; advancing northward across the Palatinate, it took Speyer, Worms and Mainz and then turned eastward and seized Frankfurt, which it held till Dec. 2. In September Sardinian resistance collapsed before the marquis de Montesquiou (A. P. de Montesquiou-Fezensac) in Savoy and Jacques d'Anselme in the county of Nice.

5. First Coalition and the Jacobin Regime.—The new Convention, which had been at one in proclaiming the republic on Sept. 21, 1792, was afterward deeply divided, and its extremists were insistent on an aggressive and provocative policy, which the deceptive triumphs of 1792 greatly encouraged. On Nov. 16, 1792, it declared that the navigation of the Scheldt was open to all nations, thus abrogating the Austrian regime's undertaking of 1785 and inviting British hostility. Three days later, France offered assistance to any people rising against its government. In December, as if this challenge were not enough, the Convention undertook to introduce the social reforms of the Revolution in the territories occupied by French forces. It was moreover in the months after Valmy and Jemappes that France's claims to "natural" frontiers—the Rhine, Alps and Pyrenees—were heard, in effect, for the first time (the history of the concept can be traced to Vauban's memoranda in Louis XIV's time and even to Julius Caesar). Some inhabitants of Nice, Savoy and the Rhineland had asked for annexation by France and, consequently, social reform, in the first weeks of their occupation. Later the commanders of the ill-found occupation forces had pursued varying policies in the administration of their territories, frequently to the disillusionment of local champions of revolution (after Sept. 1793 the committee of public safety ordered the systematic spoliation of all the occupied territories). Savoy was annexed on Nov. 27, 1792. Anxious to escape wholesale reform, particularly of the church, the Belgians (Dec. 4) and the Rhinelanders asked for independence. The financial difficulties of the Revolution and its armies encouraged the Convention to conclude that the Austrian Netherlands should pay for its own "liberation" by the proceeds of enforced reforms and that the already heavily inflated assignats should be "exported." Nice was annexed on Jan. 31, 1793. Next the Belgian provinces were absorbed, since it had become clear that only annexation would prevent a counterrevolution in the occupied countries. The Rhineland was taken over on March 17 and the bishopric of Basel made a *département* on March 23.

Confronted by such policies, Great Britain, already allied with the Dutch from 1788, was inevitably drawn into the war. In addition to their alarm at the course of French conquests, the British became suspicious of French intentions toward the United

Provinces of the Netherlands. Lord Grenville, the British foreign secretary, protested to the French ambassador, F. B. de Chauvelin, against decrees of Nov. 6 and 19 and finally, on Jan. 24, 1793, gave him his passports. A week later the Convention declared war. War between France and Spain was declared on March 7; and before long the French republic was to find itself at war with all Europe, save for Switzerland and Scandinavia.

After some initial successes, the weaknesses of the first coalition were to bring its armies to a standstill or else to retreat before the hasty general mobilization of the French population. The coalition was based on Great Britain's alliances with Russia (March 25, 1793), Sardinia (April 25), Spain (May 25), Naples (July 12), Prussia (July 14), Austria (Aug. 30) and Portugal (Sept. 26). There was thus no common pact, and there was to be no common understanding of aims, still less a united command. The absence of an integrated strategy and the dispersal of forces to Poland and to naval and colonial warfare hamstrung the coalition's attack on France. Austro-Prussian unity, in particular, shaken as it was by the defeats at Valmy and at Jemappes, was further impaired because Prussia, in Jan. 1793, concluded with Russia a second treaty for the partition of Poland under which Austria received nothing.

Against the formidable numbers to be sent against them in 1793 the French had their regular troops and the volunteers who had remained with the colours. To bring the armies up to strength it was agreed in February—too late to influence the early stages of the campaign—to levy 300,000 men (about half this number joined the army); and during March the measure was applied, with general success, through the exertions of 82 *représentants en mission*. By July French effectives numbered about 650,000, and it was with these forces that the rest of the campaign of 1793 was fought, since the 440,000 men raised by the *levée en masse* of Aug. 23 had yet to be equipped and incorporated. The *amalgame* of the army's regular and Revolutionary formations was decreed in principle in Feb. 1793 but not begun until spring 1794. Until then, recruits were drafted into existing formations.

The course of military events in the spring and early summer of 1793 (*see* below) might well have been disastrous for the republic but for the advent to power of the energetic government of the Jacobins in Paris.

On April 6, 1793, the Convention, which had condemned Louis XVI to death in January, established a Jacobin-inspired committee —the committee of public safety—intended to control the acts of the moribund and discredited Girondin ministry. As earlier in the Revolution, a movement in public opinion further to the left and recourse to extremist measures had arisen in response to the imminent danger that the regime would be overthrown by the allies' final success in the field. The Convention and the commissioners, namely *représentants en mission*, whom it was now sending to each army to establish its authority, were already dominated by the committee before the overthrow of the Girondins on June 2, 1793. In the north the *représentants en mission* ordered a local *levée en masse* on Aug. 4. Ten days later, Lazare Carnot (*q.v.*), the moving spirit of the committee in military affairs and later to be justly called the "organizer of victory," entered the committee with a demand for a general *levée en masse* for which he drafted the decree of Aug. 23:

> Article I. From this moment until that in which our enemies shall have been driven from the territory of the Republic, all Frenchmen are permanently requisitioned for service in the armies.
>
> Young men will go forth to battle; married men will forge weapons and transport munitions; women will make tents and clothings and serve in hospitals; children will make lint from old linen; and old men will be brought to the public squares to arouse the courage of the soldiers, while preaching the hatred against kings and the unity of the Republic.

The new government's actions, and its plight, were no less extreme than this declaration. It had to make way against the collapse of public credit and formidable economic difficulties. The Bourse had closed on June 27, 1793. Forced loans were raised, and between October and December all foreign commerce was prohibited. The notorious Law of Suspects (Sept. 17, 1793) announced the employment of the Terror to crush obstruction to the central committee's purpose. The queen was sent to the guillotine on Oct. 16. A fortnight later the Girondin chiefs were tried and condemned; and in November constitutional changes replaced local self-government by an almost complete centralization of power. The effect of Jacobin rule, however, on the recruitment and immediate organization of the army was decisive in stemming the tide of invasion.

The successes of the army of the Revolution and its composition, however, have given rise to many misunderstandings. Its novelty lay in its numbers, far greater than those of the other states of the period; in its wholesale adoption of the divisional system; and in its composition, which, as a result of conscription, made it the first national army of modern times. The divisional system, in which the units were between 8,000 and 9,000 strong in 1794, was developed during the Revolution to permit the articulation of an army in which detachable and independently maneuverable members replaced a single, rather rigid mass; but its introduction can be dated from developments in the 1760s. The really effective appearance of the corps system, like the strategy which its use permitted, is directly associated with Bonaparte during the consulate and empire.

6. Campaigns of 1793.—Foreseeing that the French would invade Holland rather than pursue their advance into Germany on the northern front, the Prussians early in Feb. 1793 sent some reinforcements to the Dutch, to whom the British also sent a small contingent under Frederick duke of York. Dumouriez, having launched his invasion, found himself obliged to hasten back to Belgium to confront an advance by the Austrians under Prince Josias of Coburg (Friedrich Josias of Saxe-Coburg-Saalfeld). Prematurely engaging the Austrians at Neerwinden, west of Liège, he was severely defeated on March 18. Defeated again at Louvain three days later, he then entered into negotiations and concluded an armistice with Coburg's chief of staff, Karl von Mack: the Austrians were to reoccupy the southern Netherlands, and Dumouriez would lead the French troops against Paris to overthrow the Convention. In the event, however, Dumouriez failed to persuade his troops to take part in his treasonable plan and had to seek refuge behind the Austrian lines (April 5), whereupon the Austrians went forward into French Hainaut (April 9). The French had to abandon their entrenchments at Famars, 5 mi. S. of Valenciennes, on May 23; and the Austrians finally took Condé on July 10 and Valenciennes on July 28. While the French under Charles Jennings Kilmaine now concentrated in Artois on his right, Coburg moved toward Cambrai, the next step on the road toward Paris. There was an encounter at Marquion, between Cambrai and Arras, on Aug. 10. At this moment Coburg, the coalition's commander in chief in the north, had 100,000 men at his disposal; but he could not press forward with them because the Prussians on the one hand transferred their contingent to the east while the Anglo-Hanoverians on the other insisted on besieging Dunkerque. The scene of active operations was thus temporarily shifted to the country between Lille and the Channel coast. Reinforced, the French army there, under Jean Nicolas Houchard, defeated the Hanoverian general F. X. J. Freytag at Hondschoote on Sept. 8, thus relieving Dunkerque. Houchard, however, failed to follow up his advantage, and Coburg, still on the front north of Cambrai, was able to take Le Quesnoy on Sept. 12 and to begin the siege of Maubeuge, farther to the east, on Sept. 28. The victory of the French at Wattignies (Oct. 15–16) compelled him to raise the siege and averted the immediate threat to Paris.

On the eastern front, meanwhile, Custine, with 45,000 men, was threatened with encirclement in the spring of 1793. The Prussians crossed the Rhine at Bacharach and defeated his left on the Nahe (March 27–28), while D. S. von Wurmser's Austrians, crossing the Rhine north of Speyer, advanced on his right. To extricate himself and to protect Alsace, Custine withdrew most of his forces to Landau. The Prussians were thus free to invest Mainz, where the French garrison put up a fine resistance and obtained an honourable capitulation before marching out on July 23. The fall of Mainz, however, was the only real success for the allies on this front. Throughout the summer Brunswick's Prussians took no decisive action against the French army of the Moselle in the

Saarland, though they prevented its junction with the army of the Rhine and won a battle at Pirmasens (Sept. 14). South of Landau the army of the Rhine was in a strong position in the Wissembourg line on the Lauter river; and when at last Wurmser breached this line (Oct. 13) the French made good their retreat farther south, while Landau still held out. By November, Carnot could send more forces to the eastern front and find new commanders for the two armies: Pichegru for the Rhine and Hoche for the Moselle. Both armies took the offensive, but Hoche's attempt to relieve Landau by a direct attack from the east against the Prussians was checked at Kaiserslautern (Nov. 28). Hoche then turned southeast, unhindered by the Prussians, to join the slowly advancing army of the Rhine. Wurmser, to avoid being caught between the converging armies, retired northward. Hoche, placed in command of the two French armies, now advanced steadily down the Rhine valley to Speyer, relieving Landau on the way. By the end of the year Wurmser's Austrians were back on the right bank of the Rhine.

On the southeastern front the Sardinians (20,000 men) were held in check throughout the spring by Kellermann's army of the Alps. In Kellermann's rear, however, Lyons revolted against Jacobin control at the end of May, and the subsequent diversion of forces from the army of the Alps enabled the Sardinians to overrun Savoy; but though the siege of rebel Lyons lasted from Aug. 8 to Oct. 8, the French were strong enough to recover Savoy in the autumn. The revolt of Marseilles, coinciding with that of Lyons, had necessitated a further diversion from the army of the Alps but was put down by the end of August. A more serious blow to the republicans was the loss of Toulon, handed over by the royalists there to Adm. Lord Howe's British squadron on Aug. 28. William Pitt, the British prime minister, was particularly anxious to exploit this opportunity, but could not do so for lack of ready ships and men, 7,000 troops having been sent to the Caribbean in the preceding winter; nor could the Sardinians afford much help for Toulon, since the contingents that they had been expecting from Austria were sent instead to help Wurmser on the Rhine. After a long siege by the republican forces, among which the young Napoleon Bonaparte distinguished himself, Toulon fell on Dec. 19. The only lasting result of the enterprise for the allies was the destruction of 34 French warships in the harbour, including 13 ships of the line.

On the southwestern front the Spaniards, with 50,000 men and a Portuguese contingent, concentrated their major effort on the invasion of Roussillon from the eastern end of the Pyrenees. Gen. Antonio Ricardos led his forces across the frontier on April 16, 1793, and reached the Tech river on April 18, but his advance on Perpignan was repulsed on July 17. Villefranche de Conflent, southwest of Prades, fell however to the Spaniards early in August, and by the end of the month the Spaniards had established themselves on the left bank of the Têt. The northward progress of the Spaniards was halted by the French recapture of Villefranche on Sept. 17. At the western end of the Pyrenees, where Ventura Caro was in command of the Spanish armies, a few frontier positions changed hands in 1793, but the campaign was fought for the most part defensively by both sides.

Western France in 1793 was thrown into confusion by the revolt of the Vendée, which broke out in March and soon grew into a civil war (*see* VENDÉE, WARS OF THE). The rebels appealed for British help and won some notable victories until the late summer. Then the 12,000 men who had capitulated at Mainz could be set to serve against the rebels. The open war was virtually brought to an end by the republican victory at Savenay (Dec. 23), though guerrilla actions continued.

7. Campaigns of 1794.—Despite their largely unnecessary setbacks in 1793, the allies had reconquered Belgium and the left bank of the Rhine and taken three fortresses (Condé, Valenciennes and Le Quesnoy) in the north of France. Yet by the beginning of 1794 their prospects of success were far smaller than they had been in the previous year. The increase in French effectives was now assuming massive proportions; and with Kosciuszko's successful rising against the Russians in Poland in March 1794 the attentions and resources of the continental powers were drawn irresistibly to the suppression of the revolt and toward the final partition of Polish territories. Inevitably Polish affairs dissolved what understanding remained between Austria and Prussia.

Great Britain's relations with Prussia were unsatisfactory from the start of the campaign of 1794. On April 19 Pitt's envoy Lord Malmesbury signed a treaty with the Prussians, who had threatened to quit the field, by which Great Britain undertook to support 62,400 troops by paying £300,000 and thereafter £50,000 per month. Reinforcements from Prussian troops in British pay under W. J. H. von Möllendorff in the Palatinate did not move to the Low Countries, as Pitt had wished, and thus further friction between London and Berlin had been caused to no avail. The British had barely 12,000 men in the theatre, and since the Austrians could spare no reinforcements, the allies had only 185,000 between the sea and Luxembourg. Against them the French had almost as many, and Möllendorff's lethargy in the south, like Brunswick's in 1793, was to allow them to achieve heavy numerical superiority and to seize their advantage on the main front.

In the spring of 1794 the allied forces under Coburg in northern France occupied a deep salient between the French army of the North (150,000), which blocked their road to Paris and threatened their right flank in western Flanders, and the army of the Ardennes, which stood on their left between the Sambre and the Meuse. When Pichegru, in command of both armies, began his offensive with a thrust into Flanders by his left, Coburg's Austrians could move southward up the Sambre to take Landrecies (April 30) and engage the French centre round Le Cateau; but the attempt to isolate the advanced French left under Joseph Souham and J. V. Moreau between the Lys and the Scheldt was frustrated by the French victory at Tourcoing (May 18). The army of the Ardennes, meanwhile, was trying to take Charleroi but had so far met with no success, though its numbers were raised to 50,000 through the efforts of Saint-Just, the Convention's *représentant en mission*. It was the arrival of 40,000 more men under Jourdan from the army of the Moselle that transformed the situation. The army of the Moselle was primarily supposed to contain the Prussian right and centre on the eastern front; but in the last week of May the 40,000 under Jourdan set off northwestward from Longwy against the Austrians under J. P. de Beaulieu in the duchy of Luxembourg east of the army of the Ardennes and drove them back toward the Meuse. The junction with the army of the Ardennes was effected on June 3, and the resultant formation was to become famous in the annals of the Revolution as the army of Sambre-et-Meuse. Charleroi fell to it on June 25, while Pichegru's army of the North, on the Flanders front, took Ypres. Coburg now decided to withdraw from his increasingly dangerous salient before the French could cut off his retreat by a drive from Charleroi. Anxious to prevent Jourdan's interference with his withdrawal, Coburg attacked him with inferior forces near Fleurus, 7 mi. N.E. of Charleroi, on June 26, and was defeated, but the disorganization of the French forces after their victory and their heavier losses allowed the allies to retreat from Belgium in good order.

On July 27, the very day of Pichegru's entry into Antwerp and Jourdan's into Liège, the regime of Robespierre and Saint-Just in Paris was overthrown. Though the successes of the armies that the Jacobins had raised and reorganized had removed the justification for extreme measures, the Terror had nevertheless been intensified; and reaction against the regime had culminated in the *coup d'état* of 9 Thermidor and in the death of Robespierre and of Saint-Just next day (July 28). (*See* FRANCE: *History.*)

On the eastern front all this time the Prussians under Möllendorff and Hohenlohe were concerned chiefly to keep their army in being. They worsted the French in two actions at Kaiserslautern (May 23 and Sept. 30) but finally retired across the Rhine in October. The armies of the Rhine and of the Moselle could thus converge to besiege Mainz. When Jourdan's army, having consolidated its position in Belgium, turned eastward in September, the Austrians in Germany between the Meuse and the Rhine gave way: Aachen and Cologne fell, and by Oct. 23 Jourdan was in Coblenz. By the end of the year, therefore, the army of Sambre-et-Meuse and the army of Rhin-et-Moselle were in contact along

the left bank of the Rhine from the frontier of the Netherlands to Alsace; and Mannheim, on the right bank, was taken on Dec. 24. At the same time Pichegru, having crossed the Dutch frontier in October and overrun the country south of the Lek, was on the point of completing the conquest of the rest of the United Provinces, from which the British troops were withdrawn to Hanover. Behind the French lines, however, an Austrian garrison, besieged from Nov. 24, still held the fortress of Luxembourg.

The disastrous outcome of the coalition's campaign in the Low Countries was largely attributable to Prussia's and to Austria's reaction to the Polish rising of March 1794. Since the Russians could not find enough troops to suppress the rising at once, Prussia sent 50,000 men into Poland in the summer; Austria, however, sent no more than 20,000. Russian reinforcements did not arrive till October, and the rising was brought to an end only with the capitulation of Warsaw on Nov. 6. The Poles, therefore, had prevented any of the Russian forces from being used against France and had tied down numbers of the Prussian and Austrian; and the virtual defection of the Prussians from the fighting in the west so exasperated the British government that in Oct. 1794 it stopped its subsidy to Prussia. Thereupon Frederick William gave orders for negotiations to be sought with the French. In following this course, he could hope not only to free his own hands for action in Poland but also to leave Austria embroiled in the west and so unable to exclude Prussia from the forthcoming third partition of Poland.

Against the Sardinians and their Austrian auxiliaries the French maintained two armies in 1794: that of the Alps and that of Italy. The army of the Alps captured the Little St. Bernard pass and the Mont-Cenis pass in April–May, while the army of Italy, from Nice, occupied the Col di Tenda. Bonaparte's plan for a co-ordinated invasion of Piedmont, with the major thrust delivered by the army of Italy across Genoese territory, was suspended, however, in August (after Thermidor). Instead, Carnot decided to reinforce J. F. Dugommier's army of the Eastern Pyrenees. Dugommier already had driven the Spaniards out of Roussillon (April–June 1794) and entered Catalonia but was held up by the lines in front of Figueras. On Nov. 28, however, Figueras fell to the French, who then proceeded with the siege of Rosas. At the western end of the Pyrenees the French repulsed a Spanish offensive on the Bidassoa, took the offensive themselves in April, crossed the frontier into the Baztán valley and, by outflanking the Spaniards, captured Fuenterrabia and San Sebastián in the summer. By the end of the campaign the Spaniards had lost Tolosa also. A Spanish force of 8,000 men crossing the central Pyrenees from Jaca in order to surprise Oloron by marching down the Gave river was routed by 1,000 Frenchmen at Lescun in September.

8. War at Sea and in the Colonies, to 1795.—At the outbreak of war the British navy had 113 ships of the line, of which 75% could be put into service once crews had been found for them. Against these the French could mobilize 76. But the French navy suffered greatly in the early years from the consequences of emigration, treason and indiscipline, and it proved far more difficult to create an efficient fleet than it did to reorganize the army. Later, however, the French were to have not only the Dutch fleet of 49 ships but also the Spanish, which numbered 76 of the line in 1793 (of which 56 were in commission). In the early years of the war the British navy was not strong enough to free large squadrons to seek general actions, for it had to provide ships to maintain the blockade and to protect Great Britain's extensive lines of communication. The successive capture or destruction of enemy ships and the heavy program of naval construction, which was to furnish 24 ships of the line between 1793 and 1801, permitted the admiralty to affirm its command of the seas by the late 1790s, when a series of successful battles was fought and the earl of St. Vincent (John Jervis) organized, after 1798, a system of permanent surveillance off enemy ports.

In May 1794, Earl Howe had set out to intercept a large French convoy from America and met Louis Villaret de Joyeuse's squadron, which had come out to protect it. In the battle of the First of June (*q.v.*) the British captured six of the French ships of the line, but Villaret was able to return to Brest, though he had only 9 ships left capable of action to Howe's 15. Howe's successor, Henry Hotham, was no more successful in establishing an unchallenged British supremacy at sea, and he did not find it possible to fight a decisive battle. In the Mediterranean, however, the British fleet could scarcely be challenged, thanks largely to the Spanish and Neapolitan alliances. Apart from the intervention at Toulon (1793), the British were able to occupy Corsica, where Pasquale Paoli (*q.v.*) had appealed to them for help: Nelson took Calvi in Aug. 1794. In Nov. 1794, however, Tuscany made overtures for peace with France.

In colonial warfare, too, the French succeeded in maintaining an unequal struggle longer than the British or they themselves might have expected. In the autumn of 1793 the British occupied the ports of Santo Domingo. During 1794 the 7,000-man expeditionary force with which Jervis had set sail in Nov. 1793 to assault the French West Indies succeeded in capturing Guadeloupe, St. Lucia, Marie Galante and the Saints, and established itself on Haiti, where it took Port-au-Prince by midsummer. In Haiti, however, the rising of Toussaint L'Ouverture's 500,000 followers was directed against both the French and the British, and the British held only the coastal settlements by the close of 1795.

9. Peace Treaties and the Campaigns of 1795.—The prospect of peace with Prussia and with Tuscany was opportune, indeed, for France, where the abandonment of the Jacobins' controlled economy after Thermidor had precipitated the worst consequences of inflation. The administration of the army, which lacked equipment and supplies, fell into disorder. This disorder, the course of political events and the removal of the threat of invasion served to increase the rate of desertions alarmingly.

A peace treaty with Tuscany was signed on Feb. 9, 1795. This was followed by the convention of La Jaunaye (Feb. 17), whereby an amnesty was accorded to the guerrilla leaders of the Vendée. Then, in the night of April 5–6, the peace of Basel was finally concluded between France and Prussia: to safeguard Prussian neutrality, a line of demarcation was drawn whereby northern Germany, including Hanover, was closed to the belligerents; and by a secret clause Frederick William agreed to abandon his support of the exiled stadholder of the Netherlands, William V of Orange. This peace of Basel enabled the French to deliver an ultimatum to the Dutch; and by the peace of The Hague (May 16, 1795) the estates-general of the United Provinces ceded the left bank of the Scheldt estuary, Maastricht and Venloo to the French republic and allied themselves with it, agreeing also to pay an indemnity of 100,000 florins. It was because of this enforced change of side that the Dutch lost some of their colonies to the British, who occupied the Cape on Sept. 16 and later seized Dutch Guiana.

The second peace of Basel was that concluded between France and Spain (July 22, 1795): the French, who had lost some of the territory won in Catalonia but had advanced farther into the Basque country, undertook to withdraw to their old frontier, while the Spaniards ceded Santo Domingo to France.

There was, however, much division of opinion in France over the policy that the Revolution should follow abroad. The matter derived more urgency from the possibility of signing a peace with the Holy Roman empire—over which Austria had very little real control—since the imperial diet was prepared to make peace with France provided that the integrity of the empire was respected; *i.e.*, if the French would abandon their conquests west of the Rhine. The French annexationist party, however, regained a majority in the government, and the proposal was rejected.

Austria, therefore, together with Sardinia and Great Britain, remained at war with France. Already in Jan. 1795 Austria and Russia had come to an understanding for a third partition of Poland, overriding Prussia's extreme claims; and on May 20 a new Austro-British treaty was concluded whereby Great Britain (weak in land forces and committed to operations overseas of decidedly secondary importance) granted Austria a subsidy of £600,000 for the maintenance of 200,000 men in the field. The Austrians, indeed, had considerable success on the Rhine in 1795. When the army of Sambre-et-Meuse under Jourdan, having taken the fortress of Luxembourg (June 25), eventually crossed the

Rhine at Düsseldorf and at Neuwied in September, Clerfayt's Austrians were at first driven back southeastward to Main; but Pichegru, instead of advancing in strength from Mannheim with the army of Rhin-et-Moselle to co-operate with Jourdan in destroying first Clerfayt and then Wurmser, let himself be repulsed: he was in treasonable collusion with the enemy. After Clerfayt had won a victory over Jourdan at Höchst (Oct. 10), Wurmser defeated Pichegru's army outside Mannheim (Oct. 18), took Mannheim (Nov. 23) and crossed to the left bank of the Rhine. Jourdan had to retreat westward as far as the Moselle, and Clerfayt, overrunning the Palatinate, obliged him to accept an armistice on Dec. 19. Pichegru, recoiling toward Alsace, likewise signed an armistice on Dec. 31. In the autumn of 1795 Russia had acceded to the Anglo-Austrian alliance.

The Austro-Sardinian forces, supported by the British fleet, had some success on the southeastern front in the early summer of 1795, but the Franco-Spanish peace of Basel made possible the reinforcement of the army of Italy. Under Barthélemy Schérer, who took command of that army in October, Augereau and Masséna won the battle of Loano (Nov. 23–24), but the immediate opportunity of pushing on to Turin was not taken.

10. Directory and the Campaigns of 1796–97.—On Aug. 22, 1795, the new and notably unrealistic constitution of the year III had been promulgated in Paris. Its greatest internal weakness lay in the tenuous relationship between the Directory and the chambers. Control of the executive lay in the hands of the five directors, to whom the ministers, named by them, were responsible. Political divisions, widespread dissatisfaction with the regime, distress among the nation at large and increasing pressure from the right obliged the government to curtail the elections for the new chambers in order to ensure a majority of Conventionnels in the council of the 500 and in the council of the *anciens*. Bonaparte overcame the threat of a royalist *coup d'état* with the "whiff of grapeshot" of Oct. 5 (13 Vendémiaire year IV). Next, on May 10, 1796, the Directory was again threatened directly, if far less seriously, this time from the left, by the Babeuf conspiracy. The difficulty of establishing a regime of moderate views and policies in a nation riven so recently by the multiple anarchies of the Revolution serves partly to explain the formation of the Directory's foreign policy. Even so, the decision of the Thermidorians to retain and extend the conquests of the Revolution had impelled France to a career of expansion in which the separate peace treaties imposed on defeated states would be no more than truces in the struggle against the rest of Europe—temporarily divided but collectively superior in economic power and in number. So long as the British maintained the struggle, the French could always foresee renewal of war with one or more of the European powers in alliance with Great Britain. Yet such far-reaching considerations were vouchsafed to only a few French statesmen, and the development of policy was to be controlled very largely by the appreciation of immediate advantages or in response to pressing needs.

The Directory undertook the campaigns of 1796 in the hope of ending the war on the continent with the advance toward Vienna of Jourdan's army of Sambre-et-Meuse and Moreau's of Rhin-et-Moselle, together 150,000 strong. The army of the Alps under Kellermann and that of Italy under Bonaparte, who received his command on March 2, 1796, were far inferior in numbers and still poorer in supplies, for they were intended to play only a secondary role, attempting, if possible, the conquest of Piedmont and Lombardy. In the event, Bonaparte's Italian campaign, his first as a commander in chief and among the most remarkable in history, was to furnish the Directory with the opportunity of forcing Austria out of the war.

Campaign in Germany.—Crossing the Rhine at Düsseldorf again at the end of May 1796, Jourdan advanced to Wetzlar on the Lahn river before the counterattack by the archduke Charles, who had taken Clerfayt's place, drove him back over the Rhine. Moreau, however, from Strasbourg, crossed the Rhine on June 24, and the Austrian opposition to him was weakened by the transfer of Wurmser with part of its strength to the Italian theatre of war. Charles, therefore, who had taken command of all the Austrian forces on the Rhine, now judged it prudent to withdraw from the Palatinate. Jourdan crossed the river yet again at Neuwied and this time advanced right into Bavaria, pushing back the lesser Austrian force under W. L. von Wartensleben and reaching the Naab river; but at Amberg on Aug. 24 Charles attacked Jourdan with the bulk of the Austrian army and won a victory. Pursuing Jourdan toward the Main, Charles defeated him again at Würzburg on Sept. 3, after which Jourdan withdrew to the Lahn and finally to the left bank of the Rhine again. Thus Moreau, who had been halted by Charles at Malsch on July 7 but had subsequently pressed on toward Munich with the army of Rhin-et-Moselle, might have been isolated in Bavaria if Charles had turned promptly southward after defeating Jourdan. Moreau, however, made good his withdrawal to Alsace, and throughout the winter of 1796–97 the Austrians were held at Kehl (opposite Strasbourg) and at Huningue. In the spring of 1797 Hoche, who had succeeded Jourdan in command of the army of Sambre-et-Meuse, was conducting a brilliant offensive and was on the point of enveloping the Austrians under Freiherr von Werneck between the Lahn and the Nidda rivers when the armistice of Leoben (*see* below) suspended hostilities.

Campaign in Italy.—Bonaparte's campaign of 1796 marked the appearance of the new system of war—the organization of the Revolution's methods of warfare and the ideas of previous 18th-century reformers into a coherent and immensely effective body of strategic thinking and technique. The changes in the French army's personnel, logistics and tactics during the Revolution had not been accompanied, until Bonaparte's assumption of command in Italy, by a corresponding revolution in strategy. In very many ways, the generalship of the armies of the republic had closely resembled the methods of the enemy commanders who had continued to employ the strategical concepts of the *ancien régime*, and the French had owed their successes primarily to superior numbers and mobility. Where these advantages did not obtain, the coalition powers had enjoyed a fair measure of success.

Bonaparte's first objective at the opening of the campaign was to separate the Austrian and Sardinian forces in the expectation that the defeat of the latter would lead them to fall back on their capital, Turin, and thus oblige the Austrians to withdraw from them, eastward, to protect Milan and their lines of communication.

In this grand strategy, as in the conduct of the individual battles and marches of the campaign, he sought by every means to divide the forces opposing him and to concentrate superior strength at the point that he had chosen for the decisive stroke. The difference between Bonaparte and lesser commanders who have equally perceived the advantages of such situations lay in his constant determination to create a favourable opportunity for attack—often, even, to escape from an immediately dangerous position—and in his unusual ability to calculate the means by which a successful offensive might be launched, customarily by the use of interior lines and by insistence on superior speed of movement.

After less than three weeks' campaigning and five engagements, the Sardinians were forced to withdraw from the coalition and to surrender Savoy and Nice to France (armistice of Cherasco, April 28, 1796). Bonaparte now turned his forces to attack the Austrian Milanese. As so often in this campaign, his seizure and consolidation of a bridgehead over the Po at Piacenza demonstrated the limited usefulness of river lines as a means of defense. After the encounter at Lodi (May 10), which preceded the Austrians' evacuation of Lombardy, Milan was occupied on May 15. On May 27 the French secured permission from the neutral republic of Venice to pursue the Austrians across its territory, through which the Austrians were already allowed to pass. The Mincio river was forced, principally at Borghetto on May 30, because the Austrians under Beaulieu had been strung out with few reserves and with no chance of concentrating to obtain local superiority. The Austrians abandoned the Mincio to retire to the strong fortress of Mantua and the valley of the Adige. Their temporary departure from the field allowed the French to enter the northern papal states (the legations), with which an armistice was concluded on June 23, and to occupy Leghorn, where the English base was surprised. At Genoa, Murat secured the expulsion of the Austrian ambassador and the protection of the French lines of

communication. The appearance of Wurmser and his forces from Germany restored the initiative and numerical superiority to the Austrians. His object was to relieve Mantua, where the French besieged 14,000 men and were on the point of success.

With the approach of the Austrian forces from the north Bonaparte's situation had become extremely dangerous. Before long it became clear that Wurmser was marching with the main Austrian force to relieve Mantua, whose siege he expected Bonaparte to cover, while P. V. Quasdanovich struck farther to the west to pierce the French communications at Brescia. Though it entailed the loss of his siege train and though the surrender of the fortress seemed imminent, Bonaparte abandoned the siege of Mantua and thus threw Wurmser's offensive temporarily off balance. Leaving a rear guard to check Wurmser's pursuit, Bonaparte moved all his available forces against Quasdanovich, whom he drove back at Lonato on Aug. 3. Two days later, Wurmser was defeated in his turn at Castiglione (*see* CASTIGLIONE, BATTLE OF). Bonaparte's unexpected success was due not only to his sacrifice of the investment of Mantua but to the extraordinarily hard marching that his strategy had demanded of his army.

Wurmser met with no more success in his second attempt to relieve Mantua, whose investment the French had resumed. Again the Austrians divided their forces, and when the main enemy body had been committed to the Brenta valley, Bonaparte attacked Paul Davidovich's troops in the Tirol with greatly superior numbers, instead of falling back to Verona. Thus Wurmser found himself pursued down the Brenta to be heavily defeated at Bassano on Sept. 8, whence he was fortunate to escape to Mantua.

Severe though the previous crisis had been, the French came closest to disaster with the actions fought around Arcole in November. The defeats in Germany, which now permitted the Austrians to send heavy reinforcements to Baron Alvinczy (Joseph von Barbarek) so that he could regain the initiative in Italy, had depressed French morale. The army's physical condition was pitiable. Its numbers were reduced by the losses of its numerous actions, arduous campaigning and an outbreak of fever. The enthusiasm with which it had supported prolonged marching and fighting had waned at the prospect of yet another Austrian counteroffensive. To meet it, Bonaparte dared not release the troops employed to contain the numerous Austrian forces in Mantua, and the division in the Tirol, under the comte de Vaubois (Claude Henri Belgrand), like the main French army was outnumbered. Bonaparte withdrew his force through Verona to reappear at Arcole to threaten Alvinczy's rear and lines of communication. After four days' indecisive and costly fighting in the marshes of the Adige, Alvinczy's flank was turned and his army obliged to retreat. Early in the new year, Alvinczy returned to the attack, descending the Adige while Giovanni di Provera advanced on Mantua. Leaving a defensive screen to check Provera, Bonaparte concentrated all his remaining troops to rout Alvinczy at Rivoli on Jan. 14, 1797. He then promptly regrouped the bulk of his forces to attack Provera, who had reached Mantua. Overwhelmed by Bonaparte's converging forces, Provera was obliged to capitulate on Jan. 16, and Mantua surrendered on Feb. 2.

The conclusion of Bonaparte's first campaign in Italy was no less swift and eventful than its earlier course. A fortnight's campaign was sufficient to reduce the ill-prepared papal states. By the treaty of Tolentino, Feb. 19, 1797, Pope Pius VI abandoned his claim to Avignon and consented to pay an indemnity, to hand over works of art and to cede the Romagna and the legations of Bologna and Ferrara. These territories, together with Austrian Lombardy and the duchy of Modena, the ruler of which Bonaparte deposed, were to be formed into the Cisalpine republic. The new state was to be completely under French control and to undergo the reforms of the Revolution. On March 20 Bonaparte began a short and final offensive against the archduke Charles, who had been transferred from the Rhine front to take Alvinczy's place. Charles retreated northeastward; and at Judenburg in Styria, on April 7, Bonaparte signed armistice preliminaries. On April 18 at Leoben, two days' march from Vienna, without any authorization from the Directory, he ratified the armistice and signed the peace preliminaries. Meanwhile a quarrel was being picked with the Venetians, whose ancient republic was replaced by a democratic regime in May.

11. Coup of 18 Fructidor and the Peace of Campo Formio.—Between the armistice of Leoben and the signature of the peace of Campo Formio with Austria in the autumn, the basic instability of the regime in France led to another coup in Paris. The *coup d'état* of 18 Fructidor year V (Sept. 4, 1797) was provoked by the growth of royalist representation of the councils and in the provinces, where, especially at Marseilles and Lyons, the anti-Jacobin movement was strong enough to initiate a white terror. The government, however, remained in the hands of the opposite camp, since four out of the five directors were men of Jacobin views. These four enlisted the support of Bonaparte, who sent troops to Paris under Augereau to ensure the purge of 18 Fructidor, when the director François de Barthélemy and 53 deputies were arrested, elections in more than half the *départements* annulled, liberty of the press suspended and banishments decreed. The rule, after 18 Fructidor, of what has been termed the second Directory was in effect a dictatorship, with the result that the impulse toward an ambitious foreign policy was greatly strengthened.

Bonaparte's freedom to dictate virtually his own terms to Austria led to the signature at Campo Formio, on Oct. 17–18, 1797, of what could only be a truce and not a final settlement. The treaty preserved the bulk of Bonaparte's Italian conquests for France. By way of compensation for the loss of possessions in Lombardy, Austria received the Venetian territories east of the Adige; but Venice's Ionian Islands were retained for France. At the same time Austria agreed that France should annex the occupied German lands south and west of a line drawn from Venloo on the Meuse to the source of the Nette river, then along the Nette to the Rhine between Andernach and Neuwied and then southward up the Rhine to the Swiss frontier. The estates of the empire were to meet in a congress at Rastatt to ratify these arrangements and to consider how the dispossessed German princes should be compensated.

12. Great Britain and the War (1796–97).—For Great Britain the loss of the Austrian alliance in 1797 was the culmination of a long succession of misfortunes and setbacks. Naples had signed an armistice with France on June 5, 1796, and peace on Oct. 10. On Oct. 6, moreover, the alliance between France and Spain under the treaty of San Ildefonso (negotiated in August) had been made public. This so strengthened enemy sea power as to threaten British maritime supremacy, and Pitt thought that the situation demanded an attempt to open peace negotiations. Though the Austrians at this point refused to associate themselves with the British, Malmesbury was sent to Lille on Oct. 14, 1796, to demand the abandonment of Belgium and the cession of colonies as the conditions of peace. Then the death of Catherine the Great, in November, led to a weakening of Great Britain's understanding with Russia. In little more than two months after Malmesbury's arrival, the Directory, as was to be expected, instructed him to return to England. On Aug. 10, 1797, Portugal made peace with France.

The combined French, Dutch and Spanish navies had sufficient numbers to challenge Great Britain's command of the seas, barring the British fleet from the Mediterranean, threatening communication and commerce (it was in 1797 that the French took their greatest number of prizes, capturing 700 merchantmen) and, above all, menacing the British Isles, where an invasion force, once landed, might hope to succeed. Furthermore, the completely unsatisfactory living conditions in the British fleet caused the mutinies of Spithead (April–May) and the Nore (May–June). Talks with the French were resumed on July 7 but collapsed, partly because of the growing insecurity of the government in Paris, whose fall might be expected to offer greater advantages than its representatives were prepared to admit. Yet, as has been noted, the purge of 18 Fructidor was to stiffen French policy.

Great Britain was certainly not so disadvantageously placed as to be ready for peace at any price or likely to ignore the prospects of a more favourable prosecution of the war. The economic warfare of the Directory had not prevented the increase of British exports; and though government expenditure had been almost

trebled between 1792 and 1797, the marked growth in national income permitted heavy borrowing by the government to make up the mounting deficit. For more than a year Great Britain stood alone against France, and a growing sense of the need to sustain the war and the national cause pervaded British society. In the budget of 1798 Pitt increased the assessed taxes, and in an act of 1799 he introduced the income tax, levied at 2*s.* in the pound on incomes over £200 and at graduated rates down to incomes of £60 per annum.

Apart from these internal considerations, two naval victories in 1797 did much to reduce Great Britain's immediate concern. Jervis' defeat of the Spanish fleet off Cape St. Vincent on Feb. 14 was followed by his blockade of Cádiz (*see* ST. VINCENT, BATTLE OF); and Admiral Duncan defeated the Dutch fleet at Camperdown on Oct. 11.

13. French Expedition to Egypt and Syria (1798–99).—On his return from an inspection in the west, Bonaparte advised the Directory (Feb. 23, 1798) to abandon its project for an invasion of Great Britain. He and the Directory then turned their attention to the Mediterranean and, in particular, to Egypt, from which the French might dislocate British trade in the Levant and, possibly, threatened the British position in India.

The expedition sailed from Toulon on May 19, with a fleet of 65 navy vessels escorting 280 transports and an army of 38,000 men. It reached Malta, which surrendered at once, on June 6 and landed in Egypt on July 1, having narrowly escaped the fleet with which Nelson had set off from the Gulf of Cádiz in pursuit. On July 21 the French routed the Mamelukes in the battle of the Pyramids and entered Cairo. Nelson, who had gone back as far as Sicily, appeared with his fleet in Aboukir bay, and in the battle of the Nile, in the night of Aug. 1, destroyed all of the French fleet but two ships of the line and two frigates.

Nelson's victory stimulated European opinion toward a resumption of hostilities with France and encouraged the Turks, nominal sovereigns over Egypt, to declare war on Sept. 9. With the support of a British squadron, they began to assemble an army in Syria for the invasion of Egypt. Bonaparte resolved to anticipate this by an offensive in Syria, for which he set off in Feb. 1799 with 15,000 men. The obstinate defense of Acre—assisted by Sir Sydney Smith's capture of the vessels bringing the French siege artillery—obliged Bonaparte on May 20 to begin the retreat to Egypt, in which his already much depleted force suffered considerable losses. Not long after his return to Egypt the Turks landed an army at Aboukir which the French destroyed on July 25. On Aug. 22, 1799, Bonaparte handed over the Egyptian command to Kléber in order to return to France. The allies in the war of the second coalition had reached the frontiers of France and had brought the government close to collapse. Its weaknesses, together with the threat of a royalist reaction, offered Bonaparte the opportunity to make himself its master.

14. Formation of the Second Coalition.—If Bonaparte's expedition to Egypt had paved the way to a second coalition by inspiring the alliance of Great Britain, Russia and Turkey, the foreign policy of the Directory itself had served still more to provoke a new alliance which, with the adhesion of Austria, would oblige the French to exert every effort if they were to retain their conquests in Europe. From the beginning of 1798 the Directory had undertaken new conquests which Vienna could construe as a violation of the settlement of Campo Formio. At the end of 1797 local revolutionaries had attempted a rising in Rome. For this the French were blamed, and their general, Léonard Duphot, was killed in a riot. The French army of Italy was ordered to march on Rome, where the Roman republic was proclaimed on Feb. 15, 1798. Bonaparte had prompted the Directory to occupy Switzerland, where the democratic party had hoped not for a French invasion but for sufficient menaces from the French to make the governing classes submit to its demands. On the night of Feb. 13–14, 1798, the Directory ordered an advance on Bern, which capitulated after some brisk fighting. The cantons were summoned to raise 15,000,000 francs for France. At the same time the French intervened in the internal affairs of the other satellite republics. In Holland the Batavian assembly was obliged on Jan. 22, 1798, to draft a new constitution more in keeping with French demands. On Feb. 21 the Directory concluded an alliance with the Cisalpine republic which maintained its occupation by 25,000 troops at the expense of the population. Meanwhile, at the congress of Rastatt, which had begun its sessions on Nov. 16, 1797, the French demanded not only the Rhine frontier as proposed at Campo Formio but also the Cologne area north of the Nette; and the estates of the empire agreed to this in principle on March 9, 1798. In the nine *départements* which the French had formed from the Austrian Netherlands, the bishopric of Liège and the territory ceded by the Dutch in 1795, and in the four *départements* of the Rhineland, the Directory installed administrations controlled by Paris.

In Sept. 1798, with the consent of the Turkish government, a Russian fleet entered the Mediterranean, where the emperor Paul, appointing himself protector of the Order of St. John of Jerusalem, intended it to liberate Malta from the French. This, together with Nelson's victory at Aboukir bay, encouraged the Neapolitans, with British help, to attack the new Roman republic, and they occupied Rome on Nov. 26, 1798. Inevitably the Directory declared war on Naples (Dec. 4), and it sent French troops to invade Sardinian Piedmont. The French commander in Rome, Jean Étienne Championnet, who had withdrawn beyond the Tiber, was attacked by the Neapolitans at Cività Castellana, but routed them and then advanced to occupy not only Rome but also Naples. Russia then signed alliances with Naples and with Great Britain (Dec. 29), undertaking to send contingents to Naples and to Lombardy in return for a British agreement to pay £225,000 and £75,000 a month; and also with Turkey (Jan. 3, 1799, new style; Dec. 23, 1798, old style). Meanwhile the Russians attacked the Ionian Islands; Corfu, the last to fall, capitulated on March 3, 1799. Austria, which had signed a defensive alliance with Naples in May 1798, but was hesitating, despite assurances of Russian support, to break with France, finally declared war on March 12.

15. French Dispositions in 1799.—The renewal of general war found the Directory ill-prepared numerically as well as materially. Since the allies could bring roughly twice as many men into the field, the safest course for the French would have been to concentrate their forces in the two most vital theatres—southern Germany and the north of Italy—in the hope of containing the initial allied offensives until such time as the conscription introduced in Sept. 1798 yielded sufficient men for the French to adopt a more ambitious policy. Instead, they dispersed their armies and were consequently defeated in detail; they were spared further reverses only because the Austrians likewise failed to distribute their forces to best effect.

At the opening of the campaign nearly 80,000 Austrians under the archduke Charles were assembled behind the Lech river in Bavaria. To the south were 26,000 in Vorarlberg commanded by David von Hotze, and behind them, in Tirol, a further 46,000 under H. J. J. von Bellegarde. With the 85,000 in Italy there were thus close on 240,000 deployed against the French before the arrival of the Russians, who were expected to add another 60,000. Against these formidable numbers the French had 210,000 men, of whom only 136,000 were made available to meet the Austrians. In Italy, where the total French effectives stood in the region of 110,000, the Directory could find no more than 60,000 for the defense of the Adige. They had resolved to retain Macdonald in the south with 30,000 men in order to complete the conquest of the kingdom of Naples, though this would count for nothing if their principal army were defeated in the north. Of their remaining 100,000 troops, 24,000 were in Holland under Brune, which left Jourdan on the upper Rhine to face Charles with 46,000 men, while 30,000 were in Switzerland with Masséna.

16. Campaigns of 1799.—Having decided that the best prospect of success lay in attacking before the Russians could appear on the scene, the French took the offensive on all three fronts. Early in March Jourdan went forward between the upper Danube and Lake Constance while the army of Switzerland advanced toward Vorarlberg. On the centre and right of his front, Masséna obtained a number of advantages, the most notable being the march of Claude Lecourbe into Tirol along the Engadine. Masséna failed, however, to capture the essential post of Feldkirch (March

23) whose possession would have enabled him to open communication with the army of the Danube. Jourdan, meanwhile, had already been forced to fall back before Charles's doubly superior numbers and on March 25 was defeated at Stockach. By April 6 Jourdan's troops had re-crossed the Rhine, and Masséna, who was now in command of both armies, began to concentrate his forces for the defense of central Switzerland. In Italy Schérer opened his offensive along the Adige on March 26, but did not exploit his initial success. Ten days later, he was beaten at Magnano and withdrew prematurely to the Oglio and then to the Adda. The Austrians, under Paul Kray, halted on the Mincio, where they were joined by 18,000 Russians under Suvorov, the allied commander in chief. On the French side, the much abler Moreau replaced Schérer, and Macdonald was instructed to make his way northward. After four days' costly fighting along the Adda (April 25–28), the French were obliged to resume their retreat. Fortunately for Moreau the allies neglected to press their pursuit of his greatly weakened forces toward Alessandria and the mountains north of Genoa. For more than a month Moreau maintained himself in the Apennines while awaiting Macdonald's approach from the south. At length he advanced to threaten the allies' rear as Macdonald marched westward from Parma. Suvorov nevertheless succeeded in gathering together sufficient troops to defeat Macdonald on the Trebbia (June 17–19). After withdrawing eastward by way of Parma and Modena, Macdonald finally re-crossed the Apennines to reach Moreau at Genoa in mid-July.

In the northern theatre the French left wing and centre had retired to the Rhine in early April. During the next six weeks Masséna's right wing was pushed back through the Grisons by the Austrians under Bellegarde and Hotze. When the French right had completed its retreat the Austrians redistributed their forces, Hotze marching to join the archduke east of Zürich while Bellegarde was sent south to Lombardy. On June 4, Masséna repulsed Charles and Hotze before Zürich prior to withdrawing to establish his front along the Aar river. There the Austrians left him virtually undisturbed for longer than two months while they waited for the arrival of Aleksandr Korsakov with 30,000 Russians. The lull was broken in mid-August when the French right wing under Lecourbe recaptured the St. Gotthard pass at the same time as Masséna beat off an assault on the Aar. The allies had originally intended to employ both the archduke's and Korsakov's armies against Masséna's front and to complete his difficulties by bringing Suvorov against his rear. They now decided to send Charles and 35,000 of his army to unimportant operations on the middle Rhine. Before long the consequences of leaving Hotze and Korsakov to contain Masséna were to prove decisive. Meanwhile, in Italy, where Barthélemy Joubert had replaced Moreau as commander in chief, the French had sought battle only to receive a heavy defeat at Novi on Aug. 15. Soon afterward the allied command in Italy also changed hands with the departure for Switzerland of a 28,000-strong contingent under Suvorov. The transfer of Charles's forces to Germany had reduced the allied strength in Switzerland to 55,000 men, and the French, who had disposed of 77,000, took the offensive while Suvorov was still at the St. Gotthard. In the second battle of Zürich (Sept. 25) Masséna gained a crushing victory over Korsakov and drove the Russians northward across the Rhine. On the same day Soult routed Hotze on the Linth river southeast of the Lake of Zürich. To the south, Suvorov forced the St. Gotthard and continued his advance, still harassed by Lecourbe, until he reached the southern end of the Lake of Lucerne, where he was obliged to turn eastward. Pursued by increasing numbers, the Russians achieved an extraordinary retreat to Ilanz, where their arrival on Oct. 7 marked the virtual end of the campaign. The emperor Paul recalled his Russians on Oct. 23.

It remains to summarize the course of the Anglo-Russian expedition to Holland. On June 22 the two powers concluded an agreement in which the British, who were to furnish 30,000 men, undertook to pay and transport a Russian contingent of 18,000. It was hoped that the enterprise would free the Low Countries of the French, but the sole positive outcome was the surrender of 13 Dutch ships of the line, together with a number of other warships, three days after the first British landing at the Helder (Aug. 27). At Bergen, on Sept. 19, Brune's Franco-Batavian army halted the allies' advance; the expected rising of the Dutch against the French did not take place; and after a further reverse at Castricum (Oct. 6), the duke of York was obliged to sign the convention of Alkmaar (Oct. 18) for the evacuation of his forces. The expedition, with inadequate food supplies, further had been hampered by excessive rains, by flooding from broken dikes and by the outbreak of fever.

The final defeat of the coalition and its dissolution belong to the campaigns of Bonaparte in 1800 in Italy, where the Austrians were decisively defeated at Marengo on June 14, and of Moreau in Germany, where he forced them out of the war by his crushing victory at Hohenlinden on Dec. 3 (*see* NAPOLEONIC WARS). The consequences of the second coalition had proved fatal to the Directory. Blamed for the resumption of hostilities in Europe, it was compromised by its defeats in the field and by the measures required to repair them. Conditions were now ripe for the military dictatorship of Napoleon Bonaparte, who landed at Fréjus on Oct. 9. A month later he seized power by the *coup d'état* of 18 Brumaire year VIII (Nov. 9, 1799) to make himself first consul. *See* also references under "French Revolutionary Wars" in the Index.

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FRENCH RIVIERA (CÔTE D'AZURE): *see* RIVIERA.

FRENCH SOMALILAND: *see* SOMALILAND, FRENCH.

FRENCH UNION (UNION FRANÇAISE), a political entity created by the constitution of 1946, which replaced the French colonial empire. It absorbed the colonies (overseas *départements* and territories) and gave autonomy to the former protectorates (associated states). It was replaced, in the 1958 constitution, by the Communauté (*see* FRENCH COMMUNITY). (HU. DE.)

FRENCH WEST AFRICA (AFRIQUE OCCIDENTALE FRANÇAISE, abbreviated to A.O.F.) was until 1959 a federation uniting eight territories, with an approximate population (1957) of 19,000,000 (of whom about 92,000 were Europeans) and an area of about 1,800,000 sq.mi. The territories were divided into two groups. The first group embraced Senegal, Mauritania, French Sudan, Upper Volta (Haute-Volta) and Niger, in the northern tropical zone. The area has a generally dry climate with a single rainy season and covers the country of the baobab, tall grasses, millet, peanuts and humped cattle. The inhabitants are Sudanese Negroes who settled on the land and many of them were converted to Islam. Farther north the savanna gives place to steppe lands of scrub and thorn and then to the Sahara desert with nomadic Moors and Tuaregs. The second group comprised Guinea and (fronting the Gulf of Guinea) Ivory Coast and Dahomey, in the northern equatorial zone with two rainy seasons. There the usual vegetation is green savanna with gallery forest, which

on the lower Ivory Coast gives way to dense forest. The inhabitants are Guinean Negroes who are Christians, Muslims or pagans. Cassava, yams, millet and oil palms are cultivated, and, since their introduction early in the 20th century, coffee, cocoa and bananas. The country is mostly flat, the chief mountainous districts, Fouta Djallon and Mt. Nimba, rising to about 6,000 ft.

History.—The French were long established on the west coast of Africa, but their main object was the trade in slaves and gum as practised by other European states. Their two principal factories were in Senegal, at St. Louis and on the island of Gorée, which the English disputed with them until the early 19th century. Other factories were temporarily established along the "Riviera of the south" (Guinea) and at Assinie (Ivory Coast). A new era was inaugurated by Col. L. L. C. Faidherbe, who in 1854–65 subdued the hinterland of Senegal and conceived the plan of linking the upper Senegal with the upper Niger. From 1876 onward the coast settlements were considerably extended into the hinterland by a series of campaigns and missions, and at the same time the possessions of other powers in the region were reduced to enclaves by various conventions. The most important events were: the campaigns on the upper Niger (1876–90) which destroyed the upstart empires of Omar el-Hadj and Samory; L. G. Binger's mission to the Ivory Coast (1887–89); the campaigns of Dahomey (1889–94); the occupation of Tombouctou (Timbuktu) (1893); and the Franco-British conventions of 1890 and 1898.

French West Africa was constituted in 1895 by the grouping of the several colonies under one governor general with headquarters at Dakar. During World War II the governor general R. Boisson remained under the orders of the Vichy government of Marshal Pétain until Nov. 1942, when he rallied the A.O.F. to the new administration at Algiers. The constitution of 1946 transformed the colonies into territories of the French republic. In 1958 they became autonomous states of the French Community, except Guinea which chose immediate independence. French West Africa ceased to exist on Jan. 21, 1959, and in 1960 its remaining states declared their independence. *See* appropriate sections of the articles AFRICA; SAHARA; WEST AFRICA; the articles on the former constituent states, now republics; *see* also references under "French West Africa" in the Index volume.

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FRENCH WEST INDIES: *see* FRENCH ANTILLES.

FRENEAU, PHILIP MORIN (1752–1832), U.S. poet, essayist and editor, known as the "poet of the American Revolution," was born of parents of French Huguenot descent in New York city on Jan. 2, 1752. After graduating from Princeton in 1771, he taught school and studied for the ministry until the outbreak of the American Revolution, when he turned his ready pen to vitriolic satire against British and Tories. Not until his return from two years in the Caribbean islands, where he produced two of his most ambitious poems, "The Beauties of Santa Cruz" and "The House of Night," did he become, however, an active participant in the war, joining the New Jersey militia in 1778 and sailing as a privateer to the West Indies. Captured and imprisoned by the British in 1780, he wrote bitterly, on his release, of *The British Prison-Ship* and with infectious enthusiasm of *American Independence*, and during the next several years he wrote patriotic contributions to the *Freeman's Journal* in Philadelphia. The war over, Freneau became a sea captain until 1790, when he again entered partisan journalism, ultimately as editor from 1791 to 1793 of the outspokenly republican *National Gazette*, in which he so effectively attacked Federalist policies that Thomas Jefferson credited him with saving the country when it was "galloping fast into monarchy." Ardently devoted to principles of liberty, but recognizing also the necessity of finding solitude for poetry, he alternated his time between quiet periods at sea and periods of active newspaper work, until he retired early in the 19th century to his farm in Monmouth county, N.J., where he died on Dec. 18, 1832.

For more than 50 years his verse and prose appeared in periodicals and in something more than a dozen volumes; collected editions were published in 1786, 1788, 1795, 1809 and 1815. Well schooled in the classics and in antecedent English poetry, he strove for a fresh idiom which would be unmistakably American, but except in a few poems he failed to avoid the influence of his models. He has been called the father of American poetry, anticipating Bryant and Poe in theme and technique. A dozen years before Wordsworth's influence was felt on English verse, Freneau looked with wonder on nature in such poems as "The Wild Honey Suckle" and "Stanzas Written on the Hills of Neversink" which, with "The Indian Burying Ground" and "To the Memory of the Brave Americans," deserve a place in any anthology of his period.

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FRENSSEN, GUSTAV (1863–1945), German novelist, perhaps the most powerful of the school of writers of the *Heimatkunst* (*i.e.*, literature of particular regions), was born at Barlt, Holstein, Oct. 19, 1863. He took orders in 1890 and until 1902 was pastor at Hemme; but he had already for several years been known as a novelist, and after the success of *Jörn Uhl* (1901), he gave up his pastorate and devoted all his time to writing. He died at Barlt, April 11, 1945. His novels include *Die Sandgräfin* (1896); *Die drei Getreuen* (1898; Eng. trans., *The Three Comrades*, 1907); *Hilligenlei* (1905; Eng. trans., *Holyland*, 1906); *Klaus Hinrich Baas* (1909); *Die Brüder* (1918); *Otto Babendiek* (1926); and *Der brennende Baum* (1931). He also published sermons (*Dorfpredigten*, 1899–1902) and plays. His novels give realistic and vivid descriptions of the peasantry and the countryside in north Germany. His great popularity was due partly to this and partly to the many subsidiary and propagandist elements associated with his work.

See N. Numsen, *G. Frenssen* (1940). (A. GS.)

FREON. A trade name covering a family of chemicals containing fluorine and used as fluids in refrigeration compressors. The more commonly used are usually known by a code name; for example the substance CCl_2F_2 is known as either Freon-12 or F-12; similarly F-11 is CCl_3F; F-22 is $CHClF_2$; and F-114 is $CClF_2.CClF_2$. These compounds are economically manufactured by part replacement of fluorine for chlorine in inexpensive compounds such as carbon tetrachloride (CCl_4) or chloroform ($CHCl_3$); each of the replacements causes a drop of about 50° C. in the boiling point, so that CCl_4, which boils at 76° C., becomes CCl_3F (F-11) boiling at 25° C., then CCl_2F_2 (F-12) boiling at −29° C. The low boiling property makes the compound usable as a refrigerating fluid. In addition, the presence of a group of fluorine atoms causes a general tightening up of the molecular structure of the Freons, and this results in a much improved stability which permits the Freons to resist tenaciously any destructive physical or chemical factors; it also renders them physiologically inert. It is possible to inhale or be exposed to concentrations of these materials to as large as 10% to 20% for several hours with impunity. The practice of air-conditioning public places such as theatres, restaurants, trains and auditoriums requires the use of refrigerating fluids which, in case of accidents, would not create a fire hazard or be injurious to the audience, should they leak into the atmosphere; neither can the refrigerating fluids have a detectable odour, lest a panic be created in an audience detecting even an insignificant leakage. The importance of the Freons lies in the fact that they are so stable that they are entirely harmless. The Freons were first manufactured in 1930 and increased rapidly in commercial importance after 1934. During World War II they were adapted to the use of dispersing agents for insecticides. A solution of an insecticide such as pyrethrum or DDT in Freon-12 is carried in a steel container; by opening a valve, the solution is forced out as a fine spray, and the insecticide is thereby fully dispersed in a room, a tent or the space enclosed under the mosquito nets used in the tropics. The mist so

created is harmless because it will neither burn nor injure the lungs and the space may be occupied while the fumigation proceeds. *See* also REFRIGERATION. (A. L. HE.)

FREQUENCY. A term used in scientific work generally to denote the number of occurrences of some periodic phenomenon or quantity which occur in unit time.

In physics the term is applied to wave motions of all types, mechanical, sound (*q.v.*), light (*q.v.*), electromagnetic waves (*q.v.*) or oscillations generally. *See* ALTERNATING CURRENT; BROADCASTING; FREQUENCY, RADIO; RADAR; RADIO; RADIO RECEIVER; *see* also references under "Frequency" in the Index volume. (H. B. LM.)

FREQUENCY, RADIO, a term designating the portion of the electromagnetic energy spectrum that is useful in radio communication. The frequency of electromagnetic energy is the number of complete reversals of energy direction that take place in one second and is usually expressed in cycles per second (c.p.s.), kilocycles per second (kc.) or megacycles per second (mc.) where 1 kc. equals 1,000 c.p.s. and 1 mc. equals 1,000,000 c.p.s. The radio-frequency spectrum extends from the lowest frequency that can be efficiently radiated (about 3 kc.) to the lower edge of the infrared region (about 300,000 mc.). It is often convenient to divide the radio-frequency spectrum into smaller ranges (or bands) which can be designated by appropriate abbreviations.

Radio-Frequency Classifications

Band number	Frequency range	Designation
4	3 kc.–30 kc.	Very low frequency (VLF)
5	30 kc.–300 kc.	Low frequency (LF)
6	300 kc.–3,000 kc.	Medium frequency (MF)
7	3,000 kc.–30,000 kc.	High frequency (HF)
8	30 mc.–300 mc.	Very high frequency (VHF)
9	300 mc.–3,000 mc.	Ultrahigh frequency (UHF)
10	3,000 mc.–30,000 mc.	Superhigh frequency (SHF)
11	30,000 mc.–300,000 mc.	Extremely high frequency (EHF)

The various portions of the radio-frequency spectrum are usually allocated, by law, to different types of radio service. For example, the familiar AM (amplitude modulation) broadcasting stations (540 kc.–1,600 kc.) are located in the MF band while FM (frequency modulation) and television broadcasting are allocated to the VHF and UHF bands. The two lowest frequency bands (VLF and LF) are used for radiotelephone and radio navigation service while the SHF band is primarily for radar and microwave relay systems. The highest frequency band (EHF) is used largely for experimental purposes. *See* also RADIO; BROADCASTING: *Technical Aspects.* (G. R. CR.)

FRERE, SIR HENRY BARTLE EDWARD (1815–1884), British imperial administrator of high courage and distinction, whose long career, spent mainly in India, was overshadowed at the end by controversy over his administration of South Africa. Born in Brecknockshire on March 29, 1815, Frere was educated at Bath grammar school and at Haileybury, and in 1834 was appointed to a writership in the Bombay civil service. After a period as an assistant revenue commissioner he became, successively, private secretary to the governor of Bombay, assistant commissioner of customs and political resident at the court of the raja of Satara. His evident resourcefulness and loftiness of vision received further recognition in 1850 when he was appointed chief commissioner of Sind. In his nine years there he did much to foster friendly relations and promote economic development, especially the development of the port of Karachi. It was on his return to Karachi in May 1857 after a spell of home leave that Frere heard the disastrous news of the mutiny. Realizing the danger to the Punjab, he almost denuded his own province of troops in order to reinforce Sir John Lawrence and secure the fortress of Multan; local revolts he suppressed by a combination of firmness and tact. For the services he rendered at this time he received a knighthood and the thanks of parliament.

Frere served on the viceroy's council at Calcutta from 1859 to 1862 and was then appointed governor of Bombay, concerning himself especially with development of communications and educational improvements. Cotton production was stimulated to feed the Lancashire mills, starved of supplies by the American Civil War. The result was an artificial boom and wild speculation, culminating in the failure of the Bank of Bombay. Although Frere tried to curb the speculative mania, he cannot be entirely acquitted of responsibility for this financial disaster. He returned to England in 1867 and for the next ten years served on the India council, a service interrupted only by a special mission to Zanzibar in 1872 to negotiate a treaty for the suppression of the slave trade, and to accompany the prince of Wales on his tour of India in 1875. He was created a baronet in 1876.

Frere was sent to the Cape as governor and high commissioner in 1877. He was unusually well qualified for these posts, but the colonial secretary, Lord Carnarvon, had decided on a policy of confederation and had chosen him as governor-to-be of the South African dominion. Unfortunately Frere's arrival at Cape Town coincided with one of the most turbulent periods in South African history. Within a matter of days the annexation of the Transvaal was announced by Sir Theophilus Shepstone. Unrest on the eastern frontier of the Cape soon led to the waging of yet another frontier war; and, intimately connected with this, there followed a rupture between Frere and J. C. Molteno, the Cape's first prime minister. Frere's solution was to dismiss the intransigent ministry, a solution which was endorsed by the Cape parliament and press. But Carnarvon's resignation in 1878 and his replacement by Sir Michael Hicks Beach deprived Frere of the support he had the right to expect and of which he was soon to stand in need.

Aiming at confederation, Frere was convinced by Shepstone that the Transvaal Boers could not be reconciled to British rule unless their long-standing territorial dispute with the Zulus was settled in their favour; as the Natal settlers also feared Zulu aggression he accepted the fact that Zululand would have to be annexed. In this he believed that he had the support of the colonial office; but when he sent an ultimatum to Cetewayo in Dec. 1878 he discovered that a Zulu war was regarded as inopportune. Lord Chelmsford's disastrous defeat at Isandhlwana was Frere's undoing. Publicly censured, and superseded as high commissioner by Sir Garnet Wolseley, Frere was nevertheless allowed to retain his governorship, from which he was not recalled until July 1880 when it had become clear that confederation was no longer a live issue. His departure was greatly regretted by the colonists, who held him in the highest regard. Frere died at Wimbledon on May 29, 1884, while preparing a vindication of his conduct.

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(G. B. NO.)

FRERE, JOHN HOOKHAM (1769–1846), English diplomat and author whose fame rests on his spirited verse translations of Aristophanes, was born in London on May 21, 1769. He was educated at Eton, where he met George Canning, and at Caius college, Cambridge. He entered public service in the foreign office and sat from 1796 to 1802 as M.P. for the close borough of West Looe in Cornwall. He and Canning were ardent supporters of William Pitt and contributors to the *Anti-Jacobin*. On Canning's removal to the board of trade in 1799 he succeeded him as undersecretary of state; in Oct. 1800 he was appointed envoy extraordinary and plenipotentiary to Lisbon; and in Sept. 1802 he was transferred to Madrid, where he remained for two years. He was made a member of the privy council in 1805; in 1807 he was appointed plenipotentiary at Berlin, but the mission was abandoned, and Frere was again sent to Spain in 1808 as plenipotentiary to the Central Junta. The condition of Spain rendered his position a very responsible and difficult one. When Napoleon began to advance on Madrid, Frere wholeheartedly advised Sir John Moore not to retreat. After La Coruña public opinion accused him of having endangered the army and he was recalled.

Thus ended Frere's public life. In 1816 he married Elizabeth Jemima, dowager countess of Erroll, and in 1820, on account of her failing health, he went with her to the Mediterranean. There he finally settled in Malta, where he lived the rest of his life. He died at the Pietà Valetta on Jan. 7, 1846. Frere's mock-heroic Arthurian poem, *The Monks and the Giants* (1818), written in ottava rima, gave Byron a stanza pattern for *Beppo*. His transla-

tions of Aristophanes were privately printed in Malta (1839) and published in England in 1840 (reprinted 1886).

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FRÈRE-ORBAN, HUBERT JOSEPH WALTHER (1812–1896), Belgian statesman and Liberal reformer, twice prime minister, was born in Liège on April 24, 1812. After studying law in Paris, he practised as a barrister in Liège, took a prominent part in the Liberal movement and in June 1847 was returned to the chamber as member for Liège. In Aug. 1847 he became minister of public works in Charles Rogier's cabinet, and from 1848 to 1852 he was minister of finance. He founded the Banque Nationale and the Caisse d'Épargne, abolished the newspaper tax, reduced the postage and modified the customs duties as a preliminary to a decided free-trade policy. To facilitate negotiations for a new commercial treaty, he conceded to France a law of copyright, which proved highly unpopular in Belgium; he resigned office, soon followed by the rest of the cabinet. His work *La Mainmorte et la charité* (1854–57), published under the pseudonym of "Jean Van Damme," helped his party back to power in 1857, when he again became minister of finance. He now embodied his free-trade principles in commercial treaties with Great Britain and France and abolished the octroi duties and the tolls on the national roads. He resigned in 1861 on the gold question but soon resumed office and, on Jan. 2, 1868, succeeded Rogier as prime minister. In 1869 he defeated the attempt of France to gain control of the Luxembourg railways. Defeated in 1870, he returned to office on June 19, 1878, as prime minister and foreign minister. He provoked the bitter opposition of the Catholic party by his law of 1879 establishing secular primary education and in 1880 broke off diplomatic relations with the Vatican. Frère-Orban, while rejecting the Radical proposal of universal suffrage, conceded an extension of the franchise (1883), but the hostility of the Radicals and the discontent caused by a financial crisis overthrew the government at the elections of 1884. Frère-Orban continued to lead the Liberal opposition till 1894, when he failed to secure re-election. He died in Brussels on Jan. 1, 1896.

See Paul Hymans, *Frère-Orban,* 2 vol. (1905–10). (C. Ve.)

FRÉRET, NICOLAS (1688–1749), French historian, renowned as a scholar and voluminous author, was born in Paris on Feb. 15, 1688. His father was *procureur* to the *parlement* of Paris and destined him to the profession of the law. In 1714 he was admitted as pupil to the Academy of Inscriptions. His memoir, *Sur l'origine des Francs* (1714), led to his internment in the Bastille for libeling the monarchy. From the time of his liberation in March 1715 his life was uneventful. In Jan. 1716 he was received associate of the Academy of Inscriptions, and in Dec. 1742 he was made perpetual secretary. The list of his memoirs, many of them posthumous, occupies four columns of the *Nouvelle Biographie générale.* They treat of history, chronology, geography, mythology and religion. He was one of the first scholars of Europe to undertake the study of the Chinese language. He died in Paris on March 8, 1749.

Bibliography.—The best account of his works is "Examen critique des ouvrages composés par Fréret," in C. A. Walckenaer's *Recueil des notices,* etc. (1841–50). *See* also J.-M. Quérard, *La France littéraire,* vol. iii (1829).

FRERICHS, FRIEDRICH THEODOR VON (1819–1885), German pathologist who was one of the founders of the scientific teaching of clinical medicine, was born March 24, 1819, at Aurich. He received his medical degree at Göttingen in 1841 and returned there as a professor in 1848 after practising medicine in his native town. His initial inclination was toward chemistry and physiology, but at Kiel, where he became professor in 1850, he undertook the study of pathology and clinical medicine. He pursued this study at Breslau after becoming clinical professor and pathologist there in 1851. From 1859 until his death he was professor at Berlin university, where his pupils included Bernard Naunyn, Heinrich Quincke, Carl Ewald, Joseph von Mering and Paul Ehrlich. In his teaching he endeavoured to show how treatment on physiological grounds was related to diagnosis. At the completion of his 25th year as a professor at Berlin the German government awarded him the patent of nobility. In 1855 he identified leucine and tyrosine in the urine of patients with acute yellow atrophy of the liver. He published a first volume on liver disease in 1858 and a second volume in 1868. He also published monographs on Bright's disease (1851) and on diabetes (1884) in which he discussed the cause of uremia. He died in Berlin on March 14, 1885. (C. McC. B.)

FRÉRON, ÉLIE CATHERINE (1718–1776), French controversialist, prominent mainly as the opponent of the *philosophes,* was born at Quimper in Brittany, Jan. 20, 1718. He was editor of *L'Année littéraire,* founded by him in 1754, which gave a thorough survey of French literary production. Although submissive to authority, he was imprisoned at Vincennes in 1746, in the Bastille in 1757, and narrowly escaped a similar fate in 1765. He appears to have carried his opposition to the *Encyclopédie* to the length of denouncing the printers to the police. He was not without affability in his private life, but was bitterly attacked on many occasions by Voltaire, most notably in his comedy *L'Écossaise* (1760). He died in Paris, March 10, 1776.

See F. Cornou, *Élie Fréron* (1922). (Rt. S.)

FRÉRON, LOUIS MARIE STANISLAS (1754–1802), French Revolutionary journalist and both an ardent republican and leader of the royalist *jeunesse dorée* during the Thermidorian reaction, was the son of Élie Catherine Fréron (*q.v.*), and was born in Paris on Aug. 17, 1754. After his father's death he took over until 1790 *L'Année littéraire* under the editorship of G. H. Royou and J. L. Geoffroy. After the Revolution began he brought out a paper, *L'Orateur du peuple* (Dec. 1789), containing violent criticism of the government. After Louis XVI's flight to Varennes (June 20, 1791), Fréron demanded his execution and had to hide until the fall of the monarchy on Aug. 10, 1792. As a deputy for Paris in the Convention he voted for the king's death. In March 1793 he was sent on a mission to Marseilles and Toulon to punish the royalist and Girondin rebels. He ordered many executions and was accused of having misappropriated *assignats* worth 800,000 livres.

On 9 Thermidor year II (July 27, 1794), with P. Barras, he led the national guard of the bourgeois quarters of Paris against the Hôtel de Ville, the refuge of Robespierre's party. In September *L'Orateur du peuple* reappeared to attack these Montagnards and Fréron became the leader of the fashionable royalist *jeunesse dorée.* Although denounced, he was sent by the administration to quell the royalists in the Midi in Oct. 1795. In 1796 he published his *Mémoire historique sur la réaction royale et sur les malheurs du Midi.* He was not re-elected deputy and was greatly in debt when he was appointed subprefect of Santo Domingo on Nov. 15, 1801. He died there on July 15, 1802. (Je. Bo.)

FRESCO (Ital. "cool," "fresh"), a term introduced into English, both generally (as in such phrases as *al fresco,* "in the fresh air"), and more especially as a technical term for mural painting on plaster. In the latter sense the Italians distinguished painting *a secco* (when the plaster had been allowed to dry) from *a fresco* (when it was newly laid and still wet). *See* Fresco Painting and Painting.

FRESCOBALDI, GIROLAMO (1583–1643), Italian organist and composer who was perhaps the first great master of organ composition, was born in Ferrara, Sept. 1583. His predecessors, to name only Antonio de Cabezon, Girolamo Cavazzoni, Andrea Gabrieli and, in Germany, the composers represented in the Buxheim organ book (*c.* 1460–70), had developed a keyboard style based largely on transcriptions or imitations of vocal pieces. Frescobaldi, himself noted from his early years for his skill as a performer, produced in his numerous compositions a model that, through his pupil J. J. Froberger, was to reach supreme heights in the German baroque school in the work of J. S. Bach. His influence here was equaled only by that of J. P. Sweelinck.

A pupil of Luzzasco Luzzaschi, Frescobaldi began his public career as organist at the church of Sta. Maria in Trastevere in Rome in 1607; he soon left Italy for the Netherlands and published, while in Antwerp, a book of madrigals. Within a year or so he was back in Rome, where, on Nov. 1, 1608, he played in St. Peter's to a vast

audience. Twenty years later, Frescobaldi left Rome for Florence, where he remained until he returned to his former position at St. Peter's in 1634. He retained this post until his death on March 1, 1643. It was during the years 1637 to 1641 that Froberger worked as Frescobaldi's pupil.

Unlike Sweelinck and the Gabrielis, Frescobaldi wrote no vocal music of great significance and his fame as one of the great masters of the early baroque rests on his instrumental works. Among his works keyboard compositions greatly predominate, though the *canzone* for unspecified instruments with *basso continuo* are of outstanding historical significance in the development of the trio sonata.

In 1608 Frescobaldi published his first collection under the title *Il primo libro delle fantasie a quattro di Geronimo Frescobaldi Ferrarense, organista.* These fantasias, 12 in number, are notable for variety and for contrapuntal mastery of the highest order. The textures are idiomatic in a way rarely found in earlier examples of the form. Chromaticism is not favoured by Frescobaldi (the latter part of no. 2 is exceptional) though modulation is used in many pieces. Like Bach's *Art of Fugue* they were printed in open score in the original edition. In 1624 Frescobaldi published, again in open score, a collection of 10 *ricercari,* 5 *canzone* and 11 *capricci.*

The composer's preface contains valuable information about performance. After observing that technical difficulties must be overcome by practising, he continues, "Should the player find it tedious to play a piece right through he may choose such sections as he pleases, provided only that he ends in the main key." Again, "The opening passages should be played slowly so that what follows may appear more animated. The player should broaden the tempo at cadences. . . ."

Much of Frescobaldi's keyboard music was intended for the harpsichord; this is made clear in the title of his *Toccate d'intavolature di cimbalo e organo* (1637). The volume includes also partitas on various melodies and pieces on ground basses. The partitas consist of variations, usually on familiar bass patterns such as *Romanesca, Ruggiero* and *folia* (*see* GROUND BASS). These show Frescobaldi's free inventiveness in genuine keyboard textures and figuration. A collection first published in 1627 and reprinted in 1637 contains, in addition to toccatas, *canzone, verse d'hinni, Magnificat, gagliarde, correnti ed altre partite.* The preface here again gives information of great value to the interpretation of baroque instrumental music; *e.g.,* "Play the opening of a toccata slowly and arpeggiando"; "If one hand has a trill, while the other plays a 'passage,' do not play note against note but play the trill rapidly and the other expressively." Such directions indicate the extent to which keyboard style had moved away from its origin in transcriptions of vocal or instrumental compositions. Frescobaldi's remaining publication, the *Fiori Musicali* of 1635, consists of organ music intended for liturgical use.

The *canzone* with *continuo* belong to the transitional type that led to the full-developed trio sonata, which was the principal chamber music medium until it was displaced by the string quartet.

Quite apart from its historical importance, Frescobaldi's music deserves to take its place among the most imaginative and vital products of the early 17th century.

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FRESCO PAINTING. Fresco is a method of painting on freshly applied, wet lime-plaster walls with colours made by grinding artists' dry powder pigments in pure water. The colours dry and set with the plaster and become a permanent part of the wall. The terms *buon fresco* and *a fresco* are sometimes used to distinguish true fresco from its substitutes.

Like other processes which have their roots in remote antiquity, it is basically simple and direct; it operates on the most commonplace of chemical reactions; and at the same time it demands of the painter thorough competence and familiarity with a multitude of details. The execution of a fresco should not be attempted by the inexperienced. The restrictions imposed in modern times by economic and other circumstances usually preclude the use of this most desirable kind of mural painting.

A mural is not merely a large-scale version of an easel painting, blown up and projected on a wall. No other form has so many technical requirements. In addition to the restrictions common to all forms of painting, resulting from the artist's desire for maximum control of the paint and for permanence, mural painting has certain limitations peculiar to itself. The mural must be effective when viewed from any point in the room, whereas the easel painting may be effective only from the most favourable point. Ideally, the surface of the mural should be without glare under general illumination. It must have a "mural quality"—it should seem to be a part of the building rather than a superimposed embellishment.

From the early Renaissance to the present day, fresco has been the technique that has met all mural requirements in the most satisfying way; it has survived and retained its pre-eminence as the most appropriate medium through every change in style.

History.—Nobody knows when or where fresco painting began. One theory was that it arose from the preparatory outlines drawn on the plaster for setting mosaics. The most accepted explanation points to the ancient use of stucco to cover rough or unsightly masonry: a smooth, flawless white finish was gradually developed, which was then tinted or coloured by the addition of pigments and eventually decorated with more intricate colours in the form of designs and pictures.

The Egyptians did not use fresco. Mud plaster was employed for building; lime was not used until its introduction by the Romans. Wall painting was prominent, however, throughout the long history of Egypt. Examples have survived because of the dryness of the climate and the protection of the tombs. Some of these paintings have simple water-colour binders; after thousands of years they are still bright, but can be removed with a damp sponge. Others, particularly those used with carving, were mixed with a resinous binder.

True frescoes, of a high level of technical accomplishment, were a prominent feature of the prehistoric Minoan culture in Crete (before 1500 B.C.) discovered in the 20th century. Chemical analysis showed the lime and all the earth pigments of the Minoan frescoes to have been produced locally with the exception of an imported Egyptian blue frit. Some, not all, of the Etruscan wall paintings still to be seen in Italy, notably at Tarquinia, were painted in fresco. No wall paintings from ancient Greece have survived but writings suggest that fresco was a standard method there. Little is known about Greek painting from the artistic or stylistic viewpoint, or what relation it had to Roman wall painting, but it is known that the Romans were profoundly influenced by Greek methods and technical procedures.

Roman fresco painting is well documented, especially in the books of Vitruvius and Pliny. Whole frescoed walls have been excavated in Pompeii and Herculaneum and fragments have been unearthed in nearly every Roman site.

In India the cave temples of Ajanta (*q.v.*) contain a large number of frescoes skilfully executed with lime and pigments of local origin plus Afghan lapis lazuli blue. Considerable ingenuity and resourcefulness must have been used to overcome local difficulties. There is no indication of joins in these murals; a possible explanation is that the work was done by guilds or families rather than individual painters, so that a wall could be finished in one session. Another isolated find of ancient frescoes (5th–8th centuries A.D.) is a group of Buddhist decorations at Tun-huang, Kansu, in remote western China.

European artists from the 13th through the 17th centuries employed fresco as their major mural painting method, and this was its heyday, especially in Italy where it fulfilled the requirements of every conceivable personal technique and pictorial objective. From the 18th century, artists and chemists experimented widely with new methods designed to replace fresco with mediums more resistant to the polluted atmosphere of towns and cities, but technically fresco remained the most desirable.

The demanding and formidable process does not conform to the exigencies of the 20th century, so it has been largely supplanted

by inferior methods, such as *secco* and the traditional easel painting techniques—(*e.g.*, oil, casein, tempera). In the 1930s, during a period of extensive construction of public buildings, there was a widespread revival of fresco painting in the United States and in Mexico. (*See* also PAINTING; MURAL PAINTING.)

Technique.—Onto a brick, tile or metal lath wall, the artist or his plasterer trowels or "throws" three coats of specially made mortar composed of aged slaked lime-putty (quicklime which has been slaked with water and kept in storage for a year or more to improve its plasticity), sand and sometimes marble dust, each in its own carefully measured proportion. The first or scratch coat (*trulisatio*) and the second or brown coat (*arricciato*) are applied and allowed to set. The artist, who has made enlarged full-scale cartoons completely finished in detail from his original drawings, then transfers them onto the wall in outline, usually by going over the lines of a tracing of the cartoon with a perforating wheel; while the tracing is held in place against the wall, a little cloth bag of dry powder pigment is tapped or pounced through the perforations. The final painting coat (*intonaco*) is then smoothly troweled on as much of the upper left-hand corner of the wall as can be painted in one session. The boundaries of this area are confined carefully along contour lines, so that the joins of each successive day's work are imperceptible. The perforated tracing is then held against the fresh *intonaco* and lined up carefully with the adjacent drawing; the pigment is then gently pounced over it once more.

If the wall has been correctly prepared the *intonaco* will hold its moisture for a long working period. When the painter freely dilutes his colours with water and applies them with deft brushstrokes, they will be drawn into, or imbibed by, the surface through capillary action. As the wall dries and sets, the pigment particles become bound or cemented along with the lime and sand particles. They are part of the same cementitious, porous mass; their colour permanence and resistance to aging is entirely due to their own chemical inertness and not to a transparent skin or binding medium as is the case with other forms of painting. The painting is actually part of the wall, not a superimposed layer of paint.

After the mortar reaches a certain degree of set or dryness, it will no longer take or absorb colours from the brush; as soon as this is observed, the painter must stop and await the next fresh area of plaster, or else his colour will lie on the surface like dusty pastel instead of becoming incorporated into the rocklike mass.

Secco or limewash painting is a simplified offshoot of fresco which does away with the complex preparation of the wall with fresh plaster. Dry, finished walls are soaked with limewater and painted while wet with casein colours. The colours do not penetrate into the plaster but form a surface film like any other paint. Practised since early times, it has always held an inferior position to true fresco.

Pigments.—The fresco palette is more rigidly restricted than any other. The pigments not only must have the usual colour stability required of artists' pigments in general, but also must be completely alkali proof to resist the caustic action of the lime and sufficiently acid resistant to withstand concentrations of acid impurities existing in the atmosphere. As a routine check on the behaviour of his pigments, the fresco painter makes a plaster test block upon which his supply of pigments is tried so that he can check on their colour when dry, their ability to combine with the mortar and their resistance to the lime (six months' aging is necessary for this test).

The modern fresco painter uses the following pigments: white, either plain lime-putty, the traditional *bianco sangiovanni* (partially carbonated lime putty) or blanc fixe; Mars black; Indian red; light red; the umbers; the siennas; green earth; ochre (or Mars yellow); Mars violet; a special cementitious rosy-red earth called Pozzuoli red; chromium oxide green; viridian; cobalt blue; cerulean blue; phthalocyanine blue; and some specimens of cobalt violet (must be tested). Most painters reject vermilion, the cadmium yellows and reds and ultramarine blue, because they contain sulfides and are therefore extremely sensitive to the action of acids. These are used by others on the theory that they are no more sensitive to acids than the calcium carbonate of the wall.

Three chemical reactions are involved: the making of lime, the slaking of lime and the hardening of mortar. Lime is obtained from kilns where limestone or marble or some other form of calcium carbonate is burned to form quicklime (calcium oxide). The slaking or mixing with water converts it into hydrated lime (calcium hydroxide). When the mortar is spread out and exposed to air, its lime is converted to calcium carbonate, chemically identical to the original limestone or marble. The carbonation is caused by carbon dioxide which is a constituent of the atmosphere. Calcium carbonate is a durable substance indoors, where plastered and frescoed walls have lasted for centuries and where marble retains a high polish. But it is too susceptible to the abrasion of rain and air-borne particles and to acid conditions to be used outdoors or even in a semiexposed position.

Chemists rate fresco as a completely permanent indoor method but not sufficiently permanent outdoors. For exposure to outdoor or drastic conditions, some imperishable mural method must be chosen, for example, mosaic and terra cotta or one of the modern developments such as ethyl silicate or porcelain enamel.

See also references under "Fresco Painting" in the Index volume.

See Olle Nordmark, *Fresco Painting* (1947); Ralph Mayer, *The Artist's Handbook of Materials and Techniques*, rev. ed. (1957), extensive bibliography. (RH. M.)

FRESENIUS, KARL REMIGIUS (1818–1897), German chemist and author of standard texts on chemical analysis, was born at Frankfurt am Main on Dec. 28, 1818. In 1836 he was apprenticed to an apothecary. He studied at Bonn in 1840 and at Giessen in 1841, where he acted as assistant in Justus von Liebig's laboratory, and in 1843 became *Privatdozent* in chemistry. In 1845 he was appointed to the chair of chemistry, physics and technology at the Wiesbaden Agricultural institution, and in 1848 he became the first director of the chemical laboratory and school for chemists which the Nassau government established there. This establishment, which was set up in his home, was augmented in 1862 with a pharmacy school, and in 1868 with an agricultural experiment station especially devoted to the wine industry. He established a bacteriologic institute in 1884. Fresenius occupied himself almost exclusively with analytical chemistry, and the fullness and accuracy of his textbooks on that subject (of which that on qualitative analysis first appeared in 1841 and that on quantitative in 1846) soon rendered them standard works. They passed through numerous editions and were translated into many languages, including Japanese. Many of his original papers were published in the *Zeitschrift für analytische Chemie*, which he founded in 1862 and continued to edit until his death.

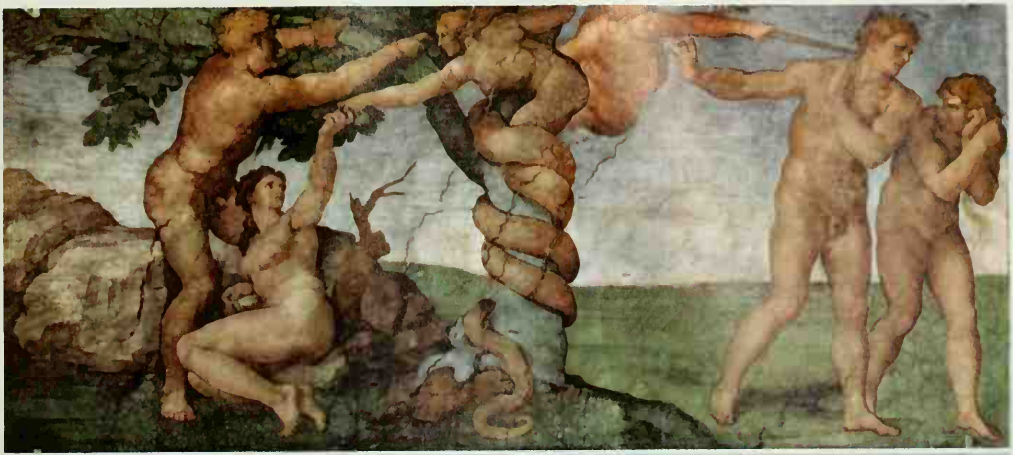
Fresenius died suddenly at Wiesbaden on June 11, 1897. His sons and brothers continued the laboratory and school.

(R. E. O.)

FRESHWATER, a seaside resort in the Isle of Wight, Eng., about 10 mi. S.W. of Newport by road. Pop. (1951) 3,423. It is a scattered township lying on the peninsula west of the river Yar at the western extremity of the island. Freshwater bay is separated from Alum bay on the west by the promontory between, with the group of detached rocks, known as the Needles, jutting from the sea. The cliffs are magnificent, rising 400–500 ft.

Farringford house in the parish was the home of Alfred, Lord Tennyson, who is commemorated by a tablet in All Saints' church and by a great cross on High down overlooking Freshwater bay. There are two golf links on the downs.

FRESNEL, AUGUSTIN JEAN (1788–1827), French physicist and pioneer in optical theory, was born at Broglie, Normandy, on May 10, 1788. He was educated at the École Centrale in Caen, the École Polytechnique, and finally went to the École des Ponts et Chaussées. He served as an engineer in several departments, but lost his appointment in 1814 because he opposed Napoleon's return from Elba. On the second restoration he obtained a post as engineer in Paris. His researches in optics appear to have been begun about 1814, when he prepared a paper on the aberration of light, which, however, was not published. Fresnel's work on interference did a great deal to establish the wave theory of light, and various devices for producing interference fringes bear his name. He applied mathematical analysis to his work and



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CEILING OF THE SISTINE CHAPEL

Among the most important series of frescoes were those painted by Michelangelo (1475–1564) on the ceiling of the Sistine chapel in the Vatican. This work, which took four and a half years to complete, is comprised of 343 figures grouped in scenes from the Book of Genesis. Bordering the central panels of the vaulted ceiling of the chapel are large, seated figures of prophets and sibyls and, interspaced with these, triangular spandrels depicting the ancestors of Christ and four miraculous salvations of the chosen people. The ceiling (painted between 1508 and 1512) is enclosed in and divided by a painted framework

Top: The Fall, one of the central panels, shows Adam and Eve taking the forbidden fruit and being expelled from the Garden. The serpent, with the head of a woman, is coiled around the Tree of Knowledge

Bottom left: The Prophet Zacharias. The Genii of the Intellect peer over the shoulders of the prophets and sibyls

Bottom right: The Delphic Sibyl. Five sibyls and seven prophets are depicted

FRESCO PAINTING

"Cat Hunting a Pheasant"; late Minoan period (c. 1500 B.C.) from Hagia Traida. Facsimile from original in Candia museum, Crete

"Six-Tusked Elephant and the Queen of Benares," Indian fresco from Ajanta, cave XVII

"Pietà" from "The Life of Christ and the Virgin" by Giotto; painted 1305–06. From the Arena chapel, Padua, Italy

"Lady Playing the Cithera," Roman fresco from Boscoreale, 1st century A.D.

"Musicians," Etruscan wall painting of the 5th century B.C. Detail from the Tomb of the Leopards, Tarquinia

Detail from "Legend of the True Cross" by Piero della Francesca, painted between 1452 and 1466. Church of S. Francesco, Arezzo, Italy

Detail of panel 1, "Procession of the Magi," by Benozzo Gozzoli; about 1460. From the Ricciardi-Medici palace, Florence, Italy

"Creative Man" by José Clemente Orozco (1883–1949), Mexican. From a series at the New School for Social Research, New York city

FRESCO PAINTING OF VARIOUS PERIODS

BY COURTESY OF (SECOND ROW LEFT) METROPOLITAN MUSEUM OF ART, ROGERS FUND, 1903. (BOTTOM RIGHT) THE NEW SCHOOL. PHOTOGRAPH BY PETER JULEY & SON; PHOTOGRAPH, (BOTTOM LEFT) ALINARI

removed a number of objections to the wave theory. With D. F. J. Arago he studied the laws of the interference of polarized rays. Circularly polarized light he obtained by means of a rhomb of glass, known as "Fresnel's rhomb." He was a pioneer in the use of compound lenses instead of mirrors for lighthouses. He was a member of the Académie des Sciences and a foreign member of the Royal society. He died at Ville-d'Avray, near Paris, on July 14, 1827.

Fresnel's labours in the cause of optical science received during his lifetime only scant public recognition, and some of his papers were not printed by the Académie until many years after his death. But, as he wrote to Thomas Young, the English scientist, in him "that sensibility, or that vanity, which people call love of glory" had been blasted. "All the compliments," he said, "that I have received from Arago, Laplace and Biot never gave me so much pleasure as the discovery of a theoretic truth, or the confirmation of a calculation by experiment."

See *Oeuvres Complètes* (1866–70).

FRESNILLO (FRESNILLO DE GONZÁLEZ ECHEVERRÍA), a town of the state of Zacatecas, Mex., 37 mi. N.W. of Zacatecas city. Pop. (1960) 35,582. Fresnillo is located on a plain between two ranges of mountains, about 7,700 ft. above sea level. It has a generally temperate climate but is often swept by cold winds. Five miles northeast is a station of the Mexican National railroad linking the town with Mexico City and with El Paso, Tex. Fresnillo is on the central highway and has an airport.

The town was founded in 1554 by Francisco de Ibarra. It has been an important silver mining centre since 1569, when rich mines were discovered in the neighbouring Proaño hill. A school of mines was founded in 1853. Gold, copper, lead and zinc are produced in limited quantities.

The region served by Fresnillo has become important agriculturally. Limited irrigation facilities have been instrumental in increasing grain and vegetable production and the livestock industry dates from the colonial period. (J. J. J.)

FRESNO, a city of California, U.S., near the geographical centre of the state, is the chief city of the San Joaquin valley and the seat of Fresno county. It is the commercial and mercantile centre of an area extending from the Sierra Nevada to the Coast range, and for 100 mi. to the north and south. The population, which in 1900 was 12,470, increased rapidly. Pop. (1960) city 133,929; standard metropolitan statistical area (Fresno county) 365,945; for comparative population figures *see* table in CALIFORNIA: *Population.* The chief national groups are Armenians, Mexicans and Russian Germans, the last-named being the descendants of German colonists who in the 18th century settled in Russia and in the late 19th and early 20th centuries emigrated to the U.S. The city presents the aspects of a large farm town; it is the focus for the processing of farm products as well as the distributing point for farm labour and machinery.

Fresno was settled in 1872 as a station on the newly opened line of the Central (later Southern) Pacific railway, in an arid and flat area which up to that time bad supported only a sparse population; the name (Sp., "ash tree") comes from the name of the county, so called because of the ash trees in the foothills, not at the townsite. The introduction of irrigation canals in the 1870s and 1880s made intensive agriculture possible and encouraged settlement. The seat of Fresno county was transferred from Millerton to Fresno in 1874 and the city was incorporated in 1885.

A fertile soil and favourable climatic conditions have made Fresno county one of the richest agricultural counties in the United States. The chief crops are cotton, grain, alfalfa and fruits (especially raisin grapes, figs, peaches and melons). There is little industry apart from wine making and the drying and packing of fruit.

Higher education is provided by Fresno State college (established 1911) and Fresno City college, a junior college established in 1910. There is a philharmonic orchestra and Roeding park has a zoological garden. Three national parks—Yosemite, Sequoia and Kings Canyon—are within 90 mi. of the city. (HE. M. M.)

FRET, in decorative art and architecture, is any one of several types of running or repeated ornament consisting of lengths of straight lines or narrow bands, usually connected and at right angles to each other in T, L or square-cornered G shapes, so arranged that the spaces between the lines or bands are approximately equal to the width of the bands. Occasionally the system is arranged so that the lines intersect or interlace, as in the common "swastika (*q.v.*) fret." As the fret is one of the simplest and most natural decorative forms that can be produced in textiles, it is one of the most widely spread and is found alike from early times in all the continents. Thus it was a favourite decoration for the ceilings of Egyptian tombs from the 4th dynasty on, in later examples combined with rosettes, scarabs and the lotus into patterns of great richness.

In America, it is found in early Peruvian textiles, it is frequent in sculpture and architecture in the Maya and Aztec remains in Middle America, and it is one of the most universal of pottery decorations among American Indians. It was highly developed by both Chinese and Japanese for textiles as well as for architectural ornament; it occurs not only as a band but as a complicated all-over pattern, sometimes with acute and obtuse angles instead of the more usual right angles. But its most important development was that by the Greeks (hence the common name "Greek fret"), who used it not only for pottery, but painted on architectural members, such as the abaci of capitals, and later carved it.

Like so many Greek motives it was widely used by the Romans particularly in Syria (*e.g.*, the propylaea at Damascus and the great temple at Baalbek) and occurs in Byzantine and Romanesque work.

"Fretwork" has a wider significance and is the most often used of any small-scale repeated ornament in which geometrical forms occur, especially if in low relief or pierced. (T. F. H.; X.)

FREUD, SIGMUND (1856–1939), founder of psychoanalysis, was born of Jewish parents at Freiberg in Moravia on May 6, 1856. From the age of 4 until the age of 82 he lived in Vienna. As a student he found it difficult to decide on a profession. Though he was greatly impressed by the work of Darwin and other scientists of that period, he also was attracted to the history of culture and to philosophy; one volume of the German edition of John Stuart Mill's collected works was translated by Freud. In his preliminary studies he was interested in chemistry, but finding that he was not particularly gifted in that field he turned for a time to physiology and anatomy, in which he did some original research work in his student days. He was not primarily interested in the therapeutic aspects of medicine, preferring scientific research. Still, he finally decided to study medicine, as many of the great physiologists had done.

Freud worked for several years in the physiological laboratory of E. W. von Bruecke and later in the psychiatric clinic, then under the direction of the brain anatomist T. H. Meynert. But his financial condition did not allow him to follow a career in research, particularly after he decided to get married. Thus he came to start practice as a neurologist (1886). In the following years he made some important contributions to neurology, his studies on aphasia and on the cerebral paralyses of children remaining highly regarded by neurologists. But in that period the interests that were to become the centre of his lifework were already in the ascendancy.

In 1885 Freud studied in Paris under the neurologist Jean Charcot, who strengthened his determination to investigate hysteria from a psychological point of view. But the decisive influence in his turning to problems of psychopathology and psychology came from another source. An outstanding Viennese physician and thinker, Josef Breuer, had told him of an extraordinary experience in which he had cured symptoms of hysteria by getting the patient to recollect in hypnosis the circumstances of their origin and to express the emotions accompanying them. After his return from Paris, Freud suggested to Breuer that they publish the case, together with some others Freud had in the meantime treated with the same method, and with an added chapter on the theoretical conclusions that could be drawn from their observations. This book about what they called the "cathartic" method of treatment (*Studien über Hysterie*, 1895) was the starting point of what later became psychoanalysis.

Soon afterward, however, Freud took the decisive step of re-

placing hypnotism by the method of free association. This allowed him to isolate and study the phenomena of resistance (which the patient opposes to the uncovering of repressed experiences) and transference (the patient's emotional ties to the analyst). These two factors have ever since remained central in the technique of psychoanalysis. From this change from catharsis to free association the beginning of psychoanalysis (in the sense that the word is used today) is generally dated.

The development of Freud's psychological thinking also greatly benefited when, beginning in 1897, he had the courage to use his newly acquired knowledge for a study of his own unconscious mental processes. The degree of insight that he achieved in this way is accessible by the method of self-analysis only to the very few. But from this pioneering experience grew the demand that the student of analysis undergo, as part of his training, a personal analysis conducted by an experienced psychoanalyst.

In Freud's work the clinical, theoretical and technical aspects are closely interrelated. His method of free association is essential to the therapeutic technique and also a powerful tool of psychological research. Freud, who had been reluctant to abandon research for medical practice, discovered a practically efficient method of treatment that was at the same time to satisfy what he considered the main endeavour of his life: "To infer or to guess how the mental apparatus is constructed and what forces interplay and counteract in it." (E. Jones, *The Life and Work of Sigmund Freud*, New York: Basic Books, London: Hogarth Press, 1953, vol. 1, p. 45.) This led to radical progress in the understanding of neurosis, psychosis, perversion and, of course, the normal mind. Some fundamental aspects of this are: (1) the dynamic effect of unconscious processes on consciousness and action; (2) the central role of mental conflict not only in pathology but also in normal development—part of this was the insight into the various mechanisms of defense by which instinctual tendencies are either excluded from consciousness and action (as in repression) or modified (as in sublimation); (3) the structural aspects of personality; (4) the motivating force of the instinctual drives (sexuality and aggression); and (5) more specifically, the existence and importance of infantile sexuality. (For the Oedipus conflict, *see* PSYCHOANALYSIS.)

Freud's first classical contribution to normal psychology was *Die Traumdeutung* (*The Interpretation of Dreams*, 1900), which he considered his greatest book. It was followed by studies of the parapraxes and of wit, by analytic interpretations of works of literature and by the application of psychoanalysis to anthropology and to the psychology of religion.

Freud's work contains striking discoveries; it is also the expression of a powerful mind, capable of extracting the fullest meaning from his discoveries. His unfailing intellectual courage allowed him to face previously unknown aspects of the human mind. The characteristic elements of his style of thinking and his creativity remained unimpaired either by age or by a disease process that started when he was 67 and led to his death 16 years later. He wrote one of his most lucid and significant papers at the age of 80. His last book, *Moses and Monotheism* (1939), was written at 83; in this he uses his full mastery of the method and science he had created to elucidate one of those questions of the history of culture that had fascinated him as a young man.

Freud's discoveries, particularly his findings about the sexuality of children, from the beginning met opposition, misunderstanding and abuse. This reaction did not surprise Freud, after he had learned from his work the role played by opposition to the uncovering of unconscious motivations. Recognition of analysis was slow to come. Freud, though he had the title professor, was never made a full professor at the University of Vienna. Only in his last years, and partly under the influence of the comparatively broad acceptance of analysis in the United States, did the opposition to analysis also in other countries assume a less vehement character. In 1930 he received the Goethe prize and in 1936 he was elected to the Royal society.

For ten years Freud had worked alone at psychoanalysis. About 1906 he was joined by a number of colleagues who met in 1908 at the first International Congress of Psychoanalysis, and two years later the International Psychoanalytic association was founded.

Freud was married to Martha Bernays in 1886. They had six children, the youngest of whom, Anna Freud, became a famous psychoanalyst in her own right. In 1938, after the annexation of Austria by Nazi Germany, Freud moved to London, where he died on Sept. 23, 1939.

Freud's works have been translated into many languages. An English standard edition of his complete works was being edited by J. Strachey.

For Freud's own account of psychoanalytic theory in the first quarter of the 20th century and for later developments, *see* PSYCHOANALYSIS; *see* also references under "Freud, Sigmund" in the Index volume.

See Ernest Jones, *The Life and Work of Sigmund Freud*, 3 vol. (1953–55). (Hz. H.)

FREY, ADOLF (1855–1920), Swiss poet, novelist and literary historian, was born at Küttigen near Aarau, Feb. 18, 1855. His lasting achievements are his biographies of Swiss writers from Haller to Keller, and his dialect poetry. As a biographer he showed a predilection for sound, rich characters in the manner of the 19th-century realists. As he knew many writers and painters personally when he was professor of German literature at Zürich university (1898–1920), his portraits of them contain important authentic material. With his poetry, rooted in the style of the folk song, he inaugurated, together with M. Lienert and S. Hämmerli-Marti, new creative developments in Switzerland. His rather heavy historic novels and plays are of less importance. He died at Zürich, Feb. 12, 1920.

His writings include *Erinnerungen an G. Keller* (1892); C. F. *Meyer* (1899); *A. Böcklin* (1903); *Der Tiermaler R. Koller* (1906); *Schweizer Dichter* (1914); *Duss und underm Rafe* (poems, 1891); and *Die Jungfer von Wattenwyl* (novel, 1912).

See L. Frey, *A. Frey, sein Leben und Schaffen*, 2 vol., with bibliography (1923–25). (A. Bx.)

FREY (FREYR), in Scandinavian mythology, was son of the fertility god Njörðr and himself ruler of peace and fertility, rain and sunshine. Worshiped especially in Sweden, he was also well known in Norway and Iceland. His sister and female counterpart, Freyja, was goddess of love and fertility. Frey and Freyja figure in many lays and stories of medieval Iceland. *See* also GERMANIC MYTHOLOGY AND HEROIC LEGENDS. (G. T.-P.)

FREYBERG, BERNARD CYRIL FREYBERG, 1ST BARON (1889–1963), of Wellington, New Zealand, and of Munstead, Surrey, commander in chief of the New Zealand forces in World War II and governor general of New Zealand from 1946 to 1952, was born in London on March 21, 1889. Two years later he emigrated with his parents to New Zealand and was educated at Wellington college and at the New Zealand university. He joined the army in New Zealand in 1909. In 1914 he took part in the Mexican revolution on the side of Pancho Villa.

Early in World War I he served in a British naval division in the retreat from Antwerp and took part in the operations in Gallipoli from the landing to the evacuation. Later in France he took part in many of the fiercest battles and was awarded the Victoria cross (Dec. 16, 1917). He was promoted to brigadier general at 27, then the youngest of that rank in the British army. He commanded the 29th division in 1917–18. Freyberg was nine times wounded, and his bravery became legendary. Between the wars he held senior staff appointments and a command in England. In World War II, as major general, he commanded the New Zealand Expeditionary force, and the Allied forces during the battle of Crete, in 1941. Later in the war he fought in the western desert and in Italy under Montgomery and Alexander. During the latter campaign he received a third bar to his Distinguished Service Order. In 1942 he received a knighthood. Freyberg in 1946 became governor general of New Zealand, an appointment he held for six years. He was created a baron in 1951, and in 1953 was appointed deputy constable and lieutenant governor of Windsor castle. He died at Windsor on July 4, 1963. (E. B. Bn.)

FREYCINET, CHARLES LOUIS DE SAULCES DE (1828–1923), French statesman and engineer who was four times premier and whose tenure of the ministry of war for five years

(1888–93) resulted in a refashioning of the armed forces, was born at Foix (Ariège) on Nov. 14, 1828. Educated at the École Polytechnique in Paris, he entered the government service as a mining engineer. Appointed traffic manager to the Compagnie des Chemins de Fer du Midi in 1858, he returned to the engineering service in 1862 and rose to be inspector general of mines in 1883. He was meanwhile sent on a number of special missions: one to England led him to write his *Mémoire sur le travail des femmes et des enfants dans les manufactures de l'Angleterre* (1867). On the establishment of the republic in Sept. 1870, during the Franco-German War, he offered his services to Léon Gambetta, was appointed prefect of Tarn-et-Garonne and, in October, became chief of the military cabinet of the government delegation at Tours. It was mainly Freycinet's powers of organization that enabled Gambetta to muster forces to oppose the advancing German armies. In 1872 he published an account of his administration—*La Guerre en province en 1870–1871*.

Freycinet entered the senate in 1876 as a follower of Gambetta and in Dec. 1877 became minister of public works under Jules Dufaure. He carried a scheme—known as the Freycinet plan—for the state's gradual acquisition of the railways and the construction of new lines at a cost of 3,000,000,000 fr. and for the development of the canal system at a further cost of 1,000,000,000 fr. He retained his post under W. H. Waddington, whom he succeeded as premier on Dec. 28, 1879, when he also took the ministry of foreign affairs. He passed an amnesty for the Communards, but lost Gambetta's support in attempting to steer a middle course on the question of the religious associations and resigned on Sept. 19, 1880.

Freycinet again became premier and minister of foreign affairs on Jan. 30, 1882, but resigned on Aug. 7 on the rejection of his plan to occupy the Isthmus of Suez. Becoming minister of foreign affairs under Henri Brisson on April 6, 1885, he retained that portfolio when he became premier for the third time on Jan. 7, 1886. Though he assumed office with an ambitious program of internal reform, he settled little except the exile of the Orléans and Bonaparte pretenders, and his ministry fell on Dec. 3, when the chamber adopted an amendment suppressing the *sous-préfets*. He failed as a candidate in the presidential election of Dec. 1887, won by Sadi Carnot.

Freycinet became minister of war under Charles Floquet on April 3, 1888—the first civilian to hold that office since 1848. His services in this capacity were the crowning achievement of his career. He held this office in five successive governments: those of Floquet and of Pierre Tirard; his own fourth cabinet (March 17, 1890–Feb. 18, 1892); and those of Émile Loubet and of Alexandre Ribot. He introduced the three-year term of military service and established a general staff and a supreme council of war, but was forced to resign on Jan. 10, 1893, as he could not clear himself entirely of complicity in the Panama scandals. He was again minister of war under Charles Dupuy (Nov. 1898–May 1899).

Freycinet was elected to the Académie des Sciences in 1882 and to the Académie Française in 1890. He died in Paris on May 14, 1923. He had published, besides several technological and scientific works, his *Souvenirs*, two volumes (1912–13), and also some remarkable "Pensées," under the pseudonym Alceste, in the *Contemporain*.

See J. Chastenet, *L'Enfance de la Troisième* (1952), *La République des Républicains* (1954) and *La République triomphante* (1955).

FREYCINET, LOUIS CLAUDE DE SAULCES DE (1779–1842), French navigator and explorer, was born at Montélimar, Drôme, on Aug. 7, 1779. He entered the French navy in 1794 and took part in several engagements against the British. In 1800 with his brother, Louis Henri Freycinet (1777–1840), he joined the expedition sent out under Capt. Nicolas Baudin in the "Naturaliste" and the "Géographe" to explore the coast of south and southwest Australia and of Tasmania. Some of the regions already explored by M. Flinders (*q.v.*) were visited and places renamed. On his return to Paris in 1805, he prepared the maps and plans of the expedition, and completed the narrative, entitled *Voyage de découvertes aux terres australes* (1807–15). In 1817 he was appointed to command the "Uranie" as leader of an expedition directed to carry out magnetic and other researches in the Pacific. He visited Rio de Janeiro, and then sailed to the Pacific by way of the Cape of Good Hope, visiting Timor, the Mariana and the Hawaiian Islands, and in the Samoa group discovering Rose Island, named after his wife. Sailing homeward from Sydney via Cape Horn, he lost the "Uranie" by shipwreck in the Falkland Islands, but his collections and notes were saved, and in Nov. 1820 he returned to France in an American ship renamed "Physicienne." The voluminous observations made on the voyage were published under his supervision as *Voyage autour du monde sur les corvettes "l'Uranie" et "la Physicienne"* (1824–44). Freycinet was one of the founders in Paris of the Société de Géographie (1821). He died at his estate of Freycinet, near Loriol (Drôme), on Aug. 18, 1842. (H. M. Ws.)

FREYSSINET, (MARIE) EUGÈNE (LÉON) (1879–1962), French civil engineer, chiefly renowned for his successful development of prestressed concrete, was born at Objat, Corrèze, on July 13, 1879. After studying at the École Polytechnique and the École Nationale des Ponts et Chaussées, he was appointed bridge and highway engineer at Moulins in 1905. From then until 1914 he designed and built many reinforced-concrete bridges, including one of 300-ft. span. After World War I he worked for a firm of contractors until 1928. In the late 1920s he built Plougastel bridge, with three 600-ft. spans, the largest reinforced-concrete bridge to be constructed up to that time. After 1928 he devoted his time to the development of prestressed concrete and also to the making of high-strength concrete. His most significant contribution was the quantitative assessment of creep and shrinkage and the realization that only a high-strength steel at a high stress would achieve a permanent prestress in concrete. At first little recognized, Freyssinet's methods, successfully applied at the Gare Maritime at Le Havre in 1933, were gradually adopted. After his invention in 1938 of a practical tool to stress wires his methods were used all over the world. He died on June 8, 1962, in St. Martin-Vésubie, Alpes Maritimes, France. (F. Wy.)

FREYTAG, GUSTAV (1816–1895), German writer of realistic novels celebrating the merits of the middle classes, was born at Kreuzburg, Silesia, on July 13, 1816. During his boyhood he saw the activities of the Germans in the eastern territories and their relations with the Polish population, and conceived a great admiration for the civilizing influence of the German race. After studying philology at Breslau and Berlin, he became *Privatdozent* in German literature at the University of Breslau (1839), but resigned after eight years to devote himself to writing. He was much excited by the events of 1848 and became, with Julian Schmidt, joint editor of the Leipzig weekly *Die Grenzboten*, which he made into the leading organ of the middle-class liberals. His main political ideas were faith in the power and ability of the middle classes to educate and civilize the whole country and a determination that Germany should be united. He abhorred both the democratic radicalism of the *Jungdeutschen* ("Young Germany") and the escapism of the romantics. From 1867 to 1870 he represented the national liberal party in the North German *Reichstag* and he served at the headquarters of the 3rd army in the Franco-German War until the battle of Sedan (1870).

His literary work was influenced by his early reading of English novelists, especially Sir Walter Scott and Charles Dickens, and of French plays. His name was made with the comedy *Die Journalisten* (1854; Eng. trans. *The Journalists*), still regarded as one of the most successful German comedies, and he acquired an international reputation with his widely translated novel *Soll und Haben* (1855; Eng. trans. *Debit and Credit*, 1857). It celebrates the solid bourgeois qualities of the German merchants, and the close relationships between people's characters and the work they do is well brought out. The novel is noteworthy for its detailed realism upon which much of the effect depends. The influence of Dickens is apparent. The success of the novel was such that its author was recognized as the leading German writer of his day. He attempted to realize a similar intention with *Die verlorene Handschrift* (1864; Eng. trans. *The Lost Manuscript*, 1865), which depicts Leipzig university life in the same realistic manner, but the plot is much weaker and the effect less successful. His

most ambitious literary work was the novel-cycle *Die Ahnen* (6 vol., 1873–81) which unfolded the story of a German family from the 4th century A.D. up to Freytag's own time. The stories are conveyed in a vast web of detail, which involves much painstaking scholarship, and it cannot be said that Freytag entirely succeeded in wearing his learning lightly. His *Bilder aus der deutschen Vergangenheit* (5 vol., 1859–67; partial Eng. trans. *Pictures of German Life*, 1862–63) were originally contributed to *Die Grenzboten* and give a vivid and popular account of the history of the Germans, in which Freytag stresses the idea of folk character as determinative in history. Parts of it are still studied in schools. His other works include a study of drama (*Die Technik des Dramas*, 1863; Eng. trans. *Technique of the Drama*, 1895) and reminiscences (*Grinnerungen*, 1887; Eng. trans. 1890). His *Gesammelte Werke* (22 vol., 1886–88) were reissued, edited by E. Elster (12 vol.) in 1926. He died at Wiesbaden on April 30, 1895.

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FRIAR, the English generic name for members of the mendicant religious orders (from Lat. *frater* through Fr. *frère;* "brother"). Formerly it was the title given to individual members of these orders, as Friar Laurence (in *Romeo and Juliet*), but this is no longer common. The ten mendicant orders are the Dominicans, Franciscans, Augustinians (Austin Friars), Carmelites, Trinitarians, Mercedarians, Servites, Minims, Hospitallers of St. John of God and the Teutonic Order. *See* MONASTICISM; MENDICANT.

FRIARBIRD, the name given to several Australian birds of the honey eater family, from their ruff of feathers on the head and their sober plumage. The best-known species is *Tropidorhynchus corniculatus,* also known as pimlico and as four-o'clock, after its loud cry. Friarbirds are bold and noisy, haunting trees in small flocks. The forms inhabiting some of the islands of the Malay archipelago are mimicked by orioles.

See HONEY EATER; ORIOLE.

FRIBOURG (FREIBURG), a city and capital of the canton of Fribourg in western Switzerland, lies mostly on the left bank of the Sarine (Saane) river, 17 mi. S.W. of Bern. Population, mostly French-speaking, was 32,583 at the 1960 census. It is the seat of the bishopric of Lausanne-Geneva-Fribourg and is the centre of Swiss Catholicism. The oldest part of the town (the Bourg) is high above the river bank; the Neuveville and the Auge quarters (with the Planche or Matte quarter on the right bank) form the lower town (Basseville). West of the Bourg and still higher are the Places, with the railway station, and the Pérolles, with modern buildings and factories, and other new quarters extending west and northwest. The old quarters have retained much of their medieval and picturesque appearance with their Gothic-fronted houses, fountains with sculptured statues (16th century) and the remains of ramparts with towers and gateways (13th–17th centuries) which originally surrounded the town. Fribourg possesses numerous works of art mainly preserved in its churches and in the Art and History museum, which is housed in four places—Hôtel Ratzé, the university art gallery (which contains works by the 15th-century Fribourg painter Hans Fries and by the 16th-century sculptors Hans Geiler and Hans Gieng), the cantonal and university library and the Marcello museum. Medieval architecture includes the cathedral church of St. Nicholas (13th–15th century; choir rebuilt 17th century) with its imposing tower (253 ft.) and celebrated organ by Aloys Mooser (1770–1839); the old basilica of Notre-Dame, entirely restored in the 18th century; the Franciscan church with a 15th-century reredos; the 13th-century church of the Augustinian Fathers (or St. Maurice) with a baroque reredos; St. Bartholomew's chapel with 16th-century stained glass; the baroque chapel of Loretto; and the convent of the Maigrauge with a restored 13th-century church. The town hall dates from the 16th and 17th centuries and nearby is the lime tree (*Le Tilleul*), supposedly planted on the day of the battle of Morat a relic of the battle of 1476. The city has an international Catholic (state) university (founded in 1889) and numerous schools. The Natural History museum is housed in the university. Modern architecture includes the university buildings (completed 1941) and the church of Christ the King (1953). The Sarine is crossed by several bridges, notably the seven-arched Pont de Zaehringen (275 yd. long, 161 ft. high); the Pont du Gotteron suspension bridge (165 yd. long) over the Gotteron valley was replaced in 1960 by a concrete bridge 193 yd. long and 246 ft. high.

Fribourg is on the main railway from Lausanne to Bern and is a junction of lines to Morat and Payerne, as well as a centre for bus and mail road services. In the middle ages it had extensive trade connections (Spain, Venice, Germany, Holland) but was primarily industrial. Weaving and tanning flourished from the 13th to the 15th centuries but then declined until the 19th century. There are now breweries, a foundry and factories for chocolate, cardboard boxes, electric condensers and batteries, metal wrappings, photographic material, timber products and household appliances.

Fribourg was founded in 1157 and given its name by Berchtold IV, duke of Zaehringen. The site was chosen to control the ford and as a bridgehead against the surrounding feudal lords. In 1218 the house of Zaehringen became extinct and the town passed to the counts of Kyburg until 1263 when their male line became extinct, and in 1273 by marriage to the counts of Habsburg-Laufenburg until 1277 when it was sold to the sons of Rudolf of Habsburg. It was a vassal town of the Habsburgs until 1452 when they abandoned it. Wishing to escape the increasing power of Bern, Fribourg accepted the suzerainty of the dukes of Savoy (1452), who confirmed the charters granted to the town since its foundation. Later it joined the Swiss alliance in the fight against Charles the Bold, duke of Burgundy, and assisted at his defeat at Grandson and Morat (1476). Released from the overlordship of Savoy in 1477, it was admitted to full membership of the Swiss confederation in 1481. By a skilful policy of purchase, conquest and negotiation Fribourg increased its possessions until it reached its present extent by the inclusion of the town of Morat in 1803. In that year the town's administration was separated from the state administration and it became an autonomous commune.

In the 16th century the democratic government had developed into an oligarchy, which remained in power until the French occupation in 1798. Under the French a "democratic" constitution came into force under the one and undivided Helvetic republic, sweeping away the old institutions, and Fribourg was one of the 19 Swiss cantons by the act of mediation imposed on Switzerland by Napoleon in 1803. On the fall of this regime in 1814, however, the old patrician rule was partly restored; in 1830 it gave way to a more representative democracy. In 1846 Fribourg joined the Sonderbund (league of Catholic cantons) and had to surrender to the federal army in 1847. The Radical regime, which then came back to power, was replaced in 1857 by the Conservatives who have since maintained office. (*See* also SWITZERLAND: *History.*)

FRIBOURG CANTON is situated in an elevated plain (plateau Suisse) and rises from the flat land in the west by the lake sides through a hilly region up to the Prealps, the highest summits of which are to the south in Gruyère district (the best known are Vanil Noir 7,838 ft., Moléson 6,568 ft., the Berra 5,640 ft.). Population, mostly Roman Catholic, was 159,194 in 1960. Area 645 sq.mi., of which 568 sq.mi. are classed as productive. It is watered by the Sarine river (with its tributaries Jogne [Jaunbach], Gérine, Singine [Sense] and Glâne) which flows from south to north, dividing the canton into two almost equal parts and joins the Aare, an affluent of the Rhine. On the west the Broye flows from southwest to northeast into the lake of Morat and thence into that of Neuchâtel. In the southwest the Veveyse river flows south into the Lake of Geneva. The Lac Noir (Schwarzsee) and the artificial lakes of Montsalvens and Gruyère are in the mountainous region. Traces of prehistoric lacustrine settlements have been found on the shores of Neuchâtel and Morat lakes.

The canton is divided into 284 communes and took its name from its capital around which its component districts gradually gathered. It is on the linguistic frontier of Switzerland; two-thirds of the people, in the west and south, are French-speaking

and one-third, in the east and north, speak German. There are numerous monasteries and convents: the Charterhouse of the Valsainte in the Gruyère, the Cistercian abbey at Hauterive (near Fribourg), the Cistercian nunneries at La Fille Dieu (near Romont) and at Maigrauge (near Fribourg), Franciscan nuns at Montorge (Fribourg) and Carmelite nuns at Le Pasquier (near Bulle).

Fribourg canton is predominantly agricultural; cattle breeding, milk production and the processing of dairy products are important occupations; Gruyère is famous for its cheese. Large-scale market gardening, cereals, tobacco and fruit prosper in the fertile north and northwestern parts and on the hillsides in the centre of the canton; vines are grown on the southern slopes of Mt. Vully. Light industries are largely concentrated in Fribourg, Düdingen and Morat districts, and the timber industry in the Gruyère region. Five power stations on the river produce sufficient electricity for home consumption and for export to neighbouring cantons and even to France. Tourism is mostly developed on the lakes, in Fribourg and in the mountainous parts; the main centres beside Fribourg are Bulle, Châtel-St. Denis, Morat (Murten), Romont, Estavayer le Lac, Düdingen and Kerzers.

The canton is crossed by the main railway line from Lausanne to Bern, with several branch lines. There are bus services through the less populated districts and in summer boat services on the lakes of Neuchâtel and Morat, which intercommunicate through the Broye canal. The canton's three airfields are at Ecuvillens, Fillistorf and Epagny.

FRICK, HENRY CLAY (1849–1919), U.S. industrialist, art collector and philanthropist, was born at West Overton, Pa., Dec. 19, 1849. He organized the firm Frick and Company (1871), acquired extensive coal deposits, built about 12,000 coke ovens and supplied the Pittsburgh steel mills with the coke that city required for its steel and iron industry. During the Homestead (Pa.) steel strike of 1892 Frick was shot and stabbed by Alexander Berkman, an anarchist, but survived. He was chairman of the board of Carnegie Brothers (1889–92), and a director of a number of railroads and of U.S. Steel corporation.

Frick died in New York city on Dec. 2, 1919. He left a park to Pittsburgh with an endowment and established the H. C. Frick Educational foundation. He bequeathed his New York town house to that city with numerous paintings, bronzes and enamels. He also endowed many hospitals and educational and charitable institutions. (J. W. O.)

FRICTION is the resistance which is offered to the sliding of one solid body over another. From earliest times man has made ingenious attempts to diminish it to as small a value as possible. The development of the wheel helped considerably; since rolling friction is less than sliding friction it is easier to pull a cart along the ground than to pull a sledge of the same weight. It is not so much the work done in overcoming the friction—the power loss—which is important, although this can be considerable. In a motor-car about 20% of the power is so wasted, in an airplane piston engine about 9% and in a turbojet engine about 1% to 2%. The most important aspect is the damage which is done by friction—the wear or seizure of some vital parts of the machine.

The two main experimental laws which govern the friction of sliding solids are simple. The first states that the friction is independent of the area of the solids. If a brick is pulled along a table the frictional force is the same whether the brick is lying flat or standing on its end. The second law is that the friction is proportional to the load (W) between the surfaces. If the load is doubled by putting a second brick on top of the first, the force required to cause sliding is twice as great. If a pile of three bricks is used the friction would be three times as great and so on. This means that for any particular pair of surfaces, the ratio of

$$\frac{\text{friction } (F)}{\text{load } (W)}$$

is constant and this constant is called the coefficient of friction (μ). In the case of a brick sliding on a clean wooden table, the coefficient of friction (μ) is about 0.5 (*i.e.*, a force equal to one-half the weight of the brick is required to pull it along). The coefficient of friction varies widely for different solids. For ice sliding on ice, for example, it is about 0.02, so that a pull equal to about $\frac{1}{50}$ of the weight of the ice block will cause sliding. With copper sliding on copper, the coefficient of friction is about 0.8 to 1.0 and, if the metal is carefully cleaned so that all traces of surface contamination are removed, it may rise to a much higher value still.

These two laws were formulated by Leonardo da Vinci and rediscovered by the French engineer G. Amontons in 1699. Amontons' observations were verified in 1785 by C. A. de Coulomb, who made a clear distinction between the static friction (the force required to start sliding) and kinetic friction (the force required to maintain it). He showed that kinetic friction could be appreciably lower than static friction.

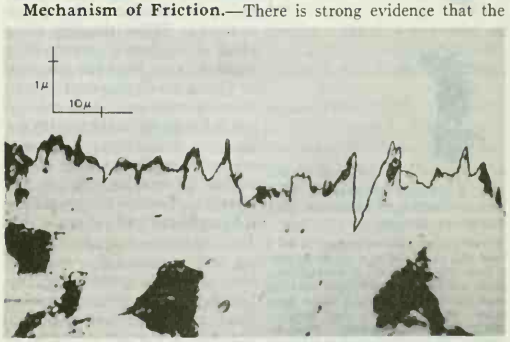
Coulomb concluded that friction was due to the interlocking of the surface asperities and represented the work of lifting the load over these asperities. Modern work suggests, however, that it is due primarily to a local adhesion between the surfaces.

Area of Contact.—A detailed examination of the contours of solid surfaces by electron microscopy and other delicate methods has shown that it is almost impossible, even with the best modern methods, to make a surface which is truly flat. To a person the size of an atom an optically polished mirror surface would look like country consisting of valleys and rolling hills differing in height by a hundred atoms or more. Most of the engineer's best surfaces have irregularities which are much greater than this and may be thousands of atoms high: they may be compared with Alpine peaks rather than hills (*see* fig. 1). Putting two solids together is rather like turning Switzerland upside down and standing it on Austria, and the area in intimate contact will be relatively small.

Measurements of the electrical conductivity across metal surfaces placed together confirm that the real area of contact is indeed very small. It varies with the load, but for flat steel surfaces it may be less than $\frac{1}{10,000}$ of the apparent area. Such experiments are also interesting in that they show that the real area of contact is almost independent of the size of the surface. It is little influenced by the shape and degree of roughness of the surfaces. It depends mainly on the load which is applied to them and is in fact directly proportional to the load.

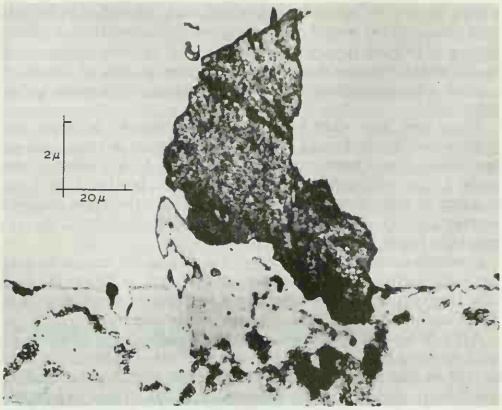
The general behaviour is consistent with the view that the surfaces are held apart by small irregularities. This means that, even with lightly loaded surfaces, the local pressure at these small points of contact is very high and may be sufficiently great to cause the hardest metals to flow plastically. Although the stresses will cause elastic deformation of the metal in the vicinity of the points of contact, the experiments suggest that the summits of irregularities on which the bodies are supported flow plastically and are crushed down until their cross section is sufficient to enable them to support the applied load. The real area of contact A is given by $A = W/p_m$, where W is the load and p_m is the yield pressure of the metal.

Mechanism of Friction.—There is strong evidence that the



BY COURTESY OF F. P. BOWDEN, D. TABOR AND A. J. W. MOORE

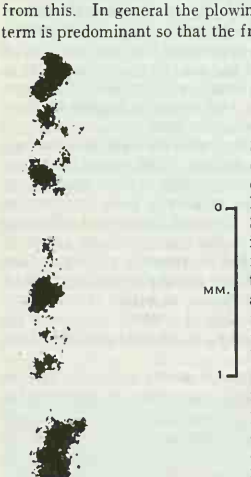
FIG. 1.—OBLIQUE SECTION OF FINELY ABRADED STEEL SURFACE. THE SECTION GIVES A VERTICAL MAGNIFICATION OF TEN THOUSAND AND A HORIZONTAL MAGNIFICATION OF ONE THOUSAND



BY COURTESY OF F. P. BOWDEN, D. TABOR AND A. J. W. MOORE

FIG. 2.—OBLIQUE SECTION OF STEEL SURFACE OVER WHICH A COPPER SURFACE HAS SLID ONCE, RESULTING IN A HEAVY PLUCKING OF COPPER (DARK), A FRAGMENT OF WHICH IS ATTACHED TO THE STEEL. THE JUNCTION IS SO STRONG THAT THE COPPER HAS PULLED THE STEEL ABOVE ITS ORIGINAL LEVEL

friction of metals is due, in large measure, to adhesion at these contact regions and represents the force necessary to shear these small junctions. In addition, if one surface is harder than the other the surface irregularities on the hard surface may plow their way through the softer surface and some of the friction will arise from this. In general the plowing term is small and the shearing term is predominant so that the friction may be written $F = A \times s$, where s is the shear strength (per unit area) of the junctions, and A the real area of contact.



BY COURTESY OF E. RABINOWICZ AND D. TABOR

FIG. 3.—AUTORADIOGRAPHIC RECORD OF METALLIC TRANSFER PRODUCED BY SLIDING

A radioactive copper surface with a load of 2 kg. is slid at a low speed over a clean steel surface. A photographic plate is then placed in contact with the steel so that radioactive copper fragments attached to the steel sensitize the photographic emulsion. When developed, an autoradiograph is obtained. The pick-up consists of small fragments and corresponds to about one-millionth of a gram of copper per centimetre of track

This offers a simple explanation of the two laws of friction. (1) Since A the real area of intimate contact is independent of the area of the surfaces, the friction will be independent of it also. (2) Since the real area of contact A is proportional to the load W the friction will be also. The formation and shearing of junctions is a primary cause of wear. If slip were to occur at the interface, wear would be negligibly small. Unfortunately, this is rarely the case—the adhesion at the surface is strong. When shearing takes place it frequently occurs at a small distance from the interface so that a small fragment of one metal is torn away and may be welded onto the other metal (*see* fig. 2). These wear fragments are very small, but may be revealed by making one of the metals radioactive by irradiating it in a pile and using it as a slider. The radioactive fragments adhering to the other surface can then be detected photographically (*see* fig. 3). In a running engine these wear fragments would accumulate in the lubricating oil so that a determination of the radioactivity of the oil can provide a sensitive test of engine wear.

Friction of Nonmetals.—So far the discussion has dealt mainly with metals but the friction of nonmetallic solids is governed by the same general principles. If the solids are deformed plastically (as a metal is) it obeys the same two frictional laws. This is true for the solids popularly known as plastics or polymers (*e.g.*, polymethyl methacrylate, polyethylene or nylon). The coefficient of friction for these solids is in the region of $\mu = 0.3$–0.6. An interesting exception is the solid polytetrafluoroethylene (Teflon) which gives a much lower friction $\mu = 0.05$–0.1.

If an elastic solid such as rubber is used the real area of contact is no longer proportional to the load W but to $W^{\frac{2}{3}}$. The coefficient of sliding friction μ should not therefore be constant. It should decrease as the load is increased, and it can be shown that μ should be proportional to $W^{-\frac{1}{3}}$. Experiment confirms this and shows that in addition an appreciable part of the friction is due to elastic hysteresis loss inside the rubber when it is deformed (see *Rolling Friction* below). The friction of wood is also due partly to adhesion at the surface and partly to internal deformation hysteresis loss inside the wood.

Diamond, which is the hardest of solids, is elastically deformed even under the heaviest loads so that its friction also obeys the elastic laws. It is interesting to note that the friction of a diamond crystal depends on the direction of sliding. The crystallographic directions which give the highest friction are those in which the diamond is mostly easily polished or abraded.

The friction of ice ($\mu = 0.02$) is remarkably low and there is evidence that this is due to the presence of a water film at the surface. This may be formed by "pressure melting" if the temperature is close to freezing or by frictional heating if the sliding speed is appreciable. There is evidence that this frictional melting can play an important part in the sliding of skis on snow.

Effect of Surface Films.—It has been assumed that the surfaces dealt with are clean. In fact metal surfaces exposed to the air are always covered with a film of oxide and adsorbed gas or vapour. This may be only a few molecules thick and invisible, but it may have a profound effect on the friction for it can enormously reduce the strength of adhesion at the points of real contact. It is difficult to get rid of these films, but if the metals are put in a vacuum and the last molecular layer is removed, it is found that the friction rises to an enormous value; in fact, complete seizure of the two metal surfaces occurs. It is only when a trace of air or other contaminating material is allowed to enter the apparatus that the friction falls to its usual everyday value. The friction of most nonmetals is also increased if these surface films are removed in a high vacuum.

Temperature of Sliding Surfaces.—Another important factor comes into play when the surfaces slide at an appreciable speed. The work done against friction is dissipated mainly in the form of heat and quite simple calculations suggest that the rise of temperature at the surface may be high. This is confirmed by experiments which show that the tiny points of sliding contact may be red hot or even white hot, although to ordinary observation there is no sign of this and the metal appears quite cool. These high temperatures can cause a local softening or melting at the points of contact of the metal surfaces, even at moderate speeds of sliding.

The upper limit of temperature is fixed by the melting point of the metal since the surface temperature will not, in general, rise above this. When metal surfaces are rubbed together at high speeds (1,000 m.p.h. or 2,000 m.p.h.) a thin film of the metal is melted which can act as a lubricant so that the friction falls to a very low value. A bullet leaving the muzzle of a gun may rub against the barrel at this speed, but in ordinary engineering the rubbing speeds are, of course, much lower.

These high surface temperatures may also be important in lubrication. At elevated temperatures lubricant films cease to be effective and a temperature flash at a rubbing hot spot may lead to failure of the lubricant precisely at the region where its protective properties are most needed.

Since the major source of friction and wear arises from interaction between the rubbing surfaces, the most effective way of reducing them is to keep the rubbing surfaces apart. The simplest

way of doing this is to put a layer of oil or some other fluid between the surfaces. Under appropriate conditions an air or gas film can be used. If the lubricant layer is a thick one the conditions are those of fluid lubrication or a hydrodynamic lubrication. If the lubricant layer is only a few molecules in thickness it is termed boundary lubrication. Boundary lubricated surfaces obey the two frictional laws mentioned above and there is evidence that some metallic or solid contact usually occurs through the boundary films. (*See* LUBRICATION.)

Rolling Friction.—There are two main types of rolling. The first occurs for example when a driving wheel rolls over a road in a motorcar or over a rail in a train. Here considerable tangential forces are involved in pulling the vehicle along and the conventional frictional grip between the wheel and the surface is of great importance. There is, however, another type of rolling which involves only a minute tangential traction—this is the type of rolling that occurs when a wheel or a ball or a cylinder rolls freely over another surface. We may call this "free" rolling and its most common application is in ball bearings and roller bearings (*see* BEARINGS). The resistance to rolling in these cases is phenomenally low, corresponding to a coefficient of friction of perhaps less than $\frac{1}{1,000}$. A ball bearing was designed by C. Varlo in 1772.

The source of rolling friction has long been a matter of speculation. The first basic study was by Osborne Reynolds in 1875. He showed that when a metal cylinder rolls over a rubber surface it moves forward a distance less than its circumference in each revolution of the cylinder. This is because the cylinder measures out its circumference over a stretched portion of rubber. Reynolds suggested that this stretching was not uniform over the region of contact so that minute slipping between cylinder and rubber occurs. Another type of microslip, of far greater importance than the Reynolds' slip, occurs when a hard ball rolls in a groove. This was first pointed out by H. L. Heathcote in 1920 and arises from the fact that the central band on the ball measures out its full circumference in each revolution whereas the bands at the edge of the groove measure out a length smaller than their circumference. Consequently some slip must occur within the ellipse of contact.

Although there is little doubt that both types of slip can occur, D. Tabor has shown that in many cases the friction arising from this is minute and constitutes only a small fraction of the total observed rolling friction. The reason for this is relatively simple. In rolling, any interfacial junctions that are formed are peeled apart, whereas in sliding they must be sheared. The peeling action is a very easy one so that little work is necessary to break the junctions during rolling. Thus interfacial frictional effects are of secondary importance. This is confirmed by the observation that lubricants which greatly reduce the sliding friction have little effect on the rolling friction.

Lubricants may play a useful and important part in reducing surface attrition or wear and it is probable that this is one of their main functions in ball and roller bearings. In addition they help to reduce corrosion and diminish sliding friction between the rolling elements and the cage (retainer) in the assembled bearing.

The main source of friction in free rolling appears to be due to deformation losses in the rolling materials. If the rolling of a hard sphere over a somewhat softer surface is considered the material ahead of the sphere is deformed elastically, and work is done on it. As the sphere rolls forward the deformed material emerging behind it recovers elastically and urges the ball forward. If the material were ideally elastic the energy restored as the material recovered behind the ball would be exactly equal to the energy stored in the front region and no net force would be required to roll the ball.

However, in practice all solids lose some energy when they are deformed elastically. This effect is known as internal friction or elastic hysteresis. It is this loss which is reflected in the work required to roll the ball along. Hysteretic properties vary enormously and there is a corresponding variation in rolling resistance. Some types of rubber which are "soggy" or "dead" have high hysteresis losses and with these materials the free rolling friction may be relatively large. Even so the rolling friction will be much less than the sliding friction. On the other hand, with hard steels, such as those used in ball bearings, the elastic hysteresis losses are small and the rolling friction is correspondingly low. In ball and roller bearings these hysterctic losses are not only important in determining the rolling friction but they are also closely associated with the fatigue life of the bearing material. As seen above the elastic hysteresis loss can also play a part in sliding friction if the solid is deformed by the sliding process.

See BEARINGS; LUBRICATION; MECHANICS; *see* also references under "Friction" in the Index volume.

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(F. P. B.)

FRIDOLIN, SAINT (fl. 6th century?), Irish missionary, first mentioned by the monk Balther of Säckingen (*c.* 1000) as apostle of the Alamanni on the upper Rhine and founder of Säckingen in the time of Clovis I. Most historians regard this account as untrustworthy. An Irishman named Fridolin was probably at Poitiers during the reign of Clovis II. St. Fridolin's feast day is March 6.

See J. F. Kenney, *Sources for the Early History of Ireland*, pp. 497–498 (1929).

(L. BR.)

FRIED, ALFRED HERMANN (1864–1921), Austrian pacifist, publicist and cofounder of the German peace movement, was born in Vienna on Nov. 11, 1864. In 1891 he went to Berlin, where he founded the pacifist periodical *Die Waffen nieder!* (from 1899 called *Friedenswarte*). In 1892, urged by Bertha von Suttner he founded the Deutsche Friedensgesellschaft (German peace society), which soon became the focus for the German pacifist movement. Humanitarian in outlook, Fried was an advocate of "causal pacifism" (*ursächlicher Pazifismus*). He believed that "international anarchy" should be met not only by legislative measures but also by spiritual regeneration and international understanding. He influenced some German theorists on international law (including H. Wehberg), but made no political impact. For his untiring work in the cause of peace he shared, with Tobias Asser, the Nobel peace prize of 1911. The outbreak of World War I shook his optimism. As a protest against official German policy, he emigrated to Switzerland, where, as editor of *Blätter für internationale Verständigung und zwischen-staatliche Organisation* (Papers for International Understanding and Inter-state Organization), he worked for an immediate peace. Nevertheless, he protested against the treaty of Versailles, though warning the Germans against attempts at forcible revision. He died in Vienna on May 5, 1921. Fried's many works include *Handbuch der Friedensbewegung*, two volumes, 2nd ed. (1911–13), and *Mein Kriegstagebuch*, four volumes (1918–20).

See R. Goldschmidt (ed.), *Alfred Hermann Fried* (1922).

(W. SA.)

FRIEDEL, CHARLES (1832–1899), French chemist and mineralogist, best known as a co-discoverer of the chemical process known as the Friedel-Crafts reaction (*q.v.*), was born at Strasbourg on March 12, 1832. In 1854 he entered C. A. Wurtz's laboratory, and in 1856 was appointed conservator of the mineralogical collections at the École des Mines. In 1871 he began to lecture at the École Normale, and in 1876 he became professor of mineralogy at the Sorbonne, but on the death of Wurtz in 1884 he exchanged that position for the chair of organic chemistry. He died at Montauban on April 20, 1899. Friedel worked both in mineralogy and organic chemistry. He collaborated from 1879 to 1887 with Émile Edmond Sarasin (1843–90) on the formation of minerals by artificial means. He also devoted much attention to the pyroelectric phenomena of crystals, to the determination of crystallographic constants, and to the study of the ketones and

aldehydes. Friedel was associated with Wurtz in editing the latter's *Dictionnaire de chimie*, and undertook the supervision of the supplements issued after 1884. He was the chief founder of the *Revue générale de chimie* in 1899. His publications include a *Notice sur la vie et les travaux de Wurtz* (1885), *Cours de chimie organique* (1887) and *Cours de minéralogie* (1893).

FRIEDEL-CRAFTS REACTION. The reaction is commonly considered as the process of uniting two or more organic molecules through the formation of carbon-to-carbon bonds under the influence of certain strongly acidic metal halide catalysts, such as aluminum chloride, boron fluoride, ferric chloride, zinc chloride, etc. The useful applications of the reaction include such typical examples as aromatic alkylation (*e.g.*, the formation of cumene from benzene and isopropyl chloride), aromatic acylation (*e.g.*, the formation of acetophenone from benzene and acetyl chloride), aliphatic alkylations (*e.g.*, the formation of iso-octane from isobutane and isobutylene) and polymerizations (*e.g.*, the formation of butyl rubber from isobutylene and isoprene), all effectively catalyzed by aluminum chloride.

The Friedel-Crafts reaction was discovered in 1877 by Charles Friedel and James Mason Crafts, working at the Sorbonne in Paris. In the amazingly short period of six weeks, they proceeded from the observation of a vigorous reaction between amyl chloride and aluminum foil to a remarkably clear definition of the scope of aluminum chloride and similar metal halides as catalysts for alkylation, acylation, polymerization and cracking. The typical reactions catalyzed by aluminum chloride, which they reported in a series of publications in 1877 and subsequently, and which now bear the general name of Friedel-Crafts reactions, have proven to be among the most versatile and useful reactions in all of organic chemistry.

One indication of the scope and utility of the reaction is the fact that a definitive monograph on the subject, appearing in 1941, encompassed 963 pages (Charles Allen Thomas, *Anhydrous Aluminum Chloride in Organic Chemistry*, American Chemical Society Monograph no. 87). Investigations of extensions and applications of the Friedel-Crafts reaction have been the subject of literally thousands of scientific publications and patents since 1877.

Aromatic Alkylation.—Among the earliest examples of the Friedel-Crafts reaction, reported in the original papers in 1877, were cases of alkylation of benzene to give toluene, ethylbenzene and amylbenzene. Perhaps the most useful applications of this reaction are in the large-scale commercial preparation of ethylbenzene and cumene (isopropylbenzene).

$$\underset{\text{benzene}}{C_6H_6} + \underset{\text{ethyl chloride}}{CH_3CH_2Cl} \xrightarrow{AlCl_3} \underset{\text{ethylbenzene}}{C_6H_5CH_2CH_3} + HCl$$

$$\underset{\text{benzene}}{C_6H_6} + \underset{\substack{\text{isopropyl}\\ \text{chloride}}}{(CH_3)_2CHCl} \xrightarrow{AlCl_3} \underset{\text{cumene}}{C_6H_5CH(CH_3)_2} + HCl$$

In each instance only small amounts of aluminum chloride are required. The reaction may be conveniently carried out either by mixing the benzene and organic chloride and then adding the aluminum chloride portionwise, or by mixing the benzene and aluminum chloride and then adding the organic chloride portionwise. The reactions proceed vigorously at room temperature or slightly above.

The above organic chlorides are prepared commercially by the addition of hydrogen chloride to ethylene and propylene, and, in fact, the Friedel-Crafts reactions are frequently carried out directly on the olefin.

$$\underset{\text{ethylene}}{CH_2 = CH_2} + HCl \longrightarrow \underset{\text{ethyl chloride}}{CH_3CH_2Cl}$$

$$C_6H_6 + CH_2 = CH_2 \xrightarrow{AlCl_3} C_6H_5CH_2CH_3$$

$$C_6H_6 + \underset{\text{propylene}}{CH_2 = CHCH_3} \xrightarrow{AlCl_3} C_6H_5CH(CH_3)_2$$

One of the major modifications of the Friedel-Crafts reaction, not encompassed in the original publications, is the use of sulfuric acid in place of aluminum chloride. Thus, the reaction of propylene (or isopropyl alcohol) with benzene in the presence of concentrated sulfuric acid produces cumene.

$$C_6H_6 + CH_2 = CHCH_3 \xrightarrow{H_2SO_4} C_6H_5CH(CH_3)_2$$

$$C_6H_6 + \underset{\substack{\text{isopropyl}\\ \text{alcohol}}}{(CH_3)_2CHOH} \xrightarrow{H_2SO_4} C_6H_5CH(CH_3)_2$$

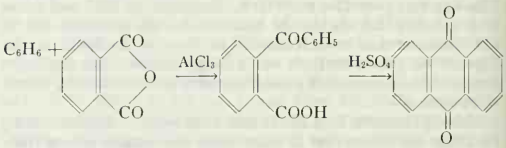
Because of the similarity of the action of sulfuric acid to that of the metal halides originally discovered by Friedel and Crafts, this modification is frequently referred to as a reaction of the Friedel-Crafts type.

Aromatic Acylation.—When acyl halides are substituted for alkyl halides in the Friedel-Crafts reaction, ketones are produced in good yield.

$$C_6H_6 + CH_3\overset{\overset{O}{\|}}{C}-Cl \xrightarrow{AlCl_3} C_6H_5\overset{\overset{O\cdot AlCl_3}{|}}{C}=CH_3 \xrightarrow{H_2O} \underset{\text{acetophenone}}{C_6H_5\overset{\overset{O}{\|}}{C}CH_3}$$

In this application, it is found that the ketones which are produced form a molecular compound with the aluminum chloride, necessitating the use of one molecular equivalent of the aluminum halide. This complex must be hydrolyzed by water to recover the ketone produced. Acetophenone is a useful article of commerce, finding particular application in the perfume industry.

Acid anhydrides also undergo the Friedel-Crafts reaction. A particularly useful example is that of phthalic anhydride.



phthalic anhydride *o*-benzoylbenzoic acid anthraquinone

Anthroquinone is produced synthetically in this way for use as a useful intermediate in the dye industry.

Aliphatic Alkylation.—Although the very first observation of Friedel and Crafts concerned the action of aluminum on a simple alkyl halide, useful application of the Friedel-Crafts reaction to nonaromatic systems was delayed nearly 50 years. The application to petroleum reactions became perhaps the most important volume use of the Friedel-Crafts catalysts. One example is the condensation of two olefin molecules.

$$2CH_2 = C(CH_3)_2 \xrightarrow[\text{or } H_2SO_4]{AlCl_3} \underset{\text{diisobutylene}}{(CH_3)_3CCH = C\begin{matrix}CH_3\\CH_3\end{matrix}} \xrightarrow{H_2} (CH_3)_3CCH_2CH(CH_3)_2$$

isooctane

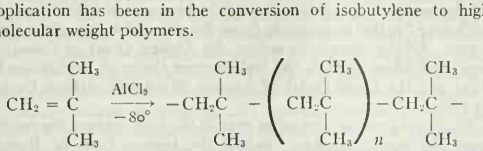
Isooctane, the standard for high-test antiknock gasoline, was once made industrially by the above procedure. In the 1950s it was made by direct reaction of isobutylene with isobutane.

$$(CH_3)_3CH + CH_2 = C(CH_3)_2 \xrightarrow[\text{or } H_2SO_4]{AlCl_3} (CH_3)_3CCH_2CH(CH_3)_2$$

The reverse of the above reaction, the "cracking" of large, saturated molecules in the presence of Friedel-Crafts catalysts, is also an extremely important reaction in petroleum refining.

Polymerization.—One other important reaction catalyzed by aluminum chloride, and recognized in the original work of Friedel

and Crafts, is polymerization. The most important commercial application has been in the conversion of isobutylene to high molecular weight polymers.



For moderate values of n, these materials are widely used to improve the viscosity characteristics of motor oil. By incorporating minor amounts (1%) of isoprene in the formulation, and carrying the polymerization to values of n in excess of 1,000, one obtains butyl rubber, from which highest quality automobile inner tubes are made.

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(C. C. PE.)

FRIEDJUNG, HEINRICH (1851–1920), Austrian historian who combined historical studies with a keen interest in politics and whose reputation as a historian suffered because of his political views and his involvement in a sensational trial. He was born at Rostin, Moravia, Jan. 18, 1851, of Jewish parents. He studied at Prague, Berlin and Vienna, was at the Institut für Österreichische Geschichtsforschung (1871–75) and taught at the Handelsakademie in Vienna (1873–79). Friedjung favoured strengthening the German character of Austria and wanted close economic connection between the two countries; he was thus unsympathetic to Slav and Magyar nationalist movements in the dual monarchy. He also wanted a centralized and liberal government. His *Der Ausgleich mit Ungarn* (1877), based on these views, led to dismissal from the Handelsakademie. He then became a political journalist, associated with the nationalist Georg von Schönerer until Schönerer's anti-Semitism made Friedjung break away.

Despite editorship of the *Deutsche Wochenschrift* (1883–86) and the *Deutsche Zeitung* (1886–87), in which he expressed his German nationalist views, Friedjung found time for historical studies. His chief historical work is *Der Kampf um die Vorherrschaft in Deutschland* (1897–98; 10th ed., 1916–17). *Das Zeitalter des Imperialismus, 1884–1914* (1919–22), unfinished at his death, was completed by A. F. Pribram, but was soon superseded by publication of important documents. His other works, dealing mainly with the period 1848–66, include *Österreich von 1848–60* (1908–12), also unfinished.

During the Bosnian crisis of 1909, Friedjung published an article based on documents supplied by the Austrian foreign office accusing leaders of the Serbo-Croat movement of treasonable practices. The men attacked sued Friedjung and the trial that followed showed that the documents were forgeries. Friedjung had used them in good faith but without adequate scrutiny and his reputation as a historian suffered. He died in Vienna, July 14, 1920.

See H. von Srbik in *Deutsches Biographisches Jahrbuch* (1917–20).

FRIEDLAND, BATTLE OF, an engagement fought at Friedland (modern Pravdinsk), 27 mi. S.E. of Königsberg (Kaliningrad) in East Prussia on June 14, 1807, between the French under Napoleon and the Russians under Gen. L. A. von Bennigsen. On June 13, eight days after the beginning of his summer campaign, Napoleon's forces were grouped near Eylau (Bagrationovsk) with detachments advanced toward Königsberg and Friedland to anticipate Bennigsen's movements. Late that evening Napoleon, who had ordered Marshal Lannes to occupy Friedland next day, heard of Bennigsen's crossing to the left bank of the Alle river there. Instructed to cover Königsberg with his army but afraid of being driven against the coast, Bennigsen compromised dangerously by halting at Friedland. Lannes began his cannonade at 3 A.M. on June 14, and Bennigsen, instead of trying to reach Königsberg or recrossing the Alle, was content to hold his position against the marshal's 12,000 men. By 10 A.M., however, the French were 40,000 strong to Bennigsen's 46,000. After midday the main French forces began to come up, and just after 5 P.M. Napoleon launched a general offensive with heavily superior forces. On his right the repulse of Marshal Ney's columns delayed the French advance, but a second attack, with a large battery of artillery brought forward, made the Russian left wing collapse. The advance of the French left and centre (about 8 P.M.) cut off the Russian right wing (which withdrew along the left bank) and completed the rout of the forces trapped against the river. Russian casualties numbered 20,000, French 7,000–8,000. On June 16 Gen. Anton Lestocq's Prussians abandoned Königsberg and withdrew to the Niemen to join Bennigsen. Napoleon reached Tilsit on June 19 and concluded an armistice two days later. *See* NAPOLEONIC WARS. (J. H. N.)

FRIEDRICH, CASPAR DAVID (1774–1840), German landscape painter and engraver of the romantic school, was born at Greifswald on Sept. 5, 1774. He studied under J. G. Quistorp, the university drawing master of his native town, and from 1794 to 1798 at the academy in Copenhagen. He then settled at Dresden, where he was a member of an artistic and literary circle of friends, which included Philip Otto Runge, Ludwig Tieck and Novalis. His drawings in sepia, executed in his neat early style, won Johann Goethe's approval and a prize from a Weimar art society in 1805. His first important oil painting, dated 1807, was an altarpiece for the castle of Graf Thun in Teschen, representing a "Crucifix in Mountain Scenery." Other notable works were the "Graveyard in Snow" (1810), "Alpine Scenery" (1828), "Two Men Contemplating the Moon" (1819) and "Rest in a Hayfield" (1835). In 1824 he was made professor of the Dresden academy. He died May 7, 1840, at Dresden. For a long time his work was forgotten; but it was revived in 1906 in a Berlin exhibition. His influence made itself felt in the work of his pupils and friends, K. G. Carus, G. Kersting, K. F. Lessing, F. Olivier, E. Öhme, the Norwegian J. K. C. Dahl and others.

FRIEDRICHSHAFEN, a town of Germany which after the partition of the nation following World War II was included in the *Land* (state) of Baden-Württemberg in the Federal Republic of Germany, lies on the north shore of Lake of Constance (Bodensee) at the junction of the Constance (Konstanz)-Lindau railway with that to Ulm, and affords a fine view of the Alps. Pop. (1961) 37,148. It was formed in 1811 through unification of the former imperial town of Buchhorn and the monastery and village of Hofen. Buchhorn, made a free imperial city by King Rudolf I in 1275, was assigned to Württemberg in 1810. Hofen monastery (from 1050 a convent for Benedictine nuns) became a provostship of monks in 1420, was suppressed in 1802, and in 1805 passed to Württemberg.

Before World War II, in which the town was greatly damaged, Zeppelin airships were built at Friedrichshafen and it now has a Zeppelin museum. Largely reconstructed, it is a lake resort with an annual fair; its industries include tanning and the manufacture of cars and aircraft.

FRIENDLY SOCIETY, in British usage, a mutual association whose chief purpose is to provide its members with money allowances during incapacity for work resulting from sickness or infirmity, and with money payments on the death of a member or of his wife. Many societies also provide other benefits or services for their members. In addition a number of societies exist, known as collecting friendly societies, which have a large aggregate membership. The facts that their contributions are collected by agents at the houses of members, and that in Great Britain they are subject to the Industrial Assurance act, 1923, distinguish these societies from the ordinary friendly society, with which alone the present article is concerned.

By the National Insurance act, 1911, the friendly societies in Great Britain became associated with the administration of national health insurance. A friendly society could, under that act, become an "approved society" for national health insurance and at the same time carry on its wholly voluntary operations as a friendly society. This arrangement was terminated by the National Insurance act, 1946, which came into force in July 1948.

The friendly societies then ceased to be concerned with national insurance.

The Friendly Societies act, 1896, described them as organizations whose purpose was to provide, by voluntary subscriptions of their members, for:

1. The relief or maintenance of the members, their husbands, wives, children, fathers, mothers, brothers or sisters, nephews or nieces, or wards being orphans, during sickness or other infirmity, whether bodily or mental, in old age (which shall mean any age after 50) or in widowhood, or for the relief or maintenance of the orphan children of members during minority; or

2. Insuring money to be paid on the birth of a member's child, or on the death of a member, or for the funeral expenses of the husband, wife or child of a member, or of the widow of a deceased member, or, as respects persons of the Jewish persuasion, for the payment of a sum of money during the period of confined mourning; or

3. The relief or maintenance of the members when on travel in search of employment, or when in distressed circumstances, or in case of shipwreck or loss or damage of or to boats or nets; or

4. The endowment of members or nominees of members at any age; or

5. The insurance against fire, to any amount not exceeding £15, of the tools or implements of the trade or calling of the members; or

6. Guaranteeing the performance of their duties by officers and servants of the society or any branch thereof;

Provided that a friendly society which contracts with any person for the assurance of an annuity exceeding £104 per annum, or of a gross sum exceeding £500, shall not be registered under this act.

These objects were widened by the Friendly Societies act, 1955, which among other things gave to any registered friendly society the power to lend funds, in certain circumstances, to other friendly societies, to invest funds in housing associations and to offer new forms of benefit, such as marriage endowments.

History.—Sickness and death benefit societies existed in early times. Burial societies and guilds of working and professional people which provided death benefits were common in Rome and the provinces of the Roman empire (*see* M. I. Rostovtsev, *Social and Economic History of the Roman Empire*, p. 178). In Great Britain similar functions were included in the objects of medieval guilds, from which the modern friendly society movement may be descended, though no definite historical links have apparently been traced.

A few societies still existing in Britain were founded before the end of the 17th century; during the 18th the system became widely established and considerable literature exists on the subject dating from that era. Thus Sir F. M. Eden's *Observations on Friendly Societies for Maintenance of the Industrious Classes During Sickness, Infirmity, Old Age and Other Exigencies* (published in 1801) referred to returns obtained for more than 5,000 societies enrolled under the act of 1793 (the first general statute relating to friendly societies). He concluded that the total number of societies then in existence was about 7,200. But many of them were financially unsound and much of the literature referred to (which included several reports of committees of the house of commons) was highly critical of them.

Most of these societies were purely local, drawing their membership from a single village or a restricted area in a town. But two other types of society began to develop in the early years of the 19th century. One was the so-called "county" friendly society, promoted by the rural gentry and clergy (the clergy were also active in the promotion of village friendly societies). This type was generally run on sounder financial principles than the local societies and covered a wider area, generally the greater part of a county. Several are still in existence.

Much more important was the rise of the orders. Little is known about their origins, but it is probable that they began to take shape in the second half of the 18th century as offsprings of Freemasonry, whose ceremonial and fraternal aims they imitated. One of the earliest was the Independent United Order of Mechanics, established in 1756 or 1757. The United Ancient Order of Druids was established in 1781.

Earlier than either were the Oddfellows, of which a lodge is known to have been in existence in 1745. This was the ancestor of many existing orders calling themselves Oddfellows, of which the largest is the Independent Order of Oddfellows, Manchester Unity. This order was established in 1813 and spread rapidly first through the industrial north of England and then through the whole country. In the late 1940s it had more than 4,000 branches with over 750,000 members in Great Britain, and many others elsewhere. Of the other large orders, the Ancient Order of Foresters was established in 1834, the Independent Order of Rechabites in 1835 and the Loyal Order of Ancient Shepherds, Ashton Unity, in 1826.

During the middle and latter part of the 19th century the orders were the most important, indeed the typical form of British friendly society. Their ceremonial and their fraternal aspirations made them social and convivial bodies meeting a need which was not otherwise well met for the lower middle class and the artisans who comprised the membership. Furthermore, they were, on the whole, much better administered and financially sounder than were the small local societies, because of the supervision which could be exercised over the branches by the headquarters of the order. Indeed, the Independent Order of Oddfellows, Manchester Unity, led the friendly societies in submitting itself to an actuarial valuation.

During the latter half of the 19th century, however, other varieties, which unlike the orders were essentially centralized, came into greater prominence. Thus there was the large centralized accumulating type, of which a leading example is the Hearts of Oak Benefit society. Founded in 1842, it met with early and continued success and by 1872 its membership had grown to 32,000; in the early 1960s it was more than 500,000.

The deposit societies form another group which came into prominence in the 1860s and 1870s and achieved a continued success. The leading example, the National Deposit Friendly society, was established in 1868. By 1899 its membership numbered 46,000; in the early 1960s it was more than 650,000.

Types of Society.—Like other English institutions, friendly societies sprang from insignificant origins and developed in a great measure independently of one another. Consequently a great variety of practice arose among them, rendering a simple classification impossible. At least three separate and overlapping classifications must be made:

General and Specialized Societies.—The typical friendly society is one assuring payments to the member during incapacity for work due to sickness, together with a lump sum on the death of the member or of his wife. The sickness benefit is generally from 10*s.* to 20*s.* a week, although many of the larger societies have introduced higher rates of contribution and benefit which members may take at their option. Sickness benefit at the full rate is usually payable for 26 or 52 weeks, after which, if incapacity still continues, it is reduced by one half. Sometimes, after a similar period, there is a further reduction. In most societies, the premiums are graduated according to age at entry in accordance with actuarial tables.

The great bulk of friendly societies offer these assurances and many provide nothing else. But in addition to these, many societies exist which have more specialized objects. These include societies offering medical or institutional treatment only, societies assuring endowments or annuities and pensions, societies for widows and orphans and a considerable number of small burial societies.

Centralized Societies and Societies With Branches.—Many friendly societies, including some very large ones, consist of a head office only, or of a head office with a number of local agencies. These agencies do not maintain any separate funds and usually have little or no control over their finances. In contrast to these there are the societies with branches, or, as they are also called, the affiliated orders. An order consists essentially of a number of local branches, all more or less closely linked by common traditions and all subject to the general rules of the order and to the central governing body. The local branch, which is called the lodge in the Oddfellows, the court in the Foresters and by other names in other orders, is the link with the individual member. He joins the branch, pays his contribution to its funds and out of its funds, as a rule, his benefits are provided. But the branches are, at any rate with the larger orders, grouped in districts on a geographical basis.

Above the district is the central authority of the order. Every branch is subject to the general rules of the order and though it has its own rules these must comply with the rules of the superior body. Branches are likewise subject to the district under which they are grouped and districts are subject to the central authority.

Often, too, districts will reinsure certain benefits in order to protect the financial stability of branches. But each branch and district must be separately registered under the act, if the order of which it is a branch is registered. If the order is unregistered no subsidiary may be registered as a branch, though it can be registered as a separate society. The domestic affairs of the branch are legally subject to the control of its own elected committee of management. The branch elects its delegates to the district meeting, at which the district committee of management is elected, and districts appoint representatives to the annual meeting of the order, at which the committee of management of the whole order is elected. Thus the typical order combines a close connection with the individual members with much of the financial stability typical of a large insurance society.

Accumulating Societies and Societies With Dividend.—This basis of classification cuts across the preceding. Thus some centralized societies are accumulating societies, while others are societies giving a dividend. Societies of the accumulating type make provision for the increasing liability to sickness as age advances by fixing the premiums for lower age groups at a figure somewhat higher than is necessary to cover the estimated sickness claims at those ages and to accumulate the surplus to form a reserve to meet sickness claims of higher age groups.

On the other hand, societies with dividend depart from this orthodox practice. In this class there are three main subdivisions, generally called "deposit," "Holloway" and "dividing" societies. All three combine some kind of savings system with the ordinary insurance. Under the deposit plan, which enjoys the widest popularity, the members are in general required to contribute monthly an amount equal to what they desire to receive daily in sickness benefit. Thus a contribution of 2*s.* a month is payable in respect of a sickness benefit of 12*s.* a week. Part of the contribution so paid is put to the member's personal savings on deposit account, part to the common fund for sickness benefit; the governing body of the society fixes the proportions in which the contributions shall be divided, but normally the proportion allocated to the deposit is considerable. Whatever sick benefit a member may claim is drawn in part from the common fund and in part from his deposit.

If, as a result, his deposit becomes exhausted, sick benefit ends and is replaced by "grace pay" at a lower rate for a limited period, but no member is allowed to resort to "grace pay" more than once in five years. If the member's deposit account is not exhausted, he may draw upon it, subject to certain restrictions, as if it were a savings bank account. He has also the option of making extra deposits to it.

The second class of society with dividend, known as Holloway societies because the idea originated with George Holloway, later member of parliament for Stroud, Gloucestershire, came into existence about 1874. These societies also achieved considerable popularity.

The principle of this system is to require a high contribution, relative to the insurance value of the benefits offered and to increase it as the member passes from age to age between 30 and 65, when sickness benefit terminates; the object of this condition is to provide, in the absence of specific reserves for sickness benefit, for the growing liability the member brings as his age increases. The claims of each year constitute a first charge on the contribution income of the year and in normal circumstances are wholly met from this source, there being no recourse to the personal account of a member in respect of his own demands for sickness benefit and no limitation on the amount of benefit that he may draw, such as the deposit system involves. The balance of the income of each year, after meeting sickness claims, is divided among the members and credited to their personal accounts.

The third type of society with dividend is known as the dividing society. Among registered friendly societies this class was declining in importance by the 1960s. In the dividing society the member pays a periodical subscription, the rate of which, like the rates of benefit, is usually fixed arbitrarily. After payment of benefits, the surplus on the year's working, or a large part of it, is distributed as a cash dividend to members. In "slate clubs" members pay small sums periodically toward accumulating a fund to be shared out at a special time (*e.g.*, at Christmas).

Legislation.—Numerous acts of parliament for the encouragement and regulation of friendly societies were passed between 1793 and 1895, but practically everything of permanent value in these measures was incorporated in the Friendly Societies act, 1896. This act is administered by the Registry of Friendly Societies at the head of which is the chief registrar, who, by the statute (as amended by the Friendly Societies act, 1924), must be a barrister of 12 years' standing or have been an assistant registrar for at least five years. The privileges which the act confers are restricted to those societies which register under it, and most, though not all, of the conditions which it imposes apply to these societies only. Unregistered friendly societies are subject, of course, to common law, but the registry office exercises no functions in regard to them. The privileges of registration apply to workingmen's clubs and to societies operating under special authorities as well as to friendly societies.

The condition of registration is the adoption of rules providing, among other things, for the following matters:

The objects of the society, which must be chosen from among the objects specified in the act; terms of admission of members; conditions entitling a member to benefit; mode of holding meetings and right of voting; manner of making, altering or rescinding rules; appointment and removal of trustees, committee of management and other officers; provision, if the society is one with branches, for the composition of the central body and the conditions under which a branch may secede from the society; investment of funds; keeping of accounts and audit thereof; annual returns to registrar; manner of settling disputes (decisions arrived at in accordance with the rules are binding, are not removable into any court of law and may be enforced on application by the county court); provision for expenses of management; and quinquennial valuation.

The rules set out the conditions of the contract which the members of a friendly society make with one another and of the remedies which the law provides to secure its fulfillment. But, although the society must state in its rules what are its benefits and the conditions under which they are payable, few conditions are imposed upon it. Thus there is no compulsion to adopt an actuarially sound table of contributions, except for the insurance of annuities.

Again, while every society is compelled to submit its accounts to an annual audit and to submit its financial position to valuation at quinquennial intervals (unless exempted by the registrar on the ground that valuation is inapplicable to its undertakings), there is no compulsion on the members to employ professionally qualified actuaries (though nearly all societies do so) or to take steps to rectify any unsoundness which the valuation may reveal. The registrar may do (and does) much, through the influence which his position enables him to exercise, to ensure that societies are run on sound lines, but he has no power to order an inquiry into a society's affairs except on the application of a specified proportion of the members as laid down in the act.

The more important privileges attaching to a registered friendly society are:

It can legally hold land and other property in the names of its trustees. It also has various privileges in respect of the transference of property from one trustee to another.

It is exempt from income tax, corporation property duty and stamp duty on certain kinds of documents.

Disputes with the society can be settled in any manner for which the rules provide, thus avoiding the cost of litigation.

The period from 1910 to World War II saw great changes in the friendly societies, largely because of the advent of national insurance, with the administration of which they were closely concerned until 1948. In 1910 the number of societies (including branches of orders) was 26,877, but membership was only 6,637,000 and funds £49,802,000. In 1945 societies numbered about 18,000, but membership was over 8,700,000 and funds over £200,000,000. Sickness benefits amounted to about £5,000,000 and death benefits to about £2,000,000 annually.

After 1945, numbers of societies and of members progressively declined. This decline was attributable largely to the comprehensive national social security schemes instituted shortly after World War II. These, together with full employment and the rise in money incomes, made the old friendly society schemes of insurance less attractive. Experience of the period after 1948 suggested that the stronger friendly societies would develop new kinds of business, including endowments and perhaps those objects permitted them by the act of 1955 (*see* above).

In the dominions settled from England, friendly societies are similar to the English in their structure; many are branches of English orders.

For a discussion of fraternal organizations, the name by which friendly societies are known in the United States, *see* FRATERNAL ORGANIZATION.

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FRIEND OF THE COURT: *see* AMICUS CURIAE.

FRIENDS, SOCIETY OF, a body of Christians commonly called Quakers and officially known in some parts of America as Friends Church. The phrases "Children of Light" and "Friends of Truth" were used in the 17th century and from the outset Quakers used the form of address "friend" within the fellowship and to all whom they encountered. The term Society of Friends does not appear to have been used until the late 18th century. The body's form of worship and religious fellowship arises from a belief in the priesthood of all believers; it emphasizes that women equally with men have a share and responsibility in worship and in church organization. It has no formulated creed demanding definite subscription, no liturgy, separated priesthood or outward sacrament. In 1960 there were about 202,000 Friends in the world —123,000 in North America; nearly 24,000 in Great Britain and Ireland, and 1,200 on the continent of Europe; 38,000 in Africa; fewer than 1,000 in Asia; nearly 2,000 in Australasia; and 14,000 in Central and South America.

HISTORY

Origins.—Quakerism arose in Great Britain out of the religious ferment of the mid-17th century. It represents the extreme left wing of the Puritan movement. George Fox (*q.v.*), its founder, was the son of a Leicestershire weaver and of a mother whom he described as "of the stock of the martyrs." At the age of 19 Fox became disillusioned with the way in which professing Christians were failing to live up to the standards they preached, and for four years he traveled from one group of sectarians to another in search of spiritual help. His *Journal* describes how, in 1647, "when all my hopes in them and in all men were gone, so that I had nothing outwardly to help me, nor could tell what to do, then, oh then I heard a voice which said 'there is one, even Christ Jesus, that can speak to thy condition'."

The year 1643, when Fox had left his home, was also the year of the Solemn League and Covenant, by which parliament undertook to introduce into England the full presbyterian system, with its doctrinal rigidity and exacting discipline. In revulsion against this, a strong body of opinion, especially in the army, attached itself to the Independents who favoured some degree of religious liberty. The General Baptists also favoured toleration and advocated an expansion of the rights, privileges and functions of the laity. In 1649, with episcopacy dethroned and presbyterianism not effectively established, there was an outburst of unrestrained sectarianism—Fifth Monarchy Men, Muggletonians, Ranters, Familists and Seekers. Many who responded to Fox's message were Independents, and in 1648 some of his earliest adherents came from a shattered Baptist society at Mansfield. The groups of Seekers—strongest in Westmorland, northwest Yorkshire and north Lancashire—"met together, not formally to pray or preach, at appointed times and places, but waited together in silence, and as anything rose in any of their minds, that they thought savoured of a Divine spring, so they sometimes spoke." These groups looked to the setting up of a church according to the pattern in the New Testament, and it was their ready response to Fox's preaching in northwest England about Whitsuntide 1652 that made of Quakerism a significant movement.

The three chief emphases of Fox's message were the immediacy of Christ's teaching and guidance, the consequent irrelevance of special buildings or ordained ministers, and the application of Christ's teaching to the whole of life. Emphasizing the need for firsthand experience and believing that, in Fox's words, "Christ has come to teach his people himself," these early Quakers gathered for worship without liturgy or prearrangement of any kind, or any appointed preacher, believing that out of an energetic and expectant silence God might use any one of the worshipers as a minister.

17th-Century Expansion.—The rapid spread of Quakerism in the north of England was followed by a vigorous expansive movement to London and the rest of England, to Scotland and Ireland, to the continent of Europe and to North America. Between 1655 and 1662 about 60 Quaker missionaries arrived in the new world, where they made converts and established meetings. Their main centres of activity were New England, New Amsterdam and Long Island, Maryland, Virginia and the West Indies. They suffered persecution in all these places (except in Rhode Island), four Friends being hanged by the Puritans of Boston between 1659 and 1661. In Great Britain, too, the extreme attitude of Friends toward what they termed "a hireling ministry," their refusal to take oaths or pay tithes and their testimony against "hat honour" all led to persecution under the Commonwealth. Sporadic local persecution gave place to more systematic efforts following Cromwell's proclamation of Feb. 1655, which noted the "rude and unchristian disturbance" of ministers practised by "Quakers, Ranters and others" and required that they "forbear henceforth all such irregular and disorderly practices," directing magistrates to proceed against offenders. The trial in 1656 of James Nayler (*q.v.*) for blasphemy created a European scandal and further brought the whole Quaker movement under grave suspicion. During the turbulent year after Richard Cromwell's abdication in May 1659, some Friends were deeply involved in Sir Henry Vane's attempts to bring about a "rule of the saints," and their complicity in this along with their other extremist views led to renewed and more violent persecution after the Restoration. The hostility of parliament found expression in the Quaker act (1662). Under this and other acts against dissenters about 15,000 Friends suffered various legal sentences, until widespread persecution was ended by the Toleration act (1689). More than 450 are known to have died in prison.

Though various experiments in church government had been made by the Seeker groups in northwest England, and conferences or "general meetings" were arranged both in England and the new world, it was not until 1667–69 that any regular system of government was established in the Quaker community. During these years Fox traveled throughout Great Britain to establish monthly meetings for church business, comprising a few Friends from several neighbouring meetings. The monthly meetings were grouped in county quarterly meetings, and these in turn were subordinate to a yearly meeting established in London. Fox wrote to America recommending that Friends there do the same. In 1670 John Burnyeat crossed the Atlantic, followed the next year

by Fox and 12 other Friends who spent nearly two years traveling among Quaker groups, establishing meetings for church affairs as well as "publishing truth" in evangelistic work.

By the end of the 17th century yearly meetings had been established on the American continent for New England (1661), Maryland (1672), Philadelphia (1681), New York (1695), Virginia (1696) and North Carolina (1698). Though each yearly meeting was technically autonomous, London yearly meeting was regarded as the "mother" body, the yearly meetings for Wales and Scotland being subordinate to it, and the national meeting in Ireland in an undefined and increasing independence.

18th Century.—The Toleration act had brought an end to the worst violence of persecution in Great Britain, but many disabilities remained. Distraints for nonpayment of tithes were considerable, the Test acts and the Corporation act (1661) prevented nonconformists from holding public office or from entering Oxford or Cambridge universities. One result of this was a concentration of Quaker intelligence and energy in commerce and industry. In an age of bargaining they insisted upon fixed prices. Through frugality of living and the society's stern discipline in cases of bankruptcy, small family businesses were built up into considerable concerns, while the Quakers' reputation for integrity led neighbours to entrust money to them for safekeeping, thus leading to the formation of many country banks.

In Great Britain Quaker thought in the 18th century was dominated by Quietism (*q.v.*), and in the latter half of the century this was also characteristic of American Quakerism. Leading Friends preached the worthlessness of human reason and the need to avoid anything that was "of the creature" so that the mind might be a blank sheet to receive divine impressions and directions. The self-abnegation of this approach helped to form many saintly men and women and, though the distrust of reason had dangerous implications, subsequent generations, in reacting against Quietism, imperiled an essential part of the Quaker heritage.

19th Century.—By the end of the 18th century, largely through the influence of Wesleyanism, the energy and theology of the evangelical movement were felt within the society. A small number of Friends embraced Unitarian or even deistic views, and a fear of being identified with this position led a number of Quietist leaders to adopt the essentials of the evangelical theology propounded particularly by Joseph John Gurney while at the same time officially disapproving of his preoccupation with disciplined theological studies. In Great Britain there was throughout the 19th century a tension between the Quietist and evangelical traditions, the Quietist representing also a conservative wing anxious to maintain the society's peculiarities of speech and dress. Two very small separations occurred: in 1835–37 that of the Beaconites, a group of ultra-evangelicals who after maintaining their own organization for a short period mostly joined the Plymouth Brethren or the Church of England; and in 1864 that of the Fritchley group, who have maintained a very small body in the conservative tradition.

In the United States, however, the 19th-century scene was far more complex. There was theological tension between the evangelicals and those mistrustful of the new theology, whose viewpoint was vigorously expressed by Elias Hicks (*q.v.*). This was accentuated particularly in Pennsylvania and New York by social and administrative as well as theological differences between city and country Friends. After several years of difficulty a separation occurred in Philadelphia yearly meeting in 1827, and in the following year separations took place in Baltimore, Md., Indiana, New York and Ohio following debates on which Philadelphia group should be recognized. In these divisions British and Irish Friends sided with the more evangelical (or "orthodox") groups and for the remainder of the century the "Hicksite" yearly meetings maintained a lonely existence. To the five 1827–28 yearly meetings were added in 1834 Genesee (upper New York and Canada) and in 1875 Illinois.

From the early years of the 19th century Friends took part in the increasing westward migration. Emigration from North Carolina and Virginia was encouraged because of the difficulties encountered on the slavery question, but from Pennsylvania too there was a considerable movement across the Alleghenies, resulting in the establishment of new yearly meetings—Ohio (1813), Indiana (1821), Western, or west Indiana (1858), Iowa (1863), Kansas (1872), Wilmington, or southwest Ohio (1892), Oregon (1893), California (1895) and Nebraska (1908). Migration mainly from New York state led to the establishment of Canada yearly meeting in 1867. The steady westward movement of the frontier resulted in a weakening of the close ties that had previously bound American Quakerism to London yearly meeting. Moreover, Friends nurtured in a frontier environment tended to be impatient of tradition, and the great revival of the 1860s profoundly affected and molded into a different form the Quakerism of the middle west. In 1845 and 1855 separations had taken place in New England and Ohio between conservative and evangelical Friends. With the adoption of revivalist methods, of a worship pattern with hymns and set sermon, and of paid pastors, it was inevitable that opposition by traditionalist Friends should lead to further separations. These occurred in Western (1877), Iowa (1877), Kansas (1879), Canada (1881) and North Carolina (1904).

20th Century.—At the beginning of the 20th century there were thus (1) a group of "orthodox" yearly meetings in fellowship with one another and with London and Ireland yearly meetings, many being "pastoral" with a formal pattern of worship; (2) a group of "conservative" yearly meetings in fellowship with each other following the traditional Quaker form of worship and maintaining also the older Quaker customs in dress and speech; (3) a group of Hicksite yearly meetings, rigorously separated from all other Quaker groups for 70 years, increasingly interested in "modern thought" and suspected of being Unitarian in theology or, at best, of being concerned with works rather than faith.

In 1887 the "orthodox" yearly meetings had held a conference at Richmond, Ind. Subsequent conferences led to the establishment in 1902 of the Five Years' meeting, in which all the orthodox yearly meetings except Philadelphia and Ohio joined. Ohio, dissatisfied with suspected liberalism in its sister yearly meetings, became the leader of a group of strongly evangelical and fundamentalist yearly meetings including Oregon and Kansas, which left the Five Years' meeting in 1926 and 1933, together with Central (1926) and Rocky Mountain (1958), formed as a result of separations within existing yearly meetings. The seven Hicksite yearly meetings joined together in 1902 in the Friends General conference, a body designed for mutual fellowship but with no legislative powers. During and after World War I the barriers of suspicion were broken down and co-operation among different branches increased. Consequently, the 20 years from 1940 to 1960 saw the union of yearly meetings previously separated. After World War II, "independent" meetings also sprang up, often around college campuses. These meetings have mostly been informal, and because there was no yearly meeting they could conveniently join, the American Friends Fellowship council was formed (1936) to foster them. Regional associations of some independent meetings have been formed, leading to new yearly meetings, Pacific (1947), South Central (1961), Southeastern (1962).

On the continent of Europe the meetings established under the first impetus of Quakerism gradually languished, though there remained a small staunch group of Dutch Friends till the mid-19th century. Meanwhile, about 1785, a mystical sect of about 150 members living in Congénies and other villages near Nîmes in the south of France came into contact with London yearly meeting, and a few years later German groups in Minden and Pyrmont were brought into a similar relationship. Mainly because of conscription, consequent persecution and large-scale emigration to America, these groups died out, while others established as yearly meetings in Norway (1846) and Denmark (1875) were reduced to a handful. Thus the growth of Quakerism on the continent has occurred almost entirely since World War I, stimulated by relief work of British and American Friends and fostered by London yearly meeting's Council for International Service (1918) and Friends Service council (1927), and by annual conferences held since 1931. From the small groups of sympathizers yearly meetings were established for Germany (1925), the Netherlands (1931), France (1933), Sweden (1935) and Switzerland (1944).

Friends long remained aloof from foreign mission work, because of fears of the "creaturely activity" involved in deliberate planning, qualms about adapting traditional Quaker worship and polity and distrust of full-time missionaries as compromising Quaker testimony against a paid ministry. In Great Britain it was not until 1867 that a Friends Foreign Mission association was started, and 50 years elapsed before it became an integral part of the yearly meeting. As a result of its work yearly meetings were established in several mission fields: Madagascar (1881), mid-India (*c.* 1901), Szechwan, west China (1904), and Pemba (1916). Near East yearly meeting (1928) has centred round both British and American educational and other mission work in Lebanon and Palestine. A number of Friends in Indiana yearly meeting formed a Foreign Mission committee in 1867, and many other American yearly meetings followed suit, including even the more conservative Philadelphia, which began educational work in Japan in 1884. Most of the work of the "pastoral" yearly meetings was united in the Five Years' meeting board of missions, but a number of yearly meetings work independently. American missionary activity has resulted in yearly meetings for Japan (1917; reconstituted 1947), Cuba (1927), Jamaica (1941), East Africa (1946) and Bundelkhand, India (1961).

Meanwhile emigration had resulted in the establishment of a number of meetings in Australia by the mid-19th century, in New Zealand in the latter years of the century and in South Africa after the South African War. Friends in these countries were organized as "general meetings" under London yearly meeting in 1902, 1909 and 1918, respectively. The last-mentioned was established as Southern Africa yearly meeting in 1948.

As noted above, British Quakerism in the 19th century was markedly evangelical, though there remained a strong if small group representative of the mystical tradition central to Quakerism. The Manchester conference (1895) gave impetus to an increasingly effective movement that sought to draw out the best in each tradition and to relate it to the discoveries, by some thought alarming, of science and of biblical scholarship. The rediscovery of the historical setting of Quakerism and the relevance of its 17th-century message to 20th-century needs led to an increased awareness of the implications of Christianity in the fields of politics, social affairs and international life. It also fostered concern for the reunion of separated branches of the society in America, which came to be seen as standing for differing emphases at the cost of others equally essential. The All Friends conference in London (1920) was followed by world conferences at Swarthmore, Pa. (1937), and at Oxford (1952). As a result of the 1937 conference the Friends World Committee for Consultation was established, as an advisory body of representatives of most yearly meetings, though a few decline membership of it. The committee meets in triennial session and works also through an American section and a European section.

POLITY, WORSHIP AND DOCTRINE

Polity.—The establishment of the Quaker system of church government has been briefly described. That it has remained substantially unaltered is a testimony to Fox's spiritual discernment and administrative flair. He conceived the system as a "gospel order" and counseled Friends "not to meet as men and women on town or parish business but to wait upon the Lord." In the conviction that they meet under the presidency of Christ, they term the officer responsible for presenting business the clerk. The clerk's function is less to direct the meeting than to record the decisions it reaches in minutes drawn up, read, amended as necessary and approved. Friends believe that this procedure—with its absence of resolutions and voting—results in united judgments, which are then loyally accepted and acted upon by the whole group.

The principal unit is the monthly meeting, a body normally (though not necessarily) meeting once a month and responsible for all matters of membership, for finance and property, for deliberation on concerns raised by individual members or referred to it by superior meetings. In Great Britain and some parts of the commonwealth and the United States, monthly meetings comprise from 2 to 20 individual meetings for worship, which may have congregational business meetings termed preparative meetings or may be less formally organized and termed allowed or indulged meetings. In most of the United States a monthly meeting comprises only a single congregation.

The quarterly meeting, comprising usually between 2 and 12 monthly meetings, is primarily a body for deliberation and united worship and fellowship, but it includes some detailed administration. Quarterly meetings in turn are grouped into yearly meetings, of which there are about 45, varying in size from 60 individual members to 30,000. All these meetings are open to all members, and men and women are equally eligible to hold appointments. Formerly, separate women's business meetings were held. Yearly meetings, though linked together by the exchange of epistles with one another and through the Friends World Committee for Consultation, are autonomous, each being responsible for regulations governing its subordinate business meetings and for the issuing of advices for the guidance of its members. In most yearly meetings collections of advices on Christian practice, statements on doctrinal questions and regulations for church government are issued as a *Book of Discipline,* more generally called *Faith and Practice.* Most yearly meetings have an executive or other general standing committee known as the Meeting for Sufferings (as in Great Britain), Representative meeting (as in Philadelphia yearly meeting), Representative committee or Permanent board. Committees or boards are also appointed in most cases to foster interest in foreign missions, education, peace, temperance, etc.

Although Friends have no ordained ministers, many yearly meetings have officially recognized that individual Friends have a particular gift in the vocal ministry, and those so recognized by their monthly meetings are termed recorded ministers; in "pastoral" meetings they are maintained by the meeting for full-time service. Monthly meetings also appoint elders, whose main duty is to watch over the ministry in their respective meetings and to foster its spiritual life, and overseers who are responsible for the pastoral care of the membership and usually administering funds for education, the care of the poor, etc. In many areas some or all of these Friends hold special meetings known as the monthly or quarterly or yearly meeting of ministers and elders, on ministry and oversight, or on worship and ministry; in earlier days such a body was frequently referred to as the select meeting.

Membership in the society rests with the monthly meeting. Applications are made usually by letter, and visitors are appointed or the application is considered by the overseers, the monthly meeting on ministry and oversight, the pastoral committee or some similar body. Some American yearly meetings require an applicant to make a profession of faith in Christ as his Saviour and to accept "the doctrines of the Christian religion as held by the Friends." The classic view, however, has been that membership in a Christian body is something spiritually discerned rather than outwardly tested and that "the chief conditions to be looked for are that he is a humble learner in the school of Christ, that his face is set toward the light and that he is able to find spiritual help and teaching in our meetings for worship." Agreement would also be expected "upon the spiritual and practical nature of Christianity—the deep and penetrating reality of worship and the claim of Christ to rule our whole life, both inward and outward." It is often but quite erroneously thought that Quaker meetings for worship are open only to members; they are in fact public occasions.

Worship.—The early Friends gathered for worship with no liturgy or other prearrangements save an agreed time and place, and with no specially appointed person to lead the worship. The responsibility rested—and rests—on each worshiper as the meeting gathers in silent expectancy. Where the spirits of the worshipers are in communion with God and with one another, so that a unity is strongly felt, Friends speak of a "gathered meeting" with a "living silence." Out of such silent worship one or another—men and women alike—may be led to speak or pray or read from the Scriptures. In a very few meetings there is occasional corporate singing, usually at the request of one of the members present, or a hymn may be sung by an individual. This traditional form of Quaker worship is to be found in Great Britain and on the continent of Europe, in South Africa and Australasia and in America. Until

the middle of the 19th century the typical Quaker meetinghouse was a plain rectangular building with rows of plain scrubbed benches facing a raised bench (or stand) across one wall. Here, in the "ministers' gallery," sat recorded ministers, and in front of them elders. The 20th century has shown a strong democratic tendency toward informality in seating, the benches or chairs being arranged in a square or circle.

As a result partly of the great revival of the 1860s and partly of the new conditions which settlers found in the westward frontier movement, many American Friends abandoned this traditional form of worship. In many meetings paid pastors were appointed and the service reflected one form or another of Protestant worship with hymns, set prayers and a prepared sermon. Where this has happened the building is frequently known as the Friends' church and the pulpit is often the dominating feature. Church bells, a printed order of service and robed choirs are features of some such meetings. Meetings of this sort are to be found in much of the United States and in mission fields such as Madagascar, East Africa and South America. In some there has been a tendency to introduce into such services some period of worship of the traditional kind; these are known as partially formal meetings.

Doctrine.—Fox's message stressed the immediate experience of Christ, and Quakers regarded their teaching as "primitive Christianity revived" after centuries of dependence on infallibility of church or Bible. Fox's question in Ulverston parish church in 1652—"You will say, Christ saith this and the apostles say this, but what canst thou say?"—evoked Margaret Fell's response, "We are all thieves, we are all thieves, we have taken the scriptures in words and know nothing of them in ourselves." This emphasis on firsthand experience has been characteristic of Quakerism throughout its history. At times it has led Friends to undervalue the place of theology or to fail to recognize that the nature of their experiences depended on real if unconsciously held theological presuppositions. From the 17th century onward, however, numerous statements have been issued by Friends at times of internal or external crisis to assert that their beliefs are consistent with Scripture and with Christian tradition. Quakerism therefore claims to be (using the words in their broad sense) both orthodox and evangelical.

One of the phrases most generally associated with Quakerism—"the inward light"—has been open to wide interpretation and misunderstanding. From the 17th century onward Quakers have been accused by their opponents of belittling the historic Christ. There may on occasion have been ground for this accusation, but the main stream of Quaker thought has accepted the doctrines of the incarnation and the atonement, while rejecting substitutionary theories of the atonement and stressing that knowledge of the outward facts about "Christ that died without Jerusalem" is useless without a corresponding experience of Christ working in the heart. Friends denied the Calvinist doctrine of predestination and preached the universality of God's grace. When faced with the problem that has beset Christian history of how those who have known nothing of the historic Christ can be saved, they quoted John i, 9 (to the point of its being known as "the Quakers' text") and argued that "the true light that enlightens every man" implied that God had "given to every man a measure of saving, sufficient and supernatural light and grace." Thus they identified the "inward light of Christ" with the Christ of history, and were enabled to have a vision of a church comprehending, in Robert Barclay's words, "all, of whatsoever nation, kindred, tongue or people, though remote from those who profess Christ and Christianity in words, as become obedient to the holy light, the testimony of God in their hearts."

The main distinctions in Quaker emphasis relate to the creeds, the Scriptures and the sacraments.

Creeds.—Friends have on occasion issued declarations of faith, of which the best known are George Fox's letter to the governor of Barbados (1671) and the Richmond declaration (1887) drawn up by seven American yearly meetings. Despite insistence that such documents were not creeds, their very issue has caused uneasiness, and London yearly meeting, for example, did not endorse the Richmond declaration. Quakers believe that creeds tend to crystallize thought on matters that cannot be embodied in human language, that they restrict the search for the more adequate expression of truth and that they serve to keep out of the Christian fold many who would gladly enter it. There have been occasions when the fear of creeds has led Friends to belittle the place of thought in Christian discipleship, and J. J. Gurney was driven to protest, "We shall never thrive upon ignorance." Friends generally have avoided this danger, but they remain suspicious of theological niceties and would probably re-echo William Penn:

> They judge that a curious enquiry into these high and divine relations, and other speculative subjects, though never so great truths in themselves, tend little to godliness and less to peace; which should be the chief aim of true Christians. And therefore they cannot gratify that curiosity in themselves or others; speculative truths being in their judgment to be sparingly and tenderly declared and never to be made the measure and condition of Christian communion.

London yearly meeting in 1940 declined an invitation to join the World Council of Churches mainly on account of its credal basis, though many American yearly meetings are members.

Scriptures.—Emphasizing the need for firsthand experience of God, early Friends criticized those of their fellow Christians who had revolted against the "infallible church" but replaced it with an "infallible book." Thus Fox in 1649, listening to a minister tell his congregation that "the Scriptures were the touchstone and judge by which they were to try all doctrines, religions and opinions," cried out "Oh no, it is not the Scriptures" and declared that the touchstone was "the Holy Spirit, by which the holy men of God gave forth the Scriptures." Again, Robert Barclay, whose *Apology for the True Christian Divinity* (1678) has been the chief theological work on Quakerism, described the Scriptures as "a secondary rule" and as "a declaration of the fountain but not the fountain itself." Friends have constantly asserted that, whatever mutilations they may have suffered, the Scriptures contain sufficient to guide men in belief and practice, but what is important is not reliance on the words, still less the bandying about of individual texts divorced from their setting, but the living experience from which the Scriptures sprang. The main body of Friends has therefore been able to accept without undue heart searching the fruits of historical and textual criticism. In certain American yearly meetings, particularly in the middle and far west, different doctrines have prevailed, and a small but strong group of Friends has accepted the doctrine of verbal inerrancy.

Sacraments.—Almost alone among Christian bodies, Friends have no form of outward observance of the sacraments. They believe in a spiritual baptism and a spiritual communion. From experience they would say that in meetings for worship and in their silent pause before meals they have known the real presence of Christ and that, though these may be heightened moments, the whole of life is sacramental. They thus interpret the command "Do this in remembrance of me" as applicable to every meal rather than as the institution of a symbolic act. Stressing the need for the daily rebirth of Christ in the heart, early Friends proclaimed every day as the Lord's day, and every week as Holy Week; therefore they abandoned not only saints' days but also the major festivals of the Christian church, keeping their shops open on Christmas Day with a dogged pertinacity. Though Friends still feel the observance of special times or ceremonies to be unhelpful, a recognition of the major Christian festivals of Christmas, Easter and Pentecost is reflected in their meetings for worship. Friends note that Christ did not baptize, and they stress that the true baptism is not the outward one of water but the inner one with the Spirit and with fire. They recognize that the outward communion is a strength and means of grace to many Christians; they deny, however, that it or baptism is necessary for salvation. They prefer not to argue from texts, but if pressed they might point out that Christ's behest to wash one another's feet might logically be taken equally literally, and indeed this episode at the Last Supper symbolizes their own ideals of Christian service. They would also urge that, at a time when what should be the bond of union between Christians is in fact the area of greatest and bitterest difference, there is a valid place for the existence of a Christian body that is able to foster its inner life without the outward observance of the sacraments.

OTHER DISTINCTIVE ASPECTS

In addition to their traditional manner of worship, their emphasis on the inward light and the place of personal experience, and their views on the sacraments, Friends are known by what they sometimes describe as "distinctive testimonies" though few are now unique and many are widely shared. These all arise directly from Friends' understanding of the Christian faith.

Peace.—The Society of Friends, the Church of the Brethren and the Mennonites (*qq.v.*) are commonly known as "the historic peace churches," and Quakers have steadily insisted that war is contrary to the will of God. As early as 1651, when George Fox was offered a captaincy, he told the Commonwealth commissioners that he "lived in the virtue of that life and power that took away the occasion of all wars." Quakerism drew many of its adherents from the ranks of the Commonwealth army, and it was several years before this conviction came to be universally shared. In 1661 Fox and other leading Friends, in a pamphlet disclaiming responsibility in the Fifth Monarchy rising, used words whose significance has increased across 300 years as an expression of Quaker belief: "We utterly deny all outward wars and strife and fightings with outward weapons, for any end or under any pretense whatsoever." This was a statement of personal conviction. Within 20 years its implications in political action had been seen, for in 1678 a work of Robert Barclay's was presented to the ambassadors negotiating the Peace of Nijmegen "wherein the true cause of the present war is discovered, and the right remedy and means for a firm and settled peace is proposed."

Subsequent Quaker history has shown two streams of thought, the one stressing the importance of maintaining a vigorous personal witness against all war or warlike measures, the other placing emphasis on the value of attempting what reconciliation is possible in the actual international scene, even if such action may seem at first sight to compromise fundamental principles. At their best moments Friends have recognized the interdependence of these two points of view. In wartime an adherent of the first is likely to demand nothing less than complete exemption under any conscription laws, while an adherent of the second is likely to accept such alternative service as his conscience will permit. In both world wars some Friends, in both Britain and America, served in the forces, many of these for noncombatant service. Others joined the (British) Friends Ambulance unit, an unofficial body undertaking work in the first place directly with the army but later responsible for wider spheres of relief work. Others undertook relief work or served on the land. In America during World War II the American Friends Service committee sponsored Civilian Public Service camps to which conscientious objectors were assigned. A number of Friends took an "absolutist" position, refused direction by the state and suffered imprisonment.

Friends' peace testimony has led since World War II to considerable concern over the ideological and political tensions between east and west. Both British and American Friends have engaged in particular studies of these problems, and official missions have been sent to both the U.S.S.R. and China.

Relief Work.—The Society of Friends is sometimes (to its embarrassment) thought to be a relief agency. Friends stress that their work for the relief of suffering springs directly from the personal concerns and insights of individuals tested by the corporate guidance and judgment of the group. It is significant that one of the first pieces of Quaker relief work—in Massachusetts in 1775–76—was a direct response to the realization of the needs of the civilian population in a war-ravaged area. Relief work was undertaken from 1822 during the Greek War of Independence, in 1846–47 during the Irish potato famine, in the Franco-German War of 1870, in World Wars I and II and in other emergencies.

Between 1914 and 1923 a War Victims Relief committee appointed by British Friends undertook work in France, Germany, Austria, Poland and Russia. After the formation of the American Friends Service committee much of this work was done jointly. Both British and American Friends undertook work with refugees from 1936 to 1941 during and after the Spanish civil war. After World War II the (British) Friends Relief service and American Friends Service committee worked again in France, Germany and Poland and also in the Netherlands and Greece. As a result of the work of the Friends Ambulance unit, Friends Service units were set up in India and China.

In 1947 the (British) Friends Service council and American Friends Service committee received the Nobel peace prize. In accepting it, representatives of the committees were concerned to stress that relief work can rightly be understood only in the context of the Quaker peace testimony.

Politics.—Though there were anarchist and Ranter elements among the earliest adherents to Quakerism, the main body pronounced firmly on Christian responsibility to serve and obey the state save where there was a conflict with the dictates of conscience. Conflicts on this score have been many and have led to much persecution, but they must not be allowed to obscure the fundamental Quaker attitude. The hope of establishing a colony free from religious persecution and in accord with Quaker convictions led to the establishment of Pennsylvania (*q.v.*) as a "holy experiment" in 1682. In the event, compromise was found to be inevitable, and after many years of uneasy government Quakers finally withdrew from responsibility in 1756. After this American Friends tended to stand aloof from politics until the close of the 19th century. Nevertheless many Friends on both sides of the Atlantic were individually active in movements for social justice and philanthropy—antislavery, women's rights, abolition of capital punishment and penal reform generally and the care of the insane. In particular John Bellers (1654–1725) was far ahead of his time in his social analysis, and John Woolman (1720–72) wrote in simple penetrating prose on personal Christian responsibility for the social order. In England the abolition of the Test and Corporation acts (1828–29) enabled Friends to stand in local elections, and in 1833 Joseph Pease was enabled to sit as the first Quaker in parliament. Though some Friends looked askance at the activities of Joseph Sturge and John Bright, political interest grew and in all about 70 Friends have sat as members of parliament. Since 1914 the number has steadily declined, and it is probably true that Quakers have found it easier to sit as independents or in parties whose majorities permitted the maximum freedom to the individual than in a closely disciplined and organized party. International affairs are, as already explained, a particular concern of Friends, and the Friends World Committee for Consultation is recognized as a "new governmental organization" under art. 71 of the United Nations charter. A small group of Friends is responsible for furthering this work in New York and Geneva.

Slavery.—As early as 1676 Fox was encouraging Friends to free their slaves after a term of years, providing for their future. From then onward steady efforts were made in Britain and America to combat slavery. Particularly through the efforts of John Woolman (*q.v.*), by about 1785 Friends owned no slaves. Friends took a large share in the movements leading to the abolition of the British slave trade (1807) and the Abolition of Slavery act (1833). Joseph Sturge and many others were influential in the British and Foreign Anti-slavery society from 1838 onward, and many U.S. Friends were similarly active. The labours of John Greenleaf Whittier and Lucretia Mott are especially noteworthy. After the Civil War a number of yearly meetings established freedmen's associations to work among the former slaves.

Oaths.—Friends have always declared oaths to be unlawful for the Christian. This they base on Christ's explicit command, "Do not swear at all" (Matt. v, 34), and they argue that the taking of an oath implies two standards of truthfulness and that exactness and truthfulness are required of all Christians. In England as early as 1696 Friends secured the right for themselves to affirm and they have taken some share in the extension of this right to others. There have been since the 18th century a small number of Friends who have felt that the affirmation no less than the oath implies a double standard and they are consequently uneasy about adopting it.

Plainness and Simplicity.—The early Friends were determined to live a life without frills whether in speech, dress or manners, and to be strictly truthful in word and action. Thus, they refused to flatter or recognize social distinction by using "thee" and "thou" to equals and "you" to superiors; they would neither

wear nor make unnecessary ornaments in clothing or luxuries in furniture; they declined to bow or curtsey or to remove the hat as a mark of deference. For their use of "thee" and "thou" and refusal to remove the hat, many early Friends suffered considerably. In the course of the 18th and early 19th century "plainness of speech, behaviour and apparel" became a complication of life rather than a simplification. The plain language (including a testimony against the heathen names for days and months) and the broad-brimmed hat and bonnet became for the outside world a symbol of quaintness. In general these practices were dropping into disuse by the mid-19th century, though a few small conservative groups retain the customs.

Early Friends shunned the theatre, dancing, the visual arts and music, and this tradition clung to the greater part of Quakerism until the beginning of the 20th century and still applies in some areas. Objection to the stage was of course common among dissenters, especially because of the immorality connected with it. The main Quaker argument was, however, that unless a great deal of time was spent on the arts the results were bound to be mediocre if not worthless, and both practice and discussion of the worthless were a waste of time. If, on the other hand, good results were to ensue, the time involved in securing them would necessarily limit the time available for religious exercise. There was, moreover, an objection to anything that excited rather than calmed the senses; and the strong Quaker tradition of domestic pursuits militated against the spending of time at public entertainments.

The Quaker approach to education was essentially empirical and practical: children were to be taught "all things civil and useful in the creation." It has been said that "it is part of the large faith in the inner light, the belief that as a man looks humbly and faithfully with his own eyes instead of learning dogmas out of books, he is learning to look with the eyes of God"; and it is noteworthy that Quaker educationists early fostered an interest in natural history and an experimental approach to science. In Quaker family life the cultivation of gardens has been a tradition, perhaps fulfilling the need for aesthetic self-expression as well as forming a simple form of outdoor exercise and fostering appreciation of natural history.

In the middle of the 19th century most Friends took an active part in the growth of the temperance movement and the promotion of total abstinence. Though Friends are united in the conviction that temperance and moderation alike in eating and drinking are a corollary of Friends' concern for simplicity, there is a diversity of view on the use of alcohol, some yearly meetings expressly forbidding both drinking and smoking.

It is to be expected that testimonies on the application of fundamental principles to the problems of daily life should vary from place to place and from age to age, for the evils of society change. It is not in the last resort against one thing or another that Friends are concerned to testify. They have rather been at pains to lay stress on a manner of life that avoids dullness or uniformity but is at the same time stripped of the snares of worldliness, of insincerity and pretentiousness and all else that encumbers the soul from communion with Christ.

See also references under "Friends, Society of" in the Index.

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FRIERN BARNET, an urban district of Middlesex, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Finchley, Hendon, Barnet and East Barnet to form the new London borough of Barnet *(see* LONDON). Friern Barnet is 11 mi. N. of Charing Cross. Pop. (1961), 28,807. The Great North road forms part of its western and East Barnet its northern and northeastern boundary. The manor was held by the friery (friary) of the Order of St. John of Jerusalem, hence the name Friern. Campes almshouses were founded in 1612. The many old trees in Friary park (23 ac.) and on the North Middlesex golf course are reminiscent of the time when the land was afforested. Friern hospital (formerly Colney Hatch) is in the district, which is a residential area.

FRIES, the name of a Swedish family distinguished for its botanists. The most eminent members are:

ELIAS MAGNUS FRIES (1794–1878) was famous for his outstanding contributions to the study of fungi. Born at Femsjö, Småland, on Aug. 15, 1794, he was educated at Lund university where he became junior professor in 1824. In 1834 he became professor of practical economy in the University of Uppsala and was professor of botany during 1851–59. He was also director of the botanical garden and museum from 1851 to 1863. He died on Feb. 8, 1878. Although the author of many important works on the botany of higher plants, he is mostly known for his contributions to mycological taxonomy on which he was regarded as the greatest authority of his time. Among his many publications are *Novitiae florae svecicae,* 7 parts (1814–24; 2nd ed., 1828); *Observationes mycologicae,* two volumes (1815–18); *Systema mycologicum,* three volumes (1821–32); *Elenchus fungorum,* two volumes (1828); *Epicrisis systematis mycologici* (1836–38; 2nd ed., 1874); and *Icones selectae Hymenomycetum nondum delineatorum,* two volumes (1867–75; 1877–84). The last mentioned work was seen to completion by Oskar Robert Fries.

THEODOR (Thore) MAGNUS FRIES (1832–1913) was noted as a lichenologist, but more especially for his studies on Linnaeus. The eldest son of Elias Magnus, he was born at Femsjö on Oct. 28, 1832, and educated at Uppsala, where, eventually, he was professor of botany and practical economy, 1877–99. He took part in the scientific exploration of arctic regions as a botanist in the expeditions of Baron N. A. E. Nordenskjöld to Spitsbergen, in 1868, and Greenland, in 1870. He also studied the vegetation of Finnmark in 1857 and 1864. He died in Uppsala on March 29, 1913.

Theodor was prominent in the fields of lichenology, mycology, arctic plant life and botanical history. His fundamental 20 years' work on the life of Linnaeus is a monument to his industry and energy. Among others, his publications include *Lichenographia scandinavica,* etc., 2 pt. (1871–74); and *Linné, lefnadsteckning af,* 2 pt. (1903).

OSKAR ROBERT FRIES (1840–1908), son of Elias Magnus, was born at Uppsala on April 5, 1840. After training in medicine at Uppsala, he practised in Göteborg, devoting all his spare time to

mycological studies. He died at Uppsala on July 18, 1908. Among his mycological works are *Synopsis Hymenomycetum Regionis gothoburgensis* (1889); *In Synopsin . . . additamentum scripsit* (1900).

KLAS ROBERT ELIAS FRIES (1876–), a well-known botanical explorer and taxonomist and the eldest son of Theodor Magnus, was born at Uppsala on July 11, 1876. He was educated at Uppsala university, where he became in 1913 instructor of biology and chemistry. In 1915 he was appointed professor of botany and director of the Bergian Botanical garden at Stockholm. He traveled widely, and wrote many important works on the flora of South America and central and east Africa, being especially interested in Annonaceae and contributing greatly to the study of this family. His interests, following the Linnean traditions of his father and grandfather, have also included the taxonomy and cytology of fungi. His publications include *Zur Kenntnis der alpinen Flora im nördlichen Argentinien* (1905); "Beiträge zur Kenntnis der Flora des Kenia, Mt. Aberdare und Mt. Elgon," with T. C. E. Fries, 14 pt., *Notizblatt des Königlichen Botanischen Gartens und Museums zu Berlin,* vol. viii–xi (1924–30); *A Short History of Botany in Sweden* (1950).

ELIAS HARALD FRIES (1878–), son of Oskar Robert, was born on Dec. 27, 1878. Trained as a physician, he practised in Göteborg, at the same time cultivating an interest in the local plant life. Among his botanical works are *Göteborgs och Bohus läns fanerogamer och ormbunkar* (1945) and a supplement in *Acta Horti gotoburgensis,* vol. 17 (1947).

THORE CHRISTIAN ELIAS FRIES (1886–1930), was best known for his botanical explorations. The son of Theodor Magnus, he was born at Uppsala on Nov. 2, 1886, and educated at the university there; he became conservator of the Botanical museum in 1920 and docent in botany in 1925. In 1921–22 with his elder brother, K. R. E. Fries, he explored Kenya and Uganda, particularly Mt. Kenya and the Aberdare mountains. In 1927 he was appointed professor of botany and director of the Botanical museum at Lund. In 1930 he led an expedition to the Transvaal and Southern Rhodesia and died in Umtali, S. Rhodesia, on Dec. 31, 1930. He was author of papers on arctic and alpine floras, and published with his brother valuable works on the flora of central and east Africa. His publications include *Botanische Untersuchungen im nördlichsten Schweden, ein Beitrag zur Kenntnis der alpinen und subalpinen Vegetation in Torne Lappmark* (1913) and *Über die regionale Gliederung der alpinen Vegetation der fennoskandinavischen Hochgebirgen* (1917).

NILS THORSTEN ELIAS FRIES (1912–), nephew of Klas Robert Elias and Thore Christian Elias, was born on July 17, 1912. In 1939 he became an instructor in botany at Uppsala. His special interest has been in the physiology of fungi. Among others, his works include "Researches into the Multipolar Sexuality of *Cyathus striatus Pers.*," *Symbolae botanicae upsalienses,* vol. 4 (1940) and "Über röntgen-induzierte physiologische Mutationen bei *Ophiostoma multiannulatum*," *Arkiv för botanik,* vol. 32A (1945).

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FRIES, JAKOB FRIEDRICH (1773–1843), German philosopher, was born at Barby, Saxony, on Aug. 23, 1773. Having studied at Leipzig and at Jena, he became professor of philosophy and elementary mathematics at Heidelberg in 1805. His attitude toward contemporary philosophies is set forth in *Reinhold, Fichte und Schelling* (1803; reprinted 1824 as *Polemische Schriften*), *System der Philosophie als evidente Wissenschaft* (1804) and *Wissen, Glaube und Ahndung* (1805). His important *Neue oder anthropologische Kritik der Vernunft* (3 vol., 1807) attempted to give a new foundation of psychological analysis to the critical theory of Kant, which he sought to reconcile with the philosophy of F. H. Jacobi. His *System der Logik* appeared in 1811. In 1816 Fries accepted the chair of theoretical philosophy at Jena. In politics he was a strong Liberal and a believer in a united Germany and did much to inspire the organization of the *Burschenschaft.* In 1816 he published *Von Deutschem Bund und Deutscher Staatsverfassung,* and his influence gave a powerful impetus to the agitation which in 1819 led to the issue of the Carlsbad decrees. He was condemned by the Mainz commission, and the grand duke of Weimar was compelled to deprive him of his professorship. In 1824 he was recalled to Jena as professor of mathematics and physics, and in 1838 the right of public lecturing on philosophy was restored to him. He died at Jena on Aug. 10, 1843.

The most important works of his Jena professorate were the *Handbuch der praktischen Philosophie* (1818–32), *Handbuch der psychischen Anthropologie* (1820–21), *Die mathematische Naturphilosophie* (1822), *System der Metaphysik* (1824) and *Die Geschichte der Philosophie* (1837–40).

FRIES, JOHN (*c.* 1750–1818), leader of the so-called "Fries rebellion" in Pennsylvania in 1799, was an unlettered, itinerant Pennsylvania German auctioneer. In 1798 the federal congress had laid a direct tax on dwellings, lands and slaves, with valuation of dwellings based in part on the number and size of windows. Bitter opposition to the tax arose in four Pennsylvania counties, where officials were attacked and housewives poured hot water on assessors making measurements, thus giving the incident the name of "Hot Water rebellion." On March 7, 1799, Fries led a mounted band that freed 23 insurgents who were being held in custody by a federal marshal at Bethlehem. Gov. Thomas Mifflin then called out 8 troops of cavalry and 500 men to suppress the insurrection. Arrested and indicted for treason in March 1799, Fries was found guilty in two trials, the first invalidated for prejudice by a juryman and the second clouded by alleged prejudice of judges Richard Peters and Samuel Chase. Sentenced to hang, Fries was pardoned by Pres. John Adams in May 1800, in connection with a general amnesty. He died in Philadelphia in Feb. 1818.

See H. M. Tinkcom, *Republicans and Federalists in Pennsylvania, 1790–1801* (1950); W. W. H. Davis, *The Fries Rebellion, 1798–1799* (1899). (W. R. SL.)

FRIESE-GREENE, WILLIAM (1855–1921), British photographer and inventor of the first practical motion-picture camera, was born at Bristol on Sept. 7, 1855. He took out almost 70 patents, that for the camera being in 1889. This camera used Celluloid film. The previous year the Photographic Society of Vienna had awarded him the Daguerre medal for a moving-picture camera using paper film with perforated edges. In 1889 he wrote to Thomas Alva Edison (*q.v.*) describing his camera and suggesting that it should be combined with the phonograph to make "talkies." He was a pioneer in stereoscopic and colour motion-picture making. He died in London on May 5, 1921. A memorial in Highgate cemetery is inscribed "William Friese-Greene, the Inventor of Kinematography."

See Leslie Wood, *The Miracle of the Movies* (1947); Ray Allister, *Friese-Greene, Close-Up of an Inventor* (1948). (R. ALL.)

FRIESLAND, a northern province of the Netherlands, is bounded east by Groningen and Drenthe, southeast by Overijssel, west and north by the Zuider Zee (or IJsselmeer) and the North sea. It includes four of the small West Frisian Islands off the northern coast, two of which, Terschelling and Vlieland, were transferred from North Holland in 1951. Pop. (1957 est.) 471,153. The population density is less than half the national average. Most of the inhabitants are Protestants, and the Frisians (*q.v.*) have maintained their own language and literature to a large degree. The area is 1,251 sq.mi. and rarely exceeds 50 ft. above sea level. The terrain in the southeast is sandy and bordered by fens; between fen and coast stretch almost flat clay marshlands. The islands are clay, covered extensively by sand dunes. Reclamation from the sea continues slowly, chiefly near Holwerd in the north; the last serious flooding occurred in 1825. Fen formation began in prehistoric times, but few fens exceed 10 ft. in thickness. Most drainage is artificial and water supply is difficult; much is drawn from the IJsselmeer. There is a vast system of canals, waterways and lakes in the north and west. The principal lakes are Tjeuke Meer, Sloten Meer, De Fluessen and Sneeker Meer. The clay marshlands provide good pasture for the famous Frisian cattle, found also on reclaimed fens and better soils in the sandy southeast. Beef and dairy produce are sold in large quantities but, in the absence of large markets, most milk is converted into cheese or butter. Arable cultivation is concentrated on the clay lands;

potatoes cover the largest acreage, wheat gives heavy yields and much sugar beet is grown. Woodlands and orchards are confined to the sandy soils. Peat cutting continues but reclamation is discouraged by the poverty of the subsoil; the fen colonies around Sneek are small isolated settlements. Agriculture is the basis of the regional economy; only one-quarter of the employed population is in industry, chiefly the processing of dairy produce. Pleasure sailing on the lakes is a modern development. Leeuwarden (*q.v.*), the capital, is the only large town; once a port, it is now famed for its cattle market. Other centres are Sneek, Bolsward, Franeker, Dokkum and Heerenveen. Harlingen, the only port, has an artificial harbour built 1870–77 and is an outlet for Leeuwarden.

(J. T. C.)

FRIEZE, in architecture, the middle of the three divisions of a classic entablature (*q.v.*), above the architrave and below the cornice (*see* ORDER); also any long, narrow, horizontal panel or band used for decorative purposes. The frieze probably developed from the necessity of carrying the crossbeams of a ceiling upon the tops of the architrave beams, but below the cornice eaves. The stone triglyphs of the Doric frieze are reminiscent of the beam ends of a primitive wood construction. In the Ionic, Corinthian and Composite orders the frieze has no architectural membering but is frequently richly ornamented. In Greek work this ornamentation consists of figures, as in the treasury of the Cnidians at Delphi (early 5th century B.C.) or the monument of Lysicrates at Athens (310 B.C.). In Roman and Renaissance work it consists of anthemions, acanthus foliage or garlands, as in the temple of Vesta at Tivoli (*c.* 80 B.C.) and the Maison Carrée at Nîmes (early 1st century A.D.). In late Roman work and many Renaissance examples the profile of the frieze is a convex curve and is known as a pulvinated frieze. The most famous of decorative friezes is undoubtedly that carved on the top of the outer wall of the cella of the Parthenon (*q.v.*), just under the ceiling of the portico.

This frieze, 40 in. high and 525 ft. long, bearing a representation of the ritual procession of the Panathenaic festival, is characterized by superb rhythmic design and faultless execution. Sculptured probably from the designs and under the supervision of Phidias, it is a perfect expression of Greek sculpture of the mid-5th century B.C. and one of the best examples of architectural sculpture of all time.

FRIGATE, in ancient times, a small, swift, undecked vessel, propelled by oars or sails, in use on the Mediterranean. The word was also applied to small, fast vessels used by the Spanish and Portuguese during the 16th and 17th centuries. The French first applied the term to a particular type of warship during the second quarter of the 18th century. The Seven Years' War (1756–63) marked the definite adoption of the "frigate" as a standard class of vessel, coming next to ships of the line and used for cruising and scouting purposes. They were three-masted, fully rigged, fast vessels, with the main armament carried on a single deck and additional guns on the poop and forecastle. The guns varied from 24 to 50, but between 30 and 40 guns was the usual number carried. The frigate "Constitution" (*q.v.*), nicknamed "Old Ironsides," won undying fame in the early years of U.S. history. "Frigate" continued in use throughout the period of transition from sail to steam but gradually gave way to "cruiser" (*q.v.*).

BY THE TRUSTEES OF THE NATIONAL MARITIME MUSEUM

ETCHING OF THREE-MASTED 36-GUN FRIGATE PUBLISHED IN 1815

During World War II, in 1942, Great Britain revived the name frigate by assigning it to a particular category of warship. In 1943 the United States also revived the term and applied it to about 70 vessels each having a full load displacement of about 2,400 tons, a speed of 20 knots and 3-in. dual-purpose guns. By 1955, however, the United States had disposed of all these vessels except 22 on loan to other countries, and had placed in the frigate classification the "Norfolk" and four destroyer leaders in commission as well as six others under construction. Great Britain meanwhile retained frigates of varying size, speed and armament, designed for various purposes. In the 1960s the U.S. navy had a number of frigates designed to carry guided missiles. Other nations employed the term frigate in such a manner that it had no precise meaning in international usage. (J. B. HN.)

FRIGATE BIRD, a large sea bird of the genus *Fregata,* constituting the family Fregatidae in the order Pelecaniformes, ranging throughout tropical and subtropical oceans. They are known also as man-o'-war birds because of their aggressive and piratical behaviour. Frigate birds are related to the pelican, cormorant, gannet, snakebird and tropic bird (*qq.v.*), and are about the size of a hen, with extremely long slender wings, the span of which may reach 7½ ft., and scissorlike tail. The black plumage is relieved by an orange throat pouch in the male and by a white head or breast in the female. Other distinguishing characteristics are the almost helpless feet with four toes webbed, and a long hooked bill, used in attacking and robbing other sea birds, particularly boobies, of their fish.

BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

MAN-O'-WAR-BIRD (FREGATA MAGNIFICENS ROTHSCHILDI)

Although they fly singly or in pairs, they nest in colonies, building nests of sticks in mangroves and on rocky islets, laying a single white egg. The nestlings are matted with soft white down, but the black wing feathers soon appear. The adults, without oil glands to waterproof the plumage, never alight on the water but are unbelievably fast and skillful in the air, soaring effortlessly and often diving to recover falling fish dropped aloft by panic-stricken boobies. Despite their flying ability frigate birds are usually found within 100 mi. of land. *F. aquila* is confined to Ascension Island in the Atlantic; *F. andrewsi* to Christmas Island and Cocos Keeling southeast of Java, the Anambas northeast of Singapore, wandering to nearby coasts, as far as India. *F. minor,* with six races, breeds on islands in the Indian, Pacific and Atlantic (south Trinidad) oceans; *F. ariel* has races similarly distributed. The magnificent man-o'-war bird, *F. magnificens,* breeds on the Galápagos and Pearl islands and ranges the eastern Pacific; with a race (*F. m. rothschildi*) breeding in the West Indies and along the coasts of the Caribbean and northern and eastern South America, wandering to the Gulf states, and another race in the Cape Verde Islands. (G. F. Ss.; X.)

FRIGG, the wife of the god Odin (Woden) in northern mythology, was known also to other Teutonic peoples, as Frïia in German and Frea in Langobardic; in English her name still survives in the word Friday. *See* GERMANIC MYTHOLOGY AND HEROIC LEGENDS.

FRIIS, JOHAN (1494–1570), Danish statesman and chancellor, was born at Lundbygaard on Feb. 20, 1494. Educated at Odense and Copenhagen, he completed his studies abroad. As a Danish secretary at the court of King Frederick I (*q.v.*) of Denmark at Gottorp in Schleswig, Friis soon established close relations with Danish and Holstein nobles, becoming successor designate to the chancellor Claus Gjordsen. When Frederick died in 1533 three factions arose: the peasants and burghers joined forces with the citizens of Lübeck under Count Christopher of Oldenburg and hoped to restore the deposed Christian II (*q.v.*) to the Danish throne; the Protestants in the *rigsraad* supported Frederick's son Christian III; and the Catholics in the *rigsraad* favoured Christian's younger brother Hans. When civil war broke out in 1534, Friis tried to persuade the nobles of Funen to join their Jutish colleagues to back Christian III. Taken prisoner by Christopher he escaped to Germany and rejoined Christian III in Jan. 1535.

He was one of the plenipotentiaries at the congress of Hamburg for peace with Lübeck. When Christian III had finally been set up as king, the Lutheran Church was established in Denmark (Oct. 1536), and all the property confiscated from the Catholic bishops was made over to Friis, who as chancellor became second in rank in the *rigsraad*. Friis took a leading part in the reorganization entailed by the Reformation, modernizing central as well as local administration.

In a few years the king, who had at first been open to influence from the Holstein nobility and the German princes, came to rely entirely on Friis and on the *rigsraad*. Whereas the Holstein nobility had tried to appease the Holy Roman emperor Charles V, who was pressing the claims of his nieces, daughters of Christian II, to the throne of Denmark, the new Danish policy was uncompromising and led to war. The issue was favourable to Denmark (treaty of Speyer, 1544). In 1544 also, Friis, opposing the Holstein nobles, divided the duchies of Schleswig and Holstein into three parts, of which one remained the king's property while two were given to the king's younger brothers.

Following Friis's example, able young Danish nobles began to enter administrative careers. Friis was moreover a great patron of learning. He encouraged Hans Svaning to write a history of Denmark (in Latin) in continuation of Saxo's *Gesta Danorum*, and he prompted Anders Anders Sörensen Vedel to translate Saxo into Danish. He also introduced Renaissance architecture to Denmark when he rebuilt his house in Funen, Hesselagergaard, after the civil war and when he built a house at Borieby, an estate in Sjaelland taken from the church. Under Frederick II, who succeeded Christian III in 1559, the Seven Years' War of the North broke out (1563). Friis felt partly responsible for this, since he had urged both Christian and Frederick to assert Denmark's hegemony in Scandinavia. He died at Köge on Dec. 5, 1570, just before the peace of Stettin ended the war.

See A. Friis, "Kansler Johan Friis' første Aar," *Scandia*, vi and vii (1933–34), and "Rigsraadet og Statsfinanserne i Christian IIIs Regeringstid," *Dansk Historisk Tidsskrift*, 10th series, vi (1942). (As. F.)

FRILLED LIZARD (*Chlamydosaurus kingi*), a tropical lizard of Australia and New Guinea, belonging to the family Agamidae, remarkable for the large erectile frill round the neck and for its ability to run on its hind legs. It is arboreal and insectivorous.

FRIMLEY AND CAMBERLEY, an urban district in the Woking parliamentary division of Surrey, Eng., on the London-Exeter trunk road, 29 mi. W.S.W. of London by road. Pop. (1961) 30,342. The district includes York Town and Frimley Green. A healthful climate, a picturesque situation in the sandy heath district and military associations have contributed to its growth as a residential township. The land rises 200 ft. from the Blackwater river in the west to the heights of Chobham ridges overlooking Bagshot heath in the east, and coniferous trees and rhododendrons abound. In Camberley is the army's staff college and nearby is the Royal Military academy, Sandhurst.

Bret Harte, the writer, is buried at Frimley parish church. Since World War II several light industries have been established in the district.

FRINGE TREE, a common name for the genus *Chionanthus*, of the olive family (Oleaceae), comprising two species of shrubs or small trees that may reach to 30 ft. and bear deciduous leaves and fluffy clusters of snow-white flowers, followed by dark-blue olivelike fruits. The American fringe tree or old-man's-beard (*C. virginica*), native from Pennsylvania and Florida to Texas, is widely planted as an ornamental. The other species, the Chinese fringe tree (*C. retusa*), has been introduced into America.

(J. M. Bl.)

FRINGILLIDAE, a family of small perching birds (order Passeriformes) comprising the buntings, finches and grosbeaks (*qq.v.*).

FRINTON AND WALTON, an urban district in the Harwich parliamentary division of Essex, Eng., on the east coast about 17 mi. E.S.E. of Colchester. Pop. (1961) 9,571. The district comprises the parishes of Frinton-on-Sea and Walton-on-the-Naze, both seaside towns with sands, and the rural parishes of Kirby-le-Soken and Great Holland. Walton came into existence as a seaside resort about 1830; it has a ¼-mi.-long pier, a Martello tower of the Napoleonic period and a late 18th-century beacon tower. This portion of the coast has in the past suffered from sea encroachment. About 2 mi. to the northeast is the Naze promontory; local low cliffs exhibit fossiliferous Red Crag formations. Frinton grew up as a seaside resort at the end of the 19th century; the old church of St. Mary dates partly from the early 16th century. Apart from the tourist industry there is some local agriculture and a small foundry at Walton. There is an electrified train service from London via Colchester.

FRISCHES HAFF (Vistula Lagoon; Polish Zalew Wiślany; Russian Vislinski Zaliv) is a shallow, marsh-fringed lagoon on the Baltic coast between Gdansk (Danzig) and Kaliningrad (Königsberg) bisected by the Polish-Soviet frontier. It is 60 mi. long, 4 to 12 mi. wide and up to 16½ ft. deep. The Nogat, the eastern distributary of the Vistula delta, is the principal river entering the lagoon, whose almost fresh waters (covering 330 sq.mi.) are retained on the north by a long curving sandspit (in Polish *mierzeja*, in German *Nehrung*). Between the latter and the Samland peninsula farther east a narrow channel, dredged to 31 ft., leads to the Kaliningrad ship canal. The lagoon has important fisheries. (Ha. T.)

FRISCHLIN, PHILIPP NIKODEMUS (1547–1590), German philologist, poet and commentator on Virgil, and one of the last of the humanists, was born Sept. 22, 1547, at Balingen, Württemberg. He was educated at Tübingen, where he became (1568) professor of poetry and history. In 1575 for his comedy *Rebecca*, which he read at Regensburg before the emperor Maximilian II, he was rewarded with the laureateship, and in 1577 he was made a count palatine.

In 1582 he had to leave Tübingen, and spent two years teaching at Laibach. Shortly after his return to Tübingen in 1585, he was threatened with a criminal prosecution for immoral conduct, and fled to Frankfurt am Main (1587). For 18 months he taught in Brunswick and he appears also to have lived at Strasbourg, Marburg and Mainz. From Mainz he wrote libelous letters, which led to his arrest in March 1590. He was imprisoned in the fortress of Hohenurach, near Reutlingen, where, on the night of Nov. 29–30, 1590, he was killed by a fall in attempting to let himself down from the window of his cell.

In his Latin verse Frischlin often successfully imitated classical models. His Latin comedies have freshness and vivacity, and his commentaries on the *Georgics* and *Bucolics* of Virgil were important contributions to the scholarship of his time. He also wrote plays in German.

See his *Operum poeticorum*, 4 vol. (1585–1602); D. F. Strauss, *Leben und Schriften des Dichters und Philologen Frischlin* (1856); G. Berbermeyer, *Tübinger Dichterhumanisten* (1927).

FRISIAN ISLANDS, a low-lying island chain, between 3 and 20 mi. distant from the mainland of northern Europe, extends in a smooth curve from Den Helder in the northwest of the Netherlands, eastward along the Dutch and German coasts as far as the Elbe, and then swings sharply north along the coast of Schleswig-Holstein and the southern part of the Jutland coast of Denmark.

Although they form a single physical feature, it is customary to subdivide them into three groups: West Frisian, East Frisian and North Frisian. After the North sea established a southwestern outlet to the Atlantic through the Straits of Dover about 5,000–7,000 B.C., its southeasterly shore probably coincided with the present curve of the Frisian Islands. But subsidence continued periodically, aided by storms and floods, and neither the natural development of sand dune barriers along the coast nor later artificial embanking succeeded in keeping the sea firmly at bay. Breachings of the old shore line have produced this long chain of islands separated from the mainland by the narrow belt of shallow waters and tidal mud flats generally called *wadden* (Ger. *Watten*). It is not surprising that many Frisian legends and folk songs tell of drowned villages. The Dutch and German governments have spent large sums not only to protect their seaward coasts but also to reclaim land from the *wadden* for farming.

The land ranges from poor sandy soils on the seaward margins to more fertile clays and silts fronting the *wadden*. Fishing, the raising of sheep and cattle, and the growing of rye, oats and potatoes are the main occupations in most islands, while the sandy beaches attract many tourists.

West Frisian.—The West Frisian Islands, which belong to the Netherlands, include from west to east the inhabited islands of Texel (62 sq.mi.), Vlieland (13 sq.mi.), Terschelling (37 sq.mi.), Ameland (22 sq.mi.), Schiermonnikoog (10 sq.mi.) and the virtually uninhabited group of Simonszand, Boschplaat, Rottumerplaat and Rottumeroog (Rottum). Extending southeast from the coastal dunes, Texel has an extensive area of polder reclaimed from the Wadden Zee; lying below sea level, this polder suffered severely during the great inundation of Feb. 1953. Very small polder areas also exist in Terschelling, Ameland and Schiermonnikoog. The population of Texel in 1957 was estimated at 10,475, of whom about one-third lived in the main settlement of Den Burg; communication with the mainland is maintained through the small fishing ports of Oudeschild and De Cocksdorp. Eijerland in north Texel is partly a nature reserve where thousands of seabirds nest. Scattered farmsteads with a few villages are typical of the five main islands.

East Frisian (Ger. Ostfriesische Inseln).—This group, which belongs to Germany, extends from the Ems estuary eastward to Jade bay (Jadebusen) with two small islands, Scharhörn and Neuwerk, lying near the estuary of the Elbe. Smaller in size than most of the West Frisian group, the chief of these islands from west to east are Borkum (14 sq.mi.), Juist (6½ sq.mi.), Norderney (10 sq.mi.), Baltrum (3 sq.mi.), Langeoog (7 sq.mi.), Spiekeroog (5 sq.mi.) and Wangerooge (2 sq.mi.). These seven have scattered farmsteads and small villages, but Scharhörn (2 sq.mi.) is uninhabited while Neuwerk (1 sq.mi.) has only lighthouse keepers and lifeboat crews. In summer, tourists visit the main islands and Nordseebad Borkum and Norderney are popular resorts. Holiday steamers ply to the islands' sheltered south coasts, from many of which light railways carry visitors inland.

North Frisian (Ger. Nordfriesische Inseln).—These are divided between Germany and Denmark. Apart from the rocky red sandstone island of Heligoland (*q.v.;* Helgoland) that stands aloof both in location and geologically, the North Frisian Islands run from Trischen (3 sq.mi.), north of the Elbe estuary, northward along the coasts of Schleswig-Holstein and the Jutland peninsula to Fanö near the Danish port of Esbjerg. Invasion by the sea has continued for centuries there, and until 1634 the present German islands of Nordstrand (19 sq.mi.), Nordstrandischmoor and Pellworm (14 sq.mi.) were part of one large island. Farther north the principal island remnants of a once extensive land area include Hooge (3 sq.mi.), Nordmarsch-Langeness (5 sq.mi.), Amrum (8 sq.mi.), Föhr (32 sq.mi.) and Sylt (36 sq.mi.), all German. Northward still lie the Danish islands of Römö (56 sq.mi.), Mandö (2 sq.mi.) and lastly Fanö (22 sq.mi.), beyond which the old coastline can be seen again in the smooth coast of northwest Jutland. Vigorous reclamation is now proceeding in the *wadden* of the entire North Frisian group. Römö and Sylt are connected to the mainland by long embankments.

The speech of the Frisians, who are known to have occupied the islands and part of the mainland from at least the 1st century A.D., has a close resemblance to English. (HA. T.)

FRISIANS, a people of western Europe whose name survives in that of the mainland province of Friesland (*q.v.*) and in that of the Frisian Islands off the coast of the Netherlands, but who once occupied a much more extensive area.

In prehistoric times the Frisians inhabited the coastal regions from the mouth of the Rhine at Katwijk (north of The Hague) to the mouth of the Ems. Much of the land then was covered by lakes, estuaries and swamps and exposed to the incursions of the sea, and the inhabitants lived mostly on man-made mounds, the so-called *terpen*. Slowly, as the shifting of the waters allowed, they brought the lower-lying land under cultivation and protected themselves against the sea by building more *terpen* (dikes were not practicable). Most of these were in the modern provinces of Friesland and Groningen; the east bank of the Rhine itself (that is, the region north of the line Utrecht-Katwijk) was almost uninhabited. Excavations in the *terpen* have thrown some light on Frisian life in the centuries before the Romans came.

Roman and Frankish Periods.—The Roman general Nero Claudius Drusus encountered the Frisians after his crossing of the Rhine from the south in 12 B.C. He then made them tributary to Rome. The fact that they supplied oxhide for the Roman army suggests considerable cattle raising. In A.D. 28 the Frisians revolted and temporarily freed themselves from Roman rule, but in A.D. 47 they were once more made tributary by Gnaeus Domitius Corbulo. Thereafter they supplied soldiery for the Roman armies. They took part in the Batavian revolt of A.D. 69–70, but relations with the Roman authority were soon restored, and Frisians continued to serve in the Roman legions in many places, including Britain (inscriptions from the 2nd and 3rd centuries, for instance at Appleby and at Watermore). Pottery from Trier and from southern Gaul and imported bronzes found in Frisia provide clear evidence of the trade that the Romans brought in return for exports of cattle. This trade developed gradually in the 2nd and 3rd centuries, but then declined, though during the 4th and 5th centuries commercial relations with Cologne and the Rhine province still existed, as coins found in Frisia show. Even so there was little fusion between the Frisian and the Roman cultures; the native ways held. Frisia here begins to show that spirit of independence which still survives in cultural, social and political matters.

By the end of the 5th century, Roman rule had disappeared and migrations were changing the face of western Europe. Between 450 and 500 the Angles and Saxons, on their way from the Elbe river to Britain, may well have invaded Frisia and spent some time there. Some of them may have settled permanently in Frisia, while a number of Frisians may have gone on to Britain with the majority of the newcomers. Some finds suggest that after about 500 the Frisians became somewhat mixed with Anglo-Saxon elements and that there was some blending of cultures (language, ceramics, architecture).

After about 600 Frankish influences also made themselves felt. The Franks pushed forward to the north and became neighbours of the Frisians, who in the meantime had expanded outside the coastal belt proper. This larger region, Frisia Magna (up to the lower reaches of the Rhine) was so named because its inhabitants were mainly Frisians from the coast. Its economy included not only agriculture and cattle breeding but also a textile industry; cloth was exported. Dorestad (southeast of Utrecht) was the commercial centre. The Frisians, a seafaring people, also traded by river with the regions of the Rhine and of the Moselle and later with the north of France.

The Franks invaded the southern borderland of Frisia Magna and occupied the remains of the Roman fort of Trajectum ad Rhenum (Utrecht) and the trading station of Dorestad about 600. About 40 years later the Frisians recovered this area and penetrated into the region between the Rhine and the Meuse; in Dorestad they even minted coins. In 689, however, the Frisian king Radbod was dislodged from Dorestad and Trajectum by the Frankish leader Pepin II, who wanted to protect both the Frankish trade on the Rhine and the Christian missions.

Anglo-Saxon missionaries now began to convert the Frisians to

Christianity; Willibrord (*q.v.*) arrived with his followers at Utrecht in 690. In the 8th century came Boniface (who was to be martyred near Dokkum in 754), and the Frisian Liudger continued the work. Utrecht was the centre of this activity, but the ill will of the Frisian kings partly counteracted its effect.

In 734 the Frankish ruler Charles Martel defeated the Frisians and drove them back to the north, thus dissolving Frisia Magna. Then Charlemagne finally subdued the Frisians, and after this they were converted permanently to Christianity. When the Saxon revolts had been crushed peace also reigned in Frisia. The national laws were codified (*Lex Frisionum*, A.D. 802). The Norse invasions temporarily disturbed this peace in the 9th century.

Territorial Divisions.—Frisia was little affected by the partition of the Frankish empire. From 925 the lands occupied by Frisians belonged to the German kingdom. The people's subsequent history, however, is that of the three regions into which the country was divided: (1) West Frisia, from the mouth of the Rhine to the Vlie and Lake Flevo; (2) Middle Frisia, from the Vlie to Lauwers; and (3) East Frisia, from Lauwers to the Jade estuary, where the region east of the Ems was penetrated by Frisians as colonists between 600 and 1200—as also was the country north of the Elbe estuary, the so-called North Frisia. The boundary between West and Middle Frisia was soon formed by the floods of Lake Flevo, which developed into the Zuider Zee.

West Frisia fell to the counts of Holland, who occupied first the south and the coastal area and, after 1250, the northeastern part (*see* HOLLAND, COUNTY AND PROVINCE OF). In East Frisia the city of Groningen, with its surrounding country, was ruled by the bishop of Utrecht, and part of the district between the Ems and the Jade became a countship (under the Cirksena family from 1454 to 1744, when it passed to the kingdom of Prussia). Middle Frisia kept itself free of overlords, whether native or foreign, except for short periods, till the end of the middle ages.

Middle Frisia or Friesland.—The Middle Frisians, jealous of their independence, repeatedly expelled the counts of Holland who sought to conquer them. Their country thus remained in "immediate" dependence on the Holy Roman emperor throughout the middle ages. Feudalism was never accepted there, hence the adage "Every Frisian is a nobleman." This gave rise to the idea of Frisian liberties which found expression in the so-called Privilege of Freedom, allegedly granted by Charlemagne but in fact a forgery, from the second half of the 13th century. Rejecting foreign interference, these Frisians settled all affairs themselves, keeping legislation, administration and the judiciary in their own hands and themselves maintaining their dikes, roads and canals. The Union of the Upstalbeam, by which they consolidated themselves politically, included some of the East Frisians. This degree of liberty is rare in medieval Europe; parallels are found only in the Swiss confederacy and in the administration of Dithmarschen.

The worst external enemies of the Frisians in the middle ages were the counts of Holland. The internal security of the country, however, was sometimes threatened by the unruliness of the *hoofdlingen* (rich farmers, who lived in stone-built houses). On the other hand the monasteries, being rich landowners, played an important role in the country's development.

As late as 1457 the emperor Frederick III acknowledged the "immediate" status of the Frisians, but in 1498 the emperor Maximilian I presented Frisia to Albert, duke of Saxony, with the title *gubernator in Frisia*. The Saxon dukes, however, could not hold their own; the Frisians, helped by Charles of Gelders, ousted them. Then, in 1524, the Frisian lands between Lauwers and the Zuider Zee fell to the emperor Charles V. Thenceforth they were joined to the Burgundian portion of the Habsburg heritage. This was the first foreign rule to bring the free Frisians a central administration they accepted.

Friesland adopted the new doctrines at the Reformation and participated in the revolt of the northern Netherlands against Philip II of Spain. It thus became a province of the republic of the Netherlands, as constituted by the Union of Utrecht (1579). A junior branch of the house of Nassau filled the office of stadholder. In 1815 Friesland was absorbed into the kingdom of the Netherlands.

Language.—The Frisian language, which has many dialects, is taught in the schools in Friesland and is acknowledged as an official language by the Netherlands government. Literary and scientific works are written in it, and there is a Frisian academy (Fryske Akademy). In East and North Frisia, however, the language is being supplanted by German.

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(W. J. AL.)

FRIT FLY (*Oscinella frit*), a small, shining black fly destructive to oats, rye, barley and wheat in North America and Europe. The creamy white larvae live in the developing grains and within the stems, causing the central leaf to wilt. Frit flies belong to the family Chloropidae (order Diptera). *See* also FLY.

(C. H. CN.)

FRITH, WILLIAM POWELL (1819–1909), English painter of large, crowded scenes, was born at Aldfield, Yorkshire, on Jan. 9, 1819. He trained first at Henry Sass's school in London (1835) and then in 1837 entered the Royal Academy school. In 1840 he exhibited there his first picture "Malvolio Before the Countess Olivia." His earlier works included portraits and subject pieces in the tradition of D. Wilkie and W. Mulready, but he developed a preciseness of technique akin to that used by the Pre-Raphaelites.

He quickly gained wide popularity. Elected associate of the Royal Academy in 1845 and a member in 1852, he established his reputation with a succession of large compositions of everyday English life, the first of which, "Ramsgate Sands" (exhibited 1854), was bought by Queen Victoria. There followed "The Derby Day" (1858, Tate gallery, London); "Claude Duval" (1860); "The Railway Station" (1862); and "The Marriage of the Prince of Wales" (1865) painted for Queen Victoria.

Frith later turned to moralizing works exemplified by the series of five paintings—"The Race for Wealth" (1880). He died in London, Nov. 2, 1909. Commemorative exhibitions were held at Whitechapel Art gallery (London) and at Harrogate in 1951.

See Nevile Wallis (ed.), *Victorian Canvas: Memoirs*, from Frith's autobiographical writings (1957). (D. L. FR.)

FRITILLARY (*Fritillaria*), a genus of hardy bulbous plants of the family Liliaceae (*q.v.*), containing about 100 species widely distributed in the northern hemisphere. Several species are native to western North America, chiefly California, and mostly with handsome flowers, among which are the white fritillary (*F. liliacea*), the yellow fritillary (*F. pudica*), mission bells (*F. lanceolata* and *mutica*), brown bells (*F. parviflora*) and the chocolate lily (*F. biflora*).

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CHECKERED FRITILLARY OR SNAKE'S-HEAD (FRITILLARIA MELEAGRIS)

The genus is represented in the southern half of England by the checkered fritillary (checkered lily) or snake's-head (*F. meleagris*), which occurs in moist meadows. A much larger plant is the crown imperial (*F. imperialis*), a native of western Asia and well known in gardens. The crown imperial grows to a height of about three feet, the lower part of the stoutish stem having leaves, while near the top is developed a crown of large pendent flowers surmounted by a tuft of bright green leaves. The flowers are bell-shaped, yellow or red, and in some of the forms double. The plant grows freely in good garden soil, preferring a deep well-drained loam.

Fritillary is also the name of several species of butterfly (*see* BUTTERFLY AND MOTH).

FRIULI, a territory at the head of the Adriatic sea, lying across the modern frontier between the Italian *regione* Friuli-Venezia Giulia and the Yugoslav republic of Slovenia. It includes parts of the Julian and Carnic Alps in the north and the alluvial plain of the Isonzo, Tagliamento and lesser streams in the south. Many of the inhabitants, known as Furlanians or Friulani, speak a Raeto-Romance language.

Subjugated by the Romans in the 2nd century B.C., the country was incorporated in Transpadane Gaul. The town from which the name Friuli is derived, Forum Julii, the modern Cividale del Friuli (*q.v.*), was founded in 52 B.C.; and Aquileia and Concordia were also important in Roman times. The Lombards in the 6th century A.D. made Friuli one of their duchies. After Charlemagne's annexation of the Lombard kingdom (8th century), Friuli became a Frankish march or margraviate on the Slavonic border. Berengar was its most eminent margrave. Acquired by the dukes of Bavaria in the 10th century, Friuli was subsequently attached to the duchy of Carinthia until in 1077 the western and larger part of the Friulian march was transferred by the German king Henry IV to the patriarch of Aquileia. The patriarchate lost this territory to Venice in 1419–20. Eastern Friuli, however, was held by the counts of Gorizia, heirs to some of the Carinthian inheritance, till 1500, when, on the failure of their line, it was appropriated for the Austrian Habsburgs by Maximilian I. Austria acquired Venetian Friuli, with Venetia, under the treaty of Campo Formio (1797), but had to cede it, with some of eastern or Austrian Friuli also, to the Napoleonic kingdom of Italy under the treaty of Pressburg (1805); and Napoleon's marshal, Géraud Duroc, was created duc de Frioul in 1808. Under the treaty of Vienna (1809), Austria had to cede the rest of Friuli, which was attached to the Illyrian provinces of the French empire. In 1815, after the fall of Napoleon, the whole of Friuli was restored to Austria. The former Venetian Friuli, however, was ceded with Venetia to Italy in 1866. Eastern Friuli went also to Italy in 1919, after World War I, but some of it had to be surrendered to Yugoslavia in 1947, after World War II.

FRIULIAN: *see* RAETO-ROMANCE DIALECTS.

FRIULI-VENEZIA GIULIA composes the most north-eastern region of Italy, and represents the remnants of a once much greater region which, by the peace treaty of 1947, was divided between Italy and Yugoslavia. Pop. (1961) 1,205,222. Area 7,851 sq.km. (3,031 sq.mi.). It consists of the provinces of Udine, Gorizia and Trieste. In the north the Carnic Alps (Alpi Carniche) form a solid wall between the region and neighbouring Austria; only the Plöckenpass (Passo di Monte Croce Carnico) (5,367 ft.) and the low Tarvisio saddle provide communications across these mountains. The range and its foothills form a semi-circular backdrop to the Tagliamento valley, the heart of Friuli, where the Tagliamento river meanders south toward the Adriatic. The southern part of the region is a low coastal plain, some of it occupied by shallow lagoons. To the southeast that part of the former Free Territory of Trieste which is now an integral part of Italy extends as a narrow corridor between the Karst (Carso) limestone plateau and the Adriatic sea, as far as the city of Trieste.

Although the northern portion of Friuli-Venezia Giulia consists for the most part of rocky uplands or of foothills with shallow infertile soils, the rainfall (the highest in Italy) favours the development of natural meadows. Large numbers of cattle and pigs are bred, and the ham, milk and dairy products of Friuli are famous. Much of the lowland remains in subsistence farms, however, and reclamation has not shown encouraging results. The larger cities all show considerable industrial development. Trieste has refineries, shipyards, breweries and textile mills; Udine is known for machinery, textiles and food products; Pordenone for ceramics and woolens. Trieste, long one of the leading ports of the Mediterranean, is one of Italy's four great ports, although its trade is much smaller than it was before 1914 when Trieste served most of central Europe. Through Friuli-Venezia Giulia pass two main railroads, from Venice through Trieste to Yugoslavia, and from Venice through Tarvisio to Austria.

The region was known in Roman times as the Julian region, but after the barbarian invasions it became separated into two parts. The coastal area was dominated, through the city and port of Grado, by the Byzantines, while the inland zone was ruled by the dukes of Friuli and the counts of Gorizia. The rise of the patriarchate of Aquileia (*q.v.*) to a position of eminence in the 11th century brought not only the seacoast but Friuli and the Istrian peninsula as well under the control of this ecclesiastical sovereignty. The period of Aquileian hegemony came to an end when Venice became the great power in northeastern Italy; Venice shared its dominion over the region with Austria. As early as 1719 Trieste was made a free port by the Habsburgs, and until 1918 its outlook was coloured by its close commercial connection with Austria-Hungary. After 1815 all Venezia Giulia and Friuli fell under the rule of the Habsburgs; the province of Udine became part of the Italian kingdom in 1866, the rest of the region in 1918. The boundary between Italy and Yugoslavia, running through the region, was not determined after World War I until 1924; after World War II, the Istrian peninsula, the hinterland of Trieste, and the Karst plateau became part of Yugoslavia. Under the terms of the Paris peace treaty of 1947 Trieste and the area surrounding it became a free territory; it was divided into a northern, or A zone, under joint U.S.-British military government, while the southern, or B zone, was administered by Yugoslavia. Failure among the Allies to agree on the fate of the territory, the incorporation for all intents and purposes, of zone B, in Yugoslavia, and the mounting pressure by Italy to have Trieste returned to it resulted in the London agreement of Oct. 5, 1954. Under the terms of the agreement the *de facto* status of the territory was recognized, and its division between Yugoslavia and Italy legalized, the latter receiving Trieste city and the A zone. *See* also VENICE; VENETIA; TRIESTE. (G. KH.)

FROBEN (FROBENIUS), **JOHANN** (*c.* 1460–1526), the best known of the Basel scholar-printers, was born at Hammelburg, Franconia. His first publication, a Latin Bible, appeared in 1491. Entering into partnership with Johann Petri (1496), Johann von Amerbach (1500) and the bookseller, Wolfgang Lachner, whose daughter, Gertrud, he married, he came to control four presses by 1515 and later, seven. He revolutionized printing at Basel, popularizing the roman type, introducing italic and Greek fonts, experimenting with smaller and cheaper books, and employing artists like Hans Holbein as illustrators. His correctors included many famous scholars who benefited from the proximity of the hitherto little used manuscript collections of Alsace and the Palatinate. About 250 of his publications have been listed. They include, notably, the first printed New Testament in Greek with a Latin translation by Erasmus (1516), who after 1513 entrusted all his works to Froben, and also the works of Velleius Paterculus (1520) and Tertullian (1521), both edited by Beatus Rhenanus. Froben died in Basel in Oct. 1526.

See C. W. Heckethorn, *The Printers of Basle in the 15th and 16th Centuries* (1907); A. F. Johnson, *The First Century of Printing at Basle* (1926). (R. R. Bo.)

FROBENIUS, LEO (1873–1938), German explorer and ethnologist, came to be regarded in his day as one of the world's greatest authorities on prehistoric art. He was born in Berlin, June 29, 1873, the son of a retired army officer. In ethnology he favoured extreme theories of diffusion, attributing a common origin to the cultures of Oceania and west Africa. Frobenius led 12 expeditions into Africa and explored centres of prehistoric art in the Alps, Norway, Spain, the Libyan and Sahara deserts, Trans-Jordan, Southern Rhodesia and the Bushman caves of South Africa. He wrote 60 books and numerous pamphlets and articles. In 1910 he announced that he had conclusive proof of the existence of Atlantis, the mythical lost continent in Africa. He died at Lake Maggiore, Intra, Italy, on Aug. 9, 1938.

FROBERGER, JOHANN JAKOB (1616–1667), German organist and composer, was born in Stuttgart on May 19, 1616. He probably received his musical education from his father, who was a cantor. Froberger became court organist in Vienna in 1637, but later in the same year went to Italy, where he studied under G. Frescobaldi. He remained there until 1641. From the evidence of two pieces of music inscribed *fait à Bruxelles 1650* and *à Paris 1656* it appears that he visited those two cities. The composer

Johann Mattheson (1681–1764) states that he also visited Dresden, where he engaged in a friendly trial of skill with the organist and harpsichord player M. Weckmann. Froberger left the imperial service in 1657. He traveled to London in 1662 and was twice robbed on the way. Mattheson says he arrived in such a state of destitution that he was glad to accept the post of organ-blower offered him by Christopher Gibbons, then organist at Westminster abbey and the Chapel Royal. On the occasion of the marriage of Charles II, when Gibbons was playing before the court, Froberger overblew the organ. In the pause brought about by the mishap Froberger seized the opportunity to play something himself. A foreign woman who had been his pupil recognized his style, and Froberger was presented to the king. He died at Héricourt, near Montbéliard, France, on May 7, 1667.

Froberger's compositions are for keyboard and are among the richest and most attractive productions of the early baroque era. Most were published posthumously. The pieces for organ include powerful and imaginative toccatas and fantasias whose forms show the influence of his master Frescobaldi and were highly regarded by J. S. Bach. In some other works, such as the *partitas*, it is more difficult to say for which of the two instruments (organ or harpsichord) the music was intended. In his *ricercari* (forerunners of the classic fugue) and capriccios, Froberger provided two versions, one for each instrument. The charming suites, however, are clearly for harpsichord or clavichord, and Froberger is the first German master in this form. His suites consist of *allemande*, courante, *sarabande* and *gigue*, with varied repeats (*doubles*); they owe something to the French suites for lute and for harpsichord, such as those by the Gaultiers and J. C. de Chambonnières, but show well Froberger's own highly individual and cosmopolitan character.

See K. Seidler, *Untersuchungen über Biographie und Klavierstil Johann Jacob Frobergers* (1930). (C. P. Co.)

FROBISHER, SIR MARTIN (*c.* 1539–1594), English navigator and explorer, was the son of Bernard Frobisher of Altofts, Normanton, Yorkshire. In 1553 and in 1554 he went on voyages to Guinea and was there imprisoned for a time by the Portuguese. About 1559 he was in Barbary. During the 1560s he was privateering in the channel and was in trouble for piracy. In 1571–72, however, he was in the queen's service off the Irish coast. He married in 1559. As early as 1560 or 1561 Frobisher is said to have become interested in the possibility of finding a northwest passage to Cathay and India, and in 1576, by help of the earl of Warwick, he was put in command of an expedition consisting of two tiny barques, the "Gabriel" and "Michael," and a pinnace. He set sail from Blackwall on June 15 by way of the Shetland Islands. The pinnace was lost in a storm and the "Michael" deserted; but on July 20 the "Gabriel" sighted the coast of Labrador. Some days later the mouth of Frobisher bay was reached and, a farther advance northward being prevented by ice and contrary winds, Frobisher determined to sail westward up this passage (which he conceived to be a strait) to see "whether he mighte carrie himselfe through the same into some open sea on the backe syde." Butcher's Island was reached on Aug. 18 and some natives then decoyed away five of his men. After vainly trying to get them back, Frobisher turned homeward and reached London on Oct. 9.

Among the things Frobisher's men brought back was some "black earth," and a rumour arose that this was gold ore. The result was that the next year a much more important expedition was fitted out, Queen Elizabeth I lending the "Aid" from the navy and subscribing £1,000. A company of Cathay was formed and Frobisher was appointed high admiral of all lands and waters that might be discovered by him. On May 26, 1577, the expedition, consisting, besides the "Aid," of the "Gabriel" and "Michael" with pinnaces and 120 men, including miners, left Blackwall and reached Hall's Island at the mouth of Frobisher bay on July 17. The time was spent in collecting ore, and very little discovery was achieved. The return was begun on Aug. 22, and the "Aid" reached England on Sept. 23, the "Gabriel" and "Michael" later. Frobisher was received by the queen at Windsor. She believed in the value of the territory, and it was resolved to send out a larger expedition and establish a colony. On May 31, 1578, the expedition, consisting of 15 vessels, left Harwich and reached the south of Greenland on June 20. On July 2 the foreland of Frobisher bay was sighted, but stormy weather and dangerous ice drove the fleet unwittingly up a new (Hudson) strait. After proceeding about 60 mi. up this "mistaken strait" Frobisher turned back, and the fleet at last came to anchor in Frobisher bay.

Some attempt was made at founding a settlement, and a large quantity of ore was shipped; but the venture was not a success, and on Aug. 31 the fleet set out for England, which was reached in early October.

The ore was eventually proved to contain neither silver nor gold, and a proposal to send Frobisher out again in 1581 came to nothing. In 1580 he commanded the "Foresight" in operations off Munster during the Desmond rebellion and took part in the capture of Smerwick. In 1585 he went in the "Primrose" as vice-admiral of Sir Francis Drake's expedition to the West Indies. He was again at sea during the vain attempts to relieve Sluys in 1587, and next year in the "Triumph" played a prominent part in the Armada campaign, being knighted during the operations. In the winter of 1588–89 he commanded a squadron guarding the Narrow Seas and in the following autumn he took another small force to the Spanish coast and the Azores. He was off the Azores again in the summer of 1590. Next year he married a second time and for a short while settled in Yorkshire, but for most of the summer of 1592 he lay off the Spanish coast with one part of a fleet fitted out by Sir Walter Raleigh. His last command was of a squadron sent in 1594 to assist in defending Brest against a Spanish force established at Ft. Crozon.

In the final assault on the fort he received a wound from which he died at Plymouth on Nov. 22. Though he appears to have been somewhat rough in his bearing, and too strict a disciplinarian to be much loved, Frobisher was undoubtedly one of the most able seamen of his time.

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FROCK originally meant a long, loose gown with broad sleeves worn by members of the clergy. The donning of the frock was part of the ceremony of becoming a monk, hence the expression "to frock," and, conversely, in stripping of power, "to unfrock." In the middle ages a frock was also a long, loose coat worn by men, or a coat of mail, and this usage carried over in the term frock coat, which in the 19th century was the fashionable double-breasted man's coat with skirts reaching to the knees. In modern times the term is applied to a woman's dress of any type (though, in the United States, it is used more often in fashion language—which regards it as a smarter term than "dress"—than in common speech) and, in England, to a child's or young girl's dress.

(M. B. K.)

FRÖDING, GUSTAF (1860–1911), one of the most outstanding Swedish lyrical poets, was born at Alster, Värmland, Aug. 22, 1860. His parents came from cultured and gifted families but both showed mental instability. He studied at Uppsala university, 1880–83, and again in 1885, but did not take a degree. At first he staved off depression by working for a liberal paper and was for ten years a journalist at Karlstad, Värmland, though forced to spend long periods in sanatoriums for treatment of nervous disorders. Stimulated by the revolt against naturalism at the end of the 1880s, in 1891 he published his first collection of poems, *Guitarr och dragharmonika* (Eng. trans., *Guitar and Concertina*, containing also later poems, 1925). It was followed in 1894 by *Nya dikter* and in 1896 by *Stänk och flikar*. These three volumes contain the essential Fröding. Passages in the last led to his prosecution for pornography, and although he was acquitted, the experience was disastrous to a man so scrupulous and oversensitive. He managed to publish two more small books of poems, *Nytt och Gammalt* (1897) and *Gralstänk* (1898), before his final breakdown. From 1898 to 1905 he was a patient in a mental hospital at Uppsala and, although he recovered a measure of sanity, he never recovered his health and died at Stockholm, Feb. 8, 1911. A collection of verse and prose, *Efterskörd*, was published in 1910, and

a posthumous collection, *Reconvalescentia*, appeared in 1913. Fröding also wrote humorous dialect sketches, literary essays and newspaper causeries.

Although Fröding never altogether abandoned the realism and social compassion which had first inspired him, he partly shared the neoromanticism of the 1890s, nostalgically looking back to an idealized, old-world country life. In outlook he remained a radical, involved in contemporary discussions inspired by the ideas of such writers as Tolstoi and Nietzsche, but as a poet he was influenced more by the great romantics: Goethe, Scott, Byron, Heine. He wrote a little book on Burns (1892) and translated several of his poems. His poetic style showed a virtuosity new to Swedish literature and unusual technical perfection. By uniting colloquial language with a rich musical form, he liberated Swedish verse from traditional patterns. He was a master of humorous verse, and his drolleries are as effective as the bitter pathos or evocative magic of his serious poetry. Readers were first attracted by the poems inspired by the scenes, characters and folklore of his native Värmland, but even in his early work there was also a strong personal note of melancholy, despair and revolt and a pathetic quest for a philosophy capable of resolving life's discords. One of Fröding's answers to this quest was humour; another was a monistic mysticism, reconciling good and evil. His popularity as a poet was enhanced by the appeal of his personality, which remained essentially kind, noble and upright, despite the tragedy of his life.

Fröding's collected writings, edited by R. G. Berg, appeared in 16 volumes, 1917–22. English translations include *Poems*, translated by A. Björck (1903) and *Selected Poems*, translated by C. W. Stork (1916).

See Henry Olsson, *Fröding, ett diktarporträtt* (1950); J. Landquist, *Gustaf Fröding* (1956). (G. SDT.)

FROEBEL (FRÖBEL), **FRIEDRICH (WILHELM AUGUST)** (1782–1852), German founder of the kindergarten and influential educational reformer of the 19th century, was born on April 21, 1782, in the Thuringian village of Oberwiessbach, where his father was pastor. His mother died when he was very young, and he was neglected as a child until an uncle gave him a home and sent him to school. For two years he was apprenticed to a forester and this influenced his future development. He acquired a thorough knowledge of plants and natural phenomena while at the same time beginning the study of mathematics and languages.

Froebel's love of nature led him to take a course at Jena, but lack of funds cut short his university career. He incurred small debts and was imprisoned for nine weeks. He tried various kinds of employment until his meeting with Anton Gruner, a pupil of Johann Pestalozzi and head of the Frankfurt am Main model school, convinced him of his vocation as a teacher. After two years as assistant to Gruner, he went to Yverdon, Switz., where he came into close contact with Pestalozzi. Though he learned much at Yverdon, he quickly discovered the weakness of organization which characterized Pestalozzi's work. He entered the University of Göttingen, where military service soon interrupted his studies. During the campaign of 1813 he formed a lasting friendship with H. Langethal and W. Middendorff, who became his devoted followers and who joined him at a school he opened at Griesheim in Thuringia in 1816. Two years later the school moved to Keilhau, also in Thuringia, and it was there that Froebel put into practice his educational theories. He and his friends and their wives formed a kind of educational community. To this period belongs Froebel's most important treatise, *The Education of Man* (1826; Eng. trans. 1885). In 1831 he left Keilhau to his partner and accepted the invitation of the Swiss government to train elementary teachers. His experience at Keilhau and as head of a new orphan asylum at Burgdorf, Switz., impressed him with the importance of the early stages of education. On returning to Keilhau in 1837 he opened his first *kindergarten*, or "garden of children," in the neighbouring village of Blankenburg. The experiment attracted widespread interest and other kindergartens were started. Unfortunately, because of a confusion with the socialist views of Froebel's nephew, the Prussian government proscribed the kindergarten and the ban was not removed until after 1860, several years after Froebel's death at Marienthal on June 21, 1852.

One of Froebel's most enthusiastic disciples, Baroness Bertha von Marenholtz-Bülow, was largely responsible for bringing Froebel's ideas to the notice of educators in England, France and the Netherlands. Later they were introduced into other countries, including the United States. The first kindergarten in London was opened in 1851 under the supervision of Madame Bertha Ronge and her sister, both pupils of Froebel. Charles Dickens visited the school and wrote a full and sympathetic account of the work in *Household Words*. The later growth of the movement in England was mainly the result of the work of Madame E. Michaelis, who was instrumental in founding the Froebel society in 1875. English teachers were attracted by the practical ideas of Froebel but at first failed to grasp the importance of his theory. It was in the United States that the Froebelian movement achieved its greatest success. Thus John Dewey adopted Froebel's principles in his experimental school at The University of Chicago. It was not until the 20th century that they were thoroughly understood by English teachers. The English nursery-school movement originated by Margaret and Rachel McMillan owed much to Froebel's ideas.

Though not himself a great philosopher, Froebel was influenced by the outstanding German thinkers of his age and by Rousseau and Pestalozzi. He was a sincerely religious man who, because of his belief in the underlying unity of all things, tended toward pantheism and has been called a nature mystic. An important contribution to educational theory was his belief in self-activity and the essential factor of play in child education. This resulted in the introduction of a series of toys or apparatus known as the "gifts," devised to stimulate learning through well-directed play accompanied by songs and music. The modern "playway" in education is much indebted to Froebel.

In addition to the *Education of Man*, Froebel wrote the *Pädagogik d. Kindergartens; Kleinere Schriften* and *Mutter-und Koselieder*. Collective editions were edited by W. Lange (1862) and F. Seidal (1883). There are English editions of the *Autobiography of Friedrich Froebel*, new ed. (1903), *Froebel's Chief Writings on Education* (1912) and the *Mother's Songs, Games and Stories* (1920).

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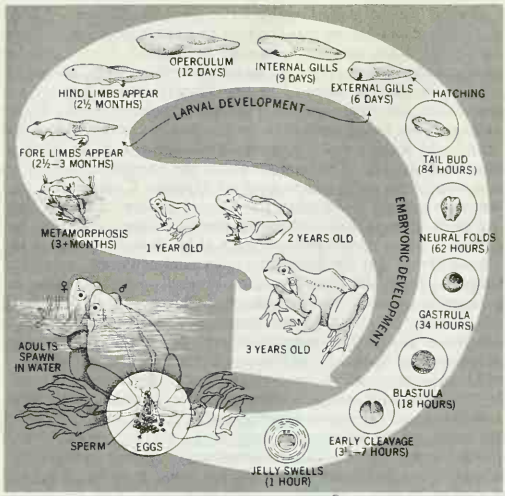
FROG, a name of wide application, strictly for any animal belonging to the family Ranidae, the true frogs, but also properly used for the members of several other families of the order Salientia (or Anura) of the class Amphibia (*q.v.*).

The family Ranidae contains about 30 genera and 500 species, most of them African or Oriental. *Rana*, with about 200 species, is the largest and most widespread genus; it is the only genus of the family in North America. The common frog of England, Europe and Asia (*Rana temporaria*) and the closely related wood frog of North America (*R. sylvatica*) are unique among the amphibia in having populations living north of the Arctic circle. The family has no native representatives in temperate Australia, New Zealand, eastern Polynesia, the West Indies or southern South America, although successful introductions have been made in some of these areas.

Most species of *Rana* have drab green or brown colours like the American bullfrog (*q.v.*; *Rana catesbeiana*). A few of the other genera are gaudy and some (the African *Phrynobatrachus*) rival the hylid tree frogs in ability to change colour. The skin is generally smooth, especially when compared with that of the warty toads (*q.v.*). Some species have poison glands, corresponding to those of toads, concentrated in longitudinal ridges on the back.

The long legs of ranids appear correlated with strong swimming and leaping powers. Little study of these abilities has been made, but some African species of *Rana* can span eight feet in a single jump, and the American bullfrog and the smaller leopard frog (*R. pipiens*) have been recorded as leaping five feet or more. The



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LIFE CYCLE OF A FROG, TYPICAL OF THE EUROPEAN EDIBLE FROG (RANA ESCULENTA)

extensive foot webbing of many ranids indicates the predominantly aquatic habits of these forms, but some species are modified for other modes of life. The terrestrial or fossorial (burrowing) types, generally toadlike in appearance, have a hard tubercle on the outer edge of the foot for digging. Other kinds have developed finger-tip discs for climbing trees or moving about in mountain stream habitats.

Adult body size of ranids ranges from slightly less than an inch (several species of *Phrynobatrachus* of southern Africa) to ten inches (*Rana goliath* of western Africa is the biggest of all frogs). In all frogs the female is invariably larger than the male. Males have thickened or horny thumb pads (especially noticeable during the breeding season) that aid in grasping mates. In many species the male is also distinguished by expansible vocal sacs on the neck or throat that serve as resonators for the mating calls; females are ordinarily nearly mute and have no mating call.

In *Rana* the annual breeding usually takes place in water. In the sexual embrace (amplexus) the male clasps the female from behind, at about the level of the armpits. The male, mounted on the female's back, extrudes sperm over the eggs as the latter are forcibly ejected by the female; fertilization is thus external. The dark-coloured gelatinous eggs, laid in numbers varying from a few hundred to about 30,000 (depending on the species), then float off in clusters or sheets and may become attached to the stems of water plants; the eggs of some species sink.

Although each ovum itself is only $\frac{1}{10}$ inch or less in diameter, the jelly layers surrounding it may swell in the water to give a total diameter of half an inch or more. The tadpole, or pollywog, hatches in a few days to a week or more and transforms (metamorphoses) into a frog within two months to three years, depending on the species and environmental conditions. A typical *Rana* tadpole superficially resembles a tiny, greenish, broadheaded fish that lacks all but the tail fin. It breathes by gills and has a specialized mouth and a long intestine adapted for a varied diet consisting chiefly of plant matter and ooze. During metamorphosis the following changes occur: lungs develop, limbs appear, the tail is absorbed, the intestine shortens and the mouth becomes typically froglike. There are variations from this pattern among the other ranids: in *Cornufer*, a forest-floor-dwelling Oriental genus, a few large unpigmented eggs are deposited on land and the young hatch as froglets, not tadpoles. In *Staurois*, another Oriental genus, the tadpole has a suctorial disc formed from the large mouthparts and the belly wall—an adaptation for clinging to stones in rushing streams.

Frogs are nocturnal and are active during most of the year in the tropics. In northern areas they spend the winter hibernating on the bottoms of lakes and streams or on land, where they secrete themselves beneath logs or in holes in the ground.

As adults, the ranids are chiefly insectivorous. They also eat such animals as snails and crayfish, and the larger species catch small vertebrates. Frogs and their tadpoles are in turn prey for fish, snakes, birds (especially herons) and mammals. They are also esteemed food for humans: the total annual catch of frogs (*Rana esculenta, R. catesbeiana* and others) for table use is on the order of several million pounds. Many thousands more are taken for use in experiments in biological laboratories and in pregnancy tests in doctors' offices and in hospitals.

See also references under "Frog" in the Index volume.

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(G. B. R.)

FROGBIT (FROG'S-BIT), common names, in America, for a small often free-floating aquatic plant known scientifically as *Limnobium spongia;* in England the term is applied to the Eurasian counterpart *Hydrocharis morsus-ranae.* Both species are members of the family Hydrocharitaceae (*q.v.*). They occur naturally in stagnant ponds and water ditches, and, with several other species of the family, are cultivated in aquariums. The plants have roundish leaves, one to two inches across, and whitish flowers, and multiply like the strawberry plant by runners, at the tips of which new leaf-rosettes and hanging fibrous roots develop.

FROGMEN, the popular name for members of naval underwater demolition teams in World War II. Their efforts reduced troop losses and facilitated the landing of men and supplies on enemy shores. Before an amphibious landing was made, frogmen reconnoitered the beach area. They measured the actual depths of the water, detected natural or man-made obstructions under the surface and observed the enemy's defensive positions close to the water's edge. One of their most important functions was to destroy dangerous underwater obstructions. Frogmen were carefully chosen volunteers who were intensively trained and worked without weapons. The explosive charges they used for demolitions, their boats, tools, equipment and clothing were developed by test and war experience.

About 1,000 frogmen prepared the way for the invasion of Okinawa, working for three days in very cold water, after the mine sweepers had done their work. The frogmen dealt with a few beaches at a time, beginning by taking soundings on the reefs offshore and examining the extensive obstructions which the enemy had erected. This was followed by the demolition work and a final recheck. The frogmen, protected by heavily concentrated gunfire and by aerial strikes, lost relatively few men. *See* also DIVING APPARATUS.

See Francis Douglas Fane and Don Moore, *The Naked Warriors* (1956).

(J. B. HN.)

FROGMOUTH, a name, in reference to the broad, froglike gape, for birds comprising the family Podargidae, in the order Caprimulgiformes, which also contains the nightjar, nighthawk, whippoorwill and oilbird (*qq.v.*). There are about 12 species of frogmouths, including *Batrachostomus auritus* of the Malay peninsula and Sumatra and Borneo, *B. septimus* of the Philippines and *B. moniliger* of India; others occur in southeastern Asia and the Malays. The genus *Podargus* of Australia and the Malays is usually called morepork (*q.v.*). Owlet frogmouths, intermediate in appearance to owls and nightjars, belong to the family Aegothelidae.

(G. F. Ss.; X.)

FROHMAN, CHARLES (1860–1915), U.S. theatrical manager, a star maker who developed, among others, Maude Adams, Ethel Barrymore, Julia Marlowe, Billie Burke, William Gillette and Otis Skinner, was born in Sandusky, O., on June 17, 1860. In his early youth his family moved to New York city, and Charles became interested in theatrical activities through his elder brothers, Daniel (*see* below) and Gustave. After several years of part-

time positions with local newspapers and theatres, Frohman, in 1883, managed the Wallack Theatre company on tour. He later opened a theatrical booking office in New York and laid the foundation of the Theatrical Syndicate, which for several years controlled U.S. theatres. Frohman's first real success was Bronson Howard's *Shenandoah* in 1889. In 1892 he engaged John Drew (*see* DREW) as his star and established the Empire Stock company. Frohman's encouragement of such playwrights as Clyde Fitch, David Belasco and Augustus Thomas was indicative of his ability to perceive theatrical talent. He dominated the U.S. theatre during 25 of its most exciting years, and when he died with the sinking of the "Lusitania," May 7, 1915, an era ended. Frohman never married.

His brother, DANIEL FROHMAN (1851–1940), was an important theatrical producer from the 1880s to his retirement in 1912. At various times he managed the Fifth Avenue, the Madison Square, the Lyceum, the New Lyceum and Daly's theatres and was president of the Actor's Fund of America. He died Dec. 26, 1940.

(S. W. H.)

FROHSCHAMMER, JAKOB (1821–1893), German Roman Catholic priest who was excommunicated for his rationalist views, was born at Illkofen near Regensburg on Jan. 6, 1821. He studied philosophy at Munich and became deeply influenced by Kant and Schelling. Ordained in 1847, he lectured in philosophy from 1850 at Munich where he began publishing his first important and controversial works: *Über den Ursprung der menschlichen Seelen: Rechtfertigung des Generationismus* (1854) and *Menschenseele und Physiologie* (1855, the year he became professor). Both books were placed on the Index in 1857 because of their expressed views on the theory of generationism. This theory, condemned in its various forms as heresy since Tertullian, states that the human soul is created from unliving matter in the act of begetting. Though Frohschammer's generationist views were moderate, he was early suspected by the church. The attack continued in *Einleitung in die Philosophie und Grundriss der Metaphysik* (1858), in *Über die Freiheit der Wissenschaft* (1861) and finally in *Die Philosophie des Thomas von Aquino kritisch gewürdigt* (1889), which criticizes the Thomist view that philosophy is the handmaid of theology. In 1862 Frohschammer founded *Athenäum*, an organ of liberal Catholicism for which he wrote the first adequate account in German of Darwin's theory of natural selection. On refusing to retract he was suspended *a divinis* but pursued his own line in *Das Christentum und die moderne Naturwissenschaft* (1868). He represents a neorationalism which postulates autonomy for philosophy and science—the brief *Gravissimas inter acerbitates* (Dec. 11, 1862) by Pope Pius IX to the archbishop of Munich and the *Syllabus* of 1864 were directed against Frohschammer. After the Vatican council of 1869–70 his polemic was specially directed against the papal claim. Excommunicated in 1871, he replied with *Der Fels Petri in Rome* (1873), *Der Primat Petri und des Papstes* (1875) and *Das Christentum Christi und das Christentum des Papstes* (1876). His main later works are *Die Phantasie als Grundprincip des Wetprozesses* (1877), *Über die Genesis der Menschheit* (1883); and *Über die Organisation und Cultur der menschlichen Gesellschaft* (1885). He died, without having lost his faith, at Bad Kreuth, Bavaria, on June 14, 1893.

See E. Hocedez, *Histoire de la théologie au XIXe siècle*, vol. ii, pp. 60–68 (1952); Lord Acton, *Essays on Freedom and Power*, ch. 9 (1956; first published 1864). (C. L. A. R. H.)

FROISSART, JEAN (*c.* 1337–*c.* 1404), 14th-century French chronicler and poet, whose *Chroniques* (*Chronicles*) contain the greatest literary work of that century in the French language, was born at Valenciennes in Hainaut, probably in 1337. Although nothing is known about his parents, most biographers have assumed that he was of bourgeois stock. Allusions to his childhood and youth are scattered throughout two of his love poems, the "Espinette amoureuse" and the "Joli Buisson de jeunesse," but, since they are written according to the courtly convention and the over-all picture they give is idyllic, they are of little value as material for serious biography. It seems likely that, at some stage, he served in a princely household, possibly at Valenciennes where Margaret of Hainaut, widow of the emperor Louis IV the Bavarian, lived in retirement from 1347 until her death in 1356, or at Beaumont where her uncle, John of Beaumont, held court.

In 1361 Froissart crossed the English channel and entered the service of Philippa of Hainaut, Margaret's sister and Edward III's consort. He remained in her entourage as secretary and man of letters until her death in 1369. He went with David Bruce on a progress through Scotland in 1365, visited Brittany before joining the Black Prince at Bordeaux in 1366 and accompanied the duke of Clarence to Milan for his marriage to Yolanda Visconti in 1368, a ceremony attended also by Petrarch. He took this opportunity to visit Ferrara, Bologna and Rome. On Philippa's death, he returned to Hainaut and Flanders where he found several patrons, the most important being Albert of Bavaria, count of Hainaut, Robert of Namur, Wenceslas, duke of Brabant, and the Frenchman, Guy of Châtillon, who had inherited the estates of his grandfather, John of Beaumont. It was during this period that Froissart wrote the original version of book I of his *Chronicles*, which he completed before 1371. It deals with events from 1325 to 1369. Ordained priest, he was appointed, probably by Wenceslas, to the living of Estinnes-au-Mont, near Binche, in 1373, where he was to remain for about ten years. During the whole of this time he wrote courtly poems; he also composed the verse romance *Meliador* and produced a revised version of book I of the *Chronicles*, recasting a number of chapters, incorporating new material, and extending its scope to include events up to 1377. After Guy of Châtillon had inherited the county of Blois in 1381, he appointed Froissart to be his private chaplain and had him raised to the dignity of canon of Chimay. The next few years were mostly spent at Blois. There the *Chronicles* became Froissart's principal work, book II being completed in 1387 or early in 1388. The greater part of it is devoted to events in Flanders between 1377 and the Peace of Tournai in 1385.

He then turned his attention to the recent wars in Spain and Portugal. In order to gather firsthand information, he stayed at the court of Gaston Phoebus, count of Foix, at Orthez, from Nov. 1388 to Feb. 1389, when he accompanied his host's 12-year-old ward, Jeanne of Boulogne, to Riom for her marriage to the 60-year-old duke of Berry. After a brief stay in Paris, Froissart visited Hainaut and Flanders, but was back in the French capital to witness the state entry of Isabella of Bavaria, queen of France, in Aug. 1389. Apart from an occasional journey to Flanders or northern France, he appears to have settled for the next few years at Valenciennes or Chimay and written book III of the *Chronicles*, which describes events in Spain and elsewhere up to 1389. Concurrently he started on book IV, which opens with the account of Isabella's entry into Paris. In 1395 Froissart revisited England, which he had left 26 years earlier. Although he was graciously received by Richard II, it was a sad occasion, for he was shocked by the weakness of the royal government and the state of the kingdom as a whole. Nothing is known about his last years. Book IV of the *Chronicles* ends abruptly in the middle of the events of 1400, but internal evidence suggests that Froissart wrote, or at least revised, the account of his journey to England at the end of 1404 or even later. According to local tradition he was buried at Chimay, but no trace of his tomb has been found. It may have disappeared in the course of extensive alterations carried out to the parish church during the 18th century.

Literary Achievement.—Froissart's writings were conditioned by the courtly tradition and the didactic character of 14th-century literature. Expressing the aristocratic view that true love is an art practised only by gentlefolk, he discussed, in his verse, the problems faced by those who dedicate themselves to it. His long narrative poems are really moralizing treatises on love in the tradition of the *Roman de la Rose* (*q.v.*) by Guillaume de Lorris, thoughts and feelings being expressed allegorically and often having a dream as their setting. Like Guillaume de Machaut (*q.v.*), to whom he owed much, he occasionally disclosed genuine personal feelings in a realistic manner, going further than his master by introducing a number of actual reminiscences. On occasion he showed a penchant for the parody of courtly themes and displayed a somewhat whimsical sense of humour, the most original feature of certain poems. He also followed Machaut in his predilection for short poems with fixed rhyme patterns, the *ballade*,

the *rondeau*, the *virelai* and the *lai*. He was a skilful rhetorician with a flair for concrete imagery.

The romance *Meliador*, begun shortly after the visit to Scotland, had not been completed at the time of Wenceslas' death in 1383. That the work is in verse is unusual, because prose had been the favoured medium for romance in French literature since the second half of the 13th century. It is in the tradition of the long Arthurian prose romances of the 13th and 14th centuries, being made up of the adventures and feats of arms of a number of knights, all of whom have to spend five years competing for the hand of the king of Scotland's daughter. The didactic element is present, for the author was describing an imaginary golden age of chivalry peopled by knights, perfect in their courtliness and valour, held up as models to the aristocratic readers.

Froissart is best remembered for his *Chronicles*, written in prose, which deal with events in western Europe from 1325 to 1400, in particular the Hundred Years' War. He may have learned the art of chronicle writing from Jean le Bel (*q.v.*), whose example he followed in his preference for documentation by interview and in his conscientious attempts to report the truth. In the first version of book I he merely incorporated Jean le Bel's narrative for events before 1356, but in subsequent versions he introduced important modifications. From 1356 onward his *Chronicles* were an original work, based principally on information collected from eyewitnesses, but occasionally on original documents. Although it seems clear that he treated his sources with great respect, he was too near the events and lacked the political acumen to give a balanced picture of his age. The opposing allegiances of his patrons are reflected in different parts of the *Chronicles*, so the views expressed are not always consistent.

Statements on the opening page of book I and in the prologue to book III make it clear that Froissart conceived his *Chronicles* as a means of handing down the chivalrous tradition to future generations rather than as a complete record of contemporary events. This explains many of the shortcomings which modern scholars have pointed out in his work—the lack of interest in any class of society except the nobility and the military, the small space devoted to diplomatic history and to such events as the Black Death: none of these served to illustrate chivalrous conduct. Single combats in battle, tournaments and pageantry were described in meticulous detail, for these were to him the living manifestations of chivalry.

Whatever the defects of the *Chronicles*, there is no doubt of the greatness of books III and IV. Books I and II were written in the somewhat austere style associated with chronicles since the translation into French from Latin of the official *Chronique de Saint Denis* in 1274. In books III and IV, Froissart made his narrative less annalistic. His material was organized with greater variety, due, no doubt, to the experience in writing romance which he had acquired when engaged on *Meliador*. Taking his historical material as a starting point, he succeeded in weaving a vast, brilliantly coloured tapestry which depicted the splendours of 14th-century chivalry. Although the historical value of his *Chronicles* may not be as great as was once thought, his place among the greatest writers of the later middle ages rests secure.

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(A. H. Dt.)

FROMAGEOT, HENRI (1864–1949), French lawyer and diplomat who became a senior member of the Permanent Court of International Justice, was born at Versailles on Sept. 10, 1864, and studied at Paris, Leipzig and Oxford. Before 1914, besides acting as legal adviser to the French ministry for foreign affairs, he took part as arbitrator or counsel in numerous international arbitrations and inquiries, including that following the Dogger Bank incident (1905), and attended the second peace conference at The Hague (1907) and the London naval conference (1908–09).

Fromageot was a member of the French delegation to the Paris peace conference (1919), and attended most of the international conferences of the 1920s, including the Conference of Locarno (1925). He also participated in the activities of the League of Nations, besides undertaking various legal and diplomatic missions for his government.

Elected a judge of the Permanent Court of International Justice in 1929, Fromageot had become one of its most senior members by the outbreak of World War II. He died at Versailles on Sept. 11, 1949.

He wrote several works on civil law, commercial maritime law, comparative law and international law. (L. N. B.)

FROME, a market town and urban district of Somerset, Eng., lies 15 mi. S. of Bath by road. Pop. (1961) 11,440. Unevenly built on high ground above the river in richly wooded country, it lies on the main road and rail routes from London to the west. It is first mentioned in history in A.D. 689. The town now combines an old-world charm with a brisk and businesslike modern industrial outlook. It is a centre for exploring some of Somerset's picturesque villages, being within a few miles of Longleat house, Mells, Stourton and Nunney castle. Unique Cheap street is lined on either side with quaint shops and has a waterway running along its centre. Gentle street, with its cobbled surface and fine old houses, leads from Gorehedge, where, it is said, victims of Judge Jefferies once swung after execution at the gibbets, to the parish church of St. John the Baptist with its *Via Crucis* and the tomb of Bishop Ken. The historical and imposing George hotel is in the market place. General Montgomery's headquarters were in Frome during the Normandy landings in 1944. The annual Frome Cheese and Agricultural show is held during the third week in September. Frome possesses a large park with playing fields, a technical and art college and a municipal trading estate. The main industries include agriculture, woolens, printing, die stamping and hot pressings, plastics, light engineering, Carley floats, quarrying, electric fuses, wrought-iron work and table and chair manufacture.

(A. W. Y.)

FROMENTIN, EUGÈNE (1820–1876), French painter and author, best known for his pictorial scenes of Algeria, was born at La Rochelle on Oct. 24, 1820. He studied under Louis Cabat, the landscape painter. The land and people of Algeria suggested the subjects of most of his works.

Among his more important early works are "Moisson en Algérie"; "Diffa, reception du Soir"; "Chasse à la gazelle"; and "Enterrement maure." They are somewhat stiff in design and execution. His second period extends until 1859 and includes the following works: "Les Bateleurs nègres"; "Le Simoun"; and "La Lisière d'oasis." They are gray in tone and were executed under the influence of Jean Baptiste Corot. After 1860 Fromentin's colour becomes bright and luminous: "Fauconnier arabe"; "Chasse au héron"; "La curée"; "Centaures et centauresses"; here Fromentin was influenced by Eugène Delacroix.

Fromentin's paintings show only one side of a talent that was perhaps even more felicitously expressed in literature; "Dominique," first published in the *Revue des deux mondes* in 1862 and dedicated to George Sand, is remarkable among the fiction of the century for imaginative observation. Fromentin's other literary works are *Visites artistiques* (1852); *Simples Pèlerinages* (1856); *Un Été dans le Sahara* (1857); *Une Année dans le Sahel* (1858); and *Les Maitres d'autrefois* (1876). He died at La Rochelle on Aug. 27, 1876.

FROMMEL, GASTON (1862–1906), Swiss theologian, professor of theology in Geneva from 1894 to 1906, was born Nov. 25, 1862. Though Alsatian by birth, he belonged mainly to French Switzerland. In his theology and philosophy Frommel sought to establish the objective basis of religious experience. His posthumously published *Etudes de théologie moderne* (1909) defined this objectivity in contrast to both Kant and Schleiermacher. Against Kant, Frommel maintained that the ultimate ground of the sense of duty is not man's subjective consciousness of a moral impera-

tive but the absoluteness and objectivity of God. Against Schleiermacher, Frommel objected that the subordination of religion to the categories of psychology led to a "religious agnosticism" that was unable to say anything definite about God and his revelation. Thus Frommel made use of the psychological study of conscience to relate each doctrine of the Christian faith to personal spiritual experience, while refusing to reduce the content of the faith to the idiosyncrasies of the believer's private world. He died May 17, 1906.

Frommel's *Oeuvre systématique* was published in 1910–16; a selection in English, *The Psychology of Christian Faith*, appeared in 1928. (J. J. Pn.)

FRONDE, the name given, in French history of the years 1648–53, first to a movement in the Paris *parlement* against royal absolutism; then to a faction that exploited this opposition and came to be called the Old Fronde; then to a rival faction, the New or Princes' Fronde; and finally to the whole period of troubles.

Underlying all this was a multiple reaction against the effects of the policy pursued by the cardinal de Richelieu (*q.v.*) in Louis XIII's reign. Richelieu had broken the power of the princes; reduced the "sovereign companies" (*parlements, chambre des comptes, cour des aides* and *grand conseil; see* French Law) to subservience; and exploited the complex struggles of the Thirty Years' War (*q.v.*) to challenge the Habsburg powers, Austria and Spain. The war, however, had not only involved alliances with German Protestants, which scandalized much French Catholic opinion, but had also necessitated oppressive taxation, so that the common people as well as other victims of the regime had looked forward to a change of policy when, on Louis XIII's death in 1643, his widow Anne (*q.v.*) of Austria had become regent for the infant Louis XIV, with the cardinal Jules Mazarin (*q.v.*) as her chief minister.

For four years all went well. Of the princes, Gaston, duc d'Orléans (*q.v.*), hereafter called Monsieur, was satisfied with his rank as lieutenant general of the realm; Louis II de Bourbon, prince de Condé (*q.v.*) from 1646, was mainly occupied with his military exploits; and François de Vendôme, duc de Beaufort (*q.v.*) having tried to supplant Mazarin, was safe in prison. Sporadic risings against taxgatherers in the provinces were easily put down. Hopes were raised by the peace negotiations in Germany.

The Fronde of the Parlement in 1648.—Serious trouble began when the government's fiscal program began to affect the rich bourgeois and the members of the sovereign companies, who held their offices by right of purchase. The bourgeois were alarmed when the government planned a levy on houses built without permission on crown land round Paris; the officeholders when it was proposed to raise money by creating 12 new *maîtres des requêtes* in the Paris *parlement*. In Jan. 1648 the bourgeois rioted and the existing *maîtres des requêtes* began a strike. Next the government announced that the *Paulette* or "annual right" (whereby officeholders could convert their offices, very profitably, into hereditary possessions by a yearly payment of one-sixtieth of their original price) would be renewed after April 1648 only if the officers would forgo four years' salary. Though the *parlementaires* were exempted from this condition, they made common cause with the members of the other companies against it. The *parlementaires* were especially excited by the English parliament's successes at that time (*see* Civil War, English) and made great play with talk of "the fundamental laws of the kingdom" to enlist the sympathy of the non-privileged.

On May 13, 1648, the *parlement* of Paris voted to send delegates to join those of the other three sovereign companies in the Chambre St. Louis to debate reforms. Anne reluctantly had to countenance this. Beginning on June 30, the assemblies produced resolutions demanding, among other things, an immediate reduction of the *taille* (*q.v.*) by 25%; recall of the royal intendants; proceedings against tax farmers; complete control by the companies over taxation and the creation of offices; measures to protect the interests of *rentiers;* and personal security for all and sundry from arbitrary imprisonment for more than 24 hours. The government made concessions, but the final royal declaration of July 31 omitted any reference to personal security and required the assemblies to cease. The *parlement* then took to debating the declaration.

The government's mildness up to now was because of anxiety over its war with Spain. News of Condé's victory at Lens (Aug. 20, 1648) reassured it. Anne and Mazarin decided to crush the king's enemies in Paris. On Aug. 26, after a service of thanksgiving for Lens in Notre Dame, two of the most outspoken *parlementaires,* René Potier de Blancmesnil and the people's hero Pierre Broussel, were arrested. Instead of overawing the troublemakers, this provoked an insurrection; barricades were put up; a mob attacked the chancellor, Pierre Séguier (*q.v.*); and when Mathieu Molé (*q.v.*), premier president of the *parlement,* led his colleagues to appeal to the queen for the prisoners' release he was threatened with death by the people if he should return empty-handed. Though earlier they had derided the offers of mediation made by J. F. P. de Gondi, the future cardinal de Retz (*q.v.*), at this time coadjutor to the archbishop of Paris, Anne and Mazarin were compelled to yield. On Aug. 28 the prisoners were returned to Paris.

For a fortnight the court endured the exaltation of the Frondeurs—as the anti-Mazarin *parlementaires* were now called (from *fronde,* "sling," as men who metaphorically slung stones at the minister). Then, on Sept. 13, 1648, Mazarin took the king quietly to Rueil, whither Anne followed. This move alarmed Paris, as it might have foreshadowed a blockade. Next, on Sept. 18, Léon Bouthillier, comte de Chavigny (*see* Bouthillier), a rival of Mazarin's who had been inciting the Frondeurs and had maliciously advised the disastrous coup of Aug. 26, was arrested at Vincennes; Charles de l'Aubespine, marquis de Châteauneuf, a veteran statesman who had also been speaking against the government, was ordered into exile; and on Sept. 23 the court moved to St. Germain-en-Laye, whence Anne hoped to launch an attack on Paris. However, Condé, back from the front and annoyed at Chavigny's arrest, and Monsieur, who had been conserving his popularity by humouring the *parlement,* insisted on negotiations instead. The result was the royal declaration of Oct. 22, according tax reforms; guarantees for *rentiers;* measures against speculators; controls over the alienation of crown lands, extraordinary expenditure and the creation of offices; a revocation of monopolies; safeguards for the civil population against depredations by passing troops; and the supremacy of the ordinary judiciary in all contentious and criminal cases, with security for its officers in the exercise of their functions. Chavigny was released from prison to exile on Oct. 27.

On the day when the *parlement* registered the declaration, Oct. 24, 1648, the peace of Westphalia (*q.v.*) was signed between France and the Holy Roman empire. No peace, however, was signed with Spain. On Oct. 31 the court returned to Paris.

A dispute now broke out at court on the question of who should have the crown's nomination for the next cardinal's hat that the pope might bestow: Monsieur wanted it for his favourite, the abbé de La Rivière (Louis Barbier), to whom it had been promised, but Condé now claimed it for his brother Armand, prince de Conti, to whom it was conceded. Monsieur was finally pacified by the grant of ministerial rank to La Rivière, but not before the Frondeurs had offered him their support against the court and Condé. They thus forfeited Condé's sympathy. When they began carping at the government again in Dec. 1648, Condé offered his services to Anne for military action. Monsieur was persuaded to agree.

The War of the Parlement (Jan.–March 1649).—During the night of Jan. 5–6, 1649, the court secretly left Paris for St. Germain. Condé began the blockade of Paris. The *parlement,* ordered to withdraw to Montargis, retorted by declaring Mazarin a public enemy (Jan. 8). Its will to resist was encouraged by the arrival in Paris of a flock of malcontent princes.

The first to appear was Charles de Lorraine, duc d'Elbeuf, who on Jan. 9 was promptly accepted as general of the Paris troops. This disconcerted Gondi, who had another candidate for this post, namely Conti himself, who was controlled by his sister Anne Geneviève, duchesse de Longueville (*q.v.*) and her lover François, prince de Marcillac, later duc de La Rochefoucauld (*q.v.*). Mme de Longueville was already in Paris, and on Jan. 10 Marcillac arrived from St. Germain with Conti and the duc de Longueville

(Henry d'Orléans), governor of Normandy. Finally Conti was appointed generalissimo, with the duc de Bouillon (F. M. de La Tour d'Auvergne), the marshal de La Mothe (Philippe de La Mothe-Houdancourt) and Elbeuf as generals. Beaufort, who had been in hiding since his escape from prison in May 1648, joined them on Jan. 13.

The plans of the generals depended not on the rabble of Paris but on two expectations: (1) that Bouillon's brother the marshal de Turenne (*q.v.*) would bring his army from the east to help them; and (2) that the *parlement,* on the pretext that Mazarin alone was preventing peace between France and Spain, would accept the offers of the archduke Leopold William, governor of the Spanish Netherlands, with whom the exiled Marie de Rohan, duchesse de Chevreuse (*q.v.*), was negotiating for them. Turenne, however, could not declare himself at once; and the *parlement,* though on a quibble it refused to receive a herald from its own king (Feb. 12) and gave audience to the archduke's envoy (Feb. 19), would not commit itself to the Spaniards.

Meanwhile Condé had taken Charenton (Feb. 8), and the appalling news of the beheading of Charles I in England had shown where parliamentary pretensions could lead. Though sorties were made to bring convoys in, food was short. Longueville's attempt to raise Normandy against St. Germain was a fiasco, though the *parlement* of Rouen declared itself for Paris, as also did that of Aix-en-Provence. The reasonable men in the Paris *parlement,* led by Molé and by Henry de Mesmes, who wanted peace, began to prevail. A deputation sent on Feb. 24 to apprise the court of the archduke's proposals found it ready to negotiate—not only for fear of the Spanish offensive but also because the provinces were restless, Guienne especially so.

On Feb. 28, 1649, two days after royal troops had taken the town of Brie-Comte-Robert, the *parlement* authorized peace negotiations, which began at Rueil on March 4. Gondi and the generals disliked this. Turenne at last declared himself, but his army, bribed by Mazarin's agents, deserted him. Then the generals began treating privately with St. Germain. The peace of Rueil, signed on March 11 but later slightly emended, was ratified by the *parlement* on April 1. It included an amnesty for all; annulment of all the *parlement's* acts since Jan. 6; confirmation of the declaration of Oct. 1648; and some personal satisfactions for the generals.

Condé's First Predominance (April 1649–Jan. 1650).—Civil war had taught many of the *parlementaires* a lesson. Agitation against Mazarin was henceforth to be conducted chiefly by groups outside the *parlement* and with less concern for English ideas. The Frondeurs of the *parlement* became the spokesmen and satellites of these groups. With this process, the name Frondeurs came to mean particularly Gondi and Beaufort, who together commanded the loyalty of the Parisian people and who set themselves up as the leaders of the Old Fronde; *i.e.,* of those who were still irreconcilable to Mazarin. They were joined by Mme de Chevreuse, back from exile.

While the court went to Compiègne, to superintend operations against the Spaniards, numbers of Mazarin's partisans returned to Paris. The Old Fronde began a pamphlet war against them, and a notable brawl took place on June 18, 1649, when Beaufort broke up a supper party to humiliate the upstart marquis de Jarzé (R. du Plessis de La Roche-Pichemer). The vital factor of the moment, however, was Condé's attitude. Having saved Mazarin in the war, he expected to control France. He objected to plans for marrying Mazarin's niece Laura Mancini to the duc de Mercoeur (Louis de Vendôme); he opposed Mazarin's design to suppress the continuing troubles in Guienne by force; and finally, he insisted that Mazarin should give the stronghold of Pont de l'Arche to Longueville, which would greatly strengthen the latter's hold on Normandy. His discontent was stimulated by the rancorous Chavigny, still hoping to overthrow Mazarin. After the court's return to Paris (Aug. 18), when Condé momentarily threatened to break with Mazarin (Sept. 10), the Frondeurs offered him their services. When a week later Condé came to advantageous terms with Mazarin, the Parisians felt themselves let down. Mazarin, however, was humiliated. When Condé next conceived the notion of imposing the fatuous Jarzé (who had deserted Mazarin for him) on Anne as a lover, neither Anne nor Mazarin could stand his arrogance much longer.

Meanwhile the *rentiers* of the lesser *bourgeoisie,* whose interest on investments at the Hôtel de Ville was not being paid satisfactorily, had begun an assembly and appointed 12 syndics to supervise payments. To win the sympathy of the *parlement* for this assembly, the Frondeurs arranged a simulated attempt on the life of a syndic, Guy Joly, for which the government, it was hoped, would be blamed; with Joly's connivance a shot was fired into his carriage (Dec. 11, 1649). At this, however, the marquis de La Boulaye (Maximilien Échalart), a professed Frondeur but probably an *agent-provocateur* of Mazarin's, made a show of trying to raise a riot, which would have justified action against the Frondeurs for sedition. Then, in the evening of the same day, someone fired a shot at a carriage supposed to be Condé's.

Proceedings in the *parlement* were instituted against Gondi, Beaufort, Broussel, Joly and Louis Charton (another Frondeur and syndic) as having plotted a *coup d'état;* and Condé fiercely demanded justice on them for the alleged attempt on his own life. Anne and Mazarin now saw their chance to enlist the weaker faction of their quarreling enemies against the stronger: they entered into secret negotiations with the accused Frondeurs through Mme de Chevreuse, who moreover secured Monsieur's consent to a coup. On Jan. 18, 1650, Condé, Conti and Longueville were arrested by the royal guards and taken to Vincennes.

The War of the Princes' Imprisonment (Jan. 1650–Feb. 1651).—Having saved each other from Condé's persecution, the Old Fronde and Mazarin found themselves in loveless misalliance. The Fronde could not publicly serve Mazarin without losing its popularity to the rapidly emerging New or Princes' Fronde; and he was not going to consolidate the power of a faction that might strike at him again as soon as occasion arose. The outward signs of reconciliation were therefore few: succession to the admiralty was assured to Beaufort; Châteauneuf, a very old friend of Mme de Chevreuse, was made keeper of the seals in Séguier's place; Mme de Chevreuse was promised money; and there was talk of Gondi's being nominated for the cardinalate. La Rivière, who had been influencing Monsieur in Condé's interest, was dismissed from favour by Monsieur, who now took Gondi as his mentor instead.

Condé's friends took to arms. Mme de Longueville tried to stir Normandy up but was easily dislodged in Feb. 1650 and had to take refuge in Stenay, on the border of Champagne and the Spanish Netherlands, where Turenne was collecting troops and treating with the Spaniards. Bouillon went to Limousin, Marcillac went from Normandy to Poitou (where his father's death made him duc de La Rochefoucauld), failed to take Saumur and then joined Bouillon. While the royal army was reducing other rebels in Burgundy (March–April), the young princesse de Condé escaped from surveillance to Montrond in the centre of France. Then Bouillon and La Rochefoucauld escorted her to Bordeaux (May 31).

The Bordeaux *parlement* had long been supporting the people of Guienne against their governor, the duc d'Épernon (Bernard de La Vallette). It was ready to give sanctuary to the princesse and to press Mazarin further for Épernon's removal, but less ready to embark with Spanish help on war for the captive princes, as the two ducs required. When the royal army began to approach Bordeaux, envoys from Bordeaux appeared in Paris, where Monsieur, Châteauneuf and Mazarin's man Michel Le Tellier (*q.v.*) had great difficulty in preventing the *parlement* from linking the Guienne question with demands for the princes' release. Monsieur on his own authority sponsored a peace plan involving Épernon's dismissal, but the ratification of this between Bordeaux and the court (at Libourne from Aug. 1, 1650) was allowed to miscarry. Full hostilities began on Sept. 1. The two ducs, with inadequate forces, resisted heroically, but were overcome. Peace, for Bordeaux, was signed on Sept. 29 and announced on Oct. 1, including a general amnesty. Private talks at Bourg between Mazarin and the ducs increased the suspicion of Monsieur and of the Old Fronde that the court and the princes might be coming to terms unbeknown to them. Already on Aug. 28, on the pretext that the enemy might surprise Vincennes, the court had had the princes moved to Mar-

coussis, out of sight of Paris. When the court was at Fontainebleau on its way back from Guienne, Monsieur and the Old Fronde, alarmed at signs of Mazarin's displeasure, demanded the nomination for Gondi, to give him safety under a cardinal's hat. When nomination was refused, they began listening to the New Fronde's overtures.

The New Fronde was the faction desiring the princes' release. Its affairs in Paris were ably conducted by the princesse Palatine (Anne de Gonzague, wife of Prince Edward of the Rhenish Palatinate). Both Molé (who wanted to see the royal family reconciled) and La Rochefoucauld would have liked to secure the release through agreement with the court, but it was not to be.

The court reached Paris on Nov. 15, 1650, and ordered the transfer of the princes to Le Havre for even greater safety. Mazarin on Dec. 1 went to Champagne with reinforcements for the marshal du Plessis-Praslin (César de Choiseul; *q.v.*), who on Dec. 15 crushingly defeated Turenne and the Spaniards in the battle of Rethel. This success alarmed all who were not Mazarin's friends. On Dec. 29 the *parlement* voted that Anne be asked to release the princes.

The princesse Palatine, playing on the Old Fronde's fears and ambitions, reached a secret understanding with it: Old and New Fronde were to combine for Condé against Mazarin. One of the principal terms was that Conti should marry Mlle de Chevreuse (Charlotte de Lorraine), Mme de Chevreuse's daughter and Gondi's mistress. Monsieur, ever timorous, was at last induced to declare himself for the princes' release and against Mazarin personally. On Feb. 4, 1651, the *parlement*, following Monsieur's proposal, called on Anne to set the princes free and to dismiss her minister. In the night of Feb. 6 Mazarin quietly left Paris for St. Germain; on Feb. 9 the *parlement* voted his banishment; on Feb. 13, at Le Havre, he freed the princes before making his way to Brühl, in the electoral territory of Cologne.

Condé's Second Predominance (Feb.–Aug. 1651).—When Mazarin left Paris the Frondeurs had patrolled the streets round the Palais Royal lest Anne should take the king away again. Anne's first desire now was to get Condé to agree to Mazarin's return, against which Monsieur and the *parlement* were committed. During March 1651, while public attention was engaged with pronouncements against Mazarin and cardinals in general and with proposals for convening the estates-general, overtures to Condé were made by Hugues de Lionne and Abel Servien, who together with Le Tellier were acting for Mazarin as "underministers" in the queen's counsels. If he would have Mazarin back, Condé was offered the governorship of Guienne for himself; that of Provence for Conti; that of Blaye, with the lieutenancy of Guienne, for La Rochefoucauld; and the upkeep of the requisite troops at the royal expense. Instead, however, of securing this offer before all else, he first offended Monsieur and the Old Fronde by a change in the government, on which they were not consulted: on April 3, 1651, Chavigny was made minister and the seals were taken from Châteauneuf and given to Molé. Beaufort's veto of Gondi's suggestion that they should now carry out a coup against this marked a split in the Old Fronde, with Beaufort's following now at the service of the New. Then on April 4, Condé broke Conti's engagement to Mlle de Chevreuse. To placate Monsieur somewhat, the seals were taken from Molé after a few days and given to Séguier.

Condé had made friends with Mademoiselle, Monsieur's daughter (*see* MONTPENSIER, ANNE MARIE LOUISE D'ORLÉANS), as well as with Beaufort, but had lost the best part of the friends brought to him by the Palatine, whom he also somehow alienated. He regretted this when Mazarin, from Brühl, countermanded most of the underministers' treaty. Condé then launched a new anti-Mazarin campaign in the *parlement*, demanding the dismissal of the underministers. In May 1651 Anne approached Gondi, who in return for the promise of nomination undertook to break Condé's power in Paris. A virulent pamphlet war ensued: the New Fronde accused the Old of being crypto-Mazarinist, the Old accused the New of using anti-Mazarinism as a pretext for subverting the royal authority. In the night of July 5–6 Condé, on a false alarm, fled from Paris to St. Maur, where members of his party rallied to him, ready for dissidence. After Anne had conceded the dismissal of the underministers, however, he returned to Paris (July 21). Then, on Aug. 17, Anne sent a denunciation of him to the *parlement*, accusing him, justly, of dealings with the Spaniards. For the ensuing debates, the halls were packed with armed gentlemen, some Condé's, some Gondi's, till on Aug. 21 they came near to bloodshed: at one moment La Rochefoucauld, holding Gondi caught in a door, was on the point of having him murdered. Finally Anne promised a declaration of Condé's innocence, but on Sept. 6 he withdrew from Paris again.

The next day, Sept. 7, 1651, was that fixed for declaring Louis XIV's majority, two days after his entering his 14th year. With the regency (and with it Monsieur's lieutenancy of the realm) now ended, the king could entrust the conduct of affairs to his mother, whose position would now be constitutionally unassailable. The government was promptly reorganized, with Châteauneuf as minister instead of Chavigny and with Molé as keeper of the seals. A fortnight later, Gondi's nomination was sent to Rome.

The War of the Princes (Sept. 1651–Sept. 1653).—Condé, who doubted the sincerity of some final overtures by the court, moved southward to organize rebellion. Having garrisoned Bourges and Montrond, whence Pierre Lenet was sent to Spain to conclude an alliance, he entered Bordeaux on Sept. 22, 1651. Guienne and a number of places in Saintonge were under his control, but the king's army soon took Bourges and besieged Montrond. Moreover, Bouillon and Turenne refused this time to take up arms for Condé. While the court settled at Poitiers, the comte d'Harcourt (Henry de Lorraine) began operations against Condé's friends along the Charente river. The rebels had to raise the siege of Cognac (Nov. 15), lost La Rochelle and were defeated at Tonnay-Charente. Spanish troops, however, landed in the Gironde.

On Dec. 24, 1651, Mazarin crossed the frontier at Sedan with an army of his own, which joined the king at Poitiers on Jan. 29, 1652. Châteauneuf resigned. Mazarin's reappearance, however, threw Monsieur and the Paris *parlement* on to Condé's side. Beaufort was made general of Monsieur's troops to co-operate with his brother-in-law, the duc de Nemours (Charles Amédée de Savoie), who led Condé's troops from Stenay and a far larger force of Spaniards into the Orléanais. Nemours, however, had orders to relieve Montrond and then to link up with Condé, but Monsieur dared not let his troops go so far from Paris. Finally ordered to relieve Angers instead, Beaufort arrived too late, as the duc de Rohan (Henry Chabot) capitulated on Feb. 28. Mademoiselle, however, on her own initiative, occupied Orléans (March 27). On Feb. 19, before the court dared revoke its nomination, Pope Innocent had promoted Gondi, who took the style cardinal de Retz.

Condé meanwhile had left the Saintonge front to save the Agenais, where Conti was doing badly. He could not do much better himself. Finally, to remedy dissension between Beaufort and Nemours, he resolved to join them. With La Rochefoucauld and a handful of others he left Agen on March 24, 1652, and after a hazardous journey in disguise reached the brothers-in-law on April 1. In the battle of Bléneau (April 6) he defeated the marshal d'Hocquincourt (Charles de Mouchy), who was saved from disaster only by the arrival of Turenne, now openly on the king's side.

Condé now made the fatal mistake of going to Paris, on the advice of Chavigny, who fancied himself as the man who, as spokesman for Condé and for Monsieur alike, would outbid and outwit Mazarin. Delusive negotiations ensued with the court, now at St. Germain, while the New Fronde's mob terrorized royalist Parisians. Meanwhile the princes' army was attacked by Turenne at Étampes (May 4, 1652) and besieged there. Charles IV (*q.v.*), duke of Lorraine, now invaded France to help the princes, but treated with the court and, after arranging that the siege of Étampes should be raised (June 7), withdrew his army (June 17). The princes' army from Étampes now marched to St. Cloud. Threatened by converging royalist armies, Condé tried to move round Paris to Charenton. Caught by Turenne, he suffered a

terrible defeat in the battle of the Faubourg St. Antoine (July 2), under the walls of Paris. The war would have been over then if Mademoiselle, overriding her terrified father's vacillations within the walls, had not fired the guns of the Bastille on the king's men and opened the gates to let the vanquished in.

The Parisian bourgeois, anxious for peace with the king, assembled in the Hôtel de Ville on July 4, 1652. An armed mob surrounded the building, opened fire on it and set it on fire. The massacre, disavowed by the princes, restored their authority, but not for long. When the *parlement* received a royal order to move to Pontoise (Aug. 6), a number of *parlementaires* obeyed. The princes, however, still insisted that Mazarin must be banished. To silence this argument, he took his departure from France again (Aug. 19)—with every intention of returning. At the end of August, Montrond fell to the royalists.

Charles IV of Lorraine invaded France again to help the princes, but on Sept. 10, 1652, the cardinal de Retz led a deputation of the clergy from Paris to the court at Compiègne to ask the king to return. Condé and Charles of Lorraine left Paris on Oct. 13, the king and the court entered it triumphant on Oct. 21.

After some exploits in Champagne, Condé took refuge in Spanish Flanders. Mazarin, recalled on Oct. 26, 1652, returned to Paris on Feb. 3, 1653. The princes' partisans in Burgundy were overcome by June 8. Bordeaux, where Conti and Mme de Longueville were lamentably quarreling with one another among local factions, including a radical group known as the Ormée, submitted on July 31, Périgueux in Sept. 1653. Though war with Spain was to go on till 1659, France was now ready for Louis XIV (*q.v.*).

BIBLIOGRAPHY.—The voluminous literature of the Fronde begins with the polemics and pamphlets that it engendered, the so-called *Mazarinades*, listed by C. Moreau, *Bibliographie des mazarinades* (1850) with supplements; with the letters of Mazarin (*q.v.*); and with the diaries of spectators, notably those of O. Lefèvre d'Ormesson, ed. by A. Chéruel, 2 vol. (1860–61), and of F. N. Dubuisson-Aubenay, ed. by G. Saige, 2 vol. (1883–85). It continues with the numerous *Mémoires* of people involved, such as those of Retz, La Rochefoucauld, Mlle de Montpensier, Molé and, for Anne, Mme de Motteville (*qq.v.*), as well as many others. *See* A. Chéruel, *Histoire de France pendant la minorité de Louis XIV* (1879–80) and . . . *sous le ministère de Mazarin* (1882); E. Kossmann, *La Fronde* (1954). (J. G. R.-S.)

FRONT. When two great masses of air forming part of the atmosphere lie side by side, each horizontally uniform in air density but with appreciable differences in density between them at each height, the heavier air lies as a thin wedge under the lighter air. The differences in density are associated with horizontal differences in temperature and humidity (*q.v.*) between them, and are accompanied by differences in air motion and transparency. The sloping area of contact of the two air masses is known as a frontal surface. The line marking the intersection of such a frontal surface with a horizontal surface, more particularly the earth's surface, is called a front. In middle latitudes such fronts, generally in motion, extend continuously for hundreds and often for thousands of miles over the earth. The interplay of great air masses at fronts results in some of the most dramatic types of weather, and the study of such interplay is therefore of primary importance in the science of meteorology.

Near the end of the 19th century H. Helmholtz pointed out that two currents of air having different densities could flow side by side with different speeds and with little mixing between them. H. Bigelow in 1902 stated that the centres of the low-pressure systems known as cyclones are to be found along the line marking the boundary between adjacent warm and cold air currents. Similar conclusions were later reached by S. Hanzlik, by Sir Napier Shaw and R. G. K. Lempfert and by H. von Ficker. However, it was not until the end of World War I that the behaviour of these frontal surfaces and fronts during the development of a cyclone (*q.v.*) of middle latitudes was described in detail, and an integrated picture presented by the Norwegian meteorologist J. Bjerknes. About the same time his father, V. Bjerknes, analyzed mathematically some aspects of the wave motion of a frontal surface. Further descriptive and theoretical investigations of frontal cyclones have been made, largely by the Norwegian school of meteorologists under the leadership of the two Bjerkneses.

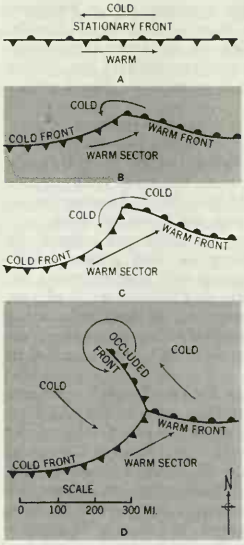

FIG. 1.—VARIOUS STAGES IN THE DEVELOPMENT OF A FRONTAL CYCLONE

(A) Initially there is a stationary front; (B) the pressure falls; cyclonic air flow commences along the front, accompanied by a wavelike deformation of the front; (C) the deformation increases; (D) finally the cold front overtakes the warm front, resulting in an occluded front; thereafter the cyclone wanes

Their approach to the problem may be briefly described as follows. There are two main types of air masses found in middle latitudes: polar air masses which have their origin at higher latitudes and are therefore cold and dry, and tropical air masses which originate at lower latitudes and are therefore warm and moist. The front marking the line of contact of these two main air masses is the polar front. The development of most cyclones of middle and higher latitudes occurs at the polar front and is associated with a deformation of it. Four stages of a typical development in the northern hemisphere viewed from above are shown in fig. 1.

Frontal Stages.—*Stage A.*—Initially there is a straight stationary or slowly moving front extending in an east-west direction; a cold polar air mass lies to the north and a warm tropical one to the south. In the warm air the wind is west, as indicated by the arrow; in the cold air the wind may be east, as shown, or west but with a smaller speed than that of the wind in the warm air.

Stage B.—The pressure starts to fall near a section of the front, cyclonic (counterclockwise in northern hemisphere) rotation of the air commences, and simultaneously the front undergoes a wavelike perturbation. The forward edge of an advancing warm-air mass with receding cold air ahead of it is a warm front; that of an advancing cold-air mass before which warm air recedes is a cold front. To the west of the centre of low pressure the black triangles on the southern edge of the front indicate that it is a cold front moving southward; to the east the black semicircles on the northern side of the front indicate that it is a warm front moving northward. The warm air between the two fronts is known as the warm sector.

Stage C.—As the pressure fall continues, the wavelike deformation of the front increases. The cold front moves more rapidly than the warm one, and as a result near the centre the warm sector becomes narrower. During stages B and C the wave moves rapidly eastward along the front, with the lowest pressure at the crest of the wave.

Stage D.—Finally, near the centre of low pressure the cold front overtakes the warm front to produce an occluded front. By this stage the pressure has ceased to fall and may have started to rise, and the eastward rate of motion of the centre has decreased. The cyclone is now past its prime, and its last hours are spent as a circular vortex of decreasing strength in which the occluded front gradually loses its identity as such. From birth to death, the life span of such frontal cyclones is from one to three days.

Cyclones of this type sometimes occur in families. One cyclone grows and then dies as it moves eastward along a front; another develops on the same front, generally to the south of the birthplace of the first, and goes through the same cycle. Three or four cyclones developing at intervals of several days may make up a family. Not all cyclones reach the unstable state represented by the occlusion phase. Some cease to develop at stage B, and thereafter move rapidly along the front as stable waves until they dissipate.

It must not be inferred from the foregoing that all cyclones of middle latitudes have a frontal structure, although the great ma-

jority do. A few cyclones develop without discernible fronts in them.

Vertical Structure.—A knowledge of the vertical structure of fronts is essential in understanding the weather phenomena which accompany them. The cold air lies as a thin wedge under the warm air. A cold frontal surface (shown in fig. 2 by a vertical cross section in a plane perpendicular to the surface front) has an average slope of about 1 in 50. The frontal surface is steeper near the ground because the roughness of the latter produces a frictional drag which retards the air just above it. Often the warm air just ahead of the frontal surface rises as the cold-air mass advances. When the rate of ascent of this warm air is small, not much cloud develops at the frontal surface. With rapid ascent, however, heavy towering clouds (fig. 2), perhaps giving showers or even thunder and lightning, may result. One often hears a comment on how a certain thunderstorm has cleared the air. When this happens, the clearing of the air is caused by the arrival of the cooler and drier air mass which replaces the sultry air; the thunderstorm merely develops at the cold front. A thunderstorm unaccompanied by a cold front affords only temporary relief. In addition, as the cold front passes, the wind suddenly veers, perhaps from southwest to northwest, and freshens, the visibility improves and the barometric pressure starts to rise.

A warm frontal surface (fig. 3) has a smaller slope, about 1 in 175. Frictional forces retard the cold air near the earth's surface, and the slope there is less than at higher levels. Usually the warm air moves more rapidly normal to the front than the cold air ahead of it, and therefore overruns the latter. Clouds form in and just below this ascending warm air. Hundreds of miles ahead

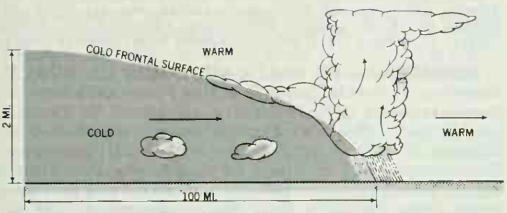

FIG. 2.—VERTICAL CROSS SECTION THROUGH A COLD FRONTAL SURFACE, SHOWING ASSOCIATED CLOUDS AND PRECIPITATION

of the surface warm front, wispy, hooked cirrus clouds (mare's-tails) made up of ice crystals are seen. As the front approaches, the cloud, now of the layer type, becomes thicker and lower, and finally rain or snow falls steadily from it. Frequently there are two or more layers of stratified cloud, with clear air between them (fig. 3). Occasionally thunderstorms develop ahead of the warm front, but not so frequently as at a cold front, for the rate of ascent of the warm air is less. The passage of the warm front is marked by a gradual temperature rise, a decrease in the rate of pressure fall, a veering of the wind, perhaps from south to southwest, and a decrease in the amount of cloud and a change in its type.

The vertical structure of an occluded front (or occlusion, as it is often called) has several interesting features (fig. 4). When the cold front overtakes the warm front, the warm air which was previously between them (fig. 1 [C]) is carried aloft, and only cold air is left at the ground. There are two types of occlusions, depending on whether the air behind the cold front is colder or less cold than the air ahead of the warm front. When the air be-

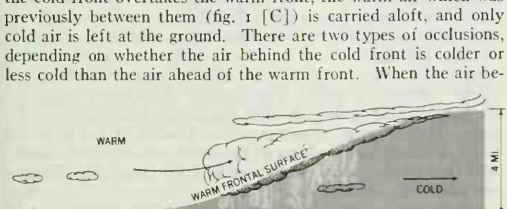

FIG. 3.—VERTICAL CROSS SECTION THROUGH A WARM FRONTAL SURFACE, SHOWING ASSOCIATED CLOUDS AND PRECIPITATION

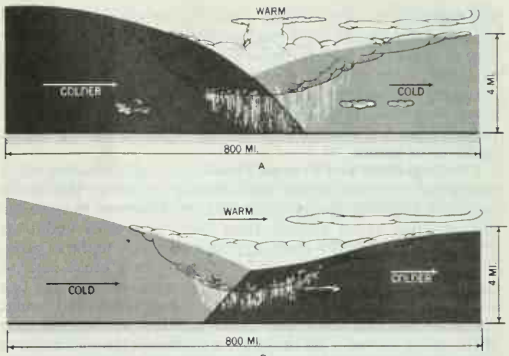

FIG. 4.—DETAILS OF OCCLUSIONS, SHOWN BY VERTICAL CROSS SECTIONS (A) Cold-front type of occlusion; (B) warm-front type of occlusion

hind is colder than that ahead (fig. 4 [A]), the former undercuts the latter, and the system displays many of the characteristics of a cold front. It is therefore known as a cold-front type of occlusion. At the forward part of the system, the clouds are similar to those which accompany a warm front. Under suitable conditions, the warm air just above the advancing cold air may ascend so rapidly that towering clouds form in it and showers or even thunderstorms occur. The warm-front type of occlusion develops when the air ahead of the warm front is colder than that behind the cold front and consequently the latter overruns the former (fig. 4 [B]), in the same way that warm air overruns cold at a warm front. Precipitation generally falls from the extensive cloud system near the frontal surfaces, but may evaporate during its descent through drier air below, and never reach the ground. The two cold air masses are sometimes so similar in physical properties that little change in temperature and humidity is noted as an occlusion passes. The chief indications of passage are the cessation of the pressure fall and the beginning of a rise and a veering of the wind, usually from southwest to northwest.

A type of front known as an upper front is associated with occlusions, but also occurs independently of them. In the cold-front type of occlusion (fig. 4 [A]), the surface front is of the cold type and only the original warm front appears aloft. The line of discontinuity aloft along which the three air masses meet acts as a warm front, and is therefore called an upper warm front. Similarly, in the warm-front type of occlusion (fig. 4 [B]), there is a

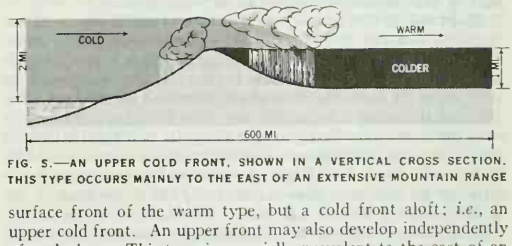

FIG. 5.—AN UPPER COLD FRONT, SHOWN IN A VERTICAL CROSS SECTION. THIS TYPE OCCURS MAINLY TO THE EAST OF AN EXTENSIVE MOUNTAIN RANGE

surface front of the warm type, but a cold front aloft; *i.e.*, an upper cold front. An upper front may also develop independently of occlusions. This type is especially prevalent to the east of an extensive mountain range lying in a north-south direction and located at the western side of a continent. It occurs when air advances eastward from the adjacent ocean over the mountain range and at the same time east of the range there is a stagnant mass of cold air near the surface (fig. 5). Frequently the maritime air is colder than the air aloft over the continent, so that it undercuts the latter, and the front is an upper cold front (fig. 5). The maritime air, being not so cold as the lower continental air, moves along aloft without disturbing it, just as if the upper boundary of the lower air were an elevated land surface. Clouds are usually present near the leading edge of the advancing cold maritime air,

and rain or snow may fall from them. Upper warm fronts of this type (not illustrated) occur less frequently than the corresponding type of upper cold fronts. Upper fronts often travel for hundreds of miles before dissipating or reaching the earth's surface and becoming ordinary fronts. The chief manifestations of upper fronts observable at the ground are the associated cloud types and precipitation, and a variation in the rate of pressure change as the upper front passes.

Frontogenesis and Frontolysis.—A field of air motion which brings two large air masses with differing properties into closer proximity promotes the formation of a front between them or the intensification of an existing front there, a process known as frontogenesis. Initially there may be a relatively uniform variation of temperature or some other property in a broad zone of transition, perhaps several hundred miles wide, between the two air masses. However, a change of air flow may occur which brings the warm and cold air masses closer together, so that the zone of transition narrows. As this process continues, the zone narrows until it becomes a true front; *i.e.,* frontogenesis has occurred. The horizontal mixing between the air masses prevents the zone from ever becoming less than several miles in width, and it is usually much wider than that. In general, near the surface, cold fronts are more sharply marked, with a narrower zone of transition, than warm fronts.

New fronts form mainly in polar air masses. The process of development occurs between their northern portions, which remain relatively cold and dry, and their southern sections, which have become warmer and moister during their journey southward. Fronts increase in intensity most frequently near the eastern coasts of the continents.

In the northern hemisphere during winter there are five main zones of frontogenesis: (1) near the east coast of North America; (2) near the east coast of Asia; (3) in the North Pacific; (4) to the east of Greenland; and (5) along the Mediterranean. In summer there are three main zones only: (1) across Canada; (2) across northern Europe; and (3) from northeast Russia to Alaska. In the southern hemisphere the main zones lie between latitudes 30° and 50° at all seasons. During both summer and winter there are zones of frontogenesis over the ocean to the west and east of South America and to the east of South Africa; in January (summer) there is a zone to the southeast of Australia and in July (winter) one to the southwest.

As the zone of transition between two air masses broadens and the front between them weakens or dissipates, frontolysis is said to occur. In the absence of frontogenesis, the horizontal mixing between the two masses slowly produces this result. In other cases, the air flow may change and cause a decrease in the sharpness of the contrast of properties between them.

Slope.—It is well known that in a state of equilibrium a lighter liquid rests on top of a heavier one; *e.g.,* oil lies on top of water. Similarly, in the atmosphere warmer and therefore lighter air tends to rest above colder and therefore heavier air. But because of the rotation of the earth, the state of equilibrium is attained not when the frontal surface is horizontal, but when it makes a slight angle with the horizontal. In 1906, Max Margules developed a formula which expresses the slope of a frontal surface in terms of the latitude at which it is found, and the winds and temperatures in the adjacent air masses. Other factors being equal, the slope is less at low latitudes than at high ones. For example, a frontal surface at latitude 60° will have a slope 50% greater than one at latitude 35° if the distribution of temperatures and winds near each frontal surface is the same. The slope of a frontal surface is relatively large when the temperature difference between the two air masses is small, and small when the temperature contrast is large. When the difference in wind components parallel to the frontal surface in the two air masses is large, its slope is greater than when the difference is small. Margules' formula is chiefly valuable in providing general criteria, such as those outlined above.

Arctic and Equatorial Fronts.—The main frontal systems of the earth are the polar fronts of the northern and southern hemispheres; these, although not continuous around the globe, nevertheless extend for thousands of miles. Of secondary importance in temperate latitudes are the arctic and antarctic fronts. These systems occur at high latitudes, and chiefly affect the weather of the polar and subpolar regions; cyclones sometimes form along these fronts.

Near the equator, true fronts are rarely if ever found. The zone along which the trade-wind systems of the northern and southern hemispheres converge, known as the doldrums, has sometimes been called the intertropical or equatorial front. A closer study of this system has revealed, however, that there is little difference in physical properties across it and little undercutting or overrunning by the air masses involved, in contrast with frontal systems of middle and high latitudes. Rather it is a region over which there is a general ascent of air which results from the horizontal convergence of the trade winds. It has therefore been given the more appropriate name of the intertropical convergence zone. Heavy cloud formations, frequently accompanied by showers and thunderstorms, occur in this zone. The width of the zone itself varies widely, being small at times, and at others very large.

The mean position of the intertropical convergence zone changes with the seasons: in August the farthest northward displacement occurs, with the zone at latitude 5° N. over South America and at latitude 25° N. over southern China; its maximum southward displacement occurs in February, when it lies near the equator between South America and western Africa, and at latitude 15° S. over northern Madagascar and over northern Australia. The violent tropical disturbances known as tropical hurricanes or typhoons develop at or near this convergence zone when at these positions of maximum displacement.

See also METEOROLOGY; WEATHER FORECASTING.

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(E. W. HE.)

FRONTENAC ET PALLUAU, LOUIS DE BUADE,

COMTE DE (1622–1698), governor of New France and architect of French expansion in North America, was born at St. Germain, May 22, 1622. His father, Henri de Buade, was colonel of the Régiment de Navarre and a member of Louis XIII's entourage; his mother was Anne Phélypeaux, of the influential Pontchartrain family; Louis XIII was his godfather. He served with the French armies during the Thirty Years' War; at the age of 23 he was colonel of the Régiment de Normandie and in 1646 was appointed a *maréchal de camp* (brigadier general). In 1648 he secretly married Anne de la Grange-Trianon, who, in consequence, was disowned by her wealthy father. They had one child, François Louis (1651–72).

Although Frontenac undoubtedly had great personal charm and much influence at court, he was also extremely egoistic and unscrupulous as well as extravagant; by 1663 his debts amounted to over 350,000 livres. In 1669 he took service as lieutenant general with the Venetian forces defending Crete against the Turks, but he had not been on the island long before he was dismissed from his post for intriguing against his superior officers. Three years later he was appointed governor general of New France. Within a year of his arrival in the colony he had founded a fur-trading post, Ft. Frontenac, on Lake Ontario. Shortly afterward he became associated with the Sieur de La Salle, who, with Frontenac's support, obtained royal consent to continue the explorations of Louis Jolliet down the Mississippi to its mouth. La Salle took advantage of this to found fur-trading posts at the foot of Lake Michigan and on the Illinois river, from which his men, with the connivance of Frontenac, illegally engrossed a large part of the western fur trade. This brought them into conflict with the Montreal fur traders, dividing the colony into two hostile factions. Despite repeated warnings from Louis XIV and J. B. Colbert, the minister of the marine, Frontenac also disputed violently with the intendant, the sovereign council, the clergy and several of the subordinate officials.

While these conflicts were raging within the colony, a much more serious external problem was developing. Until 1675 the Five Nations of the Iroquois confederacy had remained on good terms with the French because they were under attack from the

Andastes and Mohicans; but in that year the Iroquois subdued the other tribes and immediately began to contest the French hold on the western fur trade, their aim being to divert it from Montreal to Albany with themselves acting as middlemen. When they attacked the tribes allied to the French and threatened the French themselves, Frontenac tried to appease them, doing nothing to strengthen the colony's almost nonexistent defenses. This policy merely encouraged the Iroquois to press their attacks with greater vigour, until the French were in danger of being driven out of the west. During these years, too, the Hudson's Bay company established posts in James bay, posing another threat to the Canadian fur trade, one that Frontenac chose to ignore.

In 1682 Louis XIV recalled Frontenac because of his misgovernment. His successor, Le Febvre de la Barre, attempted with little success to subdue the Iroquois and in 1685 was replaced by the marquis de Denonville, who brought the Indians to terms. Then, in May 1689, England declared war on France and Frontenac was given command of an expedition to conquer the province of New York. At the same time he was appointed governor of New France, and Denonville was recalled for service in Europe. Frontenac's expedition was delayed by adverse weather, however, and he did not reach Quebec until Oct. 12. The Iroquois, meanwhile, learning of Anglo-French hostilities before the news reached New France, on Aug. 5 had launched a furious assault on the unsuspecting colony, inflicting great damage and killing or capturing about 100 Canadians. This attack, and the lateness of the season when Frontenac reached the colony, made it impossible to invade New York in force, but in January he sent three war parties to attack the English frontier settlements at Schenectady, Ft. Loyal and Salmon Falls. All three places were destroyed with heavy loss of life for the defenders, and as a result the northern English colonies united for an assault on New France. The attacking forces, led by Sir William Phips, were repulsed at Quebec by the French under Frontenac, who distinguished himself by his prudent tactics. (*See* also CANADA: *History: New France.*)

During the next few years the fighting was confined to sporadic raids on the Canadian settlements by the Iroquois, but this did not prevent a rapid expansion into the west by the Canadian fur traders. Frontenac concerned himself far more with the fur trade than with pressing the war to a successful conclusion. Despite the fact that the policy of Louis XIV was to curb expansion into the interior in order to strengthen the central colony, old fur-trading posts were strengthened and new posts established by Frontenac until French influence extended beyond Lake Superior and the flood of furs coming down to Montreal glutted the market in France. After much urging from his subordinates and the receipt of explicit orders from the minister of the marine, Frontenac finally undertook in 1696 an expedition which destroyed the villages of two of the Iroquois nations. The following year the war between England and France ended, but it was not until 1701 that a peace treaty was ratified with the Iroquois by Frontenac's successor. After a brief illness Frontenac had died at Quebec, Nov. 28, 1698.

Frontenac was one of the more colourful personages in North American history. A skilled courtier, he was adept at glossing over his failures and taking credit for himself that really belonged to his subordinates. It was, however, under his regime that the English and Iroquois attacks on New France were finally repulsed and the French extended their North American empire from Montreal to Lake Winnipeg and from Hudson bay to the Gulf of Mexico.

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FRONTINUS, SEXTUS JULIUS (*c.* A.D. 35–*c.* 103), Roman soldier and writer, was the author of the *De aquis urbis Romae*, a history and description of the water supply of Rome, including the laws relating to its use and maintenance and other matters of importance in the history of architecture. In 70 he was city praetor, and about five years later succeeded Petillius Cerealis as governor of Britain. He subdued the Silures, a tribe in southeast Wales, and held the other tribes in check until he was superseded by Agricola (78). In 97 he was appointed superintendent of the aqueducts (*curator aquarum*) at Rome. His treatise *De re militari* is lost. His *Strategematicon libri iii* is a collection of examples of military stratagems from Greek and Roman history; a fourth book, the plan and style of which is different from the rest (more stress is laid on the moral aspects of war; *e.g.*, discipline), is the work of another writer known as Pseudo-Frontinus. Extracts from a treatise on land surveying ascribed to Frontinus are preserved in C. Lachmann's *Gromatici veteres* (1848).

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FRONTO, MARCUS CORNELIUS (*c.* 100–*c.* 166), prominent Roman orator, rhetorician and grammarian, was born at Cirta in Numidia. He continued his education at Carthage and in Rome, where under Hadrian he rapidly gained considerable fame as an advocate. He was by Antoninus Pius appointed tutor to Marcus Aurelius and Lucius Verus; with the former he remained on terms of affectionate friendship. He became *consul suffectus* in 143.

Fronto's high reputation (posterity ranked him with Cato, Cicero and Quintilian) was chiefly based on his orations, all of which are lost; his grammatical and rhetorical studies won him a number of followers, called the *Frontoniani*. Modern evaluations are based on the information contained in the *Noctes Atticae* of Aulus Gellius, a member of Fronto's circle, and on the collection of letters (principally to Marcus Aurelius and Lucius Verus) and miscellaneous pieces discovered in 1815 in the Ambrosian library at Milan. The letters, though many treat of Fronto's health (which prevented him from assuming the proconsulate of Asia) or negligible topics, throw useful light on the Antonines, and on Fronto's judgments of earlier writers and his precepts about language and style. Fronto shunned the conventionalized modes of Silver Age literature; in order to invigorate the literary idiom he recommended employment of elaborate similes and careful selection of vocabulary, and encouraged literary use of words current in popular speech which are attested in early republican writers (Fronto's concern with vocabulary led to the false ascription to him in later times of the *De differentiis verborum* and the *Exempla elocutionum*). The *elocutio novella* which resulted was often artificial and pedantic. Fronto did not initiate but gave impetus and direction to an already manifested archaizing movement; in so doing he gave an important new vitality to Latin prose writing, although the removal of the restraint of classical models gave subsequent prose writers a licence to further vulgarization.

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FROSINONE, capital town of a province in southern Lazio (Latium) Italy, stands 1,960 ft. above sea level on a hill above the Cosa river, 85 km. (53 mi.) by rail S.E. of Rome. Pop. (1957 est.) of commune 29,943. It is a modern town, the centre of the Ciociaria (noted for peasant costumes), and on the Via Casilina. There are traces of a Roman amphitheatre; the 14th century cathedral, with some Romanesque elements, was rebuilt. The station (4 km.) is on the Rome-Cassino line. It was the ancient Volscian town of Frusino and became a *colonia* of the Roman empire.

FROSINONE PROVINCE has an area of 1,251 sq.mi. and a population (1961) of 443,118. It is rich in cereals, market produce and tobacco and has sheep-rearing estates. There are oil and bitumen deposits, mineral springs (especially Fiuggi), paper mills, hydroelectric stations and food industries. Principal centres are Alatri (Cyclopean walls); Anagni (papal palace 9th century); Cassino (*q.v.*; the monastery of Monte Cassino, rebuilt after World War II); Sora (milling industries); and Arpino (the birthplace of Cicero). (M. T. A. N.)

FROST, JOHN (1784–1877), British Chartist hero and a leader of the Newport rising in 1839, was born at Newport, Monmouthshire, on May 25, 1784. He was brought up by his grandfather and later apprenticed to a Bristol draper, returning to Newport in about 1806 to set up his own shop. He held radical views, but as his business prospered he became a leading citizen. In 1820, however, he was drawn into a bitter dispute with the town clerk, wrote a number of forceful pamphlets, and spent six months in jail for libel. On his release in 1823 he was silent in public but known to be a stalwart opponent of aristocracy and oligarchy. After the passing of the Municipal Corporations act in 1835 Frost became a member of Newport's first elected town council. He was made a magistrate in 1836 and became mayor at the end of the year. He had many local enemies, however, and was not re-elected in 1837. About this time he became a Chartist, and served as a delegate and an occasional chairman of the Chartist convention of 1839 (*see* CHARTISM). He was deprived of his magistracy in March 1839, and on the dissolution of the convention, decided on his casting vote, he returned to Newport. There Chartism was militant and he was drawn into the Chartist march on Newport in Nov. 1839. Frost opposed violence, but it was he who led the Chartist detachment into the town when the armed scuffle took place in which several people were killed. He was captured, tried for high treason and sentenced to death. The sentence was commuted to transportation for life, and Frost was exiled to Van Diemen's Land. He was conditionally pardoned in 1854, visited the United States and returned to England on a free pardon in 1856. He spent the last years of his life near Bristol and died there on July 27, 1877.

See David Williams, *John Frost* (1939). (A. BRI.)

FROST, ROBERT LEE (1874–1963), U.S. poet, might never have become "the poet of New England" had not his father made a dying request to be buried in his native New England. So it happened that Mrs. William Prescott Frost took her son Robert, born in San Francisco, Calif., March 26, 1874, and a younger daughter Jeanie, across the continent from San Francisco to Lawrence, Mass., for the interment of her husband in 1885. No funds were available for the return trip and the widow settled with her children in Salem, N.H., where Mrs. Frost earned a living for several years by teaching school.

Entering Dartmouth college in the fall of 1892, Robert Frost so intensely disliked formal study that he remained there less than one semester. During the next two years, he earned a living in miscellaneous ways while sending poems to uninterested editors. In 1894, to celebrate his first sale of a poem ("My Butterfly"), he privately printed six of his poems in a booklet entitled *Twilight,* an edition limited to two copies, one for his affianced, Elinor White, and one for himself.

After his marriage in 1895, Robert Frost taught for two years at his mother's private school in Lawrence and then spent the next two years as a special student at Harvard. In 1900, for reasons of health, he moved to a small farm in Derry, N.H., and conducted a small poultry business there until 1905. Failing as a farmer, he taught various subjects in the Pinkerton academy at Derry from 1905 to 1911 and then moved to Plymouth, N.H., where he taught psychology for a year in the New Hampshire State Normal school.

Still intent only on achieving success as a poet, he sold his Derry farm and with the proceeds took his family to England, where he devoted his time entirely to writing. During that extremely important three-year stay in England (1912–1915), he published his first two books of poetry: *A Boy's Will* (1913) and *North of Boston* (1914). The cordial praise given those poems by British men of letters won him lasting friendships in England and attracted the surprised attention of critics and editors in his native land. When he returned to the United States in 1915, his first two books had been reissued in New York, and *North of Boston* soon became a best seller.

Although the Frost family bought and settled on a small farm in Franconia, N.H., immediately after the return from England, the poet found himself in unexpected demand for public readings and lectures. Thus began the habit which gradually made his genial personality as well known and loved as his poetry. When he found that not even success as a poet afforded adequate financial returns, he accepted various invitations to teach from colleges and universities—Amherst (1916–20, 1924, 1926–38, 1949–1963), Michigan (1921–23, 1925), Harvard (1939–43) and Dartmouth (1943–49). He was awarded the Pulitzer prize for poetry in 1924, 1931, 1937 and 1943.

He died in Boston, Mass., Jan. 29, 1963.

After his first two works mentioned above, his major works include *Mountain Interval* (1916), *New Hampshire* (1923), *West-Running Brook* (1928), *A Further Range* (1936), *A Witness Tree* (1942), *A Masque of Reason* (1945), *A Masque of Mercy* (1947), *Steeple Bush* (1947) and *Complete Poems* (1949).

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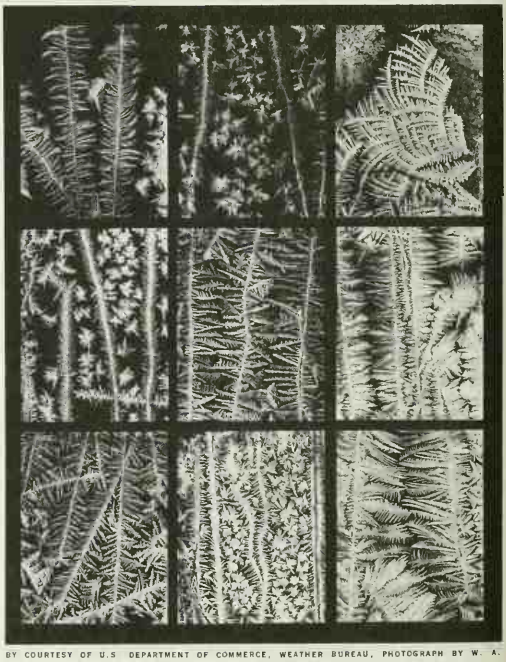
FROST, a term used in two senses: (1) atmospheric water directly crystallized on the ground and on exposed objects; and (2) the occurrence of subfreezing temperatures affecting plants and crops. Frost crystals, often called hoarfrost in the aggregate, form by the passing of the invisible water vapour of the atmosphere into the ice crystal phase without going through the liquid phase. Hoarfrost lightly covers fields and roof tops under conditions that would form dew (*q.v.*) if the temperature were above freezing at the point of formation. Sometimes the freezing temperature will be reached after dew has already formed, producing frozen dew, but this usually cannot be readily distinguished because crystals ordinarily will start forming at about the same time the freezing starts. Pertaining to plant culture, frost refers to the freezing of the aqueous solutions in the plant cells causing these



BY COURTESY OF U.S DEPARTMENT OF COMMERCE, WEATHER BUREAU, PHOTOGRAPH BY W. A. BENTLEY

FROST FORMATIONS ON WINDOWPANES

to burst and destroy the plant. Only plants containing plentiful and dilute solutions in their leaves, fruits, etc., are easily damaged. The occurrence of a killing frost without a hoarfrost deposit is sometimes popularly called a black frost.

In physiography and technology the term frost is applied to a variety of freezing processes. Thus, one speaks of the depth of frost penetration in the soil, meaning depth of frozen ground, frost action in the erosion of rocks, frost heaving of soils, frosting of surfaces by other vapours as well as water, frost damage to structures, newly laid cement, etc.

The most important aspect of frost in relation to plants is its determination of the length of the growing season, which is defined as the period from the last killing frost in spring to the first killing frost in autumn, with reference to the tenderest crop plants. There are regions of the earth where the season reaches critically short proportions for the maturing of most usable crops and others where the season is so long that more than one planting of such crops as corn (maize) and alfalfa can be brought to harvest. In regions where frost is rare or absent, other factors take on more importance.

One of the most critical situations for frost is encountered in the citrus fruit regions. There the few killing frosts likely each winter are combated by heating the groves with crude oil heaters called smudge pots or by mixing the air with huge fans to prevent the cold air from settling down. The smoke from the smudge pots reduces the heat losses of outgoing radiation to some extent but the smoke nuisance in most localities offsets this advantage and local legislation or campaigns are directed toward use of cleaner, more efficient burners.

In citrus growing regions the government meteorological offices developed special frost-warning services with a high degree of usefulness to growers in the United States. In the Pacific coast fruit regions the service was extended to make it possible to prevent frost damage to deciduous fruit crops such as peaches, apricots, almonds, pears and even apples during the period of blossoming both in the United States and in Canada. Protection of orchards was undertaken less extensively in the eastern deciduous fruit regions. Atlantic coast and Wisconsin cranberries are protected from frost at critical times of the growth cycle by flooding the cranberry bogs with water.

The crystalline and other forms of frost deposit are a subject of aesthetic as well as scientific interest. The structures differ in some respects from those of snow (*q.v.*). Granular forms produced by the freezing of droplets of liquid water carried in the air at temperatures below freezing, technically called supercooled droplets, form rime. It is best developed on mountain tops enveloped in supercooled clouds.

Rime is a common form of icing on aircraft. It also occurs in steam fogs around open springs, streams, lakes or ponds in very cold weather and in extreme conditions around chimneys from the water vapour condensed in the flue gases. True crystalline hoarfrost is of two classes, that which assumes columnar forms and that which assumes tabular forms. Generally the crystals of these two classes do not occur together on a single night; rather, one or the other will greatly predominate. Columnar forms usually comprise the majority of hoarfrosts of spring and autumn. The columns are, in their best-preserved state, hexagonal in cross section, hollow and variable in size and slenderness.

Tabular or platelike hoarfrost crystals are most common at low temperatures such as those of midwinter. They resemble snow plates, but since they must grow outward in segments from some supporting object they rarely assume the perfect symmetry of many snow crystals. Over ice-covered ponds and rivers, beautiful clusters or rosettes of fernlike or jewellike frost collect on the surface of the ice. At very low temperatures cubical crystals are sometimes found.

Children and adults alike in cold climates have been fascinated by the beautiful and varied frost forms found on the inner surfaces of windowpanes in buildings. In most cases with heated rooms the vapour condenses as a liquid first, but if the conditions are right, such as in an unheated room, the delicate pure crystalline forms are predominant. These will resemble fairy forests of fir trees, ferns, starry skies and castles or submarine gardens with corals, starfish and plants. Some of the designs, especially those that form along otherwise obscure scratches or strictions in the glass, are repeated from one occasion to the next. Factors affecting the design are the presence of films, dust particles, oily marks and irregularities on the glass. The tiny eddy currents of air over the glass and the nearness of other frost crystals also have an effect.

(H. R. B.)

FROSTBITE is an injury to the skin or underlying tissues or both, resulting from exposure to cold of such severity and duration that actual freezing (ice formation) occurs. Air temperatures must be below 32° F. (0° C.) for frostbite to occur. Unprotected areas of skin exposed to very cold wind can freeze in less than one minute, but usually freezing occurs only after longer exposure. Parts of the body most commonly frozen are toes, fingers, ears and nose. Mild true frostbite produces only swelling and reddening of the skin; severe frostbite may affect deep tissues, including bone, and may culminate in gangrene (*q.v.*) and loss of the frozen part. Reddening or blanching of the skin from mere chilling instead of freezing should not be called frostbite. Cold injuries without actual freezing, such as chilblain, immersion foot and trench foot, are frequently confused with true frostbite; these injuries occur as the result of exposure for many hours in air or water at temperatures above freezing. Experiments conducted during World War II and later showed that frostbite should be treated by very rapid thawing of the still-frozen part in warm water. The frozen part should never be rubbed with snow. *See* also SKIN, DISEASES OF.

(F. A. FN.)

FROSTWEED (*Helianthemum canadense* or *Crocanthemum canadense*), a North American plant of the rockrose family (Cistaceae), which is native to dry rocky places and sandy soils from Maine to Ontario and Wisconsin southward to North Carolina and Missouri.

It is a slender, sparsely branched, slightly woody perennial, with small, narrow, nearly stalkless leaves and showy yellow flowers, $\frac{3}{4}$ in. to $1\frac{3}{4}$ in. across, usually borne singly or rarely two together, the petals soon falling. These are followed later by small short clusters of cleistogamous (self-fertilized in the bud stage, or at least without opening) flowers, without petals, borne in the axils of the leaves. The plant is remarkable in that late in autumn crystals of ice sometimes shoot from the fissured bark at the base of the stem, whence the popular name.

The hoary frostweed (*H. majus* or *C. majus*), a similar species but of more western and southern range, exhibits the same peculiarity.

FROTTOLA, a verse form of the Italian Renaissance reminiscent of the 13th-century *ballata;* also the generic term for a style of secular vocal music fashionable in Italy during the early 16th century. The term *frottola* describes musical settings in a semipopular style of several verse forms—*strambotti, sonetti, ode,* as well as *frottole* proper. The texts, often frivolous or satirical, were set, usually in four parts, in a simple chordal style. The Venetian printer O. de' Petrucci published 11 books of *frottole* (1504–1514) that contain excellent examples of the form by B. Tromboncino and M. Caro. Other Petrucci publications contain arrangements of *frottole* for voice and lute as well as settings for solo lute.

(M. Mw.)

FROUDE, JAMES ANTHONY (1818–1894), English historian and biographer whose 12 volumes on *The History of England From the Fall of Wolsey to the Defeat of the Spanish Armada,* which appeared between 1856 and 1870, fundamentally altered the whole direction of Tudor studies. If he had written nothing else, he would be remembered for this. But in fact he was immensely prolific, ranging from some (second-rate) novels in his youth on through numerous essays on the 16th century and other periods, including a study of the Council of Trent, works on later imperial developments and some notable biographies. He was for most of his life the subject of continuous controversy, both over his facts and his conclusions.

He was born on April 23, 1818, at Dartington rectory, in Devon, the youngest of the eight children of Robert Hurrell Froude, archdeacon of Totnes. His mother and five of her children died

of tuberculosis while he was young and he was, both at home and at Oxford university, which he entered in 1835, dominated by his elder brother Hurrell, famous himself as one of the founders of the Oxford movement. Froude was influenced also by John Henry Newman, the future cardinal, one of his fellow students at Oriel college. But after graduating in 1842 various influences led him to take a more favourable view of Protestantism, and he broke with the movement. In 1842 he was elected a fellow of Exeter college and in 1845 took deacon's orders, but this he regretted; and, with the appearance of *The Nemesis of Faith* in 1849, the third of his novels, which was in effect an attack on the established church, he had to resign his fellowship. He thereafter made his living by his pen (including the editorship of *Fraser's Magazine*, 1860–74) until in 1892 he returned to Oxford as regius professor of modern history. He died on Oct. 20, 1894, at Kingsbridge in Devon. He was twice married, leaving a daughter by his first marriage and a son and daughter by his second.

In assessing Froude's work as a historian, it must at once be acknowledged that the charge of inaccuracy is a valid one. There are numerous instances of his careless handling of his texts, and his facts and quotations must always be used with care. Yet there is no evidence of deliberate distortion. His errors derive partly from the tremendous speed at which he worked. But they resulted also from a more fundamental cause.

For to Froude the 16th century was the crucial period in English history, when the forces of liberty, as expressed by the Reformation, were struggling against the forces of darkness as represented by the Roman Catholic Church. This theme runs through all 12 volumes of his *History* and gives to all his work a vigorous partisan quality. He believed indeed that the Anglo-Catholic revival of the 19th century was merely a later version of the same danger. It was his declared duty to open the eyes of his own generation to the perils which had been faced and overcome by the Tudors.

The other great influence upon his attitude to history was Thomas Carlyle from whom Froude absorbed the doctrines of the role of the hero in history. Henry VIII was Froude's hero; and his portrait of him was wholly at variance with those by Lord Macaulay, M. A. S. Hume and John Lingard. Henry, according to Froude, was the man of courage and energy who guided the nation through its gravest crisis. Elizabeth I, by contrast, was a weak, uncertain ruler who needed Lord Burghley—the hero of the later volumes of his *History*—to save her from the consequences of her own follies; and Mary, queen of Scots, was the treacherous foe of liberty and goodness. The defeat of the Armada, however, completed the work of Henry VIII and made the freedom of England secure.

Long before the last volumes of his *History* appeared, Froude had become the target of the most savage attacks by reviewers, of whom the most vigorous was the historian E. A. Freeman (*q.v.*). Yet this had no effect, either on his methods as a historian, or on his popularity with the reading public. There followed, among other works, *The English in Ireland in the Eighteenth Century* in three volumes (1872–74), *The Life and Letters of Erasmus* in two volumes (1894) and *English Seamen in the Sixteenth Century* (1895). But the great work of the later part of his life was his biography of Carlyle, which appeared in four volumes (1882–84), as well as an edition of his papers (2 vol., 1881). Here too he was severely handled by his enemies, again for his inaccuracy, but also for his frank analysis of Carlyle's defects of character which, Froude claimed, as an honest biographer he must fully examine.

In his work as a whole there are many errors; apart from this, his narratives contain very little on the economic, social and constitutional forces which have moulded society and a disproportionate amount on the achievements of great men. Yet although, for example, he clearly overstated his case for Henry VIII, he did effectively bring out, as was needed at the time, that he was no mere lustful tyrant but a statesman of considerable historical importance. Froude's books remain acute and vivid contributions to English history, while their attractive, lucid style gives them a secure place in English literature, in which field indeed Froude believed history truly belonged.

BIBLIOGRAPHY.—Article by A. F. Pollard in *Dictionary of National Biography*, supplement (1901); H. Paul, *Life of J. A. Froude* (1905); W. H. Dunn, *James Anthony Froude: a Biography 1818–1856* (1961).
(JL. H.)

FROUDE, RICHARD HURRELL (1803–1836), Anglican clergyman and leader of the Oxford movement, was born March 25, 1803, at Dartington, Devon, an elder brother of J. A. Froude. He was educated at Eton and Oriel college, Oxford where the high church principles of his home were deepened and illuminated by John Keble. Elected fellow of Oriel in 1826, he joined J. H. Newman as tutor in 1827. He was ordained in 1829. His importance thenceforth lay in two associated fields. First, he became a forceful opponent of the several forces (principally Erastianism and liberalism) that seemed to him to threaten the church's independence and divine authority; through the pungency and entertaining extravagance of his conversation, and then in a series of articles in the *British Magazine* (1832–34), more than anyone else in that early stage of the high church revival he taught respect for the medieval church, suspicion of the Protestant reformers and caution regarding the alliance of church and state. Second, he became intimate with Newman, assisted his conversion to high church views and by bringing him into close touch with Keble formed the team that began the *Tracts for the Times* and thus started the Oxford movement in 1833. Froude's health declined rapidly after 1831 and he spent much time abroad. His influence did not end with his death in Dartington on Feb. 28, 1836. The publication of his *Remains* (1838–39), full of anguished introspection and self-mortification, first made the Oxford movement widely suspect in Protestant circles. (G. F. A. B.)

FROUDE, WILLIAM (1810–1879), English engineer and naval architect, who founded the modern science by which the forces on a ship are predicted from experiments with geometrically similar models, was born at Dartington, Devon, on Nov. 28, 1810. He was educated at Westminster school and Oriel college, Oxford. He worked as a railway engineer until 1846, after which he began the pioneer work on ship hydrodynamics for which he is famous. In 1868 he served on a committee appointed by the British association to study naval design. The other committee members were agreed that tests with models could not be relied upon for predicting the performance of ships, but Froude advocated a more thorough investigation of the laws governing the extrapolation from model to full scale. He was invited to explain his proposals to the admiralty, and this led, in 1870, to a grant for the construction of a ship model testing tank. This, the forerunner of the model tanks which are now to be found in all maritime countries, was built at Froude's home near Torquay. Here he found that the chief components of resistance to motion were skin friction and wave formation, and showed how the total resistance of a ship could be extrapolated from the results of model experiments.

His methods in all probability inspired pioneers in aerodynamics to adopt model testing and thus contributed to the rapid development of aircraft design. In 1870 he was elected a fellow of the Royal society, whose royal medal he received in 1876. He died on May 4, 1879, while on a visit to South Africa. His many published papers were reprinted in one volume by the Institution of Naval Architects in 1955. (S. J. P.)

FROZEN FOODS: *see* FOOD PRESERVATION; FOOD PRESERVATION (IN THE HOME).

FRUCTOSE: *see* CARBOHYDRATES: *Occurrence.*

FRUGONI, CARLO INNOCENZO (1692–1768), the most prolific of the Italian Arcadian poets (*see* ITALIAN LITERATURE). Born at Genoa, Nov. 21, 1692, he took monastic vows at the age of 17. In 1716 he formed an Arcadian society and was later recommended by Cornelio Cardinal Bentivoglio as poet laureate to Antonio Farnese, duke of Parma. He dedicated sonnets to the duchess of Parma, Philip V of Spain and, in 1734, a pindaric ode to the French ambassador. Having obtained remission of his monastic vows, he lived in Venice in great poverty, but after the peace of Aix-la-Chapelle was appointed poet of the court theatre in Parma. He died at Parma, Dec. 20, 1768.

Frugoni wrote over 1,000 sonnets and 250 lyrical odes besides a large number of poems in free verse. His work was admired less

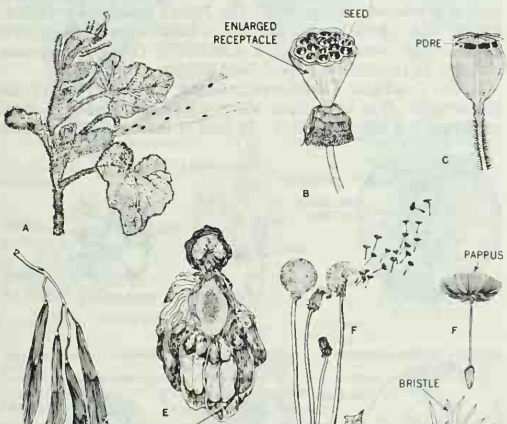
for its originality than for its facility and elegance. He was also known for his translations from the French and for his librettos for two operas by Tommaso Traetta, adapted from the librettos of Rameau's *Hippolyte et Aricie* and *Castor et Pollux*.

Frugoni's works were published in 10 vol. (1779) and 15 vol. (1779–80). *See* also C. Calcaterra, *Storia della poesia frugoniana* (1920); A. Equini, *C. I. Frugoni alle corti dei Farnesi e dei Borboni di Parma* (1919–20).

FRUIT, in its strict botanical sense, is the fleshy or dry ripened ovary of a plant, enclosing the seed or seeds: thus, apricots, bananas and grapes; bean pods, corn grains, tomatoes and cucumbers; and (in their shells) acorns, almonds and pecans are all technically fruits. Popularly, however, the term is restricted to the ripened ovaries that are sweet and either succulent or pulpy and are usually eaten as an appetizer or a dessert: of the above listed items only apricots, bananas and grapes qualify. Unless otherwise indicated, the botanical definition is to be understood wherever the term fruit occurs in this article.

Botanically, the fruit is developed from the ovary of the flower as a result of the fertilization of the contained ovule or ovules (which will then become seeds). In a somewhat broader sense the fruit of angiosperms consists of the mature ovary and any closely associated parts (*e.g.*, in the apple, mulberry and pineapple). Fertilization induces various changes: the anthers and stigma wither, the petals drop off and the sepals may be shed or undergo modifications; the ovary enlarges and the ovules develop into seeds, each containing an embryo plant. Normally no fruit is produced unless fertilization is effected; but in certain plants, mostly cultivated varieties, this is not the case (*e.g.*, the seedless orange and grapes, the banana and the cucumber).

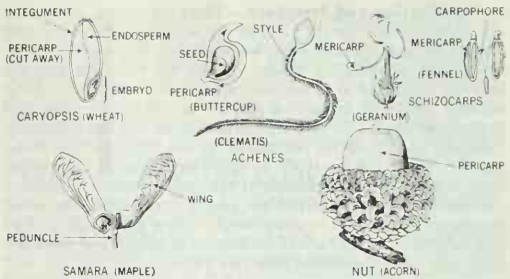
The production of fruit without fertilization is known as parthenocarpy, and as early as 1902 attempts were made to develop such fruits artificially by treating the pistil with pollen extracts and with various chemicals. Since 1934 considerable progress has been made in this work, and successful results have been obtained with the tomato, petunia, pepper, gladiolus, holly and salpiglossis. Among the compounds that gave promise in inducing parthenocarpy experimentally are naphthaleneacetic acid, indoleacetic acid, indolebutyric acid and B-naphthoxyacetic acid. The Navel orange and the Marsh grapefruit set most of their fruit parthenocarpically without treatment.



(A, B, C, D, F) FROM W. N. BROWN, "THE PLANT KINGDOM" (GINN AND COMPANY, 1935); (E) ADAPTED FROM LYMAN BENSON, "PLANT CLASSIFICATION" (D. C. HEATH & COMPANY, 1957); (G) FROM W. W. ROBBINS, A. S. CRAFTS AND R. N. RAYNOR, "WEED CONTROL" (1952); USED BY PERMISSION OF MCGRAW-HILL BOOK CO.

FIG. 1.—ADAPTATIONS OF FRUITS FOR DISPERSAL OF SEEDS

(A) Violent dehiscence in squirting cucumber. (B) Adaptation for dispersal by water in sacred lotus. Adaptations for dispersal by wind in (C) poppy; (D) ash; (E) Monterey pine (the dissected cone shows the two-winged seeds on each ovuliferous scale); and (F) dandelion, with close-up of a single mature fruit. (G) Adaptation for dispersal by fastening to a suitable moving agent in sandbur



(TOP LEFT) ADAPTED FROM LYMAN BENSON, "PLANT CLASSIFICATION" (D. C. HEATH & COMPANY, 1957); (TOP CENTRE LEFT) FROM N. J. FULLER AND O. TIPPO, "COLLEGE BOTANY" (1957), USED BY PERMISSION OF HOLT, RINEHART AND WINSTON, INC.; (TOP CENTRE RIGHT) FROM W. W. ROBBINS, A. S. CRAFTS & R. N. RAYNOR, "WEED CONTROL" (1952); USED BY PERMISSION OF MCGRAW-HILL BOOK CO.; (TOP RIGHT) FROM G. H. M. LAWRENCE, "TAXONOMY OF VASCULAR PLANTS" (THE MACMILLAN COMPANY, 1959)

FIG. 2.—INDEHISCENT DRY FRUITS

Functions of Fruit.—The fruit protects the developing seeds and may aid in their distribution when mature. This latter function is very important, and numerous devices secure a wide and effective dispersal (fig. 1). These may be classified according to the agents employed as animate and inanimate. To the second group belong those methods by which the plant itself propels the seed forcibly from the fruit. Some plants employ a combination of the two. Thus in the gorse (*Ulex*) the seeds are shot out by the splitting and curling of the pod in which they are contained, and they must then be buried by insects (chiefly ants) in order to germinate. Violent dehiscence occurs in many plants. In the squirting cucumber (*Ecballium*) the walls of the pericarp exert pressure on the pulpy contents in which the seeds are placed. In the balsam (*Impatiens*) also the seeds are actively expelled. Other inanimate agents are water and wind. Fruits or seeds are sometimes sufficiently buoyant to float for a long time in water. Thus the coconut may be carried hundreds of miles in the sea; the fruits and seeds of West Indian plants are sometimes thrown up by the Gulf stream on the coasts of Europe and will often germinate; in the water lily, lotus and many other aquatic plants, the fruits and seeds float for a time before sinking to the bottom. In many cases the wind plays a part in distribution. In the poppy and many Caryophyllaceae a capsule opening by pores is borne on a long stalk that sways in the wind, thus scattering the seeds. In the pine, maple, ash and many others, there is a winglike process of the fruit; in numerous Compositae the fruit is crowned by a plumose pappus (*e.g.*, dandelion, thistle); in the clematis the style becomes feathery; and in the willow and poplar the fruit bear tufts of silky hairs. The fruit of the bladder senna (*Colutea*) is easily rolled by the wind, whereas in the rose of Jericho (*Anastatica hierochuntica*), the whole plant dries up after developing its fruits and forms a mass, easily rolled over the dry ground by the wind. A notable example of dissemination of seed by the whole plant is afforded by the tumbleweeds (*see* TUMBLEWEED).

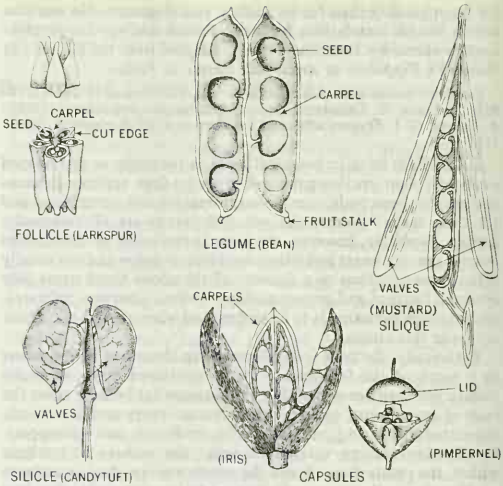
Birds and mammals are also utilized as dispersal agents by plants. The mistletoe produces sticky-covered seeds that adhere to the bill of the bird that eats the berries; these may be wiped off on the bark of trees, thus transporting the embryo to a new host. In other cases the fruit develops bristles or hooks that become entangled in the fur or feathers. Such are the fruits of cleavers (*Galium aparine*), *Ranunculus arvensis*, sandbur (*Cenchrus*) etc. In some cases the inner portion of the fruit, the endocarp, forms a hard covering surrounding the seed, whereas the remainder of the pericarp is succulent and often brightly coloured. Thus the seed, ingested with the attractive fruit, can pass through the alimentary tract of an animal without injury; *e.g.*, plum, cherry. The true fruit may be provided with stiff hairs, which cling to the beak of the bird that eats the fleshy receptacle; *e.g.*, rose.

Classification and Structure.—There are several systems of classifying fruits. On the basis of the texture of the ovary wall (pericarp), and accessory parts when present, they may be classified as dry, dry-fleshy or fleshy. In the dry types the pericarp becomes desiccated as it matures, whereas in the fleshy forms it becomes wholly or in part succulent. In the intermediate dry-fleshy types, part of the pericarp becomes desiccated and frequently hardened, while the other portions of the ovary wall become fleshy and succulent. The dry types are called indehiscent if they do not open at maturity, and dehiscent if the pericarp opens to liberate the mature seeds. The former are usually single-seeded, the latter commonly contain two to many seeds. These types may be further subdivided on the basis of the number of carpels and accessory structures that comprise the fruit (*see* Table).

Classification of Fruits

Major Types	Structure			
	One carpel	Two or more carpels	Two or more carpels plus stem axis or floral tube	Carpels plus stem axis or floral tube and accessory parts
Dry Indehiscent	Caryopsis (grain) corn, wheat, grasses Achene buttercup, anemone Legume peanut	Silique radish Samara (key-fruit) ash, elm, maple Nut acorn, hazelnut, chestnut	Achene aster, sunflower, dandelion Schizocarp carrot, fennel	
Dry Dehiscent	Follicle milkweed, columbine, marsh marigold Legume pea, bean	Capsule onion, lily, poppy Silique rock cress, cabbage Silicle shepherd's-purse, pepper-grass	Capsule iris	
Dry-Fleshy	Drupe plum, peach, almond, cherry	Drupe coconut	Pome apple, pear, quince, hawthorn Aggregate raspberry, strawberry	Multiple (pseudocarp) fig, mulberry
Fleshy	Berry May apple	Berry tomato, grape Hesperidium orange, lime	Inferior berry blueberry Pepo squash, cucumber, pumpkin, watermelon	Multiple pineapple

Dry Fruits.—The principal indehiscent dry fruits (fig. 2) are the caryopsis or grain, the achene, the schizocarp and the nut. The caryopsis contains a single seed and develops from one or more carpels. In its development the seed coverings (integuments) become so closely appressed to the pericarp that the two structures cannot be separated readily in the mature fruit. The fruits of cereal crops and other members of the Gramineae belong in this group. In the achene the pericarp is closely applied to the seed but can be separated from it. This type of fruit may develop from a single carpel, as in the Ranunculaceae, or from two carpels, as in the Compositae, in which the receptacle is also a part of the fruit. Achenes are borne singly in the dock and aggregated in the buttercup, or on a fleshy receptacle, as in the strawberry (see *Dry-Fleshy Fruits*, below). In *Clematis* the style, and in many Compositae the specialized calyx, remain adherent to the fruit. The limb of the floral tube is frequently plumose and is then termed the pappus. The schizocarp consists of two or more carpels, each of which forms an indehiscent achenelike fruit known as a mericarp and contains a single seed. Examples of this are found in wild geraniums, in which the mericarps separate from below upward, and in the Umbelliferae (carrot, dill, fennel), in which the ripe mericarps are usually suspended from a unique structure called the carpophore. Mericarps or achenes in which the pericarp is extended to form a winged appendage, as in the ash and maple, are called samaras or key fruits. A true (botanically speaking) nut has a hardened pericarp often surrounded at its base by bracts formed from the involucre as in the acorn. Other examples are the hazelnut and chestnut.



(TOP LEFT, TOP RIGHT) FROM J. G. JONES, "FLORAL MECHANISM" (BLACKIE & SONS, LTD.); (TOP CENTRE) FROM H. J. FULLER & O. TIPPO, "COLLEGE BOTANY" (1957), USED BY PERMISSION OF HOLT, RINEHART AND WINSTON, INC.; (BOTTOM LEFT) FROM W. H. BROWN, "THE PLANT KINGDOM" (GINN AND COMPANY, 1935); (BOTTOM CENTRE, BOTTOM RIGHT) ADAPTED FROM LYMAN BENSON, "PLANT CLASSIFICATION" (D. C. HEATH & COMPANY, 1957)

FIG. 3.—DEHISCENT DRY FRUIT

The principal dehiscent dry fruits (fig. 3) are the follicle, the legume or pod, the capsule, the silique and the silicle. In the follicle, there is a single line of dehiscence (separation), which usually occurs along a suture on the adaxial surface (facing the axis). The fruit is formed from a single carpel, but usually several fruits are clustered; *e.g.*, columbine and larkspur. A legume or pod differs in dehiscing along both sutures. This is characteristic of leguminous plants, such as the pea and green bean; however, a few legumes are indehiscent as in the peanut (*Arachis*), where the fruit is developed underground. The French honeysuckle (*Hedysarum*) and others have a pod that separates transversely into single-seeded mericarps; such a structure is called a lomentum and may be regarded as a specialized indehiscent legume.

In the Cruciferae (wallflower, mustard, shepherd's-purse) the characteristic fruit is a silique, which is long and narrow; if short and broad it is termed a silicle. In both of these types the carpels

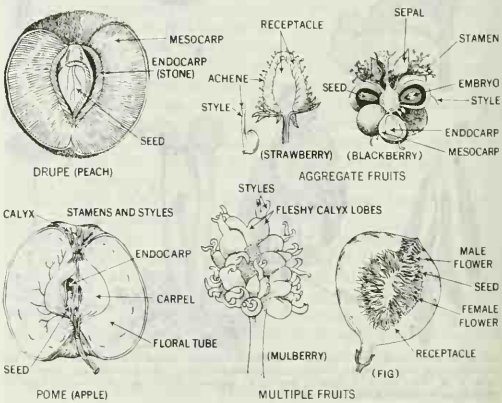


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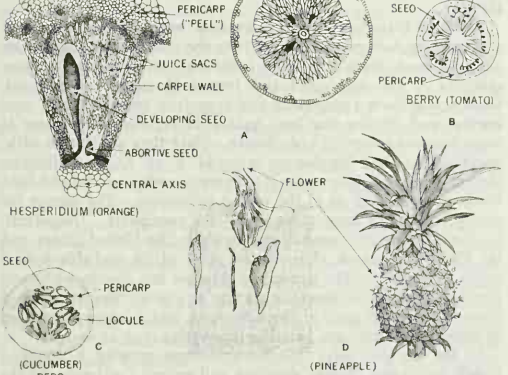
FIG. 4.—DRY-FLESHY FRUITS

dehisce by two valves from below upward; the valves separate from the placentas and leave them united by a false septum. In a few cases (radish) the fruit is indehiscent. The capsule is formed from two or more carpels and may include a portion of the axis as in *Iris*. The dehiscence of the capsule may occur by means of longitudinal splitting as in the *Iris*, by means of pores as in the poppy (fig. 1C) and *Campanula*, or by means of a lid as in the pimpernel (fig. 3).

Dry-Fleshy Fruits.—The dry-fleshy fruits include the drupe, aggregate, pome and some of the multiple forms (fig. 4). To this group belong many edible fruits. In the drupe, as shown by the cherry, peach, plum, etc., the endocarp is usually hard and the mesocarp pulpy and succulent, though in the almond it is tough and in the coconut fibrous. In the aggregate fruit, such as the raspberry and strawberry, several small drupes or achenes, respectively, develop on the receptacle, which in the case of the latter is fleshy and edible. In the pome the fleshy outer portion consists of the undiverged floral parts, which are more or less attached to the carpels. Examples of this type are the apple, pear and quince. The multiple fruit or pseudocarp differs from the aggregate fruit in that it results from the conjoint development of several flowers, whereas the latter is the product of several pistils of a single flower. Thus in the mulberry the fruit is formed by the coalescence of a spike of flowers. Each flower produces a fruit that is nutlike and surrounded by fleshy floral parts. In the fig the whole inflorescence is within a hollow receptacle, which may contain both staminate and carpellate flowers, each of the latter forming a true fruit.

Fleshy Fruits.—The principal fleshy types are the berry, hesperidium (specialized berry), and the pepo (inferior berry) (fig. 5). The berry has a fleshy pericarp at maturity. It develops from an hypogynous flower (ovary atop the receptacle), which often has two or more carpels, as in the tomato; but it may be produced



(A) FROM BARTHOLOMEW AND REEO IN H. J. WEBBER AND L. D. BATCHELOR, "THE CITRUS INDUSTRY," VOL. I, UNIVERSITY OF CALIFORNIA PRESS, 1943; (B) FROM H. J. FULLER AND O. TIPPO, "COLLEGE BOTANY" (1957) BY PERMISSION OF HOLT, RINEHART AND WINSTON, INC.; (C, D) FROM W. H. BROWN, "THE PLANT KINGDOM," 1935, GINN AND COMPANY

FIG. 5.—FLESHY FRUITS

(A) one carpel of orange (cross section at right); (B, C) cross sections of tomato and cucumber; (D) close-up of single flower and flesh of pineapple

from a single carpel, as in the May apple, *Podophyllum*. The hesperidium is a specialized berry in which the dorsal walls of the carpels form a thick rind and from the inner surface of which fleshy succulent hairs arise and more or less fill the carpellary cavities (locules). The citrus fruits—orange, lemon, lime, etc.,—belong in this group. The pepo develops from an epigynous flower (ovary embedded in the receptacle) and is similar in structure to the pome except that the outer portions frequently become very hard as in some squashes and pumpkins. The edible part consists of the carpels and a portion of the enveloping fleshy tissue, which some interpret as receptacle and others as calyx-tube (unseparated bases of the calyx members, the coralla members and the stamens). The pineapple is a fleshy type of multiple fruit in which the entire inflorescence is involved; the individual pome-like fruits are borne in the axils of more or less fleshy bracts, and the axis of the inflorescence is also somewhat fleshy.

See ANGIOSPERMS; FLOWER; HORTICULTURE; SEED; and references under "Fruit" in the Index volume. (H. E. HD.; X.)

FRUIT COOKING AND PRESERVATION: *see* CANNING, COMMERCIAL; FOOD PREPARATION; FOOD PRESERVATION; FOOD PRESERVATION (IN THE HOME).

FRUIT FARMING. The subject of fruit farming deals with the intensive culture of perennial plants whose fruits have economic significance. It is a part of the subject of horticulture (*q.v.*), which also encompasses vegetable growing and the production of ornamentals and flowers. This article places further arbitrary limitations—it takes in neither perennial nut crops nor a number of very important perennial fruit crops including the coconut and oil palms, vanilla, coffee, cacao and the tung tree (whose problems were once considered beyond the pale of horticulture) which are dealt with in separate articles, as NUT; OIL PALM; etc., and in the articles on OIL PLANTS and TROPICAL AGRICULTURE. *See* also separate articles on the various fruits discussed in this article, as BANANA; PINEAPPLE, etc.

The first section of this article deals with fruit farming from the standpoint of economics and geography, and the second section with basic problems and practices of fruit farming.

ECONOMICS AND GEOGRAPHY

Information on the world production of some of the most important fruit crops is given in the accompanying table. The data are very incomplete because they can only be concerned with commercial movement. Many fruits are used locally in large quantity without going beyond the village markets; mango and banana are examples of such fruits and both are of crucial importance in the diets of very large populations in the regions of production. It seems reasonably certain, however, that the five most important fruits are grape, orange, banana, apple and mango. In second rank of importance are olive, pear, peach and plum; and these are followed by date, fig, pineapple, apricot, avocado, strawberry, the brambles and bush fruits and many others of lesser significance.

The table illustrates the general increase in world fruit production that has taken place in the middle of the 20th century and shows the dramatic rise in importance of commercial fruitgrowing in the tropics and subtropics, due largely to increases in output of bananas and citrus fruits. Improvements in technology and consolidation of the industries in the most favoured climates have been responsible for a steady increase in yield per unit of land during this period, so that the total acreage devoted to fruit crops has not risen in proportion to the rise in production.

The geography and main products of the more important of these varied enterprises are briefly discussed below.

FRUITGROWING ENTERPRISES OF THE TROPICS

Although the principal perennial fruit plants of these warm regions differ in many ways, most of them are evergreen and are seriously injured or killed by temperatures below freezing.

Banana.—The banana, which originated in southeastern Asia, is now cultivated throughout the torrid tropics. The ease with which this giant herb may be propagated from pieces of rhizome (rootstock) has made it possible for vast acreages of a few seedless varieties to be planted in widely separate regions. Important among these varieties are Gros Michel, Cavendish and Mysore. Although the fruit is very perishable, its ability to develop good eating quality after having been harvested green has permitted the growth of intricately co-ordinated plantation, shipping and marketing agencies that bring bananas to the temperate zone cities of the western world throughout the year. Perhaps three-quarters of the bananas for these distant markets originate in Central America, northern South America and the islands of the Caribbean. Dried banana "figs" and other palatable products are made, but most of

World Commercial Production of 15 Major Fruits

Climatic zones of production and fruits grown	Average annual production (000 metric tons)		Ratio × 100 1959/previous
	Previous*	1959	
Tropical:			
Banana	11,700	15,100	129
Pineapple	1,340	2,010	150
Subtropical:			
Date	1,150	1,420	123
Citrus			
Grapefruit	1,700	1,800	106
Lemon and lime	1,600	2,200	138
Orange and mandarin	12,000	16,700	139
Total citrus	15,300	20,700	—
Warm temperate:			
Apricot	670	990	148
Fig (fresh basis)	1,370	1,360	99
Grape	34,400	44,900	131
Olive	5,150	6,280	122
Peach	2,400	3,790	158
Plum and prune	2,940	3,310	113
Cool temperate:			
Apple (excl. cider)	9,600	15,900	166
Cherry (sweet and sour)	1,180	1,360	115
Pear (excl. perry)	3,320	3,870	117

*Five-year average 1948–53.
Source: Food and Agriculture Organization of the United Nations, *Yearbook of Food and Agricultural Statistics: Production* (1960)

the fruit is sold for consumption unprocessed.

Pineapple.—The pineapple is indigenous to the warm regions of northern South America and has been distributed around the world in the humid tropics during relatively recent times. A small semiherbaceous perennial with the drought-resistant leaves of an epiphyte, or air plant, it can be cultivated successfully in somewhat drier and cooler tropical areas than the banana. Easy vegetative propagation from slips or suckers has permitted heavy concentration on a few seedless varieties, the most important of which are Smooth Cayenne, Red Spanish and Queen. At present about half the world's commercial production originates in the Hawaiian Islands and a third in the Caribbean islands, Central America and northern South America. Although shipments of the fresh fruits, harvested a little green, are considerable, the canned fruit is the most important commercial product for distant markets, accounting for practically all of the Hawaiian output.

Mango.—The mango tree probably originated in southern India and has been under cultivation in the tropical areas there, in Malaya and in Africa for many centuries. In India alone, there were about 2,200,000 ac. occupied by mango trees in the second half of the 20th century. During the past two centuries the mango has been introduced to the Philippines and to the American and Australian tropics; in the 20th century a small industry was begun in the United States in southern Florida. This large evergreen tree is most apt to be productive in tropical regions with a considerable dry season which coincides with the annual period of bloom. Many varieties have been selected and propagated by graftage, among the most important of which are Mulgoba, Saigon, Carabao, Haden and Julie. In spite of its great importance as a food and dessert in the regions where it is grown there are no reliable statistics on world production. The extreme perishability of the fresh fruit and special problems with harvesting and storage curtailed its exploitation as a crop for shipment to distant markets. In the second half of the 20th century no appreciable volume of the fruit was processed commercially as a canned or frozen product, although considerable quantities were used for preserves and chutney.

Avocado.—The avocado tree is native to the cool tropical regions of Central America, and was under primitive culture at the time of the Spanish conquests, both on the isthmus and on some of the Caribbean islands. During the 20th century intensive selection of superior varieties formed the basis for small commercial industries producing 40,000 to 50,000 tons annually in the United States, in southern California and Florida. These selections are now distributed widely throughout the tropics and may result in further exploitation of this nutritious salad fruit. Narrow limitations in climatic adaptability and inherent problems of harvesting and postharvest care may continue to limit the avocado's commercial outlets to the luxury bracket, insofar as distant markets are concerned. Among the most important varieties in the second half of the 20th century were Fuerte, Zutano, Lula and Booth 8.

Fruitgrowing Enterprises of the Subtropics

Perennial fruit species successful in subtropical regions are able to develop some resistance to injury from freezing temperatures during the winter months, and are benefited in one way or another by the slight seasonal periodicity of the climate. Like species of the tropics they are usually evergreen.

Date.—The majestic date palm is native to the oases in the desert region of the Persian gulf and for thousands of years the fruit has been an essential part of the diet of indigenous populations living in suitable climates of the eastern Mediterranean basin and north Africa. Although the palm has been distributed widely in modern times, nine-tenths of the commercial production emanates from the areas of ancient culture. This may result largely from three circumstances: (1) a desert climate with no rainfall during most of the period of fruit development is essential for a marketable product, yet there must be ample soil moisture during this same period; (2) the product is stable and there is a sufficient output in the indigenous region to satisfy most of the world demand at moderate prices; (3) propagation of the superior varieties must be by offshoots from relatively young palms, and the supply is so limited as to make establishment of new date gardens in distant countries very slow and expensive. In spite of these facts a small industry based on old-world varieties, of which Deglet Noor is the most commonly planted, was established in the Coachella valley desert region of California during the 20th century.

Date varieties selected over the past centuries may be divided into three classes according to their physical properties and their sugar content. Dry dates, sometimes called "bread" dates, which are firm and relatively low in sugars are important locally in the old-world desert regions for daily nourishment; the variety Thoory is an example. Semidry varieties soften at maturity, but being firm enough to pack and ship well are the most important commercially; Deglet Noor, Dayri and Zahidi are examples of this type. Soft dates, used mainly as confection, are most difficult to handle; examples of this kind are Barhee, Khadrawy and Hayany.

Citrus.—Introduced to the western world by traders from southeastern Asia over the period from the 12th to the 18th century A.D., the most important citrus fruits are now produced in large quantity in the subtropics and tropics throughout the world. Orange, mandarin (tangerine) and grapefruit trees are most productive and develop the best quality in regions where there is some seasonal periodicity of climate. Since they are able to withstand exposure to a few degrees below 32° F. (0° C.) in midwinter, they may be intensively cultivated in regions where occasional light frosts occur as well as in the milder subtropics. The orange industry is of great importance on all the continents. Grapefruit, on the other hand, is mainly significant in the United States and the Caribbean region, close to the point of its probable hybrid origin in Jamaica. The lemon and lime are less able to withstand freezing temperatures than the orange; as a result they are planted in more protected parts of the subtropics, and a larger proportion of lemons and limes are found in the tropics than of oranges.

In the United States, commercial citrus growing is confined largely to central Florida, southern and central California, southern Texas and Arizona. In Florida, which produces 60% of the nation's oranges, the four principal varieties are Parson Brown, Hamlin, Pineapple and Valencia; the first two are sent to the early fresh-fruit market whereas perhaps half of the Pineapple and Valencia crops are sold for fresh fruit and the rest are processed for frozen concentrate. California is responsible for most of the rest of the orange crop, with the two varieties Washington Navel and Valencia accounting for practically all the acreage. Most of these oranges are sold as fresh fruit. Grapefruit production comes from four states: Florida, Texas, California and Arizona. The main varieties are Marsh Seedless, Foster, Ruby and Duncan. About half the crop is marketed fresh and the rest is either processed for canned sections or for juice. Practically all the mandarins are produced in Florida and are of one variety, the Dancy tangerine. The small lime industry of the United States is located in southern Florida, and has depended on two relatively large-

fruited varieties, Tahiti and Barss; the "Key" lime, grown extensively on the Florida Keys, has gradually disappeared as a dominant factor. Lemons are produced almost exclusively in the more protected citrus areas of southern California. The main varieties are Lisbon, Eureka and Villafranca. Most of the fruit is sold fresh but an increasing proportion of it has been processed for frozen concentrate or canned juice.

Fruitgrowing Enterprises of the Warm Temperate Zone

Most of the perennial fruit species adapted to the warm temperate zone are deciduous, passing the winter leafless, although a few, of which the olive is one, are evergreen. Practically all of these species are capable of developing resistance to temperatures below 20° F. (about −7° C.) during winter dormancy. Most of them cannot be grown commercially in the subtropics or tropics because exposure to a considerable period of chilling temperatures below 45° F. (about 7° C.) is required for normal growth and flowering. On the other hand, this chilling requirement is relatively short, winter hardiness is not great and a long, warm growing season may be necessary for satisfactory productivity and fruit quality; hence, they are not well adapted to cooler regions.

Grape.—The old-world grapevine (*Vitis vinifera*) is by far the most important perennial fruit plant. It has been cultivated for thousands of years in the Mediterranean basin and southwestern Europe. In the last half of the 19th century the grape phylloxera, a plant louse carried on stock from the U.S. to France, ravaged the vineyards of central Europe until resistant rootstocks were obtained from the U.S. (*see* Grape). Although more than two-thirds of the world's grapes still come from those areas, there is now important production on all continents in the milder parts of their temperate zones, whether north or south latitude. In the United States practically all the vinifera grapes are produced in the great central valley of California, with small acreages in the southern part of the state and in Arizona.

The fruit from this species may be consumed fresh, dried for raisins or used for wines and alcoholic distillates. By far the largest part of the European and Mediterranean production goes to the wine press and only a small proportion is eaten fresh or as raisins. The California vinifera industry, on the other hand, dries more than half its production, ships 10% to 15% as table and canning stock and uses the remaining third for fermented products. The important varieties differ in their versatility for these uses. Sultanina (Thompson Seedless) and Muscat of Alexandria are grown in quantity for all three purposes; the Flame Tokay and several others are used both for fresh fruit and for specialty wines. On the other hand, Zante currant is grown only for its raisins, and a number of varieties including Zinfandel, Carignane and Alicante Bouche are produced exclusively for fermentation.

Several species native to North America contribute to two other grape-growing enterprises of the United States. The larger of these accounts for about 10% of the total U.S. production and is based on hybrids between *V. vinifera* and native species. Most important varieties of this labruscana group are Concord, Delaware and Catawba. They are hardier than vinifera varieties and less subject to humid climate diseases; hence the industry is centred in New York and Michigan. The principal product is unfermented Concord grape juice, with some outlet for wines. In addition, in the Gulf states the native species *V. rotundifolia* is the basis for minor production of grapes, mainly for muscadine wine. (*See* also Wine.)

Olive.—The olive tree was under cultivation in the warm temperature parts of the eastern Mediterranean basin 3,000 years ago and its spread into north Africa and southern Europe was undoubtedly completed during the Arab invasions if not before. Introductions to the new world were made by Spanish colonists and have resulted in small industries in South America and California, but the world's supply of this important fruit and its oil depends almost entirely on the countries bordering the Mediterranean. Although evergreen and able to grow normally under subtropical conditions, the tree does not flower unless exposed to temperatures below 45° F. (about 7° C.) for a considerable period of time. The tree is tolerant to winter temperatures as low as 15° F. (about −9° C.), but the fruit is injured at temperatures slightly below freezing. This resistance to cold, coupled with endurance of hot summer weather and rather severe moisture deficiency, has caused the olive to be planted in many situations not suitable for other fruit crops.

The principal outlets for the fruit are as olive oil (*q.v.*), pickled in brine or canned ripe. Most of the European production is used for olive oil, although in Spain, particularly, there is substantial production of pickled olives. Because of high labour costs, olive oil is mostly considered a by-product market of the small United States industry and the major concentration is on production for ripe canned or for pickled olives. Examples of important olive varieties are: Manzanillo, Barouni and Mission. Only varieties high in oil are useful for extraction, and the others are processed as fruit.

Fig.—Like the olive and grape, the fig tree was under cultivation in the warm temperate climate of the Mediterranean basin long before the time of Christ. Some of the varieties of that region have probably been carried down to modern times by vegetative propagation for over a thousand years. Practically all of the commercial production, mostly Brown Turkey, still comes from the area of ancient culture with the United States contributing about 7% of the total and small additional production from Australia. Italy, Spain, Turkey, Greece and Algeria are the leading producing countries.

The tree is able to withstand cold temperature to 15° F. (about −9° C.) but has a relatively short chilling requirement; in fact some varieties grow and fruit satisfactorily in the tropics. Where the crop is sun-dried after harvest and because the maturing fruit is subject to infection from fungus and bacterial diseases, the most favourable climate is semiarid with available irrigation water and no rain during the period of fruit maturation and drying. Some varieties are grown under humid conditions, however, for local sale or to be used in canning. Thus, in the United States the main production area is the irrigated central valley of California with rainfall ranging from 10 in. to 20 in. annually, and a long hot growing season. The most important varieties of that region are Calimyrna (Lob Injir), Adriatic, Mission and Kadota (Dottato). The first two of these varieties constitute three-quarters of the production and practically all are dried. Mission may be dried or marketed fresh and Kadota is canned in light sirup. In the Gulf states—Louisiana, for instance—the varieties Brunswick and Celeste are dominant. In that humid climate most of the limited production is marketed fresh and a small proportion is canned.

Apricot, Peach, Plum and Prune.—These three kinds of fruit grow on small deciduous trees of the genus *Prunus* whose climatic requirements are satisfied in the warm temperate zone and whose culture extends to the milder parts of the cool temperate zone. All of them are cultivated widely in the climatic regions of the world to which they are adapted.

The apricot is somewhat more restricted climatically than the other two partly because it has a shorter chilling requirement and therefore blooms earlier, and partly because its great susceptibility to a fungus disease (brown rot) makes culture difficult in regions where rainfall is high during the growing season. In the United States and Canada most of the apricots are found in semiarid districts of the coastal and interior valleys from California to British Columbia. Local climatic conditions determine whether the main outlets are for fresh fruit, drying or canning; these outlets in turn may determine the varieties and cultural practices. Thus in limited areas of California where an early harvest season gives the industry opportunity to exploit a premium market for fresh fruit, the main variety has been Royal (similar to Blenheim). In the semiarid hot California regions that have midseason harvest the drying outlet predominates and the Tilton variety has been most important. In the cooler, more northern sections where canning and late market are the dominant outlets, Moorpark and Large Early Montgamet are important.

Although peach varieties adapted to climates ranging from the subtropics to the milder parts of the cool temperate zone are available, the most important peach regions of the world have long hot growing seasons and mild winters lasting at least three months

during which freezing temperatures occur frequently. In the United States these conditions occur in the semiarid central valley of California and along the coastal plain and the lower piedmont region of the east, from northern Georgia to Maryland; California, Georgia and South Carolina produce more than half the nation's peaches. As with apricots there are three outlets for this fruit and varieties differ in accordance with them. Clingstone varieties, of which Phillips, Paloro and Halford are examples, are used exclusively for the large canning industry of California. Although drying is also a by-product or distress outlet for other varieties in California, Muir and Lovell are especially desirable because of their relatively high dry matter content. The fresh-fruit market is served by a long list of delicious freestone varieties including Elberta, Halehaven and Golden Jubilee.

The world's plum and prune industries are based mainly on two species of different origin and adaptation. The Japanese plum, *Prunus salicina*, is a small, vegetative tree with approximately the same climatic requirements as the apricot. It is most successful in semiarid irrigated warm-temperate climates. Because the fruit is very high in moisture and soft, it is not useful for canning. Difficulties of handling and storage limit the opportunities for large-scale exploitation in fresh-fruit markets. The principal European species, *Prunus domestica*, is responsible for most of the commercial plum and prune production of the world. The climatic adaptability of the tree straddles the warm and cool temperate zones, and it is tolerant both to semiarid and humid climates. The most important varieties produce fruit that may be harvested in a firm condition and that has storage and shelf life of a month or more. Some varieties are very high in total solids and may be dried for prunes.

In the United States practically all the Japanese plums are grown in the irrigated valleys of California. Examples of important varieties are Beauty, Santa Rosa and Duarte. European plums are an important crop in Oregon, Idaho and Washington, as well as California. California produces all of the dried prunes of the United States; the variety French Prune accounts for most of them. Italian Prune is the main plum variety in the northwestern states for use in canning and fresh-fruit markets. Other varieties including President and California Blue are also shipped for fresh fruit.

In the south of England, several varieties of the Green Gage group are prized for their dessert qualities and such varieties as Czar, Giant Prune and Victoria are used for culinary and dessert purposes.

Fruitgrowing Enterprises of the Cool Temperate Zone

The perennial fruit species best adapted to this zone are deciduous and have relatively long chilling requirements, are able to withstand subzero (F.) temperatures when dormant and can produce fruit of satisfactory quality in a growing season of six months or less.

Apple.—The apple tree is grown commercially in cool temperate climates throughout the world. Over the centuries of culture thousands of varieties have been named and the selections that are now cultivated in different countries represent the tastes of their citizens and conform to the climatic and commercial requirements of each area. In the United States, about one-quarter of the total production originates in the irrigated semiarid valleys of Washington. There the varieties Red Delicious and Winesap are most important. Two eastern regions are responsible for another quarter of the crop. They are: (1) the slopes of the Shenandoah-Cumberland valleys from Virginia to Maryland where Stayman Winesap and Red Delicious dominate; and (2) the New York and New England areas where McIntosh and Rhode Island Greening are most important. Perhaps one-quarter of the United States production is canned or frozen and the rest moves in fresh-fruit markets.

In the United Kingdom most of the apples are grown in the south of England; in Kent, Sussex and Essex, the varieties Cox's Orange, Allington Pippin and Bramley Seedling are very important. Most of these apples go to the fresh-fruit market for dessert or culinary uses. In addition there is a thriving cider apple industry which uses large quantities of varieties suitable for production of a sparkling fermented cider.

Pear.—The European pear tree, *Pyrus communis*, is most successful in the milder apple regions and in regions climatically adapted to prune culture. It is extremely susceptible to bacterial fire blight and this limits opportunity for culture of the best varieties in humid climates where the causal organism is established—as, for instance, in eastern North America. There is significant commercial production on all the continents, with Europe and North America most important. More than 90% of the pears grown in the United States are found in the irrigated regions of California, Oregon and Washington and one-half the total are produced in California. Bartlett (Williams Bon Chrétien) is the dominant variety with significant production of Beurre Bosc and d'Anjou. Because the Japanese sand pear, *P. serotina*, has marked resistance to fire blight, it has been hybridized with the European pear and several varieties, among them Kieffer, have been found to have increased resistance and to be acceptable for processing in these humid regions. About one-half the Bartlett crop of California is canned commercially, the rest and other varieties are sent to fresh-fruit markets.

In the United Kingdom pears are grown in the same areas in the south of England as apples and plums. The varieties Conference, Williams Bon Chrétien and Doyenné du Comice are important. On the continent, there is large production of a number of varieties of local origin for fresh-fruit consumption. A special group of varieties contributes the fruit for a fermented cider called perry.

Cherry.—The sweet and sour cherry also are found in the milder apple regions throughout the world. Because sweet cherry fruits are subject to cracking damage if exposed to rain at the end of the maturation period, orchards of that species are more limited to semiarid climates than are sour cherry orchards. In the United States sweet cherry production is about 45% that of sour cherry. About 85% of the sweet cherries are grown under irrigation in California, Washington, Oregon and Idaho, whereas more than 90% of the sour cherry production originates in New York, Michigan and Wisconsin. The principal sweet cherry varieties are Bing, Lambert, Windsor and Napoleon (Royal Ann); all but the last, which is used mostly for canning and artificial maraschino cherries, are sold chiefly in the fresh-fruit markets. Montmorency is the basis of the sour cherry industry; frozen and hot-pack preservation for pie stock stabilizes the greatest part of this crop for year-round marketing.

Cherry culture in England is concentrated mostly in Kent where the summer rainfall atmospheric conditions are reasonably favourable; there are venerable sweet cherry orchards whose trees date back more than 100 years in that locality. Practically all of the fruit is consumed fresh. The most important varieties include Early Rivers, Napoleon and Noir de Guben.

Strawberry.—The cultivated strawberry, probably the most cosmopolitan of all perennial fruit plants, is cultivated from the cool tropics to the arctic zone. Its great climatic range results partly from the fact that it is evergreen but at the same time so small that it can be protected from the coldest winter temperatures, and partly from the fact that different varieties exhibit special adaptabilities to the various environmental conditions in this broad area. No summary of the production over the world is available.

While it is impossible to assert that one climate or another is the best for strawberries the fact that annual yields of more than ten tons per acre are obtained from plantings of the variety Lassen in the Watsonville area of California suggests that this may be the ideal climate for the species. On the other hand, strawberry growing is a sound commercial business in the cooler parts of the United States and in the United Kingdom. It is also a good business on the continent as far north as Denmark, Sweden and Norway. In the United States there are two principal outlets: as fresh fruit and for frozen pack. The perishability of the fresh fruit and the excellence of the frozen pack caused the latter to increase in importance greatly as this industry perfected its procedures. In addition appreciable quantities of strawberries are preserved as jams and some are canned. The following varieties, grouped by

harvest seasons, are very important: winter and early spring, Missionary and Klonmore; mid-spring, Blakemore and Temple and (from California) Lassen and Shasta; late spring, Catskill and Sparkle. In the United Kingdom, Royal Sovereign and the Cambridge varieties such as no. 5 are important varieties.

Raspberry and Blackberry.—Raspberries and blackberries are produced by a number of deciduous species of the genus *Rubus* called biennial because the canes fruit in their second growing season, and then die. These canes may require support by trellis or stake or they may be erect. The different species vary in climatic requirements but the most important belong in temperate regions that do not have either extremely hot summers or extremely cold winters. For this reason they do very well in the south of England and on the western slope of the Coast range in Oregon and Washington in the United States and in British Columbia. Some species are also cultivated in Europe as far north as Denmark, Sweden and in other similar climates. Red raspberry varieties of importance in the United Kingdom are Lloyd George, Norfolk Giant, Malling Promise and Malling Enterprise. In the United States, Cuthbert, Washington and Newburgh are excellent varieties. The black and purple raspberry are less common, and their culture is mostly confined to eastern United States. All these fruits are marketed fresh locally and are processed frozen or in preserves. Several trailing and semitrailing blackberry species are important in Europe and hybrids among them or with raspberry have contributed large fruited, juicy berries very satisfactory in preserves and canned. Among the most exploited of these are the Himalaya berry, the Oregon evergreen blackberry, boysenberry and youngberry.

Currant and Gooseberry.—Currants and gooseberries are hardy deciduous bushes well adapted for fruitgrowing in the cool temperate zone. Their culture is particularly important in Great Britain, but there are small industries in most countries with suitable climates. These fruits are used primarily in preserves, but gooseberry also is an important culinary fruit in Britain and on the continent, and black currant juice has special dietary uses. Among the important varieties are: red currant, Wilder, Red Lake; black currant, Mendip Gross, Seabrook's Black, Baldwin; gooseberry, Poorman, Careless, Lancashire Lad.

Blueberry.—Several species of blueberry indigenous to North America are harvested in the wild and a rapidly expanding intensive industry developed during the 20th century, based on varieties of a hybrid of the two hardiest of them, *Vaccinium corymbosum* and *V. pennsylvanicum*. Although these bushes have rather special soil requirements, productive plantings have been established in New Jersey, North Carolina, Michigan and western Washington. Examples of important varieties are Concord, Jersey, Stanley and Dixi.

Cranberry.—The cranberry is the smallest intensively cultivated perennial fruit plant, and one species, *Vaccinium macrocarpon*, is the basis of a unique fruitgrowing enterprise of North America. Culture is confined to drained bogs whose substratum is acid in reaction; the most productive of these bogs may be flooded at will in order to give control over temperature and certain pests. Commercial acreages are found in Massachusetts, New Jersey, Wisconsin and western Washington. Among the important varieties are Early Black and Howes.

BASIC PROBLEMS AND PRACTICES OF FRUIT FARMING

Although fruitgrowing enterprises cover great ranges of climates and plant materials their technologies are bound together by problems and practices that have much in common. The most significant of these are discussed below.

The Variety, Its Propagation and Improvement

The first step in establishing a fruitgrowing industry is the selection of individual plants having high productivity and with fruit of superior acceptability in the market place. Such an individual is a horticultural variety. If it is multiplied vegetatively from rooted cuttings, from root pieces that throw shoots or by graftage, the entire group of resulting plants is a single clone, each plant identical with the others. All perennial fruit crops considered in this article are clonally propagated; *i.e.*, their varieties are multiplied vegetatively by one means or another.

Many important varieties of fruit plants were selected generations ago, and some are hundreds of years old. The Sultanina (Thompson Seedless) grape, the Lob Injir (Calimyrna) fig and the Gros Michel banana are examples of fruit varieties of obscure origin, planted by the millions since selection, with each subsequent specimen actually a vegetative continuation of the selected individual growing on an independent root system. But regardless of the age of a fruitgrowing industry or the perfection of some of the selected varieties continuing search for new varieties is essential because there is always room for improvement in climatic adaptability, in insect and disease resistances and in the solution of special horticultural or marketing problems.

Not only is varietal selection and improvement a continuing need, but so also is the maintenance of existing varieties. Although vegetative mutation of a variety is exceptional, the opportunities for accidental multiplication of degenerate mutants increase in proportion to the number of specimens of the variety. As a result, care is taken to propagate a clone only from superior individuals and in the case of citrus where mutation is unusually common, further precautions are necessary. There are, of course, occasional mutations that improve a variety and these may be selected and propagated.

The most effective technique of vegetative propagation varies with the kind of fruit plant. Date, banana and pineapple are multiplied by use of offshoots or suckers. Grape, fig, olive, currant and blueberry are usually propagated from cuttings. Strawberry and black raspberry reproduce vegetatively by special organs—the former are stolons, the latter tip layers. Many kinds of fruit tree must be grafted or budded on specially grown rootstocks because the species to be multiplied self-root with difficulty; apple, pear, peach, mango and citrus are examples of this group. (*See* also Arboriculture; Plant Propagation.)

With most fruit species a period of one to two years intervenes between the time that a cutting is rooted and the plant is ready for setting in the field, or between graftage or budding and field planting. During this interval the plants are held in a nursery where they can be given intensive culture in rows. Strawberry, raspberry, pineapple and banana planting materials do not require the intervention of a period in the nursery before field planting, however.

The grower's problem in choosing varieties of the fruits he intends to produce has two aspects: (1) to recognize the relative adaptabilities of available varieties to the climatic and soil conditions of his farm; and (2) to select from those best adapted to his conditions a group that satisfy both his management needs and the market demands. For instance, an apple producer in northeastern United States may depend on four varieties: Milton, McIntosh Red, Red Delicious and Rome Beauty. The main harvest seasons for these succeed each other at about two-week intervals, and this helps him to extend the period of harvest. The first two cross-pollinate satisfactorily, and so do the last two. The first of these varieties is usually marketed without storage, and the cold-storage seasons of the others are of increasing length; this helps him to extend the marketing period.

The Site

The site of a fruitgrowing enterprise is as significant in determining its success as the varieties grown on it. In fact, variety and site together set the ceiling of productivity and profit that may be attained under the best management. In most developed fruit regions microclimatic conditions (climatic conditions as influenced by slight differences in soil, soil covering and elevation) and soil conditions are the two components of a site that determine its desirability for a fruitgrowing enterprise. Sometimes, particularly with very perishable fruits, transportation problems must also be considered.

Local conditions of a site exposing it to unusual frost hazard are as detrimental to citrus in Florida as they are to peach trees in New Zealand and apple trees in the south of England. In regions and sites where temperatures during the season of concern may

drop no more than a few degrees below freezing, artificial frost protection is sometimes used (*see* FROST).

For highest productivity most fruit trees need to be able to root extensively to a depth of four feet or more. Heavy subsoil or other conditions causing imperfect internal drainage may result in shallow, weak root systems that are unable to exploit the soil efficiently for water and nutrients. In semiarid and arid regions it is not uncommon for accumulation of saline salts in a subsurface layer to limit rooting of fruit trees as well as to cause leaf scorching and abnormal defoliation symptoms. Tiling and surface ditching help to decrease the accumulation of water in poorly drained subsoils, and are beneficial in dealing with wet spots in otherwise satisfactory sites. Special control of irrigation procedures and periodic leaching may alleviate the worst salt effects in saline soils. Choice of tolerant species, varieties and rootstocks may make exploitation of imperfectly drained or mildly saline sites economical, but it is rare that the performance of the plants is up to that on sites free from these inherent difficulties.

Once a site is selected it is prepared by clearing and cultivation of the surface and installation of such permanent drainage, irrigation and road systems as may be required. In rolling or sloping terrain where contour planting is needed to control erosion and conserve moisture, the locations of the plant or row positions are determined by the contour intervals established. In old lands, where there are residual nematode or other pest populations that make fumigation desirable, this must also be done before the new plants are set. In very infertile sites or where the physical condition of the surface soil is poor, it is sometimes useful to apply fertilizer and lime and to grow a succession of leguminous cover crops for a year or more before planting.

Planting and Spacing Systems

Growth, flowering habits and light requirements on the one hand, and management problems on the other, determine the most satisfactory planting plan for a fruitgrowing enterprise.

Such crops as strawberry and pineapple having compact plants close to the ground are usually managed in beds containing several rows or in less formal matted rows. In an acre of strawberries, 200,000 or more plants may occupy the matted rows. A pineapple plantation with two-row beds, having plants a foot apart in rows two feet apart contains 15,000 to 18,000 plants per acre. Intense competition within such dense populations for light, water and nutrients causes the production of the individual plant and the size of the average fruit to be less than they would be if more space were provided; but the total yield per unit of land is usually greater than it would be with lower plant numbers. There may also be indirect benefits from these high populations; for instance, the problem of hand weeding or hoeing may be substantially decreased by the shading effects of the fruit plants.

The spacing of grapevines along a trellis row, and of trees in an orchard, involves the same group of problems. Maximum vineyard production frequently results with vine distances of 8 to 9 ft. (600 per acre). Peach trees set 20 ft. apart (100 per acre) and apple trees 40 ft. apart (27 per acre) are apt to attain maximum acre yields at full maturity.

With those species and varieties that require cross-pollination by the agency of insects, the planting plan must take their special pollination needs into account. This is a problem with apple, pear, plum and sweet cherry orchards. At least two varieties that cross-pollinate successfully must be planted in association with each other.

Training and Pruning

Pruning, the removal of parts of a plant in order to influence growth and fruitfulness of the rest, is an essential fruitgrowing practice. In the first few years after fruit trees or vines are planted, primary attention is given to form, because that may influence the strength and longevity of the mature plant as well as the efficiency of other practices; this kind of pruning is called training. Subsequently, as the plant approaches maximum fruitfulness and fills its allotted space, maintenance pruning for various purposes becomes increasingly important.

The grape responds favourably to heavy pruning by one of two groups of training systems: those that involve cutting the growth of the previous season (canes) to short spurs and those that permit the canes to remain relatively long. Whether a spur system or a long cane system is to be followed depends on the flowering habit of the particular variety (*see* GRAPE). Relatively small trees that respond favourably to severe annual pruning, such as the peach, apricot and Kadota fig, are usually trained to systems creating an open-centred tree with a scaffold of four or five main branches that originate on a short trunk constituting the head of the tree. These main branches are in turn branched a number of times so that they permit fruiting. Annual renewal pruning can be reasonably efficient under these circumstances. Larger trees which do not respond favourably to heavy annual pruning may often be best trained to systems which encourage the original main leader branch to grow erect to a height of eight to ten feet, with four or five main branches at intervals on its sides forming the scaffold which carries fruiting wood up and out; this is called a modified leader system.

The principal reasons for maintenance pruning are: (1) to permit efficient spraying and harvesting operations; (2) to maintain satisfactory light exposure for most of the leaves; (3) to create a satisfactory balance between flowering and leaf surface. Maintenance pruning to regulate crop size is largely confined to species whose fruitfulness is directly related to vegetative vigour. The grape is this kind of a plant, and pruning of it is primarily to regulate crop size; peach and apricot are also pruned heavily in order to reduce the number of fruits. *See* also ARBORICULTURE: *Pruning.*

Soil Management, Irrigation and Fertilization

Two soil management practices, clean cultivation and permanent sod culture, illustrate contrasting purposes and effects. In clean cultivation, the surface soil is stirred periodically throughout the year in order to prevent establishment and growth of vegetation that competes with the fruit crop for nutrients, water and light. The stirring increases the decomposition rate of soil organic matter and thereby releases nitrogen and other nutrients for the use of the fruit crop. It may also provide transient improvement in water penetration. On the other hand, laying bare the soil surface exposes it to erosion; destruction of organic matter results in lowered fertility and degeneration of structure. Sod culture minimizes the destructive processes and may permit modest increase in fertility, but the sod itself competes with fruit plants for water and nutrients and may compete for light. As a result, permanent sod culture is practical only with tree crops that are normally rather low in vegetation—apple, sweet cherry and mango, for instance; and competition from established sod is detrimental with extremely vegetative fruit plants like grape, peach and raspberry.

Because each of these soil management systems has advantages and disadvantages, three modifying or complementary practices are used under many circumstances: cover cropping, mulching and chemical control of vegetation. Cultivation combined with winter cover cropping is used widely in grape, peach, cherry, bush fruit and citrus plantings, as well as with other species. Mulching is the addition of undecomposed plant materials such as straw, hay or processors' refuse to the soil in the fruit planting. In orchards mulching materials are most often applied under the branches of trees maintained in permanent sod. Chemical control of vegetation has come into increasing use as a supplement to or substitute for cultivation.

In semiarid and arid regions irrigation is necessary. Probably the maximum demand occurs in date gardens, because they expose a very large leaf surface the year around, under conditions of very high evaporation and practically no rainfall. Irrigation in humid climates is generally limited to shallow-rooted fruit crops such as strawberry and blueberry. There are a few exceptions, however, and the banana appears to be one. Large acreages of this species are irrigated on coastal lowlands of the torrid tropics where annual rainfall exceeds 60 in. Various procedures for irrigation are used in fruit plantings; of these furrow, basin or sprinkler systems are most common. (*See* IRRIGATION.)

Needs of perennial fruit plants for fertilizers depend partly on

the natural fertility of the soil supporting them and partly on their special requirements. Of the essential elements, supplemental nitrogen is almost always needed and potassium supplements may be commonly needed. Although phosphorus responses of strawberry, grape and a few fruit tree species have been reported occasionally, phosphorus deficiency is rather rare, and it is evident that perennial fruit plants are more efficient in absorption of this element than are many other plants. Calcium deficiency has seldom been reported, even in very acid soils, but limestone and hydrated lime are sometimes desirable because of indirect benefits. Lack of magnesium, on the other hand, has been noted by workers studying a wide range of fruit species. Of the trace elements, zinc, iron and boron are most apt to be lacking. Iron deficiency is difficult to control in orchards in soils of high pH, or acidity. Three other trace element nutrients, manganese, copper and molybdenum, are sometimes deficient in fruit plantings. *See* also FERTILIZERS AND MANURES.

POLLINATION

The stimulus of pollination and seed formation are needed for normal development of most of the fruits. (Banana, pineapple and some citrus and fig varieties are exceptions.) Transfer of pollen from anthers to stigmas is accomplished in nature either by movement in air or by agency of insects. With the possible exception of olive and grape and some varieties of citrus and fig, the perennial fruit plants considered here are benefited either by insect pollination or by artificial or hand-pollination. *See* POLLINATION and articles on individual species, as APPLE; FIG; etc.

THINNING

Removal of flowers of young fruits (thinning) is done for two purposes: (1) to permit the remaining fruits to grow more rapidly and (2) to prevent the development of so large a crop that the plant is unable to flower in subsequent years.

Thinning may be done by hand or chemically. With date, the pistillate flower cluster is reduced in size at the time of hand-pollination. In the case of certain table grape varieties, some clusters may be removed shortly after they appear, and in addition parts of clusters may be cut off. Young peach fruits may be thinned by striking the branches with a padded pole. Hand thinning of young apple and peach fruits once was also a common practice, but because of the expense and difficulty there has been increasing use of chemical sprays as a substitute. Two kinds of treatment may be used: (1) mildly caustic sprays applied during bloom and (2) sprays of growth-regulating substances applied shortly after bloom. These two kinds of treatment have been used with varying success but they have been successful enough to permit chemical thinning to find a place as one of the supplementary fruit growing practices. *See* SPRAYS AND DUSTS IN AGRICULTURE.

PEST CONTROL

In many fruit enterprises, pest control is the most expensive and time-consuming occupation of the grower, and where the concentration of fruit farms in an area warrants it, individual efforts are complemented by legislative measures including quarantine regulations and by technical and advisory services from public agencies. Sometimes the most economic control procedures are biological in nature. Selection of varieties that are immune, resistant to attack or tolerant to specific pests is a biological control procedure widely used. Parasites or other enemies of pests also have been used to control those pests. Chemical control procedures, however, are relied on most heavily. For discussion of these measures of pest control *see* ENTOMOLOGY: *Principles of Insect Control;* FUMIGATION; PLANT QUARANTINE; SPRAYING AND DUSTING MACHINERY; SPRAYS AND DUSTS IN AGRICULTURE.

HARVESTING AND POSTHARVEST PRACTICES

The different fruits vary greatly in the way they ripen both as to the specific changes that take place during maturation and the rates at which they occur. Each kind of fruit has a characteristic pattern of cumulative increase in volume, and by the time physiological maturity has been reached the rate of growth is relatively slow. As this time is approached the colour changes to that of the mature fruit, and the ultimate chemical composition is approached. There is a tendency for the fruit of many species, including apple, pear, orange, lemon and grapefruit, to drop from the tree during the last part of the maturation period. Preharvest drop of these fruits is delayed by application of dilute sprays of growth regulating substances like naphthalene acetic acid. These same sprays increase the rate of ripening somewhat.

Most kinds of fruit are harvested as close to the time that they are eating ripe as possible so that they will attain the best quality when they do ripen. But a few, of which banana and pear are outstanding, may be harvested very immature and still ripen satisfactorily. Orange, grapefruit and some varieties of avocado may be held on the tree for several months after they attain good quality; this property is helpful in permitting convenient storage over a long marketing period.

The actual harvesting for these fruits involves hand-picking, except for prunes to be dried and olives for processing ripe. Thus mechanization can only be used to improve the efficiency of the handling operation after the fruit is off the plant. With soft or easily bruised kinds, rather little can be done to speed the handling procedures. With citrus, however, bulk handling has helped to reduce handling costs appreciably; large open containers on trailers are used for collecting fruit from pickers, and mechanized lifting equipment empties them into trucks which in turn are emptied by gravity.

The maximum life of the fresh fruit after harvest varies greatly depending on the kind and on the storage conditions. Strawberries last for no more than two weeks in the best storage environment whereas apples or lemons can be held for more than six months. Cold temperature storage is the most common means of prolonging the life of fruit. Most temperate zone fruits can be held safely at 32° to 35° F. (0° to 1.67° C.), but many subtropical and tropical fruits, including the lemon, avocado, banana and mango, show chilling injury after prolonged exposure to temperatures below 40° to 45° F. (about 4° to 7° C.). Storage life is extended on several fruits, including apple, pear and banana, by holding them in sealed refrigerated rooms in which internal atmospheres are modified to contain less oxygen and somewhat more carbon dioxide than normal air. For some apple varieties storage in an atmosphere containing 2% oxygen and 5% carbon dioxide by volume increases the life several months. Another important way of extending the storage life of some fruits is the removal of ethylene and other volatiles from the atmosphere.

Drying is a standard means of stabilizing dates, figs, raisin grapes, prunes and apricots; canning is of paramount importance to the pineapple, peach and pear industries; and freezing is a means of stabilizing some of the most perishable fruits including strawberry, raspberry and blueberry. *See* CROP DRYING AND PROCESSING; COCOA; COFFEE; VANILLA; and articles on other individual plants.

See also references under "Fruit Farming" in the Index volume.

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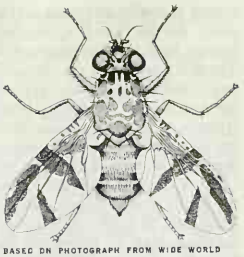
See also *Horticultural Abstracts* (quarterly) for world coverage of technical articles on temperate and tropical fruit crops; *Journal of Horticultural Science* (annual); *Proceedings of the American Society for Horticultural Science* (annual). In the United States, the Department of Agriculture and State Agricultural Experiment Stations publish bulletins on the culture of fruits, on insect and disease problems and on economic and marketing problems. Similar information is published by the British Ministry of Agriculture for fruit crops important in Great Britain.

Current production statistics are summarized annually under "Fruit" in *Britannica Book of the Year.* (D. BN.)

FRUIT FLY, the common name properly applied to species of the dipterous family Trypetidae, but also given (often as "small fruit fly") to species of the family Drosophilidae, which are better termed vinegar, or pomace, flies (*see* below). The Trypetidae (also termed Tephritidae or Trupaneidae), small to medium in size, ordinarily have the wings banded or spotted with brown, often in an ornate pattern. Many of the species are of considerable economic



BASED ON PHOTOGRAPH FROM WIDE WORLD

MEDITERRANEAN FRUIT FLY (CERATITIS CAPITATA)

importance, their larvae attacking various cultivated fruits. The Mediterranean fruit fly (*Ceratitis capitata*), for example, lays its eggs in citrus and other fruits, the larvae tunneling into the flesh of the fruit, making it unfit for human consumption. In 1929 this fly was discovered in a wide area of Florida; it was thought to have been eradicated by 1930, but reappeared in 1956. The apple maggot, the larva of *Rhagoletis pomonella*, burrows in apples, causing the fruit to become spongy and discoloured. This species and the closely related cherry fruit fly (*R. cingulata*) cause extensive losses in the northeastern United States.

Other widespread pests include: the Mexican fruit fly (*Anastrepha ludens*), which attacks citrus crops; the Oriental fruit fly (*Dacus dorsalis*), which infests many kinds of subtropical fruits; and the olive fruit fly (*Dacus oleae*), which destroys olives in the Mediterranean region. Control methods vary with the species and include spraying of fruits with residual insecticides during the egg-laying season, destruction of infested fruit and control by parasites. (*See* also ENTOMOLOGY: *Applied Entomology: Principles of Insect Control.*) Some trypetid flies, such as the European celery fly, are leaf miners; others burrow in plant stems. A species of *Eurosta* causes a common stem gall of goldenrod.

Drosophilidae are attracted to ripe or rotting fruit and other decomposing plant matter, where they feed on yeasts developing thereon; they are extensively used in heredity studies (*see* DROSOPHILA).

See FLY; *see* also references under "Fruit Fly" in the Index volume. (G. W. Bs.)

FRUIT SUGAR: *see* CARBOHYDRATES: *Monosaccharides:* D-*Fructose.*

FRUMENTIUS, SAINT (4th century A.D.), founder and first bishop of the Ethiopian Church, was a native of Tyre. He and his brother Aedesius were captured as young boys by the Ethiopians in the Red sea and sent to the king in Aksum. Later, after acting as tutor to the king's son, Frumentius went to Alexandria to ask for a bishop for the Christian community in Ethiopia, and was himself consecrated forthwith by Athanasius to that office. The contemporary historian Rufinus relates the story of Frumentius which he claims to have heard from Aedesius himself, and in 356 the emperor Constantius referred in a letter to the consecration. In the Ethiopian Church, where his feast day is on July 20, Frumentius is known as Abba Salama, in reference to the fact that he preached the peace of Christ. His feast day is Oct. 27 in the west and Nov. 30 in the east.

FRUNDSBERG, GEORG VON (1473–1528), German soldier, a capable and chivalrous fighter and a devoted servant of the Habsburgs, was born at Mindelheim on Sept. 24, 1473. He fought for the German king Maximilian I against the Swiss in 1499, and in the same year was among the imperial troops sent to assist Ludovico Sforza, duke of Milan, against the French. Still serving Maximilian, he took part in 1504 in the war over the succession to the duchy of Bavaria-Landshut, and afterward fought in the Netherlands. Frundsberg assisted Maximilian in organizing the *Landsknechte,* and at the head of bands of these formidable mercenaries he was of great service to the empire and the Habsburgs. In 1509, 1513 and 1514 he gained fresh laurels against the Venetians and the French. When the struggle between France and the empire was renewed he took part in the invasion of Picardy (1521). Proceeding to Italy, he brought the greater part of Lombardy under the influence of Charles V through his victory at Bicocca in April 1522. He was partly responsible for the great victory over the French at Pavia in Feb. 1525. Returning to Germany, he helped to suppress the peasants' revolt, using on this occasion diplomacy as well as force. He died at Mindelheim on Aug. 20, 1528.

See F. W. Barthold, *Georg von Frundsberg* (1833); A. M. Miller, *Herr Jörg von Frundsberg* (1928).

FRUNZE, MIKHAIL VASILIEVICH (1885–1925), Soviet army officer and military theorist, regarded as one of the fathers of the Red army, was born on Feb. 2, 1885, in Pishpek (renamed Frunze) in Kirgizia, the son of a medical orderly. His revolutionary activity began in 1904 while he was a student at the St. Petersburg Polytechnical institute, and he adhered to the Bolsheviks from the start. He took part in the Moscow rising in 1905 and, after frequent arrests for revolutionary activity, escaped in 1915 to conduct agitation in the Russian army, first on the western front and, after the March Revolution, in Belorussia. He became one of the outstanding commanders of the civil war, commanding in turn the eastern front, against Adm. A. V. Kolchak, in 1919 and the southern front, which routed Gen. P. N. Wrangel, in 1920. He became deputy people's commissar for war in March 1924 and replaced L. D. Trotski as people's commissar for war in Jan. 1925. He died on Oct. 31, 1925, following an operation.

Frunze was one of a group that opposed Trotski's views during the civil war and in consequence won the support of Stalin, who ensured his advance after 1921. He was the author of the "unitary military doctrine," according to which the army should be trained throughout in a spirit of offensive action, united by its ideology and by its determination to carry out the task with which the proletariat would be faced—the promotion of world revolution. This could not, in his view, be achieved so long as the army was commanded by officers of the old imperial army whom Trotski, for practical necessity, had put in command of the new Red army after 1918. Frunze's writings on military doctrine are still quoted with approval. (L. B. Sc.)

FRUNZE (formerly PISHPEK) the capital town of the Kirgiz Soviet Socialist Republic of the U.S.S.R., lies in the Chu valley 125 mi. W.S.W. of Alma-Ata at an altitude of 2,600 ft. Pop. (1959) 223,831. Frunze was formerly also the name of an *oblast* abolished by a decree of Jan. 1959 and now subject to direct republican administration. A mere tumble of huts until the 1920s Frunze has grown into a sizable modern city with up-to-date municipal and health services, wide streets, parks and public buildings. The principal buildings are the opera and ballet theatre, the Academy of Sciences and the Polytechnic institute. Besides the state university (founded in 1951) there were about 40 schools and several technical training establishments in the early 1960s.

Frunze is on the branch of the Turksib railway line from Lugovaya to Rybachye on Lake Issyk-Kul. There are metaled roads to Alma-Ata, Dzhambul and other cities, and regular air services to Moscow and Alma-Ata. A considerable industry has been developed. The M. V. Frunze agricultural machinery works is of nationwide importance, and light industries include meat-packing and manufactures of metalware and textiles.

In the first half of the 19th century the fort of Pishpek was founded by the khans of Kokand, a khanate which extended into Kirgizia. It was captured by the Russians in 1862. In 1913 its population was given as 14,000. It developed rapidly after the construction of the Turksib railway in 1924, and in 1926 it was constituted the capital of the newly formed Kirgiz Autonomous Soviet Socialist Republic (status raised to a constituent republic in 1936) and took the name of Frunze after the revolutionary general M. V. Frunze who was born there in 1885. (G. E. WR.)

FRUSTRATION: *see* ADJUSTMENT (IN PSYCHOLOGY); MOTIVATION; PERSONALITY; PSYCHOLOGY.

FRUSTUM, in geometry, the part of a solid figure, such as a cone or pyramid, cut off by a plane parallel to the base or lying between two parallel planes; and hence in architecture a name given to the drum of a column.

See CONE: *Truncation;* COLUMN.

FRY, ELIZABETH (1780–1845), English philanthropist, and, after John Howard, the chief promoter of prison reform in Europe, was born at Norwich on May 21, 1780. Her father, John Gurney, a wealthy merchant and banker, represented an old family which for some generations had belonged to the Society of Friends. As a girl she showed the benevolence of disposition, clearness and independence of judgment and strength of purpose for which she

was afterward distinguished. In Aug. 1800 she became the wife of Joseph Fry, a London merchant.

Amid increasing family cares Elizabeth Fry was unwearied in her attention to the poor and the neglected of her neighbourhood, and in 1811 she was acknowledged by the Society of Friends as a "minister." She had made several visits to Newgate prison as early as Feb. 1813, but the great public work of her life dates effectively from the formation of the association for the improvement of the female prisoners in Newgate in April 1817. Its aims included the separation of the sexes, classification of criminals, female supervision for women and adequate provision for religious and secular instruction, as also for useful employment. The ameliorations effected by this association, largely by the personal exertions of Mrs. Fry, led to a rapid extension of similar methods to other places. In 1818 she, with her brother, visited the prisons of Scotland and the north of England. The publication (1819) of the notes of this tour, and the cordial recognition of the value of her work by the house of commons committee on the prisons of the metropolis, led to an extensive correspondence with persons interested in prison reform in Italy, Denmark and Russia. Through a visit to Ireland, which she made in 1827, she was led to direct her attention to other houses of detention besides prisons; and her observations resulted in many important improvements in the British hospital system and in the treatment of the insane.

In 1838 Mrs. Fry visited France, where she conferred with many leading prison officials and personally visited most of the houses of detention in Paris, Rouen, Caen and other places. In 1839 she obtained an official permit to visit all the prisons in that country; and her tour, which extended from Boulogne and Abbeville to Toulouse and Marseilles, resulted in a lengthy report. Before returning to England she had included Geneva, Zürich, Stuttgart and Frankfurt am Main in her inspection. In the summer of 1840 she traveled through Belgium, the Netherlands and Prussia on the same mission; and in 1841 she also visited Copenhagen. In 1843, through failing health, Mrs. Fry was compelled to forego further travels, but she had the satisfaction of hearing from almost every quarter of Europe that the authorities were giving increased practical effect to her suggestions. She died on Oct. 12, 1845, at Ramsgate. She was survived by a numerous family, the youngest of whom was born in 1822.

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FRY, ROGER ELIOT (1866–1934), British art critic and painter, was born in London on Dec. 14, 1866, and was educated at Cambridge university. He studied painting under Francis Bate and then in Paris. His landscapes are marked by deep feeling for form and a scholarly sense of design and technique. An active member and exhibitor of the London group, he gave an exhibition of his paintings in 1920. With his wide knowledge and acute sensibility, Fry became a recognized art critic in England and abroad. He published a study of *Bellini* (1899) and edited Reynolds' *Discourses* (1905), but is best known by his championship, through much opposition and prejudice, of Cézanne and the Postimpressionists. His *Cézanne* (1927) is a study of the master. Among other publications are *Vision and Design* (1920); *Architectural Heresies of a Painter* (1921), a book of travel impressions; *A Sampler of Castile* (1923); and *Transformations* (1926). In 1933 he was appointed Slade professor of fine art at Cambridge. He died in London on Sept. 9, 1934.

See Virginia Woolf, *Roger Fry: a Biography* (1940); and E. M. Forster, *Abinger Harvest* (1936; 1955), which contains an essay on Fry.

FUAD I (1868–1936), king of Egypt from 1922 to 1936, was born at Giza palace, Cairo, on March 26, 1868. He was the youngest son of the khedive Ismail. After his father's deposition in 1879, Fuad went to Italy, returning permanently to Egypt only in the 1890s when he became aide-de-camp to the khedive Abbas II. He remained quietly in Egypt, occupying himself largely with charitable activities. In 1914, when Egypt was declared a British protectorate, Abbas having been deposed and the khediviate abolished, Fuad's elder brother, Husain Kamil, became ruler with the title of sultan. The sultan's son, Prince Kemal al-Din, having renounced his rights of succession, Fuad became sultan on his brother's death in 1917. On May 25, 1919, he married the princess Nazli, daughter of Abd-al-Rahim Sabri Pasha, who gave birth on Feb. 11, 1920, to an heir, Prince Faruk (*q.v.*).

When Great Britain relinquished the protectorate and acknowledged Egypt as an independent kingdom, Fuad was proclaimed king (March 16, 1922) and became at once an important factor in Egyptian politics. The popular demand for an even greater degree of national independence was sponsored principally by the Wafd, the major political party; and after 1922 Egyptian political life was largely dominated by the struggle for power between the Wafd and the new palace parties centred around the king. In this duel the British government made a number of interventions, some favourable to the Wafd (since it was anxious to negotiate a settlement which would not be repudiated by the most popular party), others to the palace (by reason of the periodic outbreaks of anti-British violence to which the Wafd-inspired nationalist enthusiasm gave rise). (*See* Egypt: *History: Modern Period.*)

Fuad retained his active interest in charitable and, particularly, in educational matters and was a prime mover in establishing the first Egyptian university of the western type, the Fuad I university in Cairo (1925). In 1927 he paid state visits to London and Rome. He died in Cairo on April 28, 1936.

See Lord Lloyd, *Egypt Since Cromer,* 2 vol. (1933–34); Ikbal 'Ali Shāh, *Fuad, King of Egypt* (1936). (H. S. D.)

FUAD PASHA, MEHMET (1815–1869), one of Turkey's ablest statesmen in the mid-19th century, was born in Constantinople in 1815, the son of the poet Kechejizade Izzet Molla. Having studied medicine, he was appointed an army surgeon in Tripoli, but, transferring to the diplomatic service, he became first secretary of the Turkish embassy in London (1840). After employment on special missions in the Danubian principalities, in Madrid (1845), in St. Petersburg (1849) and in Egypt (1852), he became minister of foreign affairs (1852–53). In 1854 he was entrusted with the suppression of a revolt in northern Greece. As foreign minister again during 1855–56, he represented Turkey at the Paris peace conference (1856) which followed the Crimean War. In 1860 he pacified Syria, forestalling a French occupation after a Muslim massacre of Christians. After the accession of Sultan Abdul-Aziz (1861) he was appointed grand vizier and foreign minister but was dismissed in 1862. He accompanied the sultan, however, on a visit to Egypt in 1863, and thereafter became grand vizier for a second time. He held the appointment till 1867, when he visited Europe with the sultan. He died at Nice in Feb. 1869. A liberal statesman, Fuad Pasha had served his country well. He was known as a witty speaker with an anecdote for every occasion. (E. Z. K.)

FUCHOW: *see* Foochow.

FUCHSIA, a genus of plants of the evening primrose family (Onagraceae; *q.v.*) notable for their brightly coloured drooping flowers in shades of red, blue and purple as well as in white. (The colour known as fuchsia, a vivid reddish-purple, and the synthetic dye fuchsin were named for the brilliant colour of the flowers of certain *Fuchsia* species.) The funnel-shaped corolla, consisting of four petals, is surrounded by a four-parted, spreading calyx. The fruit is a fleshy, many-seeded berry.

JOHN MARKHAM

HORTICULTURAL VARIETY OF FUCHSIA (FUCHSIA MAGELLANICA MACROSTEMA)

All the members of the genus, except a few New Zealand species, are natives of Central and South America—occurring in the interior of forests or in damp and shady mountainous situations. The various species differ considerably in size as well as in other

characters; some, as *F. parviflora,* being dwarf shrubs; others, as *F. arborescens,* attaining a height of 12 to 16 ft.; while others are treelike and have stems several inches in diameter.

F coccinea was one of the first species cultivated, primarily as a greenhouse plant. The numerous hybrid forms now existing are the result chiefly of the intercrossing of long-flowered with globose-flowered plants. In some varieties the blossoms are variegated, and in others they are double. There appears to be little limit to the number of forms to be obtained by careful cultivation and selection.

Ripe seed is sown either in autumn or about February or March in light, rich, well-drained mold, and is thinly covered with sandy soil and watered. A temperature of 70° to 75° F. (about 21° to 24° C.) has been found suitable for raising. The seedlings, when three inches in height, are transferred to three-inch pots, and are then treated the same as plants from cuttings. Fuchsias may be grafted readily, preferably by the splice or whip method, the apex of a young shoot being employed as a scion.

Among the more hardy or half-hardy plants for borders in California and southern England are varieties of *F. magellanica,* a tree up to 20 ft. high, but lower as cultivated; it is a native from Peru to southern Chile. Most of the common fuchsias in cultivation as potted plants are horticultural varieties of *F. hybrida,* a plant probably derived from *F. magellanica* and a Mexican species.

For greenhouse culture may be mentioned the following natural species: *F. corymbiflora* (Peru), four to six feet high, with scarlet flowers nearly two inches long in long terminal clusters; *F. fulgens* (Mexico), four to six feet, with drooping apical clusters of scarlet flowers; *F. procumbens* (New Zealand), a creeping or trailing form, the small flowers of which are succeeded by oval magenta-crimson berries that remain on for months; and *F. splendens* (Mexico and Guatemala), six feet high, with very showy scarlet and green flowers. These wild species, however, cannot compare in beauty or freedom of blossom with the numerous horticultural varieties.

The California fuchsia, of the same family, is *Zauschneria californica.* The so-called native fuchsias of southern and eastern Australia are plants of the genera *Correa* (Rutaceae) and *Epacris* (Epacridaceae).

FUCINO (Conca del Fucino, formerly Celano), a lake bed of the Abruzzi e Molise, Italy, is in the province of L'Aquila, 3 km. (2 mi.) E. of the town of Avezzano. The lake (Lat. Lacus Fucinus) was 59 km. (37 mi.) in circumference and 30 m. (98 ft.) deep. From the lack of an outlet the level of the lake was subject to great variations. As early as A.D. 52 the emperor Claudius, realizing a drainage project of Julius Caesar, constructed a tunnel 5½ km. (3½ mi.) long, with 40 shafts at intervals, by which the surplus waters found an outlet to the Liri (Liris). About 30,000 workmen were employed for 11 years in driving this tunnel. In the following reign the tunnel was allowed to fall into disrepair, but was repaired by Trajan. Still preserved in modern times, it is, however, no longer in use. Various attempts to reopen it from 1240 onward were unsuccessful. By 1852 the lake had gradually risen until it was 9 m. (30 ft.) above its original level. In 1854–75 Prince Alessandro Torlonia, the Roman banker, aided by French and Swiss engineers drained the lake at the cost of about 45,000,000 lire, becoming proprietor of the site in return. The outlet by which it was drained was 4 mi. long and 24 sq.yd. in section. The farmland on the former lake bed, belonging to the Torlonia family, was expropriated and subdivided into numerous small farms of 1 ha. (approximately 2½ ac.) by the Italian Land Reform acts in 1952–53. (G. Kh.)

FUEL CELL. The idea of using electrochemical processes for generating and for storing electrical energy in flashlight batteries and storage batteries is familiar to most people; the conception of deriving electrical energy directly from normal oxidizable fuels is not so familiar. From the time of Sir Humphry Davy the idea has attracted attention since the prize to be won is the generation of electricity without using any form of the heat engine with its thermodynamic and mechanical losses. It is theoretically possible to achieve very high conversion efficiencies with a corresponding saving in fuel.

Thermodynamics.—Provided the energy change in a fuel cell resulting from the chemical reaction of oxidation takes place with the production of electrical energy and no liberation of heat and in a thermodynamically reversible manner, then it may be represented by the Gibbs-Helmholtz equation:

$$\triangle H = \triangle G - \frac{T\,\delta\,(\triangle G)}{\delta T}$$

where T is the absolute temperature, $\triangle H$ is the heat of combustion and $\triangle G$ is the free energy change representing the maximum energy available. Free energy changes are known from many reactions and consequently efficiencies can be calculated. For example, the reaction $C + O_2 = CO_2$ has a value of $\triangle G$ at 25° C., which is equal to 94.2 kg.cal. per gram molecule or 4.136 kw.hr. per pound of carbon. At 1,000° C. this value is only altered by 0.02%. Thus the second term in the Gibbs-Helmholtz equation is negligible and the theoretical efficiency of conversion of heat of chemical energy to electrical energy is nearly equal to the heat of combustion. The voltage per cell is of the order of one volt on open circuit, falling as current is drawn from the cell.

Applications.—The fuel cell holds promise of application in industry. Since direct current is produced it would not seem feasible for large-scale power generation in competition with high-voltage alternating current. The characteristic of the fuel cell is falling efficiency with increasing load, which is favourable for traction applications where full load is only required for starting and climbing gradients. The good torque characteristics of direct-current motors can be used immediately. For local use the fuel cell's generation of direct current at low voltage is favourable for electrometallurgical and electrochemical processes, particularly if it is fed with industrial or natural gas.

Modern Developments.—Most progress was made after World War II in Great Britain, the U.S.S.R. and western Germany. The main work was on industrial gases rather than solid or liquid fuels. Three main types of cell were investigated: (1) the cell in which aqueous electrolyte is fed between the electrodes, the fuel gas being fed to one electrode and oxygen to the other; (2) the fused salt cell in which molten salt is used as the electrolyte; this is commonly based on carbonates having ionic conductivity; ionic solid electrolytes were also considered; and (3) the "redox" (reduction-oxidation) cell in which oxidation of the fuel by one redox agent and oxidation of another redox agent by oxygen or air both take place outside the cell, the two redox agents providing the necessary electrical energy when brought together in the cell, but separated by a semipermeable membrane.

The Bacon team at Cambridge university developed a hydrogen-oxygen cell in which the electrolyte is a caustic potash solution. The cell operates at about 200° C. and 600 pounds per square inch with treated nickel electrodes, and gives varying outputs up to 1,000 amp. per square foot for long periods. In Germany E. Justi reported success on a low-pressure hydrogen-oxygen cell and fused carbonate cells using carbon monoxide and hydrogen. Following the work of E. Baur in Zürich, Switz., O. K. Davtyan in the U.S.S.R. reported promising results on high-temperature cells using alkali carbonates. These results were improved upon in the Netherlands and Great Britain.

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(C. G. Cy.; X.)

FUELING STATIONS, NAVAL: *see* Bunkering, Ship.

FUEL INJECTION: *see* Injector; Internal-Combustion Engines; Diesel Engine.

FUELS. Fuel is a term applied to materials used to produce heat by combustion in air. Man alone among living creatures has discovered ways of creating heat and power by the use of fuel. He has thereby improved his means of procuring food, has adapted himself to live and flourish on almost the entire area of the globe

and has secured an immeasurably increased standard of comfort. Modern civilization could not exist if fuel supplies failed or became exhausted.

Following are the main divisions of this article:

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I. FUEL CONSTITUENTS

Generally speaking, the bulk of natural fuels such as coal, wood, peat, oil and natural gas are made up of compounds of carbon, hydrogen and oxygen in association with small proportions of nitrogen and sulfur, in addition to moisture and mineral ash, but in special circumstances such elements as phosphorus and the more readily oxidizable metals such as magnesium and aluminum may be utilized as fuel.

When the constituent elements of a fuel burn or unite with oxygen, heat is evolved, and a fuel is completely burned only when all of its combustible components are oxidized to the highest possible degree. In the process a definite quantity of heat is produced which can be calculated approximately from the chemical composition of a fuel. Thus one pound of carbon in complete combustion to carbon dioxide (CO_2) produces about 14,500 B.T.U. (British thermal units), but only about 4,400 B.T.U. are produced in burning to the lower oxide, carbon monoxide (CO). If, however, this is subsequently burned to CO_2, the balance of about 10,100 B.T.U. is liberated. Hydrogen burns to water vapour, about 62,000 B.T.U. being produced per pound of hydrogen burned. The value of a fuel depends primarily upon its potential heat-producing capacity per unit mass or calorific value, but the calorific intensity, or the temperature to which this amount of heat can raise the products of combustion without excess air, is also important. The impurities in a fuel affect both its calorific value and calorific intensity.

II. SOLID FUELS

Solid fuels may be divided into two main groups, natural and manufactured. In the former category are coal, wood, peat and other vegetable matter, and in the latter such products as coke and charcoal, obtained by destructive distillation (heating the raw material in the absence of air, by which gas and tar are also produced). Such processes form the basis of the manufacture of both metallurgical coke and gas, two important industries.

A. Coal and Related Fuels

The reserves of coal, which may be expected to last more than 1,000 years at the rate of consumption in the early 1960s, are far above those of any other combustible. Coal is a stratified sedimentary rock that has been formed by the action of decay, heat and pressure upon accumulations of vegetable and woody or cellulosic matter laid down in bygone ages. It varies widely in composition and properties. Although the proportions of the elements present in any particular variety of coal and its behaviour under various forms of treatment are known, the fundamental causes of the differences between the different types have not yet been placed upon a really rational basis. A knowledge of the true constitution of coal, which is being sought by many research workers, could not fail to be of great assistance to those responsible for the proper utilization of a vast but irreplaceable store of fuel.

1. Classification.—Many classifications of coal have been suggested—by geologic age, coking properties, commercial application, chemical composition, etc. There is, however, no sharp distinction between any one coal and its nearest relation, but rather an innumerable family with characteristics changing gradually from one extreme to the other. Four main divisions are given in the classification of the American Standards association: (1) anthracite; (2) bituminous; (3) subbituminous; and (4) lignite and brown coal.

Table I.—*Approximate Chemical Composition of Solid Fuels*
(moisture free)

Fuel	Carbon (C)	Hydrogen (H)	Oxygen (O)	Nitrogen (N)	Sulfur (S)	Ash
Cellulose (forms the bulk of plant structure)	44.4	6.2	49.4	...	...	...
Wood	48.5	6.0	43.5	.5	...	1.5
Peat	58.0	6.3	30.8	.9	Trace	4.0
Lignite	67.0	5.1	19.5	1.1	1.0	6.3
Coal (bituminous)	77.0	5.0	7.0	1.5	1.5	8.0
Coal (anthracite)	90.0	2.5	2.5	.5	.5	4.0

From Table I it will be seen that the transition from cellulose to anthracite is marked by elimination of oxygen and a corresponding increase of carbon.

Henri Victor Regnault and E. Gruner were among the first to formulate methods for the classification of types of coal, which they grouped according to flaming characteristics and the nature of the coke residue. S. W. Parr proposed a classification by rank (in the natural series from anthracite to lignite) based upon the heat value of the true coal substance "unit coal," free from ash or sulfur, that is, mineral matter-free (mm-free), according to fixed carbon on the dry basis or B.T.U. on the moist basis. The Parr formula for the latter is:

$$\text{Moist, mm-free B.T.U.} = \frac{\text{B.T.U.} - 50S}{100 - (1.08A + 0.55S)} \times 100$$

where S and A are the percentages of sulfur and ash, respectively. Another method of classification is that of C. A. Seyler, in which coals are divided according to their hydrogen content into five groups which are further subdivided according to the carbon content. This classification has been used by the British geological survey in publications on the coals of south Wales.

For carbonization purposes one of the most important properties of bituminous (soft) coals is their ability to form coherent coke

and the extent to which they swell or shrink during this process. This behaviour forms the basis of a useful subclassification of such coals. S. R. Illingworth and others classed coals according to the temperatures at which certain constituents decompose.

2. Tests on Carbonaceous Materials.—Accurate tests are available for such characteristics of coal as its calorific value or ultimate chemical composition, and independent determinations of these should agree closely. Tests of an empirical nature, such as proximate analysis, and special tests, such as determinations of the free-swelling index or caking characteristics, are less specific but equally important. Since in such cases variation of method might produce divergent results, the same procedures must be adopted by different workers.

In 1920 the British Fuel Research board appointed a committee to examine methods of analysis, including (1) proximate and (2) ultimate analysis, (3) determination of caking index and (4) measurement of calorific value. The following methods of analysis, which have since been essentially followed, were adopted:

Proximate Analysis.—This consists of the determination of moisture, ash, volatile matter and fixed carbon in a sample of coal ground to pass a standard sieve of 60 meshes to the inch and air-dried.

1. Moisture. This is given by the loss in weight of one to two grams of coal when heated for one hour at a temperature of 105°–110° C. Coals especially liable to oxidation should be heated in a current of dry nitrogen.

2. Ash. One to two grams of the coal in a platinum or silica dish are heated gradually in air to about 800° C. When combustion is complete the residue is cooled and weighed.

3. Volatile matter. One gram of the coal is heated for seven minutes at about 925° C. in a platinum crucible of special shape closed by a well-fitting lid. The loss of weight is taken conventionally to represent the volatile matter.

4. Fixed carbon. The value of fixed carbon is obtained by subtracting the sum of the percentages of ash, volatile matter and moisture from 100.

Ultimate Analysis.—This consists of determining the proportions of the various constituent elements of the coal. The carbon and hydrogen are determined by the combustion of 0.2 g. of coal in a current of oxygen. The products of combustion are passed over copper oxide at 800° C. and then over granular lead chromate at 600° C. to absorb sulfur compounds. The carbon dioxide and water produced are weighed separately and from these weights are calculated the percentages of carbon and hydrogen in the coal. Nitrogen is determined by digesting one gram of coal with sulfuric acid according to the method of J. Kjeldahl. The nitrogen is thereby changed into ammonia, which after distillation is titrated with standard solutions. The sulfur is determined by conversion into sulfate by heating the coal gently with a fusion mixture of lime and magnesia (Eschka's method). Detailed procedures for carrying out these tests, as later modified, are covered in *A.S.T.M. Standards on Coal and Coke* (American Society for Testing Materials, 1957).

Caking Index.—There is no laboratory test that will give completely satisfactory information as to the caking or coking action of coal in its utilization. The free-swelling index, however, gives valuable guidance on many utilization problems. This swelling test consists in heating one gram of pulverized coal in a silica crucible over a gas flame under prescribed conditions to form a coke button, which is compared in size and shape with a series of standard profiles numbered one to nine. These profiles are intended to cover the size and shape of buttons obtained from coals covering a wide range in plastic properties. The number of the standard profile with which the maximum cross-sectional area of the button most nearly corresponds is recorded as the swelling index.

Calorific Value.—The heat evolved by complete combustion of a fuel may be determined in various ways, but the most accurate method uses the bomb calorimeter. One gram of finely powdered coal is pressed into a cylindrical pellet, accurately weighed and inserted in a strong metal bomb with an airtight cover. This is filled with oxygen to a pressure of about 25 atm. and immersed in a calorimeter vessel containing water.

The pellet is ignited by passing a momentary current of electricity through a thin wire within the bomb; the heat evolved by combustion of the coal is measured by the rise in temperature produced, proper cooling corrections being applied. The accuracy obtainable is of the order of two or three units in the fourth significant figure. The calorific value of dry coal varies from 10,000 to 15,000 B.T.U. per pound, according to the type. Approximate values in the same units for dry fuels may be taken as: wood 8,000; peat 10,000; lignite 11,000; bituminous coal 13,800; and anthracite 13,500.

The heat obtainable from a fuel is always less in practice than in theory, since losses caused by imperfect combustion and by heat carried away in the flue gases, in clinkers and in ashes can never be entirely avoided. Further, in fuels containing hydrogen the calorific value measured in the calorimeter and used generally for scientific purposes (the gross calorific value) is higher than that obtainable under working conditions (the net calorific value) by an amount equal to the latent heat of vaporization of the water formed.

3. Constitution of Coal.—Since coal is derived from vegetable matter, it is to be expected that among its major constituents will be degradation products of cellulose and lignin, together with small proportions of resinous bodies and compounds containing nitrogen and sulfur. The more important methods employed in investigating the constitution of coal may be briefly enumerated as: (1) extraction by solvents; (2) action of reagents (*e.g.*, controlled oxidation, hydrogenation, chlorination, methylation, etc.); (3) carefully regulated destructive distillation; (4) microscopic examination of thin sections or etched surfaces; and (5) examination by X-rays.

One investigation has been to determine the effect of hydrogen under high pressure upon the coal substance, by which it has been found possible to confer caking properties on coals that are normally noncaking. Even anthracite has yielded to this treatment, and the substance of certain types of coal has been converted into a mineral oil. By extracting coal with benzene under high pressure, F. Fischer in Germany and W. A. Bone in England were able to separate the constituents in which the caking properties of a coal appear to reside. Similar results were obtained by Parr in the U.S. by the use of phenol and xylene as solvents.

Bone obtained a considerable yield of mellitic and other benzene carboxylic acids in the oxidation products of the residue from the benzene extraction, and concluded that a considerable proportion of the coal substance has a six-carbon ring structure; each carbon atom of the ring is connected to other carbon atoms.

According to R. V. Wheeler, bituminous coal consists essentially of insoluble ulmins (organic substances) in which organized plant tissues are dispersed. By mild oxidation (for example, with hydrogen peroxide or with air at 100°–150° C.) the ulmins are rendered soluble in alkali and may thus be separated from the organized plant remains. Fossil plant cuticles and other tissues have been recognized in this residue. The ulmins, when oxidized by dilute nitric acid, yield oxalic, succinic, picric and pyromellitic acids, indicating that the ulmin molecules consist of benzenoid groupings linked by such structures as pyrrole and furan or their derivatives.

The results of the destructive distillation of coal have proved difficult to interpret from the point of view of the constitution of the coal substance because of overlapping of the various decomposition processes taking place. Examination of the oils produced by hydrogenation of coal seems to confirm the views of Bone and Wheeler on the six-carbon ring structure of the coal substance. By microscopic study of thin sections, Marie Stopes identified four main ingredients in British banded bituminous coal, which she designated vitrain, clarain, durain and fusain. G. Thiessen, on the other hand, considered that U.S. coals contain three main ingredients which he termed mother of coal, attritus and anthraxylon. Seyler applied the methods of metallography (*q.v.*) to microscopic examination of coal surfaces and was able thereby to identify directly many forms of plant tissue in the coal.

4. Peat.—Vast accumulations of peat occur in Europe, North America and northern Asia, but the industry has been developed only in regions deficient in coal. In Ireland millions of tons are consumed annually; the U.S.S.R., Sweden, Germany and Denmark also produce and use considerable quantities, and peat is used locally in England and Scotland. Peat bogs are formed chiefly in temperate humid climates by the accumulation and partial decomposition of vegetable remains under conditions of deficient drainage, in which the immersion excludes air and prevents complete decay.

Winning of Peat.—A chief use of peat is as a domestic fuel, usually hand cut, although progress has been made in the excavation and spreading of peat by mechanical methods. In many bogs roots and tree trunks are found, but such obstructions do not necessarily preclude the successful application of mechanical winning. Peat is cut by spade in the form of blocks which are spread out on the bog to dry, and when dry weigh from three-quarters of a pound to two pounds each. In one method of machine winning a dredger or excavator digs the peat from the drained bog and delivers it to a macerater which extrudes the peat pulp through a rectangular opening; the pulp is then cut into blocks, which are spread upon the surface of the bog. After a week or two these are collected into small piles or footings and after further drying are built in open order into small clamps. Maceration tends to more uniform shrinkage and a denser and tougher fuel; it also accelerates drying under unfavourable weather conditions.

Hydraulic excavating can also be used and is especially applicable to bogs containing roots and tree trunks, the peat being washed down by a jet of water under a pressure of about 150 lb. per square inch and the pulp run to a sump. There, after slight maceration, it is pumped to a draining ground in a layer about nine inches thick, which, after partial drying, can be cut up. Complete drying is effected in the usual manner.

Composition of Peat.—Peat varies from a light, spongy material mainly composed of sphagnum moss in the upper layers to a dense, brown, more humified substance at the bottom of thick bogs. In its natural state it contains 90% to 95% water, but by draining this may be reduced to 88% or 91%. The water ratio (the ratio of water to dry peat substance) of peat containing 95% water is 19:1, that of peat containing 90% water, 9:1. The latter will thus contain more than twice as much solid matter although its water content has only been reduced by 5%. Air-drying is used in all schemes working on a commercial basis. By air-drying the water may be brought down to about 25%, the calorific value then being about 7,000 B.T.U. Peat thoroughly dried by heat takes up about 16% of water on exposure to air; it is thus useless to dry it artificially below this limit. The density of air-dried cut peat is about 0.5; that of macerated machine-cut peat is 0.85 to 1.0.

The ash in peat varies considerably, from about 1% to 8%, and usually increases with depth. The nitrogen likewise increases with the depth, from 1% to 2%. The proximate analysis of a good Irish peat, air-dried, may be taken as: moisture 20.2%; organic volatile matter 49.5%; fixed carbon 26.8%; and ash 3.4%. Peat burns readily with a smoky flame and a characteristic odour. The ash is powdery and light, except in certain varieties high in ash through the inclusion of sand, etc. Peat is used for domestic purposes and forms a fuel suitable for boiler firing in either the briquetted or pulverized form; it also has been used in gas producers, and the coke from carbonized peat forms a suitable fuel for small producers such as are sometimes used for motor-transport purposes.

5. Lignite.—It has been estimated that about 50% of the world's total coal reserves are lignitic. Being inferior in some ways to bituminous coal, these reserves have not been exploited to anything like the same extent. However, in some areas the growing urgency of the fuel problem led to extensive developments, especially in Germany, where the production of lignite has exceeded that of bituminous coal. Schemes for its utilization, particularly by briquetting, have received attention in Australia, Canada, the United States, New Zealand and other countries.

Lignite is intermediate in properties between peat and bituminous coal, containing when dry about 60% to 75% of carbon and a variable proportion of ash. Raw lignite conforms to two types, brown or amorphous and black or pitchlike; it is characterized by a high water content, which may amount to as much as 60% in the brown varieties. Upon weathering, a proportion of this moisture is given up; and disintegration or crumbling of the material occurs, reducing its value as a fuel. Lignite tends also to disintegrate during combustion; hence the losses through a grate may be relatively high. It requires special care in storing, is uneconomical to transport long distances and is liable to spontaneous combustion. Against these drawbacks, many of the beds lie close to the surface and are of great thickness, sometimes more than 100 ft.; they are, therefore, easily worked, and the cost of production is low. (*See* also LIGNITE.)

6. Subbituminous Coals.—These coals are a gradation between lignitic and bituminous coals. They are noncoking, weather readily and have a B.T.U. value on a moist mineral matter-free basis of from 8,300 to 13,000. In general, such coals are utilized in about the same manner as noncoking bituminous coals but are more difficult to store.

7. Bituminous Coals.—A large variety of coals are included under the term bituminous. These coals have more than 14% volatile content on a dry mineral matter-free basis (which causes them to burn with a smoky yellowish flame) and in general resist weathering. The moisture content is lower than that of the subbituminous and lignitic coals, often being as low as about 3%. There are noncoking and coking varieties, the latter serving for metallurgical-coke manufacture. Such coals vary over a wide range in ash content, in hardness and in their tendency to heat spontaneously.

8. Anthracite.—Anthracites are characterized by their low percentage of volatile matter and high carbon content. Their lack of smoke production and relatively slow speed of burning make them particularly adaptable for domestic use. They are also used for steam raising and are often mixed with bituminous coals to reduce smoke production; they are blended in small percentages with coking bituminous coals for coke manufacture.

9. Coke.—When a raw carbonaceous fuel is distilled or carbonized by heating it in the absence of air, gas and tar vapours are evolved and a residue known as coke remains. The characteristics of a coke vary with the type of coal treated, the temperature and time of carbonization and the peculiarities of the plant in which the operation is carried out. Coke may, however, be broadly divided into two classes—metallurgical and gas. The former is the main product of the carbonization of coal at about 2,000° F. (about 1,093° C.) in coke ovens, the tar and gas obtained usually being considered as by-products. It is used for the reduction of iron ore and for various other metallurgical processes, its essential property being strength to withstand the heavy loads placed upon it in the blast furnace. The properties desired in coke are frequently obtained by blending coals having properties complementary to each other. At about 2,000° F. gas coke is also the most important by-product of carbonization of coal in vertical or horizontal retorts for gas manufacture. Its chief uses are as a metallurgical furnace fuel and in the production of gas. It is also used for steam raising and to a small extent for domestic fuel.

Production of coke by carbonization at about 1,100° F. (about 593° C.) has attracted considerable attention. This low-temperature coke retains about 10% to 15% of volatiles compared with only 1% or 2% in gas or metallurgical coke, and so can be readily ignited, burning freely. It thus forms an excellent smokeless substitute for household coal, but it is lighter and more friable than ordinary cokes. The gas yield is less from low-temperature carbonization than from high, but the tar yield is increased.

From one ton of coal the yields of coke vary widely; a rough approximation is as follows:

Metallurgical by-product coke Gas coke	1,300 to 1,400 lb.
Low-temperature coke	1,400 to 1,500 lb.

The analyses given in Table II are typical of cokes produced by the three methods under conditions of proper quenching. If the coke has been badly quenched or stored in the open the moisture will be much greater.

TABLE II.—*Analyses of Coke Types*

Ingredient	Metallurgical coke	Gas coke		Low-temperature coke
		Horizontal	Vertical	
Proximate analysis:				
Moisture	.7	.9	.6	2.0
Volatile matter	2.6	2.9	3.5	7.5
Fixed carbon	88.2	86.5	86.4	80.0
Ash	8.5	9.7	9.5	10.5
Ultimate analysis (dry coke):				
C	88.0	85.8	85.4	78.7
H	.5	.6	.8	2.5
N	1.0	1.2	1.2	1.5
S	.9	1.9	1.8	1.0
O	.9	.6	1.0	5.6
Ash	8.7	9.0	9.8	10.7

The physical characteristics of coke have an important bearing upon its suitability for different uses. The cell structure of coke appears to be due to the formation of bubbles during the fusion of certain portions of the coal substance and their subsequent perforation. Its exact nature depends largely upon the conditions of heating, the type of coal dealt with and the fineness to which it is ground before carbonization. Thus the dense coke made from finely divided coal of suitable coking properties consists of minute cells of uniform structure; but dense cokes can be produced, even from strongly swelling coals, by blending or by pressure during carbonization.

In addition to the chemical tests already described, which are applicable to any solid fuel, certain special tests have been devised for investigating other properties of coke. Those most usually relied upon are determinations of specific gravity (apparent and true) and porosity. Strength is measured by the shatter test in which 50 lb. of two-inch screened coke are dropped four times from a height of six feet onto an iron plate and the proportion broken determined. Reactivity to carbon dioxide is also important.

10. Briquettes.—Fuels prepared from fines and dust by molding under pressure either with or without a binding material are called briquettes. Pitch and coal tar are the binders commonly used, the amount required depending upon the characteristics of the coal, usually somewhere between 6.5% and 10%. An expensive factor in the preparation of briquettes is the cost of binder; hence, materials such as clay, tar, crude oil, peat, silicate of soda, molasses, sulfite liquor, starch, etc., have been tried. Binders have also been prepared by the fermentation of waste straw, farmyard manure or seaweed; the last has the advantage of being smokeless but is difficult to make waterproof. In Europe large quantities of briquettes are made from lignite by pressure alone.

Briquetting offers a means of utilizing quantities of small coal which, though of good quality, is unsalable because of its fine size. Special processes are required for absolutely noncoking materials, such as anthracite fines, since these disintegrate on the fire through the melting out and burning of the binder. Germany occupies first place in the briquetting industry, using mainly brown coal; but briquetting is also carried on in France, Austria, the United States and Wales. Coal briquettes are used for domestic and industrial purposes; lignite briquettes, which do not stand transport well, are chiefly employed as household fuel in the neighbourhood of their manufacture.

Briquettes may be rectangular, varying in weight up to about 28 lb. Smaller egg-shaped or ovoid briquettes are produced in roll presses for domestic purposes. High-quality briquettes are uniform in composition and weight, of high calorific value, strong, waterproof and able to bear transport or storage without disintegration. Density is about 1.3, the same as that of lump coal. The ash content where pitch or a similar binder is used is less than that of the original coal, but when inorganic binders such as clay or lime are adopted the incombustible constituents of the binder are added to the ash of the coal. The calorific value is affected by the binder, but in pitch briquettes the calorific value is slightly greater than that of the raw coal.

Briquetting under pressure, either at ordinary temperatures or at temperatures high enough to cause incipient fusion of some of the constituents, is sometimes adopted as a preliminary process in the carbonization of blends of finely ground coal. It not only aids production of a homogeneous fuel but simplifies the retorting process. (C. H. L.; L. C. McC.)

11. Pulverized Coal.—When solid fuels such as coal are finely pulverized and suspended in air, they can be burned in much the same manner as atomized liquid fuels. The technique of burning pulverized coal progressed so rapidly after 1920 that by the second half of the 20th century this method of firing was universally employed for large furnaces such as cement kilns and central station steam generators. Attempts to burn pulverized coal at high rates in very restricted spaces, such as diesel-engine cylinders, locomotive fireboxes and marine boilers, met with little success because of the harmful effects of the ash inherent in all types of coal.

The burning rate of solid fuels depends primarily upon the amount of surface exposed to oxygen. A one-pound lump of bituminous coal (approximately 22 cu.in.) would have about 48 sq.in. of surface area. If the lump is pulverized until all of the fragments pass through a 200-mesh sieve (.0029-in. opening), more than 1,000,000,000 particles will result, and their surface area will exceed 50,000 sq.in. The lump would require many minutes to burn completely, whereas the pound of powder, suspended in approximately ten pounds of air and injected into a large, hot furnace, would burn in a fraction of a second.

The procedure of burning powdered coal includes: (1) pulverizing the coal; (2) conveying the pulverized coal to the furnace in a stream of "primary air"; (3) mixing the fuel with additional "secondary air" in a burner; and (4) blowing the mixture into the furnace where it is burned in suspension. Ignition is accomplished with an auxiliary oil or gas flame, which can be extinguished after the coal flame is established.

Since coal does not occur naturally in particles fine enough to be burned efficiently, it must be pulverized at some point between the coal seam and the furnace. Drying is also necessary in most applications, since wet coal is difficult to handle in bunkers, feeders and pulverizing mills. Drying and pulverizing are usually done at the point of use, because of the cost and complexity of transporting and storing powdered coal. The first successful installations, such as those at the Lakeside station of the Milwaukee Power and Light Co. (1924), used the bin-and-feeder system, in which the coal was dried, pulverized and stored in large bunkers from which it was conveyed to the furnace as required. Virtually all modern plants use the unit pulverizer system, in which the coal is dried and pulverized in the mill and conveyed to the furnace immediately by preheated air, thus eliminating the need for pulverized-coal collectors, bunkers, air cleaners, etc.

Many types of mechanical and pneumatic mills have been developed to pulverize lump coal by impact and attrition among the coal particles and the mill elements. Mechanical mills are almost universally employed because of their relatively low power consumption, 10 to 20 kw.hr. per ton of coal pulverized. The fineness required for good combustion depends largely upon the volatile content of the coal; increased fineness is required for low-volatility fuels. By proper choice of fineness, burner and furnace, coals of any volatile content, from anthracite to lignite, can be burned satisfactorily.

Pulverized coal burns with such intensely hot and radiant flames that ordinary refractory furnace linings must be replaced by specially cooled walls. In the early days of pulverized-coal firing, erosion or melting of firebrick linings was a major limitation. This difficulty was overcome by lengthening the flame path, increasing the furnace volume and circulating boiler feed water through the furnace walls. Modern steam generators with water-cooled walls burn more than 75 tons of coal and produce more than 1,500,000 lb. of steam per hour.

Ash, always present in coal to some extent, constitutes the major problem in pulverized-coal combustion. In a pulverized-coal flame, the ash exists in the form of tiny molten spheres, which freeze into fly ash as the flame is chilled below the ash-fusion temperature. If the flame impinges upon a surface, the spheres coalesce and become slag. In cement kilns, the ash is discharged with the cement, but in boiler furnaces the ash constitutes a

nuisance which cannot be ignored. The fusion temperature of coal ash ranges from 1,800° to 2,900° F. (about 982° to 1,593° C.) depending upon the chemical analysis of its constitutents. Coals with low ash-fusion temperatures are usually burned in "wet-bottom" furnaces, from which much of the ash is drawn off as molten slag. For coals with high ash-fusion temperatures, "dry-bottom" furnaces are used in which the ash is chilled and carried out of the furnace by the combustion gases. Precipitators are required to prevent the fly ash from being discharged to the atmosphere.

Pulverized-fuel firing has a number of advantages over other methods of burning solid fuel in large furnaces. Greater flexibility of fuel choice is a major asset, as is the fact that a powdered-coal furnace can also burn gas or heavy oil with little modification. Time required for starting up and shutting down is relatively short, and load changes can be made almost instantaneously. Since relatively little excess air is needed for complete combustion, and the air can be preheated to a high temperature, boiler efficiency is higher than with stoker firing. Finally, there is virtually no limitation on furnace capacity, since any desired number of mills and burners can be used to supply a single steam generator. (J. I. Y.)

B. Wood

1. Wood as a Fuel.—Although in industrial countries the use of wood as fuel has been almost entirely superseded by the use of coal, oil and gas, large quantities are still employed in less developed or outlying areas. Wood cannot be economically transported great distances by rail, and its use is generally contingent upon its being at hand more or less in a waste form, as, for example, in portions of woodlands unsuitable for timber. Large quantities of waste wood are produced in the process of converting timber into lumber; some of it is used for producing industrial power or for domestic purposes or is distilled for making charcoal, acetate of lime and wood alcohol.

The structural basis of wood is cellulose, of which the simplest form may be given as $C_6H_{10}O_5$. The composition of wood tissue has been expressed by E. Schultze and N. Schuppe as "an aggregate of cellulose and a lignone complex," $5C_6H_{10}O_5$, $C_{19}H_{18}O_8$ or, in percentage composition, C = 49.66, H = 5.74, O = 44.60. The water content of green wood ranges from 50% to more than 200% of the weight of dry fibre; in other words, wood may contain as much as two parts of water to one part of fibre, according to the species, the position in the tree and age. On air-drying this is reduced to about 15% to 20%, or still further by artificial drying. Dried wood may under certain conditions reabsorb moisture.

Both the inflammability and the calorific value of wood are greater in the soft resinous varieties such as pine, fir and spruce than in hardwoods like oak and elm, the calorific value after air-drying varying from 6,500 to 9,000 B.T.U. per pound. The temperatures attained, however, are comparatively low because of the high moisture and hydrogen content. On this account raw wood is unsuitable for metallurgical operations, but before the days of coke manufacture large quantities of wood charcoal were used in the iron industry.

2. Charcoal.—Charcoal is the solid residue of the destructive distillation of wood. Formerly it was manufactured for smelting purposes by the charring process, in which large heaps of wood, covered with earth and turf and provided with flues, were set on fire and allowed to smolder until the volatile matter was completely driven off, no by-products being recovered. In many countries of Europe and Asia charcoal was still prepared in earth kilns into the second half of the 20th century. Where concentrated supplies of waste wood are available it is prepared in retorts. In such instances the charcoal becomes practically a by-product of the wood alcohol and acetic acid industries.

Charcoal is a brittle, porous material retaining the original shape of the wood while its microstructure preserves the vegetable cell structure. It is used for heating and coking and for cooking, in the U.S. especially for grilling, barbecuing, etc., out of doors; other uses are for the manufacture of gunpowder, absorbent and decolorizing agents and heat-insulating materials and for hop drying, casehardening steel, etc. (*see* also Charcoal). Good charcoal is deep black and breaks with a bright fracture. It rings when struck and burns without smoke. In the dry state the apparent specific gravity ranges from about 0.11 for a softwood to 0.20 for a hardwood. The true specific gravity of charcoal substance varies between 1 and 2. Charcoal is comparatively low in ash and ranges from 12,000 to 14,000 B.T.U. in calorific value. The charcoals prepared at low temperatures are exceedingly inflammable, imperfectly charred pieces often being used in Europe for kindling purposes.

C. Utilization of Solid Fuels

Because of the great differences in uniformity, composition and characteristics of the various solid fuels and of any individual type of solid fuel, the problem of efficient utilization has involved years of technological study of composition and structure, experimental work and development of equipment. Tests on quantities from one gram to thousands of tons have been made. From this work, besides knowledge of the fuel, many different types of equipment and operating procedures have been evolved. This work has had a great impact on the commercial movement of fuel, its proper choice, specifications and methods of purchase and the relative competitive position of the various types. Since the actual amount of heat that can be produced and utilized is usually the main objective, the B.T.U. value of a fuel is given prime consideration. However, other characteristics have great bearing on how much of the heat produced can be utilized and also on how rapidly the heat can be produced.

The annual world production of bituminous coal, anthracite and lignite was more than 2,000,000,000 tons in the 1960s. An idea of its relative consumption by different users in a large industrial country can be gained from the following statistics on use of coal in the United States. These figures are fairly typical, although the proportions vary from year to year: electric power utilities 33%; coke plants 25%; other industries 22%; retail deliveries 13%; railroads 4%; cement mills 3%; steel and rolling mills 1%.

1. The Combustion of Solid Fuel.—The combustion of a solid carbonaceous substance is an exceedingly complex process, taking place in several stages and involving the interaction of gases, water vapour and solid carbon. The theoretical amount of air necessary to burn a fuel completely to carbon dioxide and water vapour can be calculated from a knowledge of its ultimate analysis by the use of the equations: (1) $C + O_2 = CO_2$; and (2) $2H_2 + O_2 = 2H_2O$. From (1) it follows that 12 lb. of carbon will require 32 lb. of oxygen and from (2) that 1 lb. of hydrogen will require 8 lb. of oxygen for complete combustion; thus, to burn the carbon and hydrogen in 1 lb. of coal of composition

C = 73.1%, H = 5.5%, O = 8.7% (net $H = 5.5 - \frac{8.7}{8} = 4.4\%$)

will take $\frac{0.731 \times 32}{12} + 0.044 \times 8 = 2.30$ lb. of oxygen or about 9.9 lb. of air.

In a similar manner, the percentage of carbon dioxide in the flue gases corresponding to the theoretical proportion of air can be calculated. The equations, however, tell nothing regarding the manner in which gases are given off from the raw material and interact among themselves and with oxygen and water vapour before the final products of complete combustion are formed. The mechanism of combustion is still a matter for research.

A complex mixture is involved, containing simple gases, such as hydrogen and carbon monoxide, in addition to molecules of greater complexity which are less directly acted upon by oxygen than the simpler ones. The combustion of the heavier hydrocarbons presents great difficulty, since the action of heat causes them to form still denser aggregates. Even the combustion of such a comparatively simple gas as methane (CH_4) was shown by Bone to proceed in stages involving the entry of successive atoms of oxygen. Methyl alcohol is first formed, but this is subsequently oxidized to an unstable compound which breaks up into formaldehyde and steam. Under certain conditions of slow combustion

further stages are involved before complete oxidation is effected, but under high-temperature conditions the formaldehyde is decomposed into carbon monoxide and hydrogen, which then burn directly to carbon dioxide and steam.

In the lower layers of a fuel bed, it is not definitely known whether solid carbon burns directly to carbon dioxide or whether it proceeds first to carbon monoxide (CO) and so to carbon dioxide (CO_2). Three possible reactions are involved:

$$C + O_2 = CO_2$$
$$C + \tfrac{1}{2}O_2 = CO$$
$$CO_2 + C = 2CO$$

An older theory held that the carbon was first burned to carbon dioxide which was subsequently reduced to carbon monoxide by contact with heated coke. Later studies indicate that carbon monoxide is the initial product.

By circulating air or oxygen at temperatures from 100° to 900° C. over purified wood charcoal, T. F. E. Rhead and R. V. Wheeler were led to the conclusion that CO_2 and CO are formed simultaneously from an unstable physicochemical complex, C_xO_y, which is the first product of the action of oxygen on carbon (*see* CARBON, OXIDES OF). Irving Langmuir's experiments appear to show that the first gaseous product of the interaction between carbon and oxygen is carbon dioxide, as he was unable to detect the presence of carbon monoxide. On passing upward the two oxides, in the presence of carbon, react upon each other in accordance with the reversible reaction $C + CO_2 \rightleftharpoons 2CO$; the final products are formed in definite relative proportions that depend upon the conditions, such as temperature and concentration of the various gases present, and also upon whether enough time has elapsed for equilibrium to be established. In the reaction quoted above, equilibrium is established at 850° C., when the percentages of CO_2 and CO are 6.23 and 93.77, respectively, and at 1,200° C., when they are 0.06 and 99.94. Under perfect fuel-bed conditions the gas leaving the incandescent bed will thus be composed almost entirely of carbon monoxide. With coal firing this carbon monoxide is consumed, with the gases of distillation, by the secondary air; but even a coke fire, although smokeless, may give off carbon monoxide if the supply of secondary air should be deficient or badly distributed.

When a raw carbonaceous material is burned, it must first be heated to the point of decomposition. The gases evolved at this stage vary in composition but consist chiefly of hydrocarbons, hydrogen, carbon monoxide, water and tarry vapours, mixed with a certain amount of solid carbon in a finely divided state. As the combustion proceeds, the fuel is freed from volatile matter and converted into coke.

Distillation takes place in the upper layers of an ordinary fuel bed, and to burn the gas and smoke secondary air must be supplied at some point above the fire bed. The solid coke burns in the lower portions of the fire, primary air for this purpose passing through the bed from under the grate. Thus, combustion of both solid carbon and volatile matter is involved. Special devices are sometimes used to force the volatile products through the incandescent coke; for example, by downdraft in which the flue gases are drawn away below the grate or by downward combustion in which the raw fuel is introduced at the bottom of the fire. In practice, air in excess of that theoretically necessary for complete combustion is required. In best boiler practice 20% of excess air is about the minimum necessary to ensure absence of smoke and fairly complete combustion. Too much air is undesirable, since by cooling down the gases it may retard combustion, aggravate the production of black smoke and increase heat losses. Best furnace conditions are obtainable with mechanical methods of continuous firing in which the air supply is under more exact control than can be obtained when the firing door has to be opened frequently for hand charging.

2. Solid Fuel for Domestic Purposes.—The manner of use of solid fuels for domestic purposes, such as heating, hot water and cooking, varies widely according to climate and custom. All types of such fuel are used. In Great Britain, where extremes of temperature are rare but rapid changes common, the open-grate fire persists, but, to cope with the more severe winters of parts of North America and Europe, closed stoves or central heating are widely used. There are many types of fireplaces and central-heating furnaces. Solid fuels are hand fired to some extent, but automatic fuel-burning equipment for central heating is preferred by many householders. Some of this equipment has been developed to feed the fuel from the bin, automatically controlling the fire and depositing the ashes into a container.

3. Solid Fuel for Industrial Purposes.—All types of solid fuel are burned for industrial purposes. Automatic fuel-burning equipment permits great saving in fuel and labour. Such equipment for burning coal takes many forms, depending upon the quantity of fuel to be burned per hour and many other factors, such as the fuel most cheaply available, the size and type of the boiler, load conditions, the area in which the plant is located and the type of labour available. Types of equipment include traveling-grate stokers, underfeed stokers, spreader stokers, cyclone furnaces and pulverized-fuel-burning equipment (*see* also *Pulverized Coal,* above). Stokers using bituminous coal usually burn slack coal which is run-of-mine coal with the larger sizes removed; under some conditions, particularly with the smaller stokers, small-sized coal with the fines removed is used. The largest boilers use the cyclone furnace or pulverized-fuel-burning equipment. Coal for the cyclone furnace, a furnace where burning takes place in a relatively small cylindrical furnace, is ground to pass a small-size screen. Coal for pulverized-fuel-burning equipment is ground to a fine powder and burns somewhat as a gas does.

4. The Blast Furnace.—Coal and coke are used not only for heat production but also for chemical purposes, such as the smelting of iron ores, where carbon effects the removal of oxygen, so producing metallic iron. The process is an ancient one, but until the middle of the 18th century the fuel used was charcoal. The blast furnace in which pig iron is produced consists of a hollow shaft with an internal diameter increasing from the top and bottom to the centre. At the bottom is a hearth upon which the superincumbent column of coke and iron ore rests. The exact lines of a blast furnace are important and vary with the types of ore. Heated air under pressure is blown in through tuyères (nozzles) in the lower portion of the furnace.

The ores used may be either oxides or carbonates of iron. The reactions occurring are complex. In the lower portion of the furnace near the tuyères the fuel is burned by the blast to carbon monoxide, which effects the reduction of the ore in the upper portion of the shaft where spongy iron impregnated with carbon and carbon monoxide is produced in a series of reactions of which the following is the resultant: $Fe_2O_3 + 3CO = 2Fe + 3CO_2$ (ferric oxide and carbon monoxide react to form iron and carbon dioxide). This spongy iron is melted as it passes through the lower layers and can be drawn off from time to time through tapping holes. Limestone is added to the charge to assist in fluxing.

Blast-furnace practice was greatly influenced by the work of Sir Lowthian Bell, who in 1872 applied the laws of mass action to the reactions in the blast furnace and came to the conclusion that the practical limit for the ratio of CO to CO_2 in the gases leaving the furnace could not be reduced below 2:0. In modern blast furnaces a ratio of 1:7 has been reached, but in average practice a ratio of 3:0 is more common. Bell's argument, however, remains valid, although imperfections in scientific measurement affected the accuracy of his calculation. It will thus be seen that fuel economy in iron and steel practice depends essentially upon finding uses for the combustible gases (having about 90 to 100 B.T.U.) which are necessarily rejected in large quantities from the shaft. These may be used either for heating the blast or for power and heat requirements in the subsequent treatment of the pig iron. Concentration of coke ovens, blast furnaces and steelmaking in the same works permits the fuel consumption per ton of finished steel to be reduced to a minimum, from 2,000 to 2,600 lb. of coal per ton of finished steel. *See* also BLAST FURNACE.

III. LIQUID FUELS

Liquid fuels made from vegetable oils, animal oils and petroleum

were used in ancient times to provide light and sometimes heat. They were so used to a limited extent until early in the 19th century, when the sperm-oil lamp came into wide use. Whaling fleets provided the supply of oil for several years, but needs increased beyond the ability of whalers to supply them. The modern oil industry began about 1847, when James H. Young took out a patent for making oil from oil shales, or oil rocks, in Scotland. By 1859 numerous companies in continental Europe, England and the U.S. were producing illuminating oil (coal oil) from shale, from coal and from petroleum found in seepages. In 1859 the United States saw the beginning of the petroleum era in the drilling of an oil well in Pennsylvania. The rapid development of the petroleum industry stopped most production of oil from shale and coal, although some was obtained from these solids in the second half of the 20th century in a number of places including Scotland, Europe, Africa and South America. The quantity is insignificant in total volume when compared with liquid fuels from natural petroleum.

A. Petroleum

Natural petroleum, or crude oil, as it is widely known, is the basis of practically all industrial liquid fuels. The advent of internal-combustion engines and motorcars meant an ever-increasing demand for gasoline (*q.v.*) or petrol derived from crude oil. The availability of the heavier portions of crude oil at a cheap price fostered their use for heating purposes. Lubricating oils for all kinds of machinery also come from crude oil.

Petroleum is a mixture of hundreds of different hydrocarbons—compounds composed of hydrogen and carbon—together with small amounts of other elements such as sulfur, oxygen and nitrogen. The carbon content of most crude oils varies from 84% to 88% by weight, hydrogen from 11.5% to 14.5% and the total minor constituents from 0.5% to 4.5%.

Petroleum, usually associated with water and natural gas, is found in voids or open spaces in porous sedimentary rock where the geological formation is such as to allow the oil to collect from a wide area. Impervious rock usually overlies the petroleum-containing formation in the form of an anticline (concave downward), with natural gas above the oil and dissolved in the oil and water below the oil. Other oil deposits occur in other kinds of formations in sedimentary shales, limestones and sandstones.

Recovery of crude oil through oil wells never reaches 100% of the oil present in the formation. Some fields yield only 20% of this oil, others will produce 50% or more of the oil in place, and injection under pressure of air, gas or water in certain instances can allow production of more oil than the oil field could ever produce naturally. Some heavy, thick oils will not flow through wells to the surface and can be recovered by mining, as is done in a number of countries; *e.g.*, France.

1. Petroleum Resources.—World production of crude petroleum was in excess of 7,000,000,000 bbl. of 42 U.S. gallons annually by the 1960s, continuing the steady increase shown in nearly every year since 1859. The United States was producing about 37% of the world total, followed by the middle east countries (combined), Venezuela and the U.S.S.R. Other important producers were Canada, a newcomer to the large producing areas, Mexico, Indonesia, Columbia, British Borneo and Argentina. Estimates of the amount of oil already discovered and available for production continue to increase from year to year. When the cost of finding and producing petroleum becomes too high, oils can be produced from oil shales, oil sands and coal in quantities greater than the present known resources of petroleum.

2. Preparation of Fuel Oils.—In the early days of oil, the average refining plant made only a few products and processed only about 100 bbl. of crude oil a day. A large modern refinery can handle 400,000 bbl. a day and can furnish more than 1,000 separate products. Few refineries handle less than 10,000 bbl. a day. The larger plants are huge and complex and cost many millions of dollars to build. The principal products are few in number but account for more than 95% of the total. These are gasoline (motor spirits or petrol), kerosene, distillate fuels, residual fuel oils, lubricating oils and asphalt. Gasoline remains the big volume product, accounting for 40% of total refinery output. Kerosene and the distillate fuel oils take about 25%, with another 25% in the heavy residual fuels. Lubricating-oil requirements are satisfied with less than 2% of the total production.

Crude oil, after some preliminary treatment to remove water and other undesirable substances such as sulfur, is fractionated by distillation in the refinery into portions according to a distillation temperature range, leaving an undistilled portion as a residual. Some of these fractions are used directly as the finished product but most of them are subjected to additional refinery processes.

The heavier distillates can be cracked by heating to high temperatures to yield gasoline fractions or can be catalytically cracked or reformed by passage at elevated temperatures over catalysts, generally solid particles that hasten and direct the change of the heavier hydrocarbons into lighter and more volatile hydrocarbons. The residual material likewise can be cracked to produce more desirable materials and coke; it can be used directly as industrial fuel oil or certain types can be treated to produce asphalt (used principally for road or highway surfaces). The ultimate goal of the refinery is the production of tailored products of the highest quality in the proper amounts according to seasonal demand. Gasoline production decreases and fuel-oil production for heating increases in winter.

Most countries have adopted standard specifications for all types of petroleum products, including seasonal variations to ensure proper fuels at the proper times. International co-operation in fixing these standards ensures, as an example, that airplanes can refuel anywhere in the world with assurance of uniform quality of product.

The gross calorific value of fuel oils ranges from about 18,500 to 20,000 B.T.U. per pound. The calorific value varies according to the hydrocarbon type composition, so that an oil of high specific gravity and comparatively low calorific value may produce more energy per unit volume than one of low specific gravity and high calorific value. Where storage space is at a premium, as in airplanes, the high-specific-gravity fuels may be the more desirable. Calorific value is related almost directly to specific gravity.

The flash point of an oil is the temperature at which, under specified conditions, a momentary flash is produced when a flame is passed over the oil surface. Gasolines have flash points below atmospheric temperatures. Standards and laws generally set a minimum flash point of 125° F. (51.67° C.) for distillate fuels and burner oils. Kerosene, the lighter burner oils and diesel fuels for light diesel equipment, such as buses, have flash points of 125°–130° F. (51.67°–54.44° C.). The medium-weight burner oils and diesel fuels for heavier moving equipment and for railroad diesel engines have flash points near 145° F. (62.78° C.), and the heavier oils range upward in flash point from 170° F. (76.67° C.). The temperature of a liquid fuel that will vaporize enough oil to support continuous combustion, known as the fire point, is generally about 20° F. higher than the flash point.

The viscosity of oil, which changes rapidly with temperature, is determined by its resistance to flow as measured by the amount passing through a standard orifice in a prescribed time. The formation of solid paraffins or waxes may cause difficulty in pumping oil through pipes at low temperatures. Some crudes and fuels even at atmospheric temperature must be preheated to reduce their viscosity to allow ready atomization in the burner.

Further information on petroleum production and resources will be found under Petroleum.

B. Substitute Liquid Fuels

Several processes are feasible for converting solid and gaseous fossil fuels to products that are interchangeable with liquid fuels of petroleum origin. Although large plants have been built, they have not always been commercially successful, especially where petroleum is plentiful. However, interest in such processes is increasing, not only for supplying motor fuel for certain areas or for emergency use, but also as sources of organic chemicals.

1. Carbonization.—Destructive distillation at low temperatures of solid fuels (coal, lignite, oil shale, tar sand, gilsonite)

yields crude tars and oils that may be converted to liquid fuels. Carbonization processes recover only about 15% of the total energy of coal in producing 20 gal. of crude oil per ton, compared with the recovery of about three times as much energy and up to 80 gal. of crude oil from other methods described below. Thus, low-temperature carbonization of coal is more efficient for producing combustible gases and by-products other than liquid fuels.

Commercial distillation of oil shale was first practised in France (1838), followed by Scotland (1850), Canada (1860) and Australia (1865). Industrial shale retorts are operated in France, Germany, China, the U.S.S.R., Scotland, South Africa and Sweden. The oil yield from shales in these countries varies between 10 and 130 gal. per ton. Highly mechanized underground mining procedures, applicable to massive deposits, have been developed in the United States. Crushed shale is fed into retorts that crack the organic material (kerogen) with gas or steam at 350° to 500° C. to produce crude oil similar in character to petroleum but containing higher percentages of sulfur, nitrogen and oxygen. Underground retorting, without mining except for preparing adits, also has been practised. Finished products are refined, by methods similar to those developed for treating petroleum, for use in internal-combustion engines. Sulfur and nitrogen compounds and waxes are valuable by-products, and the spent shale may be used in building aggregates.

2. Gas Synthesis.—A mixture of hydrogen and carbon monoxide (synthesis gas) may be reacted catalytically to make predominantly liquid fuels, combustible gas, waxes or organic chemicals. The synthesis gas may be made by reforming methane (CH_4 from natural or refinery gases), but large-scale installations normally gasify coal with steam according to the water-gas reaction, $C + H_2O \rightleftharpoons CO + H_2$. A number of methods have been studied, of which the Fischer-Tropsch synthesis and its variants have received the greatest attention. In this process synthesis gas at about 230° to 330° C. and 1 to 20 atm. is contacted with a suitably prepared catalyst that may contain predominantly cobalt, nickel or ruthenium, although iron is the usual major constituent. Fixed beds of catalyst (dry or submerged in oil), slurries of fine catalyst in oil and fluidized beds have been used, the main engineering problem being quick removal of the heat of reaction. In isosynthesis, a German laboratory development of World War II, the same gas is passed over metal oxides (for example 85% thoria and 15% alumina) at 400° to 450° C. and 300 to 600 atm. to produce primarily isobutane and isobutene, raw materials for aviation gasoline.

3. Coal Hydrogenation.—F. Bergius first investigated a process of adding hydrogen to coal at elevated temperatures and pressures, thus splitting the coal molecules and adding enough hydrogen to increase the hydrogen-carbon ratio of at least a fraction of the coal to that prevailing in petroleum. As carried out on a large scale in Germany before the end of World War II, coal hydrogenation consisted of two steps: (1) liquid-phase hydrogenation at about 200 atm. and 450° C. of a coal and oil paste to which a catalyst (usually a compound of tin or iron oxide) was added; and (2) vapour-phase hydrogenation of middle oil—the major product from the first step—under similar conditions of pressure and temperature on a bed of catalyst such as molybdenum sulfide, tungsten sulfide or (later) ammonium sulfomolybdate impregnated on a carrier. Later, hydrogenation in a single step at about 510° C. and also in a fluidized bed of coal at only 60 atm. were studied in laboratory equipment. A commercial plant in West Virginia adopted a modification of the liquid-phase process as a source of aromatic chemicals. Hydrogenation of U.S. bituminous coal making primarily gasoline yields about 4.3 bbl. of gasoline and 0.8 bbl. of liquefied petroleum gases per ton of moisture- and ash-free coal.

C. Utilization of Liquid Fuels

Liquid fuels derived from petroleum may be utilized either by combustion in furnaces or to produce energy directly in the cylinders of internal-combustion engines. Both light and heavy oils are applicable to the internal-combustion engine; the former can be ignited by a flame or spark while, with heavier oils, vaporization and ignition are effected by the high temperature developed on the compression stroke.

In furnaces oil must be changed from the liquid to the gaseous state before actual combustion. In general, a mixture of heavy and light gaseous hydrocarbons is formed and for smokeless combustion these must be brought into contact with a large enough supply of air to allow complete burning at the best efficiency. It requires 18 to 20 lb. of air per pound of fuel oil to burn the oil, best results generally being obtained when 10% to 20% excess air is used.

1. Oil Burners.—Oil-burner types are classified as vaporizing or atomizing. Each of these types can be used with a natural air draft or with a mechanical forced-air draft. Domestic burners for home heating use the light distillate oils and can be manually or automatically controlled. Commercial burners for space heating in commercial buildings, apartment houses and the like use the light and middle distillate oils—sometimes the residual oils. Industrial burners for industrial or power steam generation ordinarily use any heavy grade of oil to supply the heat. In many industrial installations the burners are designed to be fired with coal or oil or even with coal, oil or gas. This allows the choice of the most economical fuel from year to year.

Mechanical-draft burners use a fan or blower to supply the air needed for combustion and can be of the vaporizing or the atomizing type.

Atomization breaks the fuel into fine particles that mix with the combustion air, giving a clean flame and good burning. Atomization allows the use of heavier, cheaper grades of fuel oil and is well adapted to large industrial burners, although it does require power to produce the atomizing and first costs are comparatively high. Some burners use steam to assist atomization because of simple design requirements, low installation cost, ability to use heavy oils and flexibility of operation.

2. Advantages of Liquid Fuels.—Liquid fuel has many advantages over solid fuel. It weighs about 30% less per unit volume than coal and occupies only 50% of the space required for an equivalent amount of coal. Liquid fuels are usually readily available, can be stored conveniently, produce high heats in less furnace space, begin to burn instantly and cleanly, require little or no ash removal and need relatively little attention. For marine use, these and other advantages are readily apparent.

3. Fuels for Light Internal-Combustion Engines.—Motor gasolines are rather complex mixtures of light-hydrocarbon blending stocks tailored for best utilization in all motorcars in all seasons and climates. The refiners change the characteristics to fit these requirements. Motor gasolines distill within the temperature range of 100° to 400° F. (37.78° to 204.44° C.). Aviation gasolines are simpler blends of high-octane-number stocks produced to rigid specifications and boil in the 100° to 325° F. (37.78° to 162.78° C.) range. Four grades supply the requirements of virtually all conventional aircraft. These four grades are based on the octane-number requirements of the various aircraft engines. Fuels for jet turbine engines boil in the 100° to 600° F. (37.78° to 315.56° C.) range and have no octane-number requirement.

The above fuels, except for the jet turbine, are vaporized more or less completely and mixed with air in their passage through carburetors in the engines, and are distributed to the individual engine cylinders through suitable manifolds. The efficiencies obtained in these internal-combustion engines are a function of compression ratio, engine design and fuel characteristics. "Knocking" in such engines indicates some unbalance in the three factors indicated above and generally results from too low an octane number in the fuel used. After the 1920s octane numbers for motorcar gasolines increased from about 50 to more than 90. Small quantities of the metallo-organic compound tetraethyl lead (one to three millilitres per gallon) are used to achieve part of this increase in octane number; the rest has come through improved refining processes. (*See* also Gasoline.)

4. Liquid Fuels for Heavy Engines.—The diesel engine, unlike the gas or gasoline engine, draws in air during the suction stroke without mixture with oil. Oil is injected mechanically in the form of a spray and mixes with the air already in the combus-

tion chamber; the resultant mixture is ignited from the heat generated by the compression stroke of the engine. The diesel engine is the most efficient liquid-fuel engine. Modern developments in metal strengths and engine design allowed increased use of diesel engines in buses, trucks and small prime movers; diesel-engine application by railroads led to sharply decreased operating costs. Such engines are ideal for marine installations and many large stationary engine requirements. Stationary diesel equipment can be designed to use either oil or gas or a combination as economics dictates.

Standard specifications in world-wide use allow refiners to satisfy 90% of fuel requirements with not more than four grades of diesel fuel. Fuel composition and boiling range, plus cetane number, are important fuel characteristics. Cetane number is a measure of the time required for the fuel to ignite after fuel injection. A short delay period is indicated by a cetane number from 40 to 70, a long delay by a cetane number below 40, on an empirical scale from 0 to 100. Most engines operate satisfactorily on fuels in the 40 to 50 cetane-number range. The boiling range for the light distillate oils is 350° to 550° F. (176.67° to 287.78° C.), for medium diesel oils 370° to 650° F. (187.78° to 343.33° C.) and for the heavier fuels 400° to 700° F. (204.44° to 371.11° C.).

IV. GASEOUS FUELS

A. Types of Gaseous Fuels

Before final combustion all liquid and most solid fuels are first converted to the gaseous state. In this section fuels that already exist as gases at room temperature and atmospheric pressure will be considered separately. Gaseous fuels are composed of one or more simple gases in varying proportions and may also include some inert gases and oxygen. The simple combustible gases are most commonly hydrogen (H_2), carbon monoxide (CO), methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), propane (C_3H_8), propylene (C_3H_6), butane (C_4H_{10}), butylene (C_4H_8), benzene (C_6H_6) and acetylene (C_2H_2); the inert gases are generally carbon dioxide (CO_2) and nitrogen (N_2). As the once important use of gas for illuminating purposes lost its significance, the development of gas cooking and heating made calorific value by far the most important criterion for evaluating gaseous fuels. The most common commercial gases are described below more or less in the order of increasing calorific value.

1. Blast-Furnace Gas.—In blast-furnace operations a gas is derived from the various reactions occurring throughout the furnace. The principal combustible constituent is carbon monoxide, resulting from the partial combustion of the coke in accordance with the reaction: $2C + O_2 = 2CO$. The gas contains relatively high percentages of inert gases. Depending on the quality of the coke, as well as on the other materials charged to the furnace, the gas may range in calorific value between 90 and 110 B.T.U. per cubic foot. A typical percentage composition of the gas is: CO_2, 11.5; H_2, 1.0; CO, 27.5; and N_2, 60.0; with a gross calorific value of 92 B.T.U. per cubic foot and a theoretical flame temperature of 2,650° F. (1,454.4° C.) with no excess air. A modern blast furnace producing 1,000 tons of iron a day and consuming 1,800 lb. of coke per ton of iron produces about 127,000,000 cu.ft. of gas a day. Because it has the lowest heating value of all commercial gases, blast-furnace gas cannot be economically transported long distances. Accordingly, it is used in the steel mills for preheating the air required for the blast, as fuel for driving the blowers, underfiring the coke ovens, generating steam, heating the soaking pits and other miscellaneous purposes.

2. Producer Gas.—Outside of the steel mills, producer gas is perhaps the cheapest to manufacture for many industrial purposes. It is produced by blowing air or a mixture of air and steam through an incandescent fuel bed, which may be composed of coke, coal, lignite, peat or wood. When air alone is blown through incandescent carbon, the principal reactions are $C + \frac{1}{2} O_2 = CO$, $CO + \frac{1}{2} O_2 = CO_2$ and $CO_2 + C = 2CO$. For each volume of oxygen, 3.76 vol. of nitrogen are introduced with the air. If all of the carbon dioxide were converted to carbon monoxide, the resulting gas would be composed of CO, 34.5% and N_2, 65.5% and would have a maximum calorific value of 110 B.T.U. per cubic foot. In practice complete conversion of carbon dioxide to carbon monoxide does not take place and the gas, sometimes referred to as Siemens' gas, generally has a lower calorific value. This, coupled with operating difficulties frequently encountered by the excessive liberation of heat, is a serious disadvantage. As the reaction of incandescent carbon with steam according to the equations $C + H_2O = CO + H_2$ and $C + 2H_2O = CO_2 + 2H_2$ absorbs heat, a sufficient quantity of steam is added to the air so that the heat liberated by the carbon-oxygen reactions is balanced by the carbon-steam reactions. A secondary reaction of considerable importance in producer-gas operation is $CO + H_2O = CO_2 + H_2$.

The quality of the gas depends largely on the kind of fuel charged to the producer and ranges from 120 to 180 B.T.U. per cubic foot. Typical percentage compositions of producer gas are as follows: With buckwheat anthracite, CO_2, 8.0; O_2, 0.1; CO, 23.2; H_2, 17.7; CH_4, 1.0; and N_2, 50.0. The gross calorific value is 143 B.T.U. per cubic foot and the theoretical flame temperature 3,040° F. With bituminous coal, CO_2, 4.5; O_2, 0.6; CO, 27.0; H_2, 14.0; CH_4, 3.0; and N_2, 50.9. The gross calorific value is 163 B.T.U. per cubic foot and the theoretical flame temperature 3,175° F. With coke, CO_2, 6.4; O_2, 0.0; CO, 27.1; H_2, 13.3; CH_4, 0.4; and N_2, 52.8. The gross calorific value is 135 B.T.U. per cubic foot and the theoretical flame temperature 3,010° F. (1,654.4° C.).

Producer gas, because of its low calorific value, cannot be transported economically over any appreciable distances. Its use is therefore generally for industrial operations, such as for underfiring coke ovens, heating open-hearth furnaces, glass-melting furnaces, lime kilns, brick kilns, ceramic kilns and the like, where the producer plant is integrated with the industrial plant.

3. Blue Gas or Water Gas.—Blue gas or water gas is produced by alternately blasting an incandescent fuel bed with air and with steam. The respective reactions between the carbon and air and the carbon and steam are similar to those taking place in producer-gas operation but follow each other cyclically instead of occurring simultaneously. The cycle is balanced so that the heat liberated during the air blast and stored in the fuel bed is enough to provide the heat absorbed during the steam blast. The gases produced during the air blast, containing the nitrogen admitted with the air, are discharged to the atmosphere, while the gases generated during the steam blast provide the useful fuel gas. Depending on the character of the fuel, blue gas ranges in calorific value from 285 to 335 B.T.U. per cubic foot. A typical blue gas produced from coke has a percentage composition of CO_2, 5.4; O_2, 0.7; CO, 37.0; H_2, 47.3; CH_4, 1.3; and N_2, 8.3. The gross calorific value is 287 B.T.U. per cubic foot and the theoretical flame temperature 3,670° F. (2,021.11° C.). Blue gas may also be produced in continuous operation by substituting oxygen for air in gas producers. This results in a producer gas that is practically nitrogen-free. Blue gas as a fuel is used industrially in large manufacturing establishments for heating in forge-welding operations, but the major uses of blue gas, without enrichment, are as synthesis gas for the production of ammonia and methanol and other chemical operations.

4. Carbureted Water Gas.—For domestic and commercial cooking and heating, blue gas or water gas is usually enriched with hydrocarbon gases produced by thermal cracking of oil which takes place simultaneously with the blue-gas production. The principal components of a carbureted water gas machine are the generator, carburetor, superheater and wash box or seal. The blue gas is produced in the generator. During the air blast the gas leaving the generator is burned in the carburetor and superheater to heat the walls and checker-brick provided for storing the heat. As the products of combustion leaving the superheater retain an appreciable quantity of heat, they may be passed through a waste-heat boiler for steam generation, or they may be discharged directly to the atmosphere. During the steam blast, oil is vaporized in the carburetor and partly cracked in the stream of blue gas flowing from the generator, and the mixture then flows through the superheater in which the hydrocarbon vapours are fixed—that is, converted to permanent gases—and finally through the wash box or seal to a gasholder. Depending on the availability of natural gas

or liquefied petroleum gases, the heating value of blue gas is frequently increased by what is known as cold enrichment by mixing with these gases in their normal state. The degree of enrichment of carbureted water gas is controlled by the relative amount of oil, natural gas or liquefied petroleum gas used under the particular conditions of operation. The calorific value of carbureted water gas ranges from 425 to 575 B.T.U. per cubic foot. A typical percentage composition of carbureted water gas is CO_2, 4.3; C_2H_4, 4.7; C_6H_6, 2.3; O_2, 0.7; CO, 32.0; H_2, 34.0; CH_4, 15.5; and N_2, 6.5. The gross calorific value is 534 B.T.U. per cubic foot and the theoretical flame temperature 3,700° F. (2,037.78° C.). Carbureted water gas is widely distributed in city gas mains for general use either alone or in a mixture with other gases with which it is interchangeable.

5. Coal Gas.—Coal gas is produced by destructive distillation of bituminous coal, during which it is heated in retorts in the absence of air. Coal-gas retorts vary considerably in design and may be horizontal, inclined or vertical.

The quality and yield of gas vary with the type of coal, the temperature and time of carbonization, the type of retort and other factors. A typical gas from horizontal retorts has the percentage composition: CO_2, 2.4; C_2H_4, 1.32; C_6H_6, 1.73; O_2, 0.75; CO, 7.35; H_2, 47.95; CH_4, 27.15; and N_2, 11.35. It has a gross calorific value of 542 B.T.U. per cubic foot and a theoretical flame temperature of 3,600° F. (1,982.22° C.). Vertical retorts are often operated with the introduction of steam for the purpose of producing blue gas by the reaction with the hot coke. This in effect cools the coke before discharging and provides a larger yield of gas, although the calorific value of the gas is lower than that of straight coal gas. A typical percentage composition of gas from steamed vertical retorts is: CO_2, 3.0; C_2H_4, 1.5; C_6H_6, 1.3; O_2, 0.2; CO, 10.9; H_2, 54.5; CH_4, 24.2; and N_2, 4.4. It has a gross calorific value of 532 B.T.U. per cubic foot and a theoretical flame temperature of 3,645° F. (2,007.22° C.).

6. Coke-Oven Gas.—This is gas produced by the distillation of bituminous coal (*see* COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION). A typical coke-oven gas has the percentage composition: CO_2, 2.2; C_2H_4, 3.5; C_6H_6, 0.5; O_2, 0.8; CO, 6.3; H_2, 46.5; CH_4, 32.1; and N_2, 8.1. It has a gross calorific value of 574 B.T.U. per cubic foot and a theoretical flame temperature of 3,610° F. (1,987.78° C.). The distillation products leaving the coke ovens are drawn through hydraulic mains and coolers by exhausters and passed through tar extractors, saturaters, light-oil scrubbers, purifiers and other equipment designed for successively removing the tar, ammonia, light oil and sulfur compounds. (*See* also COAL TAR.) The specific procedures for the recovery of individual constituents vary from plant to plant.

7. Oil Gas.—Gas may be made entirely from the cracking of oil by innumerable methods and variations of equipment. A typical method of producing oil gas employs cyclic operation, in which oil atomized by steam is sprayed on previously heated checkerbrick, where the oil is cracked and the steam reacts with some of the deposited carbon to form water gas, the resulting mixture being similar to carbureted water gas. The checker-bricks are heated by the combustion of oil with an excess of air, which also consumes the carbon that failed to react with the steam. This method permits the production of gases having a very wide range of calorific values, 525 to 1,100 B.T.U. per cubic foot. The operation can therefore be adjusted to produce gas which may be interchangeable with carbureted water gas, coal or coke-oven gas or natural gas. Oil gas may also be produced by catalytic cracking methods either in continuous or in cyclic operation. In continuous operation oil vapours and steam flow through a bed of catalyst inside of externally heated tubes. In cyclic operation the catalyst is alternately heated by the combustion of some of the oil and cooled by the cracking of the oil and the reaction of the carbon with the steam. Oil gas may also be generated continuously by partial combustion with air or oxygen.

8. Reformed Natural Gas.—Natural gas is frequently decomposed by thermal or catalytic cracking or partial combustion processes to lower its heating value to render it suitable for mixing with carbureted water gas, oil gas, coal or coke-oven gas. Thermal cracking may be done in the fuel bed of a blue-gas generator or in the checker-brick of an oil-gas generator. Catalytic cracking or partial combustion is accomplished in equipment essentially similar to that employed for the cracking or partial combustion of oil. A typical percentage composition of reformed natural gas is: CO_2, 1.4; C_2H_4, 1.3; C_3H_6, 0.8; O_2, 0.2; CO, 9.7; H_2, 46.6; CH_4, 37.1; and N_2, 2.9. The gross calorific value is 599 B.T.U. per cubic foot and the theoretical flame temperature 3,615° F. (1,965.56° C.).

9. Natural Gas.—Natural gas is the ideal fuel gas where it is available for use in homes, buildings and industries or where industries can be located economically at the source of supply. It is usually found associated with crude petroleum or in areas where petroleum has been found. Geologic conditions favourable for oil generally are favourable for natural-gas occurrence. Exploration for oil in the United States led to the discovery and utilization of vast quantities of gas. Other natural-gas deposits have been found in Canada, Argentina, Mexico, France, the U.S.S.R., the middle east and elsewhere. Only in the United States has the immense supply available been put to full use. Thousands of miles of steel pipelines carry natural gas to virtually all parts of the country.

The predominant hydrocarbon in natural gas is methane, and many natural gases can be used without treatment as they are produced at the well. Others must be processed to remove the heavier hydrocarbons present (yielding large quantities of liquefied petroleum gases) and to remove other undesirable constituents such as carbon dioxide, hydrogen sulfide and other sulfur compounds. The calorific values can vary between 700 and 1,500 B.T.U. per cubic foot. In commercial pipeline operations, these variations reduce to from 900 to 1,200 B.T.U.

A typical delivered natural gas has a percentage composition: CH_4, 83.4; C_2H_6, 15.8; and N_2, 0.8. Its gross calorific value is 1,129 B.T.U. per cubic foot and the theoretical flame temperature 3,562° F. (1,961.11° C.).

10. Acetylene.—Acetylene for fuel purposes is produced by the chemical reaction of calcium carbide and water; $CaC_2 + 2H_2O = C_2H_2 + Ca(OH)_2$. Acetylene has a gross calorific value of 1,499 B.T.U. per cubic foot. When burned with air the theoretical flame temperature is 4,210° F., but when burned with 1.4 vol. of oxygen for each volume of acetylene, as in welding operations, the calculated flame temperature is 6,000° F.

Acetylene gives a highly luminous flame and is used to furnish emergency, temporary or portable lighting needs. Acetylene burned in air is used in soldering and brazing operations and with oxygen for cutting and welding operations in which the highest flame temperature of any known mixture of gases is of great advantage. Acetylene is distributed to small users in cylinders under pressure but is generated directly and distributed through pipes on the premises of large consumers. Acetylene is also used widely for producing a variety of chemicals. For this purpose, the acetylene is frequently produced by the conversion of natural or refinery gases. (*See* also ACETYLENE.)

11. Liquefied Petroleum Gases.—Liquefied petroleum gases (LP gases) are derived from gases produced in petroleum-refining operations or from natural gas. Propane, C_3H_8, has a gross calorific value of 2,572 B.T.U. per cubic foot and a theoretical flame temperature of 3,660° F. A typical commercial butane is composed of 93% butane (C_4H_{10}) and 7% propane and has a gross calorific value of 3,225 B.T.U. per cubic foot and a theoretical flame temperature of 3,640° F. (2,004.44° C.). For efficient transportation, storage and use, propane and butane are liquefied under pressure. Liquefied petroleum gases are distributed in cylinders to isolated consumers for domestic water heating, cooking, refrigeration and space heating. In small communities liquefied petroleum gases are distributed from a central point in place of manufactured gas.

B. Utilization of Gaseous Fuels

1. Combustion of Gases.—The advantages of gaseous fuels are: (1) ease of distribution; (2) high thermal efficiency of utilization; (3) no smoke or ash; and (4) ease of control giving either

oxidizing or reducing flames and flames of varying temperatures.

The general question of combustion has already been dealt with, but certain special considerations are applicable to gaseous combustion. In the burning of gases both rapidity of combustion and length of flame can be controlled by suitable adjustment of the gas rate and the primary and secondary air supplies.

2. Gas Burners.—Gas burners vary widely, but most types can be divided into two main classes, according to whether or not air is mixed with gas before it reaches the point of combustion. A relatively long flame, which may be suitable for certain types of furnace work, is produced by burning gas without primary air. On the other hand, burners of the well-known Bunsen type can, if desired, be adjusted to give a rapid rate of combustion with relatively short flames, such as are necessary where the combustion space is limited or maximum flame temperatures are required.

3. Submerged Combustion.—With a view to obtaining increased efficiency in water or steam heating, attempts have been made to develop a type of burner in which gas can be consumed under water. For such submerged combustion it is obviously essential that enough primary air for complete combustion should be intimately mixed with the gas.

4. Surface Combustion.—Sir Humphry Davy, in the early 19th century, discovered that a warmed platinum wire when introduced into a nonexplosive mixture of air and coal gas became incandescent and continued to glow until virtually all of the oxygen was consumed. Further experiments, particularly by P. L. Dulong, T. Thomson and J. W. Döbereiner, showed that many other substances had the same power. Before commencing work on this subject in 1902, Bone proved: (1) "that the power of accelerating gaseous combustion is possessed by all surfaces at temperatures below the ignition point in varying degrees, dependent upon their chemical characters and physical texture"; (2) "that such an accelerated surface combustion is dependent upon an absorption of the combustible gas, and probably also of the oxygen by the surface, whereby it becomes 'activated' (probably ionized) by association with the surface"; and (3) "that the surface itself becomes electrically charged during the process." Bone also pointed out that "there are experimental grounds for the belief that not only does the accelerating influence of the surfaces rapidly increase with the temperature, but also that the differences between the catalyzing powers of various surfaces, which at low temperatures are often considerable, diminish with ascending temperatures until at bright incandescence they practically disappear." This accelerated combustion was applied by Bone to various industrial heating appliances as a means of increasing the efficiency of heating operations. In these a mixture of air and gas in correct proportions is caused to burn without flame in contact with incandescent surfaces. The advantages are: (1) accelerated combustion; (2) concentration of combustion where required; (3) minimum excess air; (4) high temperature; (5) rapid heat transfer by radiation. Surface combustion has been applied to some extent to gas furnaces, gas cookers and heaters, etc., gas and air being forced by slight pressure through a porous diaphragm of refractory material, the mixture burning on the exit surface and maintaining it at incandescence without flame.

For further information reference should be made to the following articles. Under COAL AND COAL MINING will be found a general survey of the world's coal resources and of the methods of coal mining; cognate articles will be found under COKE, COKING AND HIGH-TEMPERATURE CARBONIZATION; CARBONIZATION, LOW-TEMPERATURE; LIGNITE. Mineral oil is treated under PETROLEUM; GASOLINE; and KEROSENE. *See* also GAS INDUSTRY.

(C. H. L.; L. C. McC.)

V. ATOMIC FUELS

Atomic or nuclear fuels are substances capable of producing heat (in conjunction with other forms of energy such as radiation) as the result of the splitting or fission of their atomic nuclei. In this respect they differ from the conventional fuels such as coal, wood, petroleum and gas, which furnish heat through the chemical process of combustion. The energy which can be obtained from nuclear processes is in vastly greater concentration than that which can be obtained from ordinary combustion, a pound of the fissionable material uranium-235 being capable of producing 3.3×10^{10} B.T.U. or roughly 2,600,000 times the amount of heat produced from burning a pound of coal. For further discussion *see* ATOMIC ENERGY; NUCLEAR ENGINEERING: *Fuels and Fuel Recovery.*

(W. L. C.)

VI. ROCKET AND OTHER HIGH-ENERGY FUELS

Special fuels with performance characteristics superior to those shown by hydrocarbon fuels are required to send rocket-powered vehicles into space and to propel aircraft and missiles faster, farther and with heavier pay loads. Aircraft and missiles powered by air-breathing jet engines require a fuel having one set of properties. Rocket-propelled vehicles must travel in space containing no oxygen shortly after launching; their fuel requirements are different and provision must be made to carry both fuel and oxidant aboard the vehicle.

TABLE III.—*Energy Content of Some High-Energy Fuels Compared With Jet Fuel*

Fuel	Form	Density	B.T.U. per pound
Jet fuel	JP-4*	0.77	18,700
Hydrogen	H_2†	0.000089	51,500
Beryllium	Be‡	1.8	29,100
Boron	B‡	2.0	25,100
Diborane	B_2H_6†	0.0012	31,370
Pentaborane	B_5H_9*	0.631	29,100
Decaborane	$B_{10}H_{14}$‡	0.94	27,900
Alkylborane	B-C-H*	0.82	25,900

*Liquid. †Gas. ‡Solid.

Fuel requirements for high-performance jet aircraft involve prime consideration of energy content on the basis of both unit volume and unit weight. Other factors such as ease of handling, inflammability limits, corrosiveness, toxicity and availability also must be considered, and may be of overriding importance. A listing of the energy content of some chemical fuels is shown in Table III with JP-4 hydrocarbon jet fuel included for purposes of comparison. Research by the armed forces in co-operation with industry has resulted in the selection of boron compounds as the base for high-energy fuels for jet-propelled weapon systems. The exact nature of the fuels is classified, but it is known that the toxic and explosive nature of the boranes has been reduced by the substitution of carbon-containing groups for some of the hydrogen, as illustrated by the alkylboranes.

For rocket systems, performance is based on the parameters of size, pay load, velocity at burnout and distance of travel, vertical or horizontal. All of these are related to fuel performance, which is measured in terms of a common factor, specific impulse. Specific impulse is defined as the pounds force of thrust developed per unit mass of propellant per second. The thrust developed by a rocket engine depends not only on the type and energy content of the fuel, but also on the type of oxidizer used and the average molecular weight of the combustion gases issuing from the rocket nozzle. In the mathematical expression of specific impulse, the important term is contributed by the ratio of the combustion-chamber temperature to the average molecular weight of the combustion products. Some examples are listed in Table IV.

TABLE IV.—*Examples of Performance Factors of Liquid Fuel-Oxidizer Systems*

Fuel	Oxidizer	Specific impulse (lb.sec./lb.)	Combustion temperature* (°F.)	Average molecular weight of products
Hydrazine	Red fuming nitric acid	250	5,200	22
Ethyl alcohol	Hydrogen peroxide	240	4,600	23
Ethyl alcohol	Liquid oxygen	247	5,150	23
JP-4 gasoline	Liquid oxygen	264	5,770	22
Hydrogen	Liquid oxygen	364	4,500	9
Hydrogen	Liquid fluorine	373	5,100	8.9

*Operating pressure, 500 lb. per square inch.

The use of hydrogen as a fuel and fluorine as an oxidant offers theoretical advantages, including combustion products of low molecular weight. However, difficulties of keeping hydrogen in liquid

form and the corrosiveness of fluorine present formidable problems.

Solid-fuel rockets are used chiefly for short and intermediate ballistic missiles. Development for long-range missiles has been handicapped by the lower thrust of available solid fuels and by difficulties of controlling their burning rate. A solid rocket propellant is made up of oxidizer particles dispersed in a binder that serves as the fuel. The binder is usually a plastic, resin or synthetic rubber compound. The specific impulse for solid propellant systems is in the range of from 180 to about 225 pound-seconds per pound. Advantages of solid-fuel rockets are their high reliability, convenience in storage and quick availability.

See AIRCRAFT PROPULSION; PROPELLANTS; ROCKETS AND GUIDED MISSILES: *Rocket Propulsion Systems; Rocket Propellants. See* also references under "Fuels" in the Index volume.

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FUERO, a term (derived from the Latin *forum*) used in Spain during the middle ages and later to refer (1) to a municipal franchise, especially one granted by the crown to a free municipality (*concejo*), and (2) to a general corpus of law relating to a class of persons or, occasionally, to a whole kingdom. Because of the great number and the variety of the medieval *fueros municipales,* and the tenacity with which the municipalities clung to privileges granted under them, the *fueros* played a very important part in the political, administrative and judicial history of Spain. The theoretical basis of medieval Spanish law was the Visigothic *Liber Judiciorum* or *Fuero Juzgo.* Visigothic law was, however, often inappropriate to actual conditions during the Reconquest, when it was necessary, by the grant of special privileges and exemptions, to provide incentives for settlers in newly conquered towns and to modify legal and administrative practice in a way appropriate for frontier towns dependent on the crown but far away from the centre of royal government.

One authority claims that nearly 800 *fueros* can be traced, most of them granted between the 11th and 14th centuries. The oldest in the west is the *Fuero de León* (*c.* 1020), which contains laws applicable to the kingdom in general and to the city of León in particular. The oldest Aragonese *fuero* was believed to be that of Sobrarbe (late 11th or early 12th century), though some modern scholars treat it as suspect. The Navarrese *fueros* were modeled on those of Aragon. A feature of the *fueros* is that they tend both to fall into closely related groups and to be borrowed by one kingdom from another. The earliest *fueros* are very short, but at the end of the 12th century they become documents of great length. That of Cuenca (*c.* 1189) is the most elaborate of the Castilian *fueros.*

The largest of the Aragonese municipal franchises is that of Teruel, modeled on that of Cuenca. Teruel, between its reconquest (1171) and 1190, had been governed by the *Fuero de Sepúlveda,* a simple frontier franchise of only 32 articles; but 20 years after its resettlement, Teruel needed a *fuero* containing 789 articles concerned with detailing the wide legal, financial, military and administrative independence granted to the *concejo de la villa.* Whereas the *Fuero de Cuenca,* however, declared all classes of nobles subject to the *fuero,* that of Teruel, reflecting the greater power of the Aragonese magnates, specifically mentions only the lowest class of nobles (*infanzones*) in this connection.

The *fueros* show great local variations. As a result, the judicial and administrative situation in medieval Spain was one of extreme fragmentation. The *fueros* created and sustained an urban middle class which was often a useful support to the crown in its struggles against the magnates, but rulers were not unaware of the disadvantages of the situation. Sporadic efforts were made to restore the *Fuero Juzgo* and in the time of Alfonso X, with the spread of knowledge of Roman law, began the long struggle of the Spanish kings to restrict the ancient rights of the municipalities. From the 15th century grants of *fueros municipales* ceased, but the *foreros* (franchise holders) stubbornly defended their rights for centuries, and the *fueros* were a powerful cause of the lasting weakness of the Spanish monarchy.

Some *fueros* were not merely municipal. Thus the *Fuero general de Navarra* (14th century) embodied the customary law of that kingdom. The *Fuero de los Fijosdalgo* (1138) stated customary law relating to nobles and clergy. Both types of *fuero* came together in the *Fuero real* (*c.* 1254) of Alfonso X, which was never generally promulgated, but was given to various Castilian cities, such as Burgos and Valladolid, as a local *fuero.* (P. E. R.)

FUERTES, LOUIS AGASSIZ (1874–1927), U.S. artist and naturalist who specialized in portraying bird life, was born at Ithaca, N.Y., on Feb. 7, 1874. He was educated at Cornell university and received art training from Abbott H. Thayer. As a painter of birds he was pre-eminent in the U.S. during a period of 30 years from 1897 to 1927. Enthusiastic and industrious, he produced abundantly, mainly as an illustrator of popular and technical ornithological books. He painted also a limited number of large pieces, some of which are owned by the New York Zoological society. His most extensive work was a series of large plates illustrating "The Birds of New York," published by the state and covering practically every species of eastern North America. A similar work for the state of Massachusetts was incomplete at his death.

His work is characterized by a fidelity to nature involving not only objective but subjective accuracy. His genius lay in the power to reproduce subtle, fleeting and intangible qualities of birds which reflected their individuality to a remarkable degree. This was quite as much the result of a highly sympathetic and very extensive knowledge of birds in their haunts as it was of technical skill. His travels covered a wide field in North America, Mexico, the West Indies, South America, Europe and Africa. His field experience, therefore, was of the widest.

He died on Aug. 22, 1927, at Unadilla, N.Y.

FUERTEVENTURA, the second largest of the Canary Islands (*q.v.*) in Las Palmas province, Spain, lies in the Atlantic 65 mi. W. of Cape Juby, Morocco, between Lanzarote and Grand Canary. Pop. (1960) 18,138. Area 666 sq.mi. It has a length of 63 mi. and an average width of 12 mi. Lava streams and other signs of volcanic action abound, but there has been no igneous activity since the Spaniards took possession. The highest peak reaches 2,770 ft. In external appearance, climate and production, Fuerteventura greatly resembles Lanzarote. La Oliva, the centre of a district with a municipal population of 2,594 is the largest inland village.

Puerto del Rosario (pop. 1,727), formerly Cabras, on the eastern coast is the capital and chief port. (R. P. BE.)

FUGGER, a German family that rose to prominence throughout Europe as merchants and bankers in the 15th and 16th centuries. The founder of the family was the weaver HANS FUGGER (d. 1409), who moved to Augsburg from his native village of Graben in Swabia in 1367. His sons ANDREAS (1388–1457) and JAKOB I (d. 1469) developed the family textile trade, but their partnership broke up in 1454. Andreas and his sons, who became known as the Fugger vom Reh ("Fuggers of the Deer") from arms granted to them in 1467, rapidly attained great wealth, conducting financial business in Antwerp and in Venice as well as at Augsburg. The eldest son, LUKAS (d. *c.* 1512), was the chief architect of this success, but some unwise speculations brought the business into decline before his death.

The Fugger von der Lilie ("Fuggers of the Lily"; arms, 1473), descended from Jakob I, rose more slowly; the firm first attained real significance under his sons, especially ULRICH (1441–1510), GEORG (1453–1506) and JAKOB II, called "the Rich" (1459–1525). They extended their business from the original trade in textile goods to trade in cotton and spice, then to transactions for the

Roman curia and, from 1482, under Jakob II, to mining.

Originally destined for the church, Jakob II entered the family firm in 1478. In 1487 he made his first loan to a Habsburg, the archduke Sigismund of Tirol, on the security of the Tirolean silver and copper mines, which the family subsequently managed; and in 1491 the family made its first loan to Maximilian, the future Holy Roman emperor. This loan was largely negotiated by Jakob, who from 1493 virtually directed the family's affairs. Aiming at a monopoly in silver and copper, the Fuggers allied themselves with Johannes Thurzo, a mining entrepreneur from Cracow, and in 1494 took over a 16-year lease of mines near Neusohl (Banska Bystrica) in Hungarian territory; they then established processing plants at Fuggerau in Carinthia and at Hohenkirchen in Thuringia. From 1496 onward, moreover, Jakob enjoyed the close and secret collaboration of the wealthy Melchior von Meckau, prince-bishop of Brixen and head of Maximilian's administration of the Tirol. In addition Jakob maintained close business relations with Rome and held the lease of the papal mint from 1508 to 1527. In 1506 he had paid 40,000 florins for jewels from the treasures of Charles the Bold of Burgundy (d. 1477), held by the city of Basel, and in 1507 he received from the emperor Maximilian the counties of Kirchberg and Weissenhorn in pledge for a loan of 50,000 florins. For the election of Charles V as emperor in 1519 Jakob personally provided 544,000 florins out of total election expenses of 852,000.

Meanwhile a network of Fugger trading posts was developing. By 1525, this extended from the Mediterranean to the Baltic and from Cracow via Antwerp as far as Lisbon and Seville. In Jan. 1525, still in debt to the Fuggers, Charles V handed over to them the so-called *maestrazgos; i.e.,* the lease of the revenues belonging to the Spanish orders of knighthood. With these came the mercury pits of Almadén and the silver mines of Guadalcanal. Predominant in the silver and copper trade, the Fuggers now had also a monopoly of mercury in Spain, which was to yield them rich gains up to 1634.

Jakob Fugger overcame repeated crises, even the confiscation by King Louis II of the property he held in Hungarian territory. Though he was a hard and resolute businessman, he was deeply religious and concerned with social problems; between 1516 and 1523 he built 52 houses in Augsburg for poor Catholic artisans and day-labourers and so richly endowed his foundation, known as the Fuggerei, that it still survives. Not only is it the oldest social settlement in the world, but its annual rent has remained unchanged since its foundation.

Under Jakob's nephew and successor Anton (1493–1560) the firm expanded dramatically. It financed the election of Ferdinand I as king of the Romans in 1531. The focus of its activities gradually shifted westward because of the constant Turkish danger in the east, and in 1543 Anton finally gave up the lease of the Hungarian mines. Furthermore, difficulties with King Ferdinand and with his officials in the Tirol, together with the progress of the Reformation, caused Anton Fugger to concentrate on developing his Spanish business. A faithful Catholic, he hoped that his financial support of Charles V and Philip II would ensure victory for them in their struggle against the Reformation. From 1534 onward he conducted an increasingly profitable fustian trade with England, which developed financial political relations between the English crown and the firm. This connection, however, he finally sacrificed to his religious ideals. Its one-sided orientation toward the Spanish Habsburgs and the financing of the Counter-Reformation was to be a contributory cause of the firm's decline under Anton's son Marcus (1529–97) and under Raimund's (*see* below) son Hans Jakob (1516–75), but other more important factors were the mediocre abilities of the next generation and the gross independence of the firm's agents abroad. Anton saw these dangers and thought of winding up his business affairs before trouble arose, but he could no longer break away from the Habsburgs; the Spanish connection had become the only significant part of the firm's activities. Like Jakob II, Anton had invested part of his wealth in land.

Anton and his brother Raimund (1489–1535) and their cousin Hieronymus (1499–1538) were made counts of the Holy Roman empire in 1530, and the family received the right to mint in 1535 and that of jurisdiction in 1541.

The Fuggers gradually lost their commercial interests and turned to politics, administration and the church. Hans Jakob, who gave up his partnership in the firm after going bankrupt in 1563 and later became chancellor to Albert IV, duke of Bavaria, wrote *Das Geheime Ehrenbuch des Fuggerischen Geschlechts* ("The Secret Book of Honour of the House of Fugger") and other historical works; Marcus wrote a book on horse breeding; and the libraries assembled by Hans Jakob and by his brothers Ulrich (1526–84) and Georg (1518–69) were of lasting historical importance.

Hans Jakob's collection became the foundation of the Bavarian state library; Ulrich's passed to Protestant friends of his at Heidelberg and reached the Vatican library, mostly as war booty; and Georg's, which was enlarged by his sons Philipp Eduard (1546–1618) and Octavianus Secundus (1549–1600) but had to be sold to the emperor Ferdinand III in 1654, now forms one of the most valuable parts of the Austrian national library.

Raimund's sons, particularly Hans Jakob, and Anton's sons received reports from agents of theirs in all parts of the known world. These "Fugger Newsletters" (*Fuggerzeitungen*) dealt mainly with business affairs but also occasionally with other topics, and the brothers circulated them among a limited number of their associates and some German princes.

Sigismund Friedrich (1542–1600), son of Hans Jakob, became bishop of Regensburg, and Anton's grandson Jakob (1567–1625) was prince-bishop of Constance.

Hans Fugger, the founder of the family fortune, had possessed approximately 3,000 gulden at his death; his younger son, Jakob I, 8,000 gulden. Jakob II the Rich and his brothers raised their estate to the tremendous height of 2,021,202 florins, and under Anton's leadership the firm reached its climax in the year 1546 with an estate of 5,100,000 gulden. From the mid-17th century the family lost its connections with finance, its members devoting themselves to cultural pursuits and patronage of the arts.

Three branches of the family survive. The descendants of Anton's nephew Georg, the Kirchberg-Weissenhorn line, have their residence at Oberkirchberg. The second branch, the Gloett-Kirchheim line, descended from Anton's son Johann (1531–98), was given princely rank in 1913 and has its seat at Kirchheim. The third branch, the Babenhausen line, descended from Anton's son Jakob (1542–98), became princes of the Holy Roman empire in 1803. The Fugger bank was re-established in 1954 by Friedrich Carl, Prince Fugger-Babenhausen (1914–).

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FUGITIVE SLAVE LAWS, a term applied in the United States to the statutes passed by congress in 1793 and 1850 to provide for the return of Negro slaves who escaped from one state into another or into a federal territory.

The first specific legislation on the subject was enacted on Feb. 1, 1793, to carry out a provision of the U.S. constitution (Art. IV, Sec 2). This law authorized any federal district judge or circuit court judge, or any state magistrate, to decide finally and without a jury trial the status of an alleged fugitive slave. The measure met with strong opposition in the northern states, some of whom enacted so-called personal liberty laws to hamper the execution of the federal law. Indiana in 1824 and Connecticut in 1828 passed laws providing that fugitives who appealed from an original decision against them were entitled to a jury trial. In 1840 New York and Vermont gave fugitives the right to a trial by jury and provided them with attorneys. As early as the first decade of the 19th century individual dissatisfaction with the law of 1793 had taken the form of systematic assistance rendered to Negroes es-

caping from the south to Canada or New England—the so-called Underground Railroad (*q.v.*). In 1842 the U.S. supreme court in the case of *Prigg* v. *Pennsylvania* ruled that state authorities could not be forced to act in fugitive slave cases, but that federal authorities must carry out the federal law. This decision was followed by legislation in Massachusetts (1843), Vermont (1843), Pennsylvania (1847) and Rhode Island (1848) forbidding state officials to help enforce the federal law and refusing the use of state jails for imprisoning fugitive slaves.

The demand from the south for more effective federal legislation resulted in enactment of a second fugitive slave law on Sept. 18, 1850, as one of the compromise measures passed by congress that year. Special commissioners were to have concurrent jurisdiction with the U.S. courts in enforcing the law. Fugitives could not testify in their own behalf nor were they permitted a trial by jury. Heavy penalties were imposed upon marshals who refused to enforce the law or from whom a fugitive escaped, and upon individuals who aided Negroes to escape. A marshal was authorized to raise a *posse comitatus, i.e.,* to call upon citizens to help him enforce the law. A fee of $10 was paid to the commissioner when his decision favoured the person who claimed ownership of the fugitive and only $5 when it favoured the fugitive. A sworn statement by the claimant was to be accepted as proof of ownership.

The severity of this measure led to abuses and defeated its purpose. The number of abolitionists increased, the operations of the Underground Railroad became more efficient, and new personal liberty laws were enacted in Vermont (1850), Connecticut (1854), Rhode Island (1854), Massachusetts (1855), Michigan (1855), Maine (1855 and 1857), Kansas (1858) and Wisconsin (1858). These laws forbade state justices and judges to take cognizance of claims, extended the privilege of jury trial to fugitives and severely punished false testimony. These state laws were among the grievances officially referred to by South Carolina in Dec. 1860 as justification for its secession from the union. Attempts to carry into effect the law of 1850 aroused much bitterness and probably had as much to do with inciting sectional hostility as did the controversy over slavery in the territories.

For some time after the beginning of the American Civil War the Fugitive Slave act was considered still to hold in the case of Negroes fleeing from masters in the border states that were loyal to the Union government. It was not until June 28, 1864, that the act was repealed.

See Allan Nevins, *Ordeal of the Union,* vols. i and ii (1947); and M. G. M'Dougall, *Fugitive Slaves, 1619–1865* (1891). (Ro. W. J.)

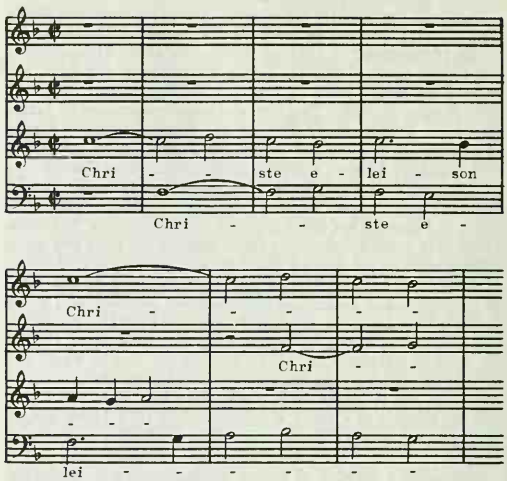
FUGUE is both a musical texture and a method of composition. A fugal texture consists of a melodic phrase repeated in various keys and at various intervals. This texture is also known as *fugato.* The name fugue is given to a piece of music built out of fugal texture.

During the 19th century, when fugal writing was scarcely part of the normal musical language, certain pedagogues, first among them L. Cherubini (d. 1842), devised rules for the writing of academic fugues as exercises that they considered to be an indispensable part of a student's training; what had been a procedure in periods of contrapuntal style was designated a "form." This artificial designation has led to a great misunderstanding of the application of fugue in true composition.

The early history of fugue is the early history of canon. The distinction between the two procedures does not become clear for some centuries. During the great canonic era of the Flemish composers, culminating in Josquin Desprès, a new chanson and motet style developed, consisting of imitative treatment of successive phrases of text. In some of these pieces imitative entries between voices occur at intervals other than the unison and octave, though no rigid system is apparent.

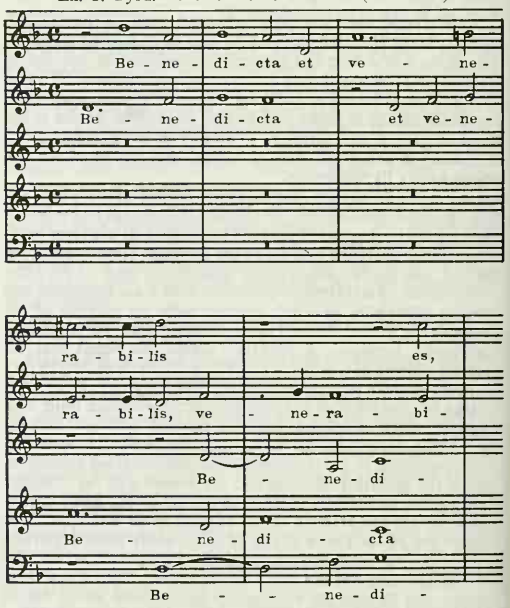
From the early part of the 16th century imitation at intervals other than the unison and octave increased, and, as the modal system inclined toward what later became the diatonic system, a tendency for answering voices to imitate at the fourth or fifth developed; the opening of the Christe Eleison of the Mass *Audi Filia* (1558) by the French composer Claude Goudimel resembles later fugal writing in this respect.

Ex. 1. Goudimel. *Missa Audi Filia*



A common feature in Palestrina, commoner still in William Byrd, is the simultaneous introduction of two-part counterpoint in the exposition, the voices entering in pairs, as in the following example, *Benedicta et venerabilis* from a *Gradualia* of Byrd. Note the alteration of the initial interval in the fourth voice for modal reasons.

Ex. 2. Byrd. *Benedicta et venerabilis* (*Gradualia*)



During the 16th century the terms *ricercare,* fantasia and *canzona* were often applied to instrumental fugal pieces. Among the earliest fugal *ricercari* are those for organ by M. A. Cavazzoni (b. *c.* 1480) in imitation of the current motet style, adapted to the instrumental medium. *Canzoni* and *ricercari* consisted of

series of little fugal sections, each using a different theme, or subject, for imitation. Further developments in the 17th century included the use of opening subjects in closing sections (Thomas Tomkin's keyboard fantasias) and rhythmic alteration of existing subjects for different sections (works by Dietrich Buxtehude and Jan Pieters Sweelinck).

By this time the diatonic system had almost completely replaced the modal system, with the result that the answer to the subject usually occurred at the interval of a fifth higher (or fourth lower). It should not be thought that such an answer is "in the dominant"; it is in the "plagal" form of the tonic key or, if the subject itself were plagal, the answer will be in the "authentic" form. *(See* MODES, MUSICAL.) Thus the natural answer to C G (in C major) is not G D but G C. When this principle is understood the 19th-century theorists' complicated rules for the behaviour of the "real answer" (an exact transposition of the subject) and the "tonal answer" (a modification of the subject for tonal reasons) become unnecessary. The adoption of the diatonic system also offered opportunities of modulation from one key to another. Harmonic contrast supplemented thematic contrast and this reduced the thematic material necessary.

Bach.—For the average musician in the 20th century the word fugue is almost synonymous with the name of J. S. Bach. Yet the conception of the fugue as a form has produced much misapprehension concerning Bach's fugal output, so that his *Wohltemperierte Clavier* ("The Forty-eight"), *The Art of Fugue*, his organ and other keyboard fugues, together with one or two well-known vocal fugues, are regarded as the bulk of his fugal writing. Fugue, however, can scarcely be discussed without reference to those other movements that are fugal in style though their forms may belong to the categories of concerto, choral prelude and movements in binary form. Many of the *gigues* in the keyboard suites, though of binary structure, are also fugues, as are several preludes that are cast in concerto form (*e.g.*, the English Suite in E minor); less obviously, the Prelude to the first English Suite is fugal, and so are the Fantasia of the Partita in A minor and at least three preludes of the "Forty-eight." Similar fugal methods abound in the Inventions, the trio sonatas and the sonatas for violin and harpsichord.

The keyboard works contain a higher percentage of "pure" fugues (those that have no other definable structure) than do other works of Bach. Among the vocal music, the Mass in B minor and *Magnificat* contain an unusually high proportion of pure fugues. However, the first Kyrie Eleison of the Mass, for example, is not a pure fugue for, though it contains a five-part fugue, it is also a vast concerto movement in structure. Before the choral fugal exposition (a fugal exposition is said to end when all voices have entered with the subject) there is a long ritornello, which no more than suggests that its opening melody will be treated exhaustively as a fugue. The ritornello is, perhaps, more orchestral than fugal in conception, and orchestral material is later used in fugal episodes (*i.e.*, passages not containing the subject). The fugue is incidental to the main ritornello structure, and the structure of the fugue in shape and key is dependent on that of the ritornello structure.

A less familiar but clearer example is the opening movement of Cantata 65, "Sie werden aus Saba kommen." Its structure may be summarized as follows: Bars 1–8: ritornello in orchestra; 9–19: chorus and orchestra begin ritornello in tonic and recommence in dominant, leading to bars 19–44: four-part vocal fugue on new material accompanied only by *continuo*, orchestra entering at bar 34. Stretto (the overlapping of entries of the subject) is used and there are two recurring countersubjects. (A regular countersubject is recurrent matter accompanying the subject and usually invertible with it so that the voices may be interchanged. *See* COUNTERPOINT.) Bars 45–53: orchestra and chorus join in the original ritornello. In this movement, therefore, the fugue is a kind of large solo episode in the main concerto structure. Bach uses fugue similarly in chorale preludes (*e.g.*, the first movement of Cantata 80).

Handel.—Consideration of Handel's fugues is more difficult because his style is less systematic than Bach's. His are rarely discussed by modern books on fugue. Theorists who have replaced Cherubini's fugal rules with a new set based on Bach's pure fugues fall into the same fundamental error as Cherubini in assuming that there should be a recognized method; such people are often shocked by Handel's propensity to change or ignore his fugue subject. Paradoxically, Handel's fugues are more commonly pure fugues than Bach's, but at the same time they are more diverse in their detail.

A study of the vocal fugues in Handel's *Messiah* and *Israel in Egypt* (referred to as "M" and "I" respectively) will give some idea of the enormous variety of method. Apart from more straightforward fugues like "They Loathed to Drink" (I), "And With His Stripes," "He Trusted in God" and "Amen" (M), typical Handelian features in these works include: (1) continuation of fugal material in the orchestral part with block harmony in the chorus; *e.g.*, "He Smote" (I); (2) sharing of subject between voices; *e.g.*, "And He Shall Purify" (M); (3) successive entries in the same key in the exposition; *e.g.*, "His Yoke Is Easy" (M); (4) homophonic presentation of subject as a tune (rare in the German school); *e.g.*, "He Smote" (I), "And He Shall Purify," "His Yoke Is Easy" (M); (5) combination of fugue and descriptive choral writing; *e.g.*, "And With the Blast of Thy Nostrils" (I); (6) fugue succeeding a homophonic opening; *e.g.*, "But as for His People" (I).

Stretto, invertible counterpoint and other contrapuntal devices are used constantly by both Bach and Handel, but rarely systematically by Handel.

After Bach and Handel.—A great simplification in the details of harmony and counterpoint is one of the features of late 18th-century style. Fugue, though occasionally used with great success by Haydn and Mozart, became associated with an archaic and severe style. Quasi-fugal development of motives is common in works by these composers, though predominantly fugal movements were confined generally to choral music, with some notable exceptions. The rediscovery of some of Bach's works stimulated Mozart's interest in fugue, and it was natural that the more deliberately serious Beethoven should show an increasing preoccupation with fugal writing. His later works contain some important fugues: the piano sonatas op. 101, 106 and 110 (op. 109 and 111 contain fugal matter); the string quartets op. 131 and 133 ("Grosse Fuge"); the overture *The Consecration of the House;* and the Mass in D. Of these, that in op. 101 occupies the development section of a sonata movement, while that in op. 110 alternates with an aria. In one way or another Beethoven's fugues usually combine with some kind of sonata structure; consequently his fugues are more dramatic in conception than those of the baroque period since the sonata style concerns itself with new tonics as well as transitory modulation. Many of Beethoven's fugues also show a preoccupation with the more artificial fugal devices such as diminution and augmentation (shortening and lengthening the note values of the fugue subject), melodic inversion (turning the fugue subject upside down) and double fugue. In the latter, Beethoven favours the Italian type (commoner also in Handel) where subject and invertible countersubject (or second subject) are stated together at the outset. In the German type (used more frequently by Bach) each subject has a separate exposition, though they are usually later combined in invertible counterpoint. There are many types of double and triple fugue. Fugue 4, Book I, from Bach's "Forty-eight," for example, has two countersubjects; only the subject itself has an exposition, the countersubjects being added later. The final chorus of *Israel in Egypt* by Handel has two main subjects in alternation, one of them with countersubject, and subsequently used in a remarkable stretto with diminution.

Later in the 19th century, fugue either became a deliberate archaism following the dissemination of Bach's music or underwent deliberately romantic treatment on a large scale. Brahms, the one important 19th-century composer whose style was deliberately classical in concept, left only a handful of fugues. Keyboard fugues were written by Mendelssohn, Schumann and Liszt, and fugues occur in Berlioz's choral works and in Verdi's *Requiem* and his opera *Falstaff*.

In the 20th century many composers adopted a more contrapuntal style and fugal writing came into its own again. Fugal writing is found in D. Shostakovich's 24 Preludes and Fugues; P. Hindemith's *Ludus Tonalis,* string quartets and *Mathis der Maler;* in Stravinsky's *Symphony of Psalms* and Mass and in his concerto and his sonata composed for two pianos; in Bartok's quartets and his Concerto for orchestra; in R. Vaughan Williams' Fourth and Sixth symphonies; and in Michael Tippett's Second String Quartet.

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(P. C. A. W.)

FÜHRICH, JOSEPH VON (1800–1876), Austrian painter celebrated for his portrayals of scriptural episodes, was born at Kratzau in Bohemia on Feb. 9, 1800. His sacred subjects were transferred in numberless repetitions to the roadside churches of the Austrian state. Führich has been fairly described as a "Nazarene," a romantic religious artist whose pencil gave shape to countless incidents of the Gospel and scriptural legends. He composed with great skill, especially in outline. His mastery of distribution, form, movement and expression was considerable. He had, however, no feeling for colour; and when he produced monumental pictures he was not nearly so successful as when designing subjects for woodcuts. Führich's illustrations to Tieck's *Genofeva,* the Lord's Prayer, the Triumph of Christ, the Road to Bethlehem, the Succession of Christ according to Thomas à Kempis, the Prodigal Son and the verses of the Psalter became well known. In 1834 he was made *custos* and in 1840 professor of composition in the academy of Vienna. After this he completed the monumental pictures of the Church of St. Nepomuk. In 1872 he was pensioned and made a knight of the order of Franz Joseph. He died on March 13, 1876.

FUJIWARA, a family of Japanese aristocrats who dominated the imperial court for several centuries. The line began with Nakatomi-no-Kamatari (614–669), a man whose family had long played a very important role at court. The Emperor Tenchi, out of gratitude for the leadership Kamatari had provided for the *coup d'état* that led to imperial leadership in the adoption of Chinese governmental forms in 645 A.D., granted him the new family name of Fujiwara in 669. (*See* under JAPAN: *History: The Taika Reforms.*) The family divided into four main branches, each founded by a grandson of Kamatari. Of these, the so-called Northern House became most influential, and the others tended to decline to the status of provincial warriors or officials of middle rank. At the Kyoto court official prerogatives that had previously been rotated between several great families gradually became the monopoly of the heads of the Northern House. The able Fujiwara clan heads used their influence to acquire large grants of tax-free lands or estates (*shōen*) from the throne, and with these resources their political influence grew steadily. The estates provided administrative posts for many Fujiwara younger sons and collateral relatives as well as ties with powerful provincial interests. Normally the clan head served as first minister at court, and the resulting confusion of private with public interest did much to create the setting within which decentralization and feudal institutions could develop.

The full development of Fujiwara power began under Yoshifusa (804–872), and it reached its climax in the career of Michinaga (d. 1027). Appointments as *kampaku* or *dajō-daijin* provided opportunities for manipulation of the reigning emperor. A pattern was established whereby Fujiwara daughters were placed as imperial consorts; emperors were encouraged to abdicate at an early age in favour of immature sovereigns who, guided by a Fujiwara regent (*sesshō*), looked to these maternal relatives for counsel. Although the Fujiwara used the throne, they also shared a community of interests with it, and there seems to have been no thought of usurpation. Later heads of the Fujiwara clan proved less able to control provincial warriors, and they lost ground to them. As disorders multiplied at the capital in the 11th century these warriors were summoned to restore order, and with this the dominance of the Kyoto aristocrats came to an end.

The Fujiwara were generous patrons of the arts and of Buddhism, and their eminence coincided with the development of Japan's classical literature, art and architecture. In art history the years 897 to 1185 are usually termed Fujiwara.

See G. B. Sansom, *A History of Japan to 1334* (1958). (M. B. J.)

FUJIWARA NO SADAIE (the characters for Sadaie can also be pronounced, in Chino-Japanese, as TEIKA, and he is commonly so called) (1162–1241), Japanese poet and critic, was probably responsible, more than any other person, for the formation of Japanese literary taste. The son of the celebrated poet Shunzei (1114–1204), Teika while still in his 20s gained renown both for his poetic genius and for his rare acumen in judging the poetry of others. His early works were in a clear, classical style, but gradually Teika's poems took on the symbolic and suggestive qualities of his mature work. One of his most famous *waka* (*see* JAPANESE LITERATURE), written when he was 37, is characteristic:

> The floating bridge
> Of the dream of a spring night
> Had shattered;
> In the sky a bank of clouds
> Was drawing away from the peak.

In this poem Teika suggests that what he sees is not merely a cloud meaninglessly drifting in the sky, but an indication, a symbol, of some truth glimpsed perhaps in his dream.

Teika's poetry in this vein at first aroused opposition and even derision, but he acquired a powerful protector in the emperor Gotoba (1180–1239), himself a distinguished poet. The *Shinkokinshu* (*New Collection of Ancient and Modern Poetry*), compiled in 1205 at Gotoba's command, was largely a product of Teika's style and taste. It is a superb collection and one that influenced later Japanese poets enormously, as indicated by the comment of a 15th-century critic: "Those who adversely criticise Teika's poetry will never know Heaven; their crime will surely be punished."

The compilation of *Hyakunin Isshu* (*Hundred Poets, a Poem Each*), a collection known by heart by almost every Japanese, is generally credited to Teika. His influence was not restricted to poetry: most of the important works of Heian prose that are still extant were edited by him, and our picture today of that glorious period is conditioned by his judgments.

See *Guide to the Composition of Poetry* in De Bary, *Sources of the Japanese Tradition* (1958); *A Hundred Verses From Old Japan,* trans. by Porter (1909).

(DD. K.)

FUJIYAMA (FUJI-SAN or MT. FUJI), highest elevation (12,388 ft.) in Japan, is located near the Pacific coast in central Honshu. A dormant Quaternary volcano whose base is 78 mi. in circumference, Fuji last erupted in 1707. Five small lakes lie at its foot. Its symmetrical, snow-capped cone is a favourite Japanese artistic theme and, held sacred, is climbed by thousands of pilgrims every summer. (J. D. EE.)

FUKIEN (FU-CHIEN SHENG), one of the three maritime provinces of south China, between Chekiang on the north and Kwangtung on the south, has an area of 47,529 sq.mi. Pop. (1957 est.) 14,650,000. Its western boundary follows the crest of the high ranges that form the watershed between the Kan section of the Yangtze basin and streams flowing eastward to the China sea. These ranges effectively separate it from its western neighbour Kiangsi and form the boundary zone between Mandarin, spoken in that province, and the Fukien dialects, of which there are about seven main varieties. Topographically isolated on the landward side and with a distinct group of languages, Fukien has marked individuality. The province is mountainous and, apart from its border ranges, is crossed by several ridges with the S.W.–N.E. axis characteristic of the eastern portion of the south China highlands. A longitudinal system of drainage parallel to these ridges has been tapped by coastal streams of which the most important is the Min, which drains two-thirds of the province. These streams are navigable for large vessels only for comparatively short distances inland but small junks penetrate far upstream and they are invaluable for floating timber. The climate is subtropical but the winters are cool on the hills. The rainfall is heavy (about 60 in. per year in Foochow) and is well distributed seasonally, but with a marked maximum during the summer monsoon. There is rich

vegetation and conditions for crop production are favourable in the valleys, where two crops of rice are harvested each year, the first in June and the second in September. The forests are of great importance as a source of timber. The most important woods are fir, pine and rosewood, mostly floated in the form of big rafts down to Foochow, a great timber emporium. The export of tea from Foochow to the European market has become insignificant, but Fukien remains a great tea-growing province with a large home market. A special feature is its production of flower-scented teas, for the manufacture of which there are nearly 50 factories in Foochow. There are also factories for the manufacture of paper from bamboo pulp.

In addition to its agricultural and timber resources, Fukien has considerable mineral wealth, including coal, iron, copper, gold, silver, graphite and good clay for porcelain. Mines are widely scattered over the province.

Foochow, on the navigable lower Min river and the outlet for the northern and central interior, is the capital of the province and the largest city. Amoy, where another system of valleys finds its contact with the sea, is the great regional centre for the south. There are several smaller intermediate ports.

The great majority of the people of Fukien live in the coastal zone, where the density is very high. A great number of Chinese from Fukien and Amoy have emigrated to countries of southeast Asia where they form the majority of the overseas Chinese. Because of its proximity to Formosa, Fukien was formerly considered as being of special interest to Japan. After the Communist victory in China in 1949 the Chinese Nationalists on Formosa restricted much of Fukien's seagoing trade. To offset this restriction a new rail line connecting Amoy to Ying-tan in northern Kiangsi was completed in Dec. 1956. (J. E. Sr.)

FUKUI, Japanese coastal prefecture on the Sea of Japan in central Honshū. Area 1,647 sq.mi.; pop. (1960) 752,696. The Wakasa bay coast west of Tsuruga, an important port, has many deep embayments and peninsulas, while the main inhabited lowland, Fukui plain, lies on the northern coast backed by high mountains. Wet-rice agriculture on the plains and forestry in the mountains are leading occupations, and Fukui is noted for its silk and rayon textile manufacturing. The capital, Fukui, and smaller towns of the Fukui plain are the main textile centres. Optical goods, cement and chemicals are also produced on a small scale. (J. D. Ee.)

FUKUI, capital and largest city of Fukui prefecture, Japan, located in the central Fukui plain along the Asuwa river. Pop. (1960) 149,823. Famed as the rayon capital of Japan, Fukui traces its modern origins to the early 17th century, when it was a thriving castle town. Silk weaving developed rapidly after 1871, and between 1920 and 1935 rayon cloth became a specialty. The manufacture of machinery and the processing of foodstuffs are also important. About one-third of the city's labour force is employed in textiles, dyeing and other textile-supply industries. The city was burned badly in 1945 and was virtually destroyed by an earthquake in 1948, but has been rebuilt. (J. D. Ee.)

FUKUOKA, Japanese prefecture of northern Kyūshū, facing on the Inland sea (northwest), Shimonoseki strait (north), Tsushima strait (west) and the Ariake sea (south). Pop. (1960) 4,006,679; area 1,892 sq.mi. Rivers draining seaward have built up extensive habitable plains. The west coast is heavily indented. Fukuoka is important industrially in coal mining. The main coal fields, industrial and transportation centres, Wakamatsu, Yawata, Moji, Tobata and Kokura (*see* Kita-Kyūshū), are concentrated in northern Fukuoka. Fukuoka is the prefectural capital. Southern Fukuoka is mainly agricultural except for Kurume (silk textiles) and Ōmuta (coal and chemicals). (J. D. Ee.)

FUKUOKA, capital city of Fukuoka prefecture, northwestern Kyūshū, Japan, and the largest and most important city of Kyūshū. Pop. (1960) 647,122. The city lies along the southern coast of Hakata bay on a river delta. Here developed the port city of Hakata, which in ancient times had many continental contacts; after 1600, the castle town of Fukuoka was established. Separated only by the Naka river, the two amalgamated in 1878. In the early 1940s incorporation of Hakozaki increased the city's area. Physically removed from the northern Kyūshū coal fields and industrial belt and poorly located for trade with the rest of Japan, Fukuoka has grown as a regional commercial, administrative and cultural centre. It has many large department stores and wholesale-retail establishments. In addition to prefectural offices, there are regional offices of a number of federal government agencies. Fukuoka is the seat of Kyūshū university (in Hakozaki) founded in 1910. The modernized port has a depth of about 30 ft. and is one of Japan's best equipped and most active fishing ports. Although the city's industries include shipbuilding and heavy chemicals, consumer goods are the main products. (J. D. Ee.)

FUKUSHIMA (Fukushima-Ken), Japanese prefecture of northeastern Honshū. Pop. (1960) 2,051,137; area 5,320 sq.mi. It is mostly mountainous and human activity is concentrated in small interior basins and along the Pacific coast. Essentially agricultural, it produces rice surpluses and such cash crops as tobacco, mulberry (silk), fruit (apples, pears and cherries) and vegetables. Forestry and fishing are important but modern industry has developed only in a few cities (Kōriyama the main centre).

Fukushima, the capital and largest (pop. [1960] 138,961) city of Fukushima prefecture, is located on the Abukuma river in the Fukushima basin. Once a castle town, it is the prefectural administrative, commercial and educational hub. It serves as the silk mart of northern Honshū and has excellent railway facilities. (J. D. Ee.)

FUKUZAWA YUKICHI (1834–1901), Japanese educator, author and publisher, one of the foremost 19th-century advocates of modernization in Japan, was born in Osaka of a low-ranking military family on Dec. 15, 1834, 20 years before Matthew Perry's arrival. He entered a school in Osaka to study the Dutch language and Dutch medicine, and this acquaintance with western civilization produced in him great enthusiasm for modernization. Fukuzawa went abroad three times, in 1860, 1861 and 1867, traveling in the U.S. and Europe. He returned to write in simple language and vigorous style the first of a large number of books exhorting the Japanese people to modernize their politics and society. In the course of his life he wrote over 100 volumes explaining and advocating parliamentary government, popular education, language reform, women's rights and a host of other causes. In 1871 he founded Keiō university, to provide the kind of education he advocated in a great university independent of government domination. His newspaper, the *Jiji Shimpō*, founded in 1882 and dedicated to enlightenment of the people, also was written in simple language and style and was for years one of Japan's most influential newspapers. To the end of his life Fukuzawa insisted on promoting his beliefs by private efforts, and refused to accept any government office. He died on Feb. 3, 1901.

See Fukuzawa Yukichi, *Autobiography*. (T. C. Sh.)

FULANI (also called Fulbe, sing. Pullo; Peul(s); Fula; Fellata) are a basically non-Negro people more than 5,000,000 strong who inhabit the savanna between Senegambia and western Sudan. Fulani is the name given to their ethnic group by the Hausa people; it not only includes the pastoral and semisedentary Fulani but also the sedentary Fulani and the Toroobe (*see* below). The rich language of the Fulani—Fulfulde or Poular—has eluded precise classification. Their antiquity and mode of dispersal has aroused speculation, mostly concerning supposed middle-eastern, biblical or classical affinities.

The pastoral Fulani (also called Burure, Bororo, Abore) depend for their livelihood on herds of cattle which their family groups move between wet- and dry-season pastures, trading surplus milk products for other foods. They speak purer Fulfulde, are less Negroid and are less amenable to Islamic influences and to administration than other Fulani populations.

Semisedentary Fulani form an intermediate population which, on the savanna, circumscribes its pastoral movements in order to farm, often because of cattle losses. They sometimes return to full pastoralism, but are more likely to be absorbed into sedentary communities. In highland areas a semisedentary mode of life may be accompanied by great wealth in cattle.

The Fulani have played an important role in the political history of west Africa. They established the states of Fouta Djallon in

Guinea in the 10th century, Fouta Toro in Senegal in the 16th century, and Macina in Sudan, Yatenga in Upper Volta, Gobir in Niger, and Bagirmi in Chad before the end of the 17th century. These early states were pagan, but the Fulani became ardent Muslims and a major force in the spread of Islam in west Africa. The 18th century saw successful revolts by Muslim Fulani against Fouta Djallon in 1725, against Fouta Toro in 1776, and against Macina.

Sedentary Fulani communities (also called Fulanin Gida, Ndoowi'en) are agricultural and sometimes urban, with long-standing cultural and political ties with other ethnic groups, particularly the Hausa (*q.v.*). From these communities come the Islamic holy men, important in the political and religious life of the western Sudan, often because of their influence over widespread or mobile Fulani communities. In the 19th century these ties were used in creating or usurping kingdoms by means of the Holy War (Jihad) for the purification of Islam. That waged by Usuman dan Fodio in northern Nigeria resulted in the Fulani-Hausa empire, in which Fulani formed the ruling aristocracy. By the mid-20th century the descendants of these rulers, known as the Toroobe, no longer spoke Fulfulde and had acquired certain physical characteristics of the Hausa-speaking people.

See AFRICA: *Ethnography (Anthropology)*: *West Africa;* NIGERIA: *The People; History; see* also references under "Fulani" in the Index volume.

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FULBERT, SAINT, OF CHARTRES (*c.* 960–1028), bishop of Chartres and educator, whose pupils called him Socrates because of his encyclopaedic knowledge and determined pursuit of truth, was born in Picardy. During his education at Reims his teacher was Gerbert, later Pope Silvester II. Robert, later king of France, was a fellow student and good friend. In 990 Fulbert was appointed chancellor of the Cathedral of Chartres, which under his direction became one of the most vigorous schools in Europe. As bishop of Chartres from 1006, Fulbert used his friendship with the king of France and the duke of Aquitaine to advantage. He was sent on diplomatic missions to Rome by both parties. In 1020 Fulbert began to rebuild the burned Cathedral of Chartres, but he died on April 10, 1028, before its completion. His feast is April 10.

See Loren C. MacKinney, *Bishop Fulbert and Education at the School of Chartres* (1957); Hilda Johnstone, "Fulbert, Bishop of Chartres," *Church Quarterly Review*, 102:45–67 (1926). (E. G. RN.)

FULBRIGHT SCHOLARSHIPS. Awards to finance studies, research and other educational activities by qualified U.S. students, teachers and professors in educational institutions in other countries were authorized under the Fulbright (Surplus Property) act of 1946 and subsequent legislation. General requirements include U.S. citizenship, possession of a college degree or its equivalent, and knowledge of the language of the country. Awards cover transportation, tuition, books and maintenance for one academic year. The program was organized as a part of the U.S. state department's efforts to promote mutual understanding and educational exchanges.

See STUDENT AID; *see* also EDUCATION, INTERNATIONAL.

FULCHER OF CHARTRES (*c.* 1059–*c.* 1127), French priest who chronicled the first crusade, set out for the Holy Land with the army led by Stephen Henry, count of Blois and of Chartres, but in 1097 became chaplain to Baldwin of Boulogne, whom he accompanied on his expedition to Edessa and with whom he finally went to Jerusalem. Royal chaplain when Baldwin became king of Jerusalem, Fulcher seems also to have been prior of the Mount of Olives. The first version of his *Historia Hierosolymitana* or *Gesta Francorum Jerusalem expugnantium* was complete by 1105. Thereafter he worked over it again, recast it and brought it down to 1127, stressing especially the affairs of the kingdom of Jerusalem itself. As an eyewitness, Fulcher provides a most valuable account of the foundation of the Latin states in the east, supplemented with borrowings from other writers and quotations from documents. Well-read, he was much interested in natural history and in geography. William of Tyre drew upon his work. The chronicle—first printed in the *Gesta Dei per Francos* of Jacques Bongars, vol. i, part 1 (1611), and included in the *Recueil des historiens des croisades*, series *Historiens occidentaux*, vol. iii (1866)—was also edited by H. Hagenmeyer (1913). There is an English translation by M. E. McGinty, *Chronicle of the First Crusade* (1941).

See D. C. Munro, "A Crusader," *Speculum* (1932). (J. B. R.)

FULDA, a town and episcopal see in the *Land* (state) of Hesse, Ger., which after partition of the nation following World War II was included in the Federal Republic of Germany. It lies in the Fulda valley 850 ft. above sea level between the Rhön and Vogelsburg hills, 109 km. (68 mi.) N.E. of Frankfurt am Main by road. Pop. (1961) 45,131. The Benedictine abbey of Fulda was founded in 744 at the instigation of St. Boniface whose remains were brought there from Holland after his martyrdom and interred in the crypt of the Dom (cathedral). The abbey became a missionary centre and its school was an important place of theological learning in the early middle ages. In 1752 the abbot acquired the rank of bishop and Fulda became a prince-bishopric. In 1802 the principality was secularized but a new bishopric was established in 1829. In 1866 Fulda was annexed by Prussia. The annual conference of German Roman Catholic bishops is now held in Fulda, which is also the seat of the Deutscher Evangelischer Kirchentag (German Evangelical Church conference).

The Dom, an early 18th-century baroque building, stands on the site of two ancient churches. Opposite are the episcopal palace (the old priory) and the round church of St. Michael (*c.* 820), once the monastery's funerary chapel. The castle, formerly the residence of the prince-bishops, is now the town hall and museum; its rooms are embellished with paintings on the walls and ceilings. At the far end of the castle park is the Orangery (early 18th century), a building of classic beauty, before which stands the Floravase carved out of a single piece of stone. The Landesbibliothek (state library) contains books from the early period of the monastery. To the north of the town is the walled Frauenberg Franciscan abbey, rebuilt about 1760. The Adolphseck castle (mid-18th century), a former summer residence of the prince-bishops, is now a museum. At Petersburg (2 mi.) is the 9th-century Probstei church with frescoes and stone reliefs of the 10th century.

Fulda is at road and rail junctions. It has textile mills specializing in raincoats and cord fabrics, rubber (tires) and enamel works, and factories producing ball bearings, candles, felt, woodwork, agricultural machinery and thermometers. (H. F. L. S.)

FULGENTIUS, SAINT, OF RUSPE (*c.* 467–532/3) was born in Telepte, Byzacium, a province of Roman Africa, of a pious mother, Mariana. After a short career as fiscal procurator of the province he became a monk, residing successively in Africa, Sicily and Rome. He accepted the bishopric of the little African town of Ruspe about 507. The Arian Vandal king, Thrasimund, exiled the Catholic bishops, and 60 of them retired to Sardinia with Fulgentius as their leader and spokesman. Thrasimund recalled Fulgentius about 515, but because of Fulgentius' intransigent Catholicism, he was exiled again. Hilderich, successor of Thrasimund, was pro-Catholic and allowed the triumphal return of Fulgentius to Africa, where he died in 532/3. His liturgical feast day is Jan. 1.

The importance of Fulgentius lies in his theological work. The suggestion has been made (but not widely accepted) that he wrote the Athanasian creed. His writings are numerous but not original. He faithfully reproduces the thought of St. Augustine, whom he admired, and he has been called the "abbreviated Augustine." His writings were in large part polemical, against Arianism and Semi-Pelagianism; his major work against the Semi-Pelagians, a refutation of Faustus of Riez, has unfortunately been lost. (*See* FAUSTUS, SAINT.) Fulgentius' surviving writings are included in J. P. Migne (ed.), *Patrologia Latina*, vol. lxv, pp. 117–150, and vol. lxvii, pp. 887–962.

See G. Lapeyre, *L'ancienne église de Carthage*, 2 vol. (1932); G. Weigel, *Faustus of Riez* (1938). (G. WL.)

FULGENTIUS, FABIUS PLANCIADES (fl. *c.* late 5th and early 6th centuries A.D.), Christian Latin writer of African origin, who sought in two of his extant works to reconcile his Christian contemporaries with ancient legends. He is the author of the fantastic *Mitologiarum libri iii* containing allegorical interpretations of myths supported by absurd etymologies and of an astonishing *Expositio Vergilianae continentiae* (= contents) *secundum philosophos moralis*, in which he makes Virgil himself appear in order to reveal the mystic meaning of the *Aeneid*. He also wrote an *Expositio sermonum antiquorum*, explanations of 62 rare Latin words supported by quotations, sometimes from authors and works that never existed, and a *Liber absque litteris de aetatibus mundi et hominis*, a strange, superficial and inaccurate work based chiefly on Bible history. As indicated by the title, one letter of the alphabet is not used in each book. His youthful poems and a work entitled *Physiologus* are lost.

Fulgentius is a foolish and insipid writer. His style is luxuriant and he sometimes violates fundamental grammatical rules. Whether he is identical with St. Fulgentius (*q.v.*), bishop of Ruspe, is disputed.

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FULGURITE is the name given to glassy tubes produced by the fusion of sand by lightning and to superficial coatings of glass formed on rocks by the same agency (from the Latin *fulgar*, "lightning"). These may be distinguished as sand fulgurites and rock fulgurites. The former are more common.

Sand fulgurites are cylindrical, more or less branching objects which usually vary in diameter from about half an inch to several inches. In length they are mostly less than a foot, but some extend ten feet or more. The central cavity is usually lined with glass and the exterior shows adhering sand grains. The temperature reached in the melting of sand to produce the fulgurite is about 1,800° C. since lightning discharges take place in less than 100 microseconds (a microsecond is a millionth of a second). The temperature is estimated from the melting point of quartz. The silica glass of sand fulgurites was called lechatelierite by Alfred Lacroix after Henry le Châtelier, noted French chemist. Among sand fulgurites those collected along the shores of Lake Michigan and the Atlantic coast of the United States are prominent.

Rock fulgurites usually occur about mountain summits. They have been found at Toluca, Mex., by Alexander von Humboldt, in the Caucasus by Otto von Abich and on Mt. Thielsen, Oregon, by J. S. Diller of the U.S. geological survey. (A. F. R.)

FULHAM, a metropolitan borough of London, Eng., which under the London Government Act 1963 was to be amalgamated on April 1, 1965, with Hammersmith to form the new London borough of Hammersmith (*see* LONDON). Fulham metropolitan borough includes Parson's Green, Walham Green and North End, which were villages until the 19th century. Pop. (1961) 111,912. Area 2.7 sq.mi. Fulham lies almost entirely on a low gravel terrace and before urbanization it was one of London's chief sources of fruit and vegetables. Its only outstanding industry is pottery, first made there when John Dwight set up his kilns in the early 1670s. There are many wharves along the river front. The electric power station (1936) supplies electricity to a wide area. Coal gas was manufactured in Fulham in 1829 and its gasworks are one of the oldest in the world.

Fulham palace or manor house, seat of the bishops of London, stands in beautifully planted grounds near the river west of Putney bridge. It was originally surrounded by a moat, believed to be Danish, but this was filled in in 1921 and part laid out as a public park. The oldest portion of the house is the picturesque western quadrangle built by Bishop Richard Fitzjames, bishop of London from 1506 to 1522. The borough includes several well-known sports enclosures: Hurlingham park, where there were two polo grounds until one was built over and the other turned into a public park; Queen's club, which has tennis, rackets and other courts; the association football grounds at Craven cottage and Stamford bridge; and the Empress hall of Earl's Court. The annual Oxford and Cambridge university boat race starts at Putney bridge.

Fulham, or in its earliest form Fullanham, is believed to signify either "the place of fowls" or "the place of dirt." The manor was bought by Waldhere, bishop of London, from Tyrhtel, bishop of Hereford, in the 8th century. There is no record of the first erection of the parish church of All Saints, but the first known rector was appointed in 1242. The four-storied tower is 14th or early 15th century work greatly restored. At the Grange in North End road Samuel Richardson lived from 1739 and Sir Edward Burne-Jones from 1867 until his death.

FULK (1092–1143), king of Jerusalem from 1131 to 1143, was the son of Fulk IV, count of Anjou, and his wife Bertrada (who ultimately deserted her husband and became the mistress of Philip I of France). He became count of Anjou in 1109. Within his county he was active in asserting and recovering his powers over his vassals; outside it he played a part in the conflicts between Henry I of England and Louis VI of France, supporting each side in turn. But his ties with Henry became closer when his son Geoffrey Plantagenet married Henry's daughter Matilda. Already in 1120 Fulk had visited the Holy Land and become a close friend of the Templars. On his return he assigned to the order of the Templars an annual subsidy, while he also maintained two knights in the Holy Land for a year. In 1128, when he was preparing to return to the east, he received an embassy from Baldwin II, king of Jerusalem, who had no male heir to succeed him, offering his daughter Melisande in marriage with the right of eventual succession to the kingdom. Fulk accepted the offer, and in 1129 he was married to Melisande, receiving the towns of Acre and Tyre as her dower. In 1131 he became king of Jerusalem.

His reign was not marked by any considerable events. The kingdom, which had reached its zenith under Baldwin II, was quietly prosperous under Fulk's rule. In the beginning of his reign he had to act as regent of Antioch and to provide a husband, Raymond of Poitiers, for the infant heiress Constance. But the great problem with which he had to deal was the progress of the atabeg Zangi of Mosul. In 1137 Fulk was beaten near Barin and, escaping into the fort, was surrounded and forced to capitulate. A little later, however, he greatly improved his position by strengthening his alliance with the vizier of Damascus, who also feared the progress of Zangi (1140); and in this way he was able to capture the fort of Banias, to the north of Lake Tiberias.

Like his predecessors in Anjou, Fulk was a great builder of castles. In southern Palestine he constructed Ibelin, Blanche Garde and Gibelin as a means of checking the Muslim garrison of Ascalon. Belvoir was founded to survey the Jordan valley south of Lake Tiberias, while in Transjordan Karak was fortified by a royal vassal. Twice in Fulk's reign the eastern emperor John Comnenus appeared in northern Syria (1137 and 1142); but his coming did not affect the king, who was able to decline politely a visit which the emperor proposed to make to Jerusalem.

Fulk died in 1143 leaving two sons who both became kings and reigned as Baldwin III and Amalric I.

Fulk continued the tradition of good statesmanship and sound churchmanship which Baldwin I and Baldwin II had begun. Unfortunately he was unable to head a combined resistance to the rising power of Zangi of Mosul.

See J. Chartrou, *L'Anjou de 1109 à 1151* (1928); S. Runciman, *A History of the Crusades*, vol. ii (1952). (E. B.; R. C. SMA.; X.)

FULK (d. 900), archbishop of Reims and supporter of the Carolingian dynasty, succeeded Archbishop Hincmar in 883. He was soon preoccupied in defending his territories against the Norman invaders. Personal ambition led him to support the claim to the West Frankish crown of his kinsman Guy of Spoleto after the deposition of Charles the Fat (887), but he grudgingly rallied to the cause of the successful candidate, Odo, count of Paris. Odo's failure to defend France against the Normans soon allowed Fulk to become the leader of unrest among the disgruntled nobility of the northeast.

Their instrument and the hope of all legitimists was the young Carolingian Charles the Simple, whom Fulk crowned at Reims in 893. From 898 (when Charles, after five years of civil war, became Odo's heir) to his death, Fulk was chancellor. His efforts to keep

the wealthy abbeys and benefices of his church out of the hands of the nobles incurred the hatred of Baldwin II, count of Flanders, who secured his assassination on June 17, 900.

FULK Nerra (*c.* 970–1040), count of Anjou from 987, the eldest son of Geoffrey I Grisegonelle (Gray Tunic) and Adela of Vermandois, succeeded his father as count of Anjou on July 21, 987. Exposed at first to the attacks of the counts of Brittany, he had to fight for a long time to defend his frontiers against them. He then turned against his neighbour in the east, Eudes, count of Blois, in order to seize the Saumur region and part of Touraine.

A ruthless warrior who burned and pillaged the monasteries in his path, Fulk nevertheless was subject to fear of divine retribution for his misdeeds. To atone for them, he made three pilgrimages to the Holy Land and founded or restored several abbeys, including that of Beaulieu, near Loches (*c.* 1007), that of St. Nicolas at Angers (*c.* 1020), that of Notre Dame de la Charité at Angers (*c.* 1028) and that of St. Florent (which he had burned during his wars) at Saumur. To protect his frontiers, meanwhile, he built a number of castles, some of which, such as the keep at Langeais, still stand. For this reason he was called *le Grand Bâtisseur* ("the great builder"). Fulk died at Metz on June 21, 1040, on his way back from his third pilgrimage, and was buried in Beaulieu abbey. By his first marriage to Elizabeth (d. 1000), daughter of Bouchard the Venerable, count of Vendôme, he had had one daughter, Adela, who married Boon of Nevers and left the countship of Vendôme to her children. By his second marriage (1006) to Hildegarde of Lorraine, he had one son, Geoffrey Martel, and a daughter, Ermengarde, who married Geoffrey, count of Gâtinais, and was the mother of Geoffrey the Bearded and of Fulk le Réchin. *See* Anjou.

See C. Port, *Dictionnaire historique . . . de Maine-et-Loire,* 3 vol. (1874–78); L. Halphen, *Le Comté d'Anjou au XIe siècle* (1906).
(J. Le.)

FULLER, ANDREW (1754–1815), English Baptist minister, theologian and first secretary of the Baptist Missionary society, was born Feb. 6, 1754, at Wicken, Cambridgeshire. In 1770 he joined the Soham Baptist church, Cambridgeshire, and five years later became its pastor. For the next seven or eight years he was painfully working his way from hyper-Calvinism to an evangelical emphasis. His *Gospel Worthy of All Acceptation* (1784) began a theological revolution among the Particular Baptists. After moving in 1782 to Kettering, Fuller became a leader of the Northampton Baptist association and a close friend of William Carey, John Ryland and John Sutcliff. This group of young men was responsible, at the instigation of Carey, for the formation in 1792 of the Baptist Missionary society, and Fuller's main activities, in addition to his Kettering pastorate, were connected with the affairs of this society. He traveled to all parts of the country, pleaded for money and conducted an extensive correspondence in the interests of enterprises in Sierra Leone, Ceylon and Jamaica, as well as India. He died at Kettering, May 7, 1815.

See A. G. Fuller, *Collected Works of Andrew Fuller* (1831); G. Laws, *Andrew Fuller* (1942). (E. A. Pa.)

FULLER, GEORGE (1822–1884), U.S. painter, noted for his haunting, dreamlike figure paintings, was born at Deerfield, Mass., Jan. 17, 1822. At first an itinerant portraitist, he settled in New York city about 1847 and enjoyed moderate success there until 1860. Then, after a visit to Europe, he retired to Deerfield and for the next 15 years managed the family farm, painting only for his own pleasure. In 1876, however, pressed for money, he sent some paintings to Boston. They attracted much attention and he never thereafter lacked patrons. He died at Brookline, Mass., March 21, 1884. Fuller is remembered for his introspective later works, notably "The Quadroon" and "Romany Girl."
(D. H. W.)

FULLER, JOHN FREDERICK CHARLES (1878–), British soldier, military analyst and war historian, one of the earliest students of armoured warfare, was born on Sept. 1, 1878. During World War I, after holding staff appointments, he became chief general staff officer of the tank corps in Dec. 1916. Armoured tactics had been given a setback by the premature use of tanks in the battle of the Somme, but Fuller introduced vigorous new concepts. He planned the surprise attack of 381 tanks at Cambrai on Nov. 20, 1917, which dates the coming of age of armoured warfare, and had a responsible share in planning the 1918 tank operations.

In 1922 Fuller became chief instructor at the Staff college and in 1926 was appointed military assistant to the new chief of the imperial general staff. Promoted major general in 1930, he retired in 1933 to devote his time to writing. His *Tanks in the Great War* (1920) was followed in 1923 by *The Reformation of War,* the first of a series of provocative books challenging many of the tenets of British military thought. Fuller's books had a devoted following of readers in Europe and the United States, though in conservative military circles he was regarded as an extremist and visionary. The lectures of his *Field Regulations III* (1932) were adopted for study by the general staffs of the German, Soviet and Czechoslovak armies. But his insistence on the potentialities of the armoured offensive for swiftly crushing an unready nation clashed with the defensive tactical doctrines of British staff officers of the 1930s, and he lost favour with Britain's allies by predicting that the Maginot line would become "the tombstone of France." Thus his controversial writings were influential chiefly in molding German and Russian tactical thought on the eve of World War II.

As correspondent for the *Daily Mail* (London), he reported the Italian invasion of Ethiopia and the Spanish civil war, and he was the only foreigner at Hitler's first maneuvers, in 1935. Fuller devoted the World War II period entirely to writing, and in 1948 he published one of the first histories of that conflict, *The Second World War, 1939–1945.* Eight postwar years were spent in the preparation of his most comprehensive work, the three-volume *Military History of the Western World* (1954–56), covering all ages of warfare from the earliest times down to the end of World War II.

Fuller's output of more than 30 books was based on a wide range of reading and research, and he was outstanding in his field for the emphasis he placed on political and economic factors shaping tactics. No other military analyst of the first half of the 20th century had such an influence on his own age, but he was criticized on the ground that his writings about World Wars I and II were coloured at times by personal prejudice. (Ln. Ms.)

FULLER, LOIE (1862–1928), U.S. dancer, achieved distinction for her innovations in theatrical lighting as well as for her invention of the "skirt dance" or "serpentine." Born Marie Louise Fuller, in Fullersburg, Ill., she made her debut as an actress at the age of four. After tours as a child prodigy, she acted in stock companies, burlesque, vaudeville and Buffalo Bill's Wild West show.

During rehearsals for a play, *Quack, M.D.,* in 1889, she received a gift of a voluminous skirt of transparent china silk. Twirling in its billowing folds, she made her first appearance as a dancer and attained instant success.

Next she experimented with "skirt dances" performed under lights of various colours, achieving spectacular effects. In her *Fire Dance* she danced on a pane of glass, illuminated from below.

Appearing at the Folies Bergère, Paris, in 1892, Fuller attracted the attention of such artists as Toulouse-Lautrec, Jules Cheret and Auguste Rodin. She had her own theatre at the Paris Universal exposition of 1900. In 1909 she toured the United States, and in 1923 staged an inferno scene for a Paris Opéra production of Berlioz' *La Damnation de Faust.* She made her last appearance in London, in 1927, in a "Shadow Ballet" employing new silhouette techniques.

A close friend of Queen Marie of Rumania, Loie Fuller accompanied her on her American tour in 1926.

See her autobiography, *Fifteen Years of a Dancer's Life* (1913), and *Chronicles of the American Dance,* ed. by Paul Magriel (1948).
(Ln. Me.)

FULLER, (SARAH) MARGARET, Marchioness Ossoli (1810–1850), U.S. writer, was born in Cambridgeport, Mass., May 23, 1810. A brilliant and erudite woman, she has been remembered by later generations more for her personality than for her

writing. Her father's rigorous supervision of her early intellectual training made her a "youthful prodigy." Although colleges were closed to women, she pursued her scholarly interests until she became both admired and feared for her learning.

Plagued by financial difficulties after her father's death in 1835, she taught in Bronson Alcott's Temple school in Boston, 1836–37, and in the Greene Street school in Providence, 1837–39. In 1839 she published a translation of *Eckermann's Conversations With Goethe* and in 1842 a translation of part of the correspondence of Fräulein Günderode and Bettina von Arnim. Her most cherished project, never completed, was a biography of Goethe. In 1840 her friendship with Ralph Waldo Emerson and her critical essays in *The Western Messenger* won her the position of editor of the *Dial*, a magazine launched by the Transcendentalists. She wrote poetry, reviews and critiques for the quarterly; but in 1842 she had to relinquish the unprofitable editorship to Emerson.

For five winters, 1839–44, she conducted in Boston classes of "conversations" for women on literature, education, mythology and philosophy. This venture into adult education was apparently a great success; she was reputed to be a dazzling leader of discussion. Her professed purpose was "to systematize thought"; more generally, she attempted to enrich the lives of women and to dignify their place in society. The same purpose guided her in writing *Woman in the Nineteenth Century* (1845). This tract on feminism went far beyond the conventional demand for political equality in its ardent plea for the emotional, intellectual and spiritual fulfillment of women. It was published by Horace Greeley, who had admired her *Summer on the Lakes, in 1843* (1844), a perceptive study of frontier life in Illinois and Wisconsin.

In 1844, Margaret Fuller assumed the responsible position of literary critic on Greeley's newspaper, the *New York Tribune*. She warmly encouraged American writers and crusaded for social reforms but made her greatest contribution, she thought, as interpreter of modern European literature. Though many of her columns were hastily written, her critical principles and judgments have led to the 20th-century evaluation that she was "one of the best-equipped, most sympathetic and genuinely philosophical critics produced in America prior to 1850."

Before sailing for Europe in Aug. 1846, she selected some of her essays for publication as *Papers on Literature and Art*. This book assured her a cordial welcome to literary circles in England and France. As America's first woman foreign correspondent, she reported on her travels for the *Tribune;* the "letters" were later published in *At Home and Abroad* (1856). After settling in Italy in 1847, she was caught up in the cause of the Italian revolutionists, led by Mazzini, and was secretly married to the Marchese Giovanni Angelo Ossoli. During the siege of Rome (1849) she superintended a hospital while her husband fought. The suppression of the republic made her decide to return to America with her husband and child; they perished in a shipwreck off Fire Island on July 19, 1850, and with them was lost her manuscript history of the revolution.

Margaret Fuller's career was one of valiant endeavour to overcome obstacles of all kinds, a few of her own making. Emotional and impulsive, she was capable of the most intense attachments; her friends, however devoted, often found her too demanding in personal relationships. Hawthorne thought her a pretentious humbug. Because her books are diffuse in organization and undisciplined in style, she has not survived as a notable writer; but her earnest, idealistic efforts to civilize the taste and enrich the lives of her contemporaries make her significant in the history of American culture.

BIBLIOGRAPHY.—*The Writings of Margaret Fuller*, selected and edited by Mason Wade (1941) has a "Bibliography of Published Writings of Margaret Fuller." Wade's *Margaret Fuller: Whetstone of Genius* (1940) lists the chief biographies to that date. Later studies are Madeleine B. Stern, *The Life of Margaret Fuller* (1942), and Faith Chipperfield, *In Quest of Love: the Life and Death of Margaret Fuller* (1957).
(W. R. EB.)

FULLER, MELVILLE WESTON (1833–1910), chief justice of the United States, was born of a cultured New England family at Augusta, Me., Feb. 11, 1833. His grandfather, Nathan Weston, was chief justice of Maine. Graduated in 1853 with honours from Bowdoin college, Brunswick, Me., Fuller attended Harvard law school for six months, being admitted to the bar in 1855, and, after a short career on an Augusta newspaper, started, in 1856, to practise law in Chicago. He was elected as a Democrat to an Illinois constitutional convention in 1861 and to the state house of representatives in 1862, but his political career deteriorated when the people refused to adopt the constitution and the Republican governor prorogued the legislature for Civil War disloyalty. Unknown nationally, but eminent at the Chicago bar, Fuller was appointed chief justice in 1888 by Pres. Grover Cleveland. In 1897–99 he served as an arbitrator in the Venezuelan boundary controversy between Great Britain and Venezuela and from 1900 to 1910 as a member of the Hague court of arbitration. He served as chief justice until his death which occurred at Sorrento, Me., on July 4, 1910, a longer term than that of any other chief justice except John Marshall and Roger B. Taney.

As chief justice, Fuller's great success was as an administrator rather than as a jurist. A gentle, modest, moderate man, scholarly and able but not of transcendent brilliance, he won the affection of his associate justices. Justice Oliver Wendell Holmes and Justice Samuel F. Miller both declared that Fuller was the best presiding judge they had ever known. By his independence and courage, his impartiality and nonpartisanship, his human sympathy and sense of humour, his skill in suppressing acrimonious dissents and, most of all, his rare executive ability, he raised the court in professional and popular esteem. He left behind no outstanding opinions of his own except those declaring the Income Tax law of 1894 unconstitutional. (W. L. K.)

FULLER, THOMAS (1608–1661), English scholar, writer and preacher, was one of the wittiest and most prolific authors of the 17th century, but, because even his weightiest pronouncements contain amusing passages and his writings abound with epigrams, anecdotes, puns and other conceits, a name for quaintness has obscured his real merits. Fuller's fame as a popular preacher and writer never prevented him from careful attention to literary form. As a historian he made no claims to profound research, but he was a serious gatherer of facts from original sources, and his larger works are still highly regarded for the information they contain. *The Holy War* (1639), a history of the crusades, is of permanent value. *The Holy (and Profane) State* (1642), a collection of characters, now Fuller's most readable work, provides both instruction and entertainment and is important to the historian of the English essay and biography. His *Worthies*, also highly readable, is still an important work of reference for biographical details of Englishmen, arranged by counties.

Fuller was born in Aldwincle, Northamptonshire, where his father was rector, and was christened on June 19, 1608. His mother's brother, John Davenant, bishop of Salisbury, had been president of Queens' college, Cambridge, and he was entered at Queens' at 13 and at 20 became the youngest M.A. in the university. In 1630 he was appointed curate of St. Bene't's, Cambridge; in 1631 he was given a prebend's stall in Salisbury cathedral and was presented to the living of Broadwindsor, Dorset. He took his bachelor of divinity degree at Cambridge in 1635. In 1638 he married Ellen Grove; she bore him a son, John, in 1641, but died a few months later. In 1640 Fuller represented the diocese of Bristol at the first church convocation in London, and established his great reputation as a preacher in the pulpits of the city churches. In 1641 he was appointed preacher at the Chapel Royal, Savoy, London, where he officiated until Aug. 1643. An adherent of the Royalist cause, he yet preached peace: "The best and only way to purge errors out, is in a faire and peaceable way; for the sword cannot discerne betwixt truth and error; it may have two edges, but never hath an eye." Yet his moderate views did not save him from the attentions of the Parliamentarians, and he found it advisable to leave London for Oxford. From Dec. 1643 to July 1644 he acted as chaplain to the Royalist army, spending several weeks with the forces besieged in Basing house, Hampshire. In May 1644 he returned to Oxford, where he preached a notable sermon entitled *Jacob's Vow*. He moved with the army to Exeter, where for nearly two years he was in attendance on the household of the infant Princess Henrietta, and there published his small

book of meditations, *Good Thoughts in Bad Times* (1645), many times reprinted, sometimes with *Good Thoughts in Worse Times* (1647).

In June 1646 he returned to London and wrote *Andronicus, or the Unfortunate Politician* (1646), a satire against Cromwell. After a few months, however, he moved to Boughton house, Northamptonshire, the seat of an old friend, Lord Montagu, where he applied himself to his two great historical works, *The Church-History of Britain* (1655) and *The History of the Worthies of England* (1662); but he was soon again leading the life of a wandering scholar.

The execution of the king on Jan. 30, 1649, was to Fuller "the midnight of misery," and his *Church-History* gives a full and accurate account of the king's death and burial. In the same year he was presented to the living of Waltham abbey, Essex. He made many friends in the district, including Izaak Walton, and was given a library at Copt hall by the earl of Middlesex. Under these conditions he was able to complete a large historical work, *A Pisgah-Sight of Palestine* (1650).

In 1652 Fuller was again appointed to preach in a London pulpit at St. Clement's, Eastcheap. He married Mary Roper, who bore him two sons and a daughter, though only one, Thomas, survived infancy, and was at last able to complete his *Church-History*, to which he added a *History of the University of Cambridge* and a *History of Waltham Abbey*. *The History of the Worthies* was published posthumously by his elder son.

Probably in 1657 Fuller had to appear before Cromwell's "Tryers" to test his fitness for public preaching. He came successfully through the ordeal, but soon after resigned his living at Waltham abbey. In 1658 he was presented to the living of Cranford, near London. He continued to preach in London, and at the Restoration was again given his prebend's stall in Salisbury cathedral and became a doctor of divinity at Cambridge. He might have received a bishopric for his loyalty but was taken ill while preaching a marriage sermon at the Savoy and died at his lodgings in Covent Garden on Aug. 16, 1661.

Fuller in his prime was described as a tall, burly man with a ruddy face and curly hair. He possessed a remarkable memory and needed little sleep, which helps to account for his great output, despite the harassed life he led. He confessed, indeed, that he had written too many books, but he loved all books for their own sake and took an interest in the physical appearance of those that he published. He has had no more sincere admirer than Charles Lamb, who made a selection of his works for Leigh Hunt's quarterly *Reflector* (1812).

BIBLIOGRAPHY.—There is a full *Bibliography of Fuller*, ed. by S. Gibson for the Oxford Bibliographical society, with introduction by Geoffrey Keynes (1936). For his life *see* the short anonymous *Life* (1661); and J. E. Bailey, *The Life of Thomas Fuller* (1874). (G. L. K.)

FULLER'S EARTH, an important industrial clay used primarily as an absorbent, so named from its use by fullers, that is, textile workers who fulled or scoured, cleansed and thickened cloth, to remove grease from it. It was increasingly employed in the second half of the 20th century as a carrier for insecticides and fungicides and in drilling mud. As these uses increased, its former use as a colour remover in mineral oil and vegetable oil refining declined. The decolorizing action of the clay is not a filtering action but a selective adsorption by which the dark constituents of the oil are absorbed as a coating on the clay particles, leaving behind the colourless constituents. This selective property, which is mainly physical, has been explained as being connected with open bonds in the clay developed by the removal of hydrogen (H), hydroxyl (OH) or some of the cations from the component minerals. It is not limited to any one clay mineral, nor is it present to an equal degree in clays that are identical in mineralogical and chemical composition. Weathering improves the adsorptive capacity of some clays and the upper exposed portion of the deposit is superior to the lower part having the same mineralogical composition. Clays having a marked bleaching action on oils are termed adsorbent clays; these are divided into active clays (or fuller's earth) that are used without any other treatment except drying and grinding, and the activated clays that are prepared by partial bleaching with strong acids. Activated clay, which includes many calcium bentonites (*see* BENTONITE), is expensive because of the added cost of the acid treatment, but it has a strong bleaching action on some oils so that a little does the same work as more of the cheaper naturally active clays. Other substitutes include activated bauxite, diatomite and synthetic magnesium silicate.

Two methods of treatment are used in industry: the contact method in which the ground adsorbent clay is stirred in the oil, heated and filtered; the percolation method, in which the oil percolates through a cylinder filled with dried clay ground to pass a 150-mesh screen. Some granular fuller's earth and bauxites that have been activated by heating can be heated at a controlled temperature to drive off the colouring matter and can be reused.

The selective adsorption of fuller's earth and bleaching clay is connected mainly with the minerals of the montmorillonite group (*see* CLAY AND CLAY MINERALS), which are hydrous aluminum silicates containing calcium, magnesium and iron. These clay minerals have base exchange properties and are often the chief components of bentonite, a clay formed by the alteration of the glass that once constituted volcanic ash. The mineral smectite, a term used synonymously with fuller's earth in the textbooks of the 18th century, has an X-ray diffraction pattern and a chemical composition identical to montmorillonite, which is the preferred name. The smectite of Cilly, Styria, and of the Woburn sands, England, shown to be montmorillonite retaining the structure of volcanic ash, is bentonite as well as fuller's earth. Decolorizing effects on edible oils and lard have been connected with a few clays composed of kaolinite and halloysite (hydrous aluminum silicates) and hydrous micas (hydrous aluminum silicates containing potash). The fuller's earth of Attapulgas, Ga., composed of the clay mineral attapulgite, has a chain structure in place of the usual sheet structure of other clay minerals. Some glauconite (a hydrous potassium iron silicate) has natural bleaching qualities that can be further developed by acid treatment. The quality of fuller's earth can be determined only by a practical test.

Fuller's earth may occur at any geological horizon; in Surrey, Eng., it is of Cretaceous Age; near Bath it is of Jurassic Age; at Bala, north Wales, it occurs in Ordovician rocks; in Saxony it is said to be the decomposition product of a diabasic rock. In North America, Ordovician to Pliocene deposits are distributed from Mexico to Alberta, Can. In the United States the main production has been from the Eocene and Miocene of Georgia and Florida and the Eocene of Tennessee, and to a lesser extent from Mississippi, Texas, Colorado, Illinois and Utah. (V. T. A.; X.)

FULLERTON, a city of Orange county, Calif., U.S., 25 mi. S.E. of Los Angeles and a part of the Los Angeles–Long Beach standard metropolitan statistical area. Within the city limits are located one of the pioneer public junior colleges of California (established in 1913) and a state college (established in 1959). In keeping pace with the tremendous growth of Orange county during and after World War II, the industrial section of Fullerton underwent rapid but orderly development. Many of the nation's leading companies located branches there. The citrus and other agricultural industries and the production of crude oil, mainstays of the city's economy before its industrialization, continued to be important sources of revenue. Besides possessing excellent local recreational facilities, the city is conveniently located within easy driving distance of all of southern California's beach, mountain and desert recreational centres. The original townsite of Fullerton was laid out in 1887 and the city was incorporated in Jan. 1904. It was named for George Fullerton, an executive of the Santa Fe railroad, who in 1879 was allocated $50,000 to invest for the company. He purchased the land on which the city lies and incorporated the Pacific Land Improvement company to develop it. Fullerton has a council-manager form of government, in effect from 1953. Pop. (1960) 56,180. For comparative population figures *see* table in CALIFORNIA: *Population*. (WM. H. K.)

FULMAR, a sea bird, *Fulmarus glacialis*, of the northern North Atlantic, Pacific and Arctic oceans. About 20 in. long, the fulmar looks like a white, gray-winged gull; but like other birds of the family Procellariidae, it has the nostrils opening in a pair of tubes on top of the base of the bill. The birds spend

much of the year at sea. In flight they alternate rapid flapping with long glides on stiffly extended wings, like the related shearwaters (*q.v.*). Fulmars settle to feed on fish, crustaceans and offal from fishing and whaling operations and commonly follow ships.

JOHN MARKHAM

FULMAR OR FULMAR PETREL (FULMARUS GLACIALIS) ON NEST

Fulmars normally breed in colonies on cliffs. Little or no nest is made and one white egg is laid. The parents take turns incubating for six to eight weeks. The downy young is cared for by both parents for almost two months, until it leaves the nest ledge.

Especially when disturbed at their nests, fulmars forcibly eject an "oil" from their mouths. This warm, musty-smelling substance, which is really a liquid, vitamin-rich wax, is probably secreted by glands in the fore part of the stomach. Its role in the life of the bird has been a matter of discussion, and the most reasonable suggestions seem to be that it may serve both to eliminate excess vitamin A from the bird's body, an excess accumulated from a vitamin A-rich diet, and to repel intruders, such as gulls, that approach the fulmar's nest. *See* also BIRD. (A. L. RD.)

FULMINIC ACID is an organic compound of formula CNOH. Its salts have been known for a long time and are of interest because they are sensitive explosives. The silver salt, fulminating silver, seems to have been obtained in the 17th century. The mercuric salt, mercury fulminate (*q.v.*), first prepared by E. Howard in 1799, is obtained by the action of ethyl alcohol and nitric acid on mercuric nitrate. The salts vary in sensitivity and some are among the most sensitive explosives known, since explosions have been recorded when they have been rubbed under water with a glass spatula.

The free acid is unknown. A solution of it in ether can be obtained by acidifying an aqueous solution of the sodium salt and extracting with ether. The acid, however, is volatile with ether vapour and cannot be separated by fractional distillation. Further, it is unstable and polymerizes rapidly in both aqueous and ethereal solution to products which are mentioned below.

The constitution of fulminic acid was a matter of controversy for many years, and investigation of the problem was not made easier by the instability of the acid and the explosive nature of both the acid and its salts. The stumbling block to general acceptance of the formula CNOH for the acid was that it implies "bivalent" carbon. Wider knowledge of the modes of union of atoms removes this difficulty. It is now known that bivalent carbon in the isocyanides, RNC, is a misconception; the link which was written $-N=C$ shows the properties of a triple link in its length, its heat of rupture and the force constants of the oscillation of the carbon and nitrogen atoms. Bivalent carbon in these compounds is not bivalent in the sense that the atom has six valency electrons: the "lone pair" of electrons of the nitrogen atom is also involved in the linkage between the two atoms so that each has the normal number of eight valency electrons. The same is almost certainly true for fulminic acid. Its behaviour makes complete investigation difficult, but the resemblance of its chemistry to that of the isocyanides is strong evidence that its structure is correctly represented by the formula $:C:::N:OH$ in which the dots represent valency electrons. (T. W. J. T.; X.)

FULTON, ROBERT (1765–1815), U.S. engineer best known for his development of the steamboat, was born on a farm at Little Britain (now Fulton), 22 mi. S. of Lancaster, Pa. At an early age Fulton became a jeweler's apprentice in Philadelphia; in 1785 he began working independently as a "miniature painter and hairworker." He went to England in 1786 to study under Pennsylvania-born Benjamin West (*q.v.*), the artist. He abandoned art for engineering in 1793, his principal interests being reflected in his *Treatise on the Improvement of Canal Navigation* (1796). Fulton tried, unsuccessfully, to interest the United States and, later, France in his canal proposals, moving to France in the spring of 1797. A few months later he submitted plans for a submarine, suggesting to the French that British warships could be destroyed by submarines attaching underwater bombs and then escaping undetected. His "Nautilus," having most of the features of David Bushnell's earlier (1775) submersible (*see* SUBMARINE), was launched in 1800 and performed creditably. The vessel was reconstructed with improvements in 1801, but nevertheless the project was rejected. Fulton turned now to steamboats, having formed a partnership with Robert R. Livingston (*q.v.*), then U.S. minister to France. Livingston had experimented with steamboats and held a monopoly for steam navigation on the Hudson river. The two men launched a steamboat of Fulton's design on the Seine in 1803. The British government, long having full knowledge of the submarine plans through Fulton's connivance, induced him to come to England in 1804; however, with the victory at Trafalgar in 1805, British interest in new naval weapons vanished. Fulton also tried unsuccessfully to interest President Jefferson in his submarine.

He returned to the U.S. in 1806, having been abroad for nearly 20 years. Livingston was also back in America, and a boat hull was ordered by the two. On Aug. 9, 1807, "The Steamboat" (as Fulton called it) made its trial runs powered by a 24-h.p. Boulton and Watt engine. Eight days later came the historic 150-mi. trip from New York to Albany. Commercial schedules were established in the fall, the boat then being advertised as "The North River Steamboat." Substantially rebuilt and lengthened to 149 feet, the boat was registered as "The North River Steamboat of Clermont" (shortened to "Clermont" by the press) in 1808. Additional boats were built in the next few years. Fulton married Livingston's cousin Harriet, established an engine works in New Jersey, and developed steam ferries for the Hudson and East rivers. The first steam navigation of the central U.S. waterways was made by the Fulton-designed, Pittsburgh-built "New Orleans" on the Mississippi in 1811. Fulton's last triumph was the promotion and building of a mobile floating fort for the defense of New York harbour in the War of 1812. This ship, known both as the "Demologus" and "Fulton the First," was launched shortly before the war ended in December 1814. Fulton died in New York on Feb. 24, 1815.

It is clear that Fulton—a clever mechanic with fertile imagination, a perennial opportunist and an astute businessman—was the leader in developing the steamboat to commercial status by the synthesis and extension of the most successful ideas of Europe and America. The steamboat patents he held were for improvements; they were not basic patents. His submarine plans were also based largely on the work of others.

BIBLIOGRAPHY.—H. W. Dickinson, *Robert Fulton, Engineer and Artist, His Life and Works* (1913); W. B. Parsons, *Robert Fulton and the Submarine* (1922); J. T. Flexner, *Steamboats Come True* (1944). (R. S. HA.)

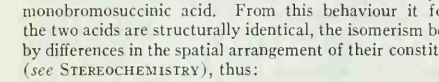
FUMARIC AND MALEIC ACIDS, a pair of stereoisomeric unsaturated organic dibasic acids. The chemical formula for both acids is $C_4H_4O_4$. Fumaric acid (*trans*-butenedioic acid) is found in fumitory (*Fumaria officinalis*), various fungi (*Agaricus piperatus*, etc.) and Iceland moss. It is obtained by heating malic acid alone to 150° C. or by heating it with hydrochloric acid or hydrobromic acid. It may also be obtained by boiling monobromosuccinic acid with pyridine in aqueous or alcoholic solution, and by heating maleic acid to 210° C. Commercially, the acid is prepared by the fermentation of sugar. It crystallizes in small prisms or needles and is practically insoluble in cold water. It sublimes to some extent at about 200° C., being partially converted into maleic anhydride and water, the reaction becoming practically quantitative if dehydrating agents are used. Potassium permanganate oxidizes it to racemic acid (*see* TARTARIC ACID).

Maleic acid (*cis*-butenedioic acid) is obtained in the form of its anhydride by distilling malic or fumaric acids, or by heating fumaric acid with acetyl chloride to 100° C. It crystallizes in monoclinic prisms, which are easily soluble in water, and it melts at 130° C. to a liquid which boils at 160° C. with decomposition

into water and maleic anhydride. When heated with concentrated hydrobromic or hydriodic acid, it is converted into fumaric acid. Oxidation by potassium permanganate converts it into mesotartaric acid.

Maleic anhydride is obtained by distilling maleic or fumaric acid with phosphorus pentoxide. The anhydride forms triclinic crystals which melt at 60° C., and it boils at 196° C. On a manufacturing scale maleic anhydride is prepared by oxidation of benzene vapour with air over a vanadium pentoxide catalyst.

Both acids yield acetylene by the electrolysis of aqueous solutions of their alkali salts, and on reduction both yield succinic acid; while by the addition of hydrobromic acid they both yield monobromosuccinic acid. From this behaviour it follows that the two acids are structurally identical, the isomerism being caused by differences in the spatial arrangement of their constituent atoms (*see* STEREOCHEMISTRY), thus:



The foregoing formulas account for the reactions mentioned above and also for the fact that maleic acid readily yields an anhydride, whereas fumaric acid does not.

Uses.—Both acids are of considerable industrial value, particularly in the preparation of (1) polyester resins; (2) various alkyd resins used in paints, varnishes and molding powders; (3) rosin esters for lacquers and quick-drying printing inks; (4) additives that improve natural drying oils.

During World War II maleic and fumaric polyesters came to be used widely as binders for glass fibres. The resin formed by the condensation of glycols with maleic or fumaric acid was dissolved in a monomeric vinyl composition such as styrene; this procedure permitted the formation of a viscous liquid which could be cured without the loss of any volatile components.

Currently these resins, together with glass fibre, are employed for the fabrication of various structural assemblies for automobiles, tank cars, furniture, complex moldings, boats, refrigerators, as well as other large structural assemblies.

See Sir T. E. Thorpe, *Dictionary of Applied Chemistry*, 4th ed. by J. F. Thorpe and M. A. Whiteley, vol. 1–10 (1937–50). (E. L. KA.)

FUMAROLE, a vent from which volcanic vapours issue, named indirectly from Lat. *fumariolum*, "a smoke hole." The vapours from fumaroles were studied first by R. W. Bunsen in Iceland, and afterward by H. Sainte-Claire Deville and other chemists and geologists in France, who examined the vapours from Santorin, Etna, etc.

The hottest vapours issue from dry fumaroles, at temperatures of at least 500° C., and consist chiefly of anhydrous chlorides, notably sodium chloride. The acid fumaroles yield vapours of lower temperature (300° to 400° C.) containing much water vapour, with hydrogen chloride and sulfur dioxide. The alkaline fumaroles are still cooler, though above 100° C., and evolve ammonium chloride with other vapours. Cold fumaroles, below 100°, discharge principally aqueous vapour, with carbon dioxide and perhaps hydrogen sulfide.

See also VOLCANISM.

FUME PRECIPITATION, ELECTRICAL: *see* PRECIPITATION, ELECTROSTATIC.

FUMIGATION, the use of gases, vapours, smoke or fumes for the destruction of organisms; the practice is derived from the early use of fumes, perfumes, smoke or vapours for ceremonies of incantation and for the purification of air. The burning of incense or other aromatic substances has long been associated with various religious ceremonies; in primitive rituals it counteracted the disagreeable odours generated by the sacrifice of animals and mystified and exerted a favourable psychological influence over the religious devotees. Later, fumigation was practised in churches to purify the air in time of public sickness and to dispel unpleasant odours. In certain churches this practice persists merely as a part of ceremony: the rising fumes of burning incense symbolize the rising prayers of the devout (*see* also INCENSE). In medicine, the term in early times meant the exposure of the body to fumes; for example, sulfur fumes once were recommended for the treatment of scabies.

The value of fumigant chemicals for destroying organisms was known to the early Greeks and Romans; Cato in about 200 B.C. described the use of fumes from a mixture of sulfur and asphalt to control tree-infesting insects.

Chemical warfare (*q.v.*), or the use of poisonous smoke or chemicals for the destruction of man, is a form of fumigation and is believed to have been attempted first during the wars of the Athenians and Spartans (431–404 B.C.), when the Spartans saturated wood with pitch and sulfur and burned it under the walls of Plataea and Belium in an effort to drive the defenders from their posts.

The modern development of fumigation for the control of noxious organisms began in 1854, when the use of carbon disulfide for insect control was reported.

Characteristics of Fumigants.—Fumigation, which requires some technical skill and certain precautions in application, is most feasible for the nonselective quick killing of vermin in large commercial operations. For the control of household pests it has been, to a considerable extent, supplanted by more convenient methods of extermination such as the application of powders and residual sprays.

Fumigation is most commonly accomplished with toxic gases. Gases have the capacity to expand or diffuse indefinitely into any volume available. This capacity, coupled with the extremely small size of their individual particles (considerably less than 0.001 micron [μ] in diameter), enables gases to reach the tissues of organisms readily via the respiratory tract. These same characteristics enable some fumigants to exert a significant toxic effect by direct penetration of exposed skin surfaces. However, this does not apply as extensively to insects and related organisms because of their protective exterior skeletal structure. Vapours (gaseous materials very near the condensation point) have a tendency to diffuse and are entirely satisfactory for use in fumigating. However, smokes and fumes do not diffuse, and with individual particle size ranges of 0.001–0.4 and 0.1–1.0 μ, respectively, are near the limit of effectiveness for fumigation. Even less effective are aerosols, which consist of air-borne liquid droplets ranging from 0.1 to 30.0 μ in diameter. An idea of the effect of particle size on the respiration of air-borne materials is gained from the knowledge that, in man, there is little effective penetration of the lungs by particles larger than three microns in diameter.

Some of the commoner fumigants are the following, used alone or in combination: hydrogen cyanide, carbon tetrachloride, methyl bromide, carbon disulfide, sulfur dioxide, chloropicrin, naphthalene and paradichlorobenzene (the last two compounds are the active ingredients in moth balls).

Methods of Fumigation.—Fumigation for the destruction of insects and rodents is accomplished in a variety of ways. Drywood termites are commonly controlled by placing a plastic tent over the entire infested building and releasing methyl bromide within it. Mills, factories, warehouses, packing plants and ships are routinely fumigated by the introduction of hydrogen cyanide within the structure, after first ensuring that all openings are sealed. (*See* also HYDROCYANIC ACID: *Pest Control.*)

Fumigation of packaged items is normally accomplished under vacuum in specially constructed chambers in order to ensure thorough penetration. The application of fumigants heavier than air to soils infested with destructive nematodes and insects is common practice, as is also the destruction of undesirable rodents and animal predators by pumping calcium cyanide (a bluish-gray powder that combines with atmospheric water to release hydrogen cyanide) into their burrows. Under certain conditions, it is possible to remove pests from living organisms with fumigants. For example, control of scale insects on citrus trees is accomplished by placing a tent over each tree and releasing hydrocyanic acid gas therein.

Extensive efforts have been made to destroy air-borne microorganisms by the release of disinfectant vapours—glycol, for example—but there are serious limitations to the practical use of this form of fumigation.

See also Sprays and Dusts in Agriculture.

See Arnold Mallis, *Handbook of Pest Control*, 3rd ed. (1960).

(K. L. K.; X.)

FUMITORY, any plant of the genus *Fumaria*, family Fumariaceae, comprising small, branched, often climbing annual herbs with much-divided leaves. The flowers are small, tubular, with a spurred base, and pink to purplish in colour. They are chiefly weeds of cultivation growing in fields and waste places. The common fumitory, *F. officinalis*, finds limited use as a garden plant. In past times it (and several other species of the family) was in esteem for its reputed medicinal properties; and in England, boiled in water, milk or whey, it was used as a cosmetic.

Of the same family is the climbing fumitory or Allegheny vine, *Adlumia fungosa*, native to moist woods in the northeastern United States, with delicate flowers and foliage. It is cultivated as an ornamental vine, being best suited to well-shaded places in the wild garden.

FUNCHAL, the administrative centre of the Portuguese Madeira Islands (officially styled Distrito do Funchal), lies on the south coast of Madeira. Pop. (1950) 37,215; with suburbs 95,000. Its whitewashed houses in gardens with tropical plants are built along the curving shore of Porto do Funchal and on the lower slopes of an amphitheatre of mountains which form a background 4,000 ft. high. Country houses (*quintas*), with terraced gardens, sugar-cane plantations and vineyards, occupy the immediate heights. The chief buildings include the Sé or cathedral (1485–1514), Anglican and Presbyterian churches, hospitals, museums and a casino. The lower city has wide tree-lined avenues, but parts of the older town have steep, narrow, cobbled streets, difficult for wheeled traffic and used by bullock-drawn sledges, man-carried hammocks and, for descents, by "snowless" wickerwork toboggans. The fine climate and scenery attract many visitors, especially in winter; foreigners engaged in the wine and other trades also live there. The British community was first established in the late 17th century. Funchal is the headquarters of Madeiran industry, commerce and communications (*see* Madeira). Since 1895, when a breakwater was built joining the Loo rock to the mainland, its harbour has been enlarged periodically by extending the jetty. (R. P. Be.)

FUNCTION, in mathematics, an expression, rule or law which defines a relationship between one variable (the independent variable) and another variable (the dependent variable). In its most general usage in mathematics the word function refers to any correspondence between two classes. For most functions the variables range over classes of numbers. For example, in a group of people, each person defines a related pair of values for the variables height and weight. In this case it may serve no purpose to designate an independent variable, and height may be stated as a function of weight, or weight as a function of height. The formula $A = \pi r^2$ gives for each positive real number r the area of the circle with radius r. The formula $w = c/\nu$ gives the wave length of radio or light waves in terms of the frequency ν. Here c is the velocity of light. The expressions $a + bx + cx^2$ and $a_0 + a_1x + \ldots + a_nx^n$ are polynomial functions of x when the coefficients $a, b, c, a_0, a_1, \ldots, a_n$ are given. The short symbols $f(x)$, $g(x)$, $P(x)$, . . . , are often used to stand for functions of the independent variable x, either for the sake of abbreviation, or because the nature of the function is unknown or unspecified. The quotient of two polynomials $P(x)/Q(x)$ is called a rational function. A polynomial is regarded as a special case of a rational function. The trigonometric functions sin x, cos x, tan x and others, where x is the measure of an angle, are defined geometrically in elementary trigonometry (*q.v.*). However, for practical purposes their values are given in tables. Many functions of practical importance are defined only by means of tables, as in statistics. For example, the death rate in each year over a period of years is given in mortality tables used by life insurance companies.

Inverse functions are obtained from given functions by interchanging the roles of the independent and dependent variables. Thus, if the given function is written $y = 2x$, the inverse function would be written $x = y/2$. The two functions determine the same correspondence between the two variables. The exponential function $y = 10^x$ gives a value of y for each real value of x. These values are not easily computed unless x is an integer. In this case the inverse function is written $x = \log_{10}y$ and its values are given in tables of common logarithms.

Functions involving more than two variables occur frequently in applications of mathematics. For example, the formula $A = \frac{1}{2}bh$ gives the area of a triangle in terms of its base b and altitude h. The formula $E = \frac{1}{2}mv^2$ gives the kinetic energy of a moving body in terms of its mass m and its velocity v.

Functions of a Complex Variable.—The preceding examples dealt with real variables. Practical applications of functions of a complex variable are not so easy to illustrate, but are nevertheless very extensive. They occur, for example, in electrical engineering and aerodynamics. In the case of a polynomial, or, more generally, of a rational function, the variables may obviously be taken to be complex variables if desired, since the operations of addition, subtraction, multiplication and division may be performed on complex numbers (*q.v.*), and satisfy the same formal laws as they do for real numbers. However, functions of a complex variable may easily be formed in more arbitrary ways. If the complex variable is represented in the form $x = u + iv$, where i is the imaginary unit, and u and v are real, it becomes possible to set $f(x) = P(u, v) + iQ(u, v)$, where for example

$$P(u, v) = u^3 + v^2, Q(u, v) = 3uv^3 - v, \text{ or} \quad (1)$$
$$P(u, v) = \sin u \cos v, Q(u, v) = 2u + 3v, \text{ or} \quad (2)$$
$$P(u, v) = u^2 - v^2, Q(u, v) = 2uv, \text{ or} \quad (3)$$
$$P(u, v) = e^u \cos v, Q(u, v) = e^u \sin v, \quad (4)$$

where $e = 2.718\ldots$ is the base of the natural system of logarithms. (*See* Logarithms.) Other less obvious and less direct methods of defining functions will be described later.

Geometric Representation of Functions.—Real-valued functions $y = f(x)$ of one real variable may be given a geometric representation by means of the analytic geometry (*q.v.*) of René Descartes. The independent variable x is plotted along a number scale on a line called the x-axis, which is usually taken as horizontal, and the dependent variable y is plotted along a number scale on another line called the y-axis which is usually taken as vertical. The graph of the function consists of the points with co-ordinates (x, y) where $y = f(x)$. For example, the graph of a quadratic function $y = a + bx + cx^2$ is parabola, if $c \neq 0$. Some functions are given only by their graphs. Examples are the temperature, air pressure and wind velocity as recorded by weather bureau instruments.

A complex number may be plotted in a complex plane. A function of a complex variable is represented geometrically by a correspondence between two planes, but this graphical representation is not so vivid as that described above for a function of a real variable. However, it has been found helpful to use geometric terminology in the theory of functions in both cases.

History.—The development of the theory of function goes back to Descartes' publication of his work on analytic geometry (1637). The abscissas x and ordinates y of a plane curve are variables; the curve pictures the dependence of the one on the other. The word function seems first to have been used in such a sense by Gottfried Wilhelm Leibniz (1694), who thus denoted certain lengths such as abscissas, ordinates, tangents, normals and radii of curvature, associated with the position of a point on a curve. J. Bernoulli (1698) applied the term to mathematical expressions involving variables and constants. The notation $f(x)$ was used by Leonhard Euler in 1734. His *Introductio in Analysin Infinitorum* (1748) may be regarded as the first treatise on the theory of functions, although its point of view would now be described as elementary and formal. As in the definition of Bernoulli, a function is identified with its analytic expression and according to the form of this expression it is classified as explicit or implicit, algebraic or transcendental.

The 18th century was a constructive period in mathematics, an epoch of discovery, when critical accuracy played a subordinate role. The first part of the 19th century ushered in the present era of criticism. The *Théorie des fonctions analytiques* of Joseph L. Lagrange (1797) was a precursor of this change. Better foundations were here sought by basing the processes of

the calculus on the properties of series of powers of the independent variable. Analytic expressions were still of central interest, but soon a new point of view was forced upon mathematicians by the discovery of Jean B. J. Fourier (1807) that a single analytic expression, a trigonometric series, may represent, in different domains, what had been regarded as different functions. It was believed at first that an arbitrary function could be represented by a series of Fourier. When it appeared that there were necessary restrictions, the way was open to a treatment of functions based on their intrinsic properties. In connection with his proof of the convergence of Fourier series (1829) Pierre G. L. Dirichlet gave a definition for the term function closely akin to that at the beginning of this article (*Werke*, vol. 1, p. 135).

Among the founders of the modern theory of functions, both real and complex, three are pre-eminent, Augustin L. Cauchy (1789–1857), Georg F. B. Riemann (1826–66) and Karl Weierstrass (1815–97). To the latter is especially due the arithmetization of the subject, whereby all definitions are based on equalities and inequalities concerning numbers. The theory of aggregates (*see* SET THEORY [THEORY OF AGGREGATES]), which furnishes a necessary foundation for ideas regarding domains and which arose from the investigations of Georg Cantor (1845–1918), has become one of the most important adjuncts of the theory of functions. Its development has been connected with generalizations of the notion of integration by Henri Lebesgue (1902) and others. (*See* also POINT SETS.)

The Notion of a Limit.—This is a fundamental concept in the theory of functions. A function $f(x)$ is said to have the limit L as x approaches a value c if for every positive number ϵ there exists another positive number δ such that if $|x - c| < \delta$ then $|f(x) - L| < \epsilon$. In more intuitive language, this means that the value of $f(x)$ remains arbitrarily near L whenever the point x is sufficiently close to c. When the variable x is real, the inequality $|x - c| < \delta$ means the same thing as the double inequality $c - \delta < x < c + \delta$. When the variable x is complex, it means that the Euclidean distance between the points of the complex plane representing x and c is less than δ. Corresponding statements apply to the inequality $|f(x) - L| < \epsilon$. In the definition of limit it is frequently required that the point x shall never coincide with c, so that if the function has a value $f(c)$ at c, that value has nothing to do with the existence or value of the limit L. But this requirement is not essential. The same logical form of the definition of limit applies to other cases, but one or both of the restrictions on the values taken by the independent variable and by the function may need to be changed in form. The notation $\lim_{x \to c} f(x) = L$ is used as a shorthand for the statement defined above. This symbol is to be read, "The limit as x approaches c of $f(x)$ is L." Simple examples of limits are the following:

$$\lim_{x \to 2} (x^2 + 5x) = 14 \tag{5}$$

$$\lim_{x \to 0} x \sin (1/x) = 0, \text{ if } x \text{ is a real variable} \tag{6}$$

$$\lim_{x \to 0} 1/x^2 = +\infty, \text{ if } x \text{ is a real variable} \tag{7}$$

$$\lim_{x \to 0} \frac{1}{10^{1/x} + 1} = 0, \text{ if } x \text{ is a positive real variable} \tag{8}$$

$$\lim_{x \to 0} \frac{1}{10^{1/x} + 1} = 1, \text{ if } x \text{ is a negative real variable} \tag{9}$$

In example (5) the value of the limit may be found by substituting 2 for x in the given expression, but this is not true for the other cases. In example (7) the inequality $|f(x) - L| < \epsilon$ in the definition of limit is to be replaced by the inequality $1/x^2 > 1/\epsilon$. The function $f(x) = \sin(1/x)$ does not have a limit as x approaches zero, since $\sin(1/x)$ osciilates infinitely between the values $+1$ and -1.

Continuity.—This is another important concept in the theory of functions. A function $f(x)$ is said to be continuous at $x = c$ if $f(x)$ has a limit (as x approaches c) which equals the value $f(c)$ of the function when $x = c$. Intuitively, a continuous function is one whose graph has no break. However, the theory of functions must consider continuous functions whose graphs cannot be drawn, as well as functions which are continuous at some points and discontinuous at many others. This makes the abstract logical form of definition essential. Examples (1), (2), (3), (4) and (5) are cases where the function is continuous for every value which may be assigned to c. The function $x \sin(1/x)$ is not continuous at $x = 0$ because it is not defined there, but if it is arbitrarily given the value zero when $x = 0$, then it becomes continuous. Such a discontinuity is called removable. The discontinuities of the functions $\sin(1/x)$ and $1/(10^{1/x} + 1)$ at $x = 0$ are not removable.

The derivative of a function, when it exists, is an important aid in the study of the function. A function $f(x)$ has a derivative $f'(x)$ in case

$$\lim_{h \to 0} \frac{f(x + h) - f(x)}{h} = f'(x) \tag{10}$$

(*See* CALCULUS, DIFFERENTIAL AND INTEGRAL for further discussion and examples.) The derivative $f'(x)$ need not exist for all values of x for which $f(x)$ is defined. This is illustrated by the example $f(x) = x \sin(1/x), f(0) = 0$.

Mathematicians formerly assumed that every continuous function of a real variable has a derivative except at isolated points, as in the example just cited. Weierstrass was the first to give an example of a continuous function of a real variable which does not have a derivative anywhere. This example was defined by means of an infinite series of trigonometric functions. From such an example a function may be constructed which has a continuous first derivative but has nowhere a second derivative, and so on.

Analytic Functions of a Complex Variable.—Functions of a complex variable which do not have derivatives are much more common than those which do. The functions given by (1) and (2) do not have derivatives anywhere but the functions given by (3) and (4) have derivatives everywhere. A criterion to be used in verifying the last statement will be given in the next paragraph. In applying the definition (10) of derivative to functions of a complex variable it is essential to notice that the variable h is also complex. A function $f(x)$ of a complex variable x which has a derivative at every point x sufficiently near a point c of the complex plane (including c itself) is said to be analytic at c or regular at c, and c is said to be an ordinary point for $f(x)$. All other points of the complex plane are said to be singular points. A single-valued analytic function, sometimes also called a holomorphic function, is one which is regular at some points. Every polynomial in x is a single-valued analytic function.

A function $f(u + iv) = P(u, v) + iQ(u, v)$ specified by formulas like (1) to (4) is regular at a point $c = a + ib$ if, and only if, the functions P and Q have continuous partial derivatives near the point c which satisfy the Cauchy-Riemann partial differential equations

$$\frac{\partial P}{\partial u} = \frac{\partial Q}{\partial v} \text{ and } \frac{\partial P}{\partial v} = -\frac{\partial Q}{\partial u}$$

It may also be proved that such a function has derivatives of all orders at points where it is regular. This is in marked contrast to the situation for functions of a real variable. By differentiation of the Cauchy-Riemann equations and elimination alternately of the function Q and then of the function P, it may be shown that the two components $P(u, v)$ and $Q(u, v)$ of an analytic function satisfy Laplace's equation

$$\frac{\partial^2 P}{\partial u^2} + \frac{\partial^2 P}{\partial v^2} = 0$$

A solution $P(u, v)$ of Laplace's equation is called a harmonic function. Every harmonic function $P(u, v)$ has associated with it another harmonic function $Q(u, v)$, called its harmonic conjugate, such that $P(u, v) + iQ(u, v)$ is an analytic function. Harmonic functions of two variables may be used to describe the electromagnetic field around a long straight wire carrying a current. If the curves $P(u, v) =$ constant in the uv-plane are the curves of equipotential, the curves $Q(u, v) =$ constant are the lines of

force if Q is a harmonic conjugate of P. Harmonic functions also are used in the theory of the flow around a straight airplane wing. Laplace's equation in three dimensions

$$\frac{\partial^2 P}{\partial u^2}+\frac{\partial^2 P}{\partial v^2}+\frac{\partial^2 P}{\partial w^2}=0$$

is satisfied by gravitational and electric potentials at the points of free space. (*See* SPHERICAL HARMONICS.)

A mapping or correspondence between two planes is called conformal or isogonal if corresponding pairs of intersecting curves always meet at the same angle in the two planes. When the sense or direction of rotation also is preserved under a conformal mapping, the correspondence is determined by an analytic function of a complex variable. Conversely, every analytic function determines a conformal mapping. The notion of conformal mapping may be applied in the case of curved surfaces as well as planes. For example, a map of the earth's surface may be conformal.

Functions of a complex variable also have applications in the theory of numbers. It seems surprising at first sight that properties involving only whole numbers should be provable by means of such functions.

Formula (4) may be used to define the exponential function e^{u+iv} for complex values of the argument. The definitions of the trigonometric functions for complex arguments may then be based on the formulas of Euler:

$$\sin x=\frac{e^{ix}-e^{-ix}}{2i},\cos x=\frac{e^{ix}+e^{-ix}}{2}$$

Other methods of defining these functions will be mentioned later.

Integral of a Function $f(x)$.—This may be defined as another function $g(x)$ whose derivative $g'(x)=f(x)$. Such an integral is also called an antiderivative, an indefinite integral, or a primitive function. The possibility of finding an antiderivative for a given function is a matter of luck. A large part of elementary integral calculus is taken up with devices for finding such antiderivatives in simple cases. In order to be sure of the existence of the entity searched for, and for other reasons, it is desirable to consider other definitions of the concept of an integral.

For functions of a real variable, one of the simplest definitions is the one which was given by Riemann, and is known by his name. Let the function $f(x)$ be defined on the interval $a\leqq x\leqq b$, and let this interval be partitioned into a finite number of parts $\Delta_i x$, of which the longest has length L. Let a point x_i be selected arbitrarily in each part $\Delta_i x$, and multiply the functional value $f(x_i)$ by the length of the corresponding part $\Delta_i x$. The sum of all such products for a particular partition of the interval from a to b may be denoted as $\Sigma f(x_i)\Delta_i x$ where $\Delta_i x$ is also the length of the part $\Delta_i x$. If this sum $\Sigma f(x_i)\ \Delta_i x$ has a finite limit I as the length L of the longest part approaches zero (this limit I being the same for all methods of partitioning the interval and choosing the points x_i in the parts) then this limit I is called the Riemann integral or definite integral from a to b of the function $f(x)$ and is written as

$$\int_a^b f(x)\ dx$$

When $f(x)$ is continuous, it is not difficult to prove the existence of its definite integral. It is seen intuitively that when in addition the values of $f(x)$ are all positive, $\int_a^b f(x)\ dx$ gives the area bounded by the x-axis, the ordinates $x=a$ and $x=b$ and the graph of $y=f(x)$. It is convenient to define the area as equal to this integral.

For functions of a complex variable, the definite integral becomes a line integral and its value may depend on the path of integration. Suppose that $x=\phi(t)$ is a continuous complex-valued function of the real variable t on the interval $c\leqq t\leqq d$, and let this interval be partitioned into a finite number of parts $\Delta_i t$. Let $\Delta_i x$ be the increment of x corresponding to the increment $\Delta_i t$, and let $x_i=\phi(t_i)$ where t_i is chosen arbitrarily in the interval $\Delta_i t$. Then the points x_i lie on separate short arcs of the curve C whose equation is $x=\phi(t)$. When $f(x)$ is defined for x on the curve C and the sum $\Sigma f(x_i)\Delta_i x$ approaches a finite limit I when the length L of the longest interval $\Delta_i t$ approaches zero, this limit I is denoted by the symbol

$$\int_C f(x)\ dx$$

and called the line integral of $f(x)$ along the path C. In examples (1) and (2) its value depends on the path, but in examples (3) and (4) its value depends only on the ends of the path.

The Fundamental Theorem of Integral Calculus.—For functions of a real variable, this theorem states that if $f(x)$ has an antiderivative $g(x)$, and also a Riemann integral $\int_a^b f(x)\ dx$, then the latter equals $g(b)-g(a)$. For functions of a complex variable, it states that if $f(x)$ has an antiderivative $g(x)$ (which is understood to be single-valued) throughout a region R of the complex plane, then $f(x)$ has also a line integral along any curve C in the region R, and if C begins at the point a and ends at b, then the line integral equals $g(b)-g(a)$, and so is independent of the path.

Cauchy's Integral Theorem.—This states that if $f(x)$ is an analytic function of the complex variable x in a region R which is simply connected (that is, R is all in one piece and has no holes in it), then the line integral of $f(x)$ is independent of the path. From this we find that $f(x)$ must also have an antiderivative. This theorem of Cauchy is the basis for the larger part of the modern theory of functions of a complex variable. An immediate consequence is Cauchy's formula

$$f(b)=\frac{1}{2\pi i}\int_C\frac{f(x)dx}{x-b}$$

where C is a simple closed curve enclosing the point b and lying with its interior in a region where $f(x)$ is regular. The fact shown by this formula, that the values of f at points inside the curve C are determined by its values on C, is a remarkable property of analytic functions of a complex variable. The property that analytic functions have derivatives of all orders is proved by successive differentiation of Cauchy's formula. This formula may also be used to prove Taylor's theorem, which states that near an ordinary point b an analytic function may be expressed by means of an infinite series of powers of the form $f(x)=a_0+a_1(x-b)+a_2(x-b)^2+\ \ldots$ where $a_0=f(b)$, $a_1=f'(b)$, $a_2=f''(b)/2!$, . . .

Singularities of Analytic Functions.—These are of various kinds. A singular point is called removable in case it becomes an ordinary point when the function is properly defined at the point. A singular point b is a pole for $f(x)$ in case there is another function $g(x)$ which is regular and not zero at b, and a positive integer m such that near b we have $f(x)=g(x)/(x-b)^m$. For convenience we say that $f(x)$ becomes infinite at a pole. All other singularities of single-valued functions are called essential singularities. The behaviour of a function near an essential singularity may be very peculiar.

The analytic continuation into a region R_2 of a function $f(x)$ which is regular in a region R_1 overlapping R_2 refers to a function $g(x)$ which is regular in R_2 and such that $g(x)=f(x)$ in the common part of R_1 and R_2. If the process of analytic continuation is repeated a number of times it sometimes gives a continuation $h(x)$ regular in the original region R_1 but having different values from $f(x)$ there. This makes the consideration of multiple-valued functions necessary. A simple example of such a function is $\sqrt{x}$, which has two values except at the origin. If we start with the value of $\sqrt{x}$ which is positive when x is positive, and continue analytically through a sequence of regions forming a single loop around the origin, we arrive at the value of $\sqrt{x}$ which is negative when x is positive. The origin is a branch point for the two-valued function $\sqrt{x}$. This type of singularity is not encountered with single-valued functions. For the geometric representation of multiple-valued functions it is convenient to substitute a multiple-sheeted Riemann surface for the plane of the independent variable. This is especially useful in the theory of algebraic functions and their integrals.

Methods of Defining a Function.—A function may be de-

fined by means of a power series. For example the series

$$e^x = 1 + x + \frac{x^2}{2!} + \ldots + \frac{x^n}{n!} + \ldots$$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} \ldots$$

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} \ldots$$

could be used to define these functions for all complex values of x. Other types of series and also infinite products may be used when convenient. An important case is the series of Fourier, expressing a function in terms of sines and cosines,

$$f(x) = a_0 + a_1 \cos x + a_2 \cos 2x + \ldots + b_1 \sin x + b_2 \sin 2x + \ldots$$

Such representations are of great importance in physics, in the study of wave motion and other oscillatory phenomena.

A function may be defined by the values of y satisfying an equation involving x and y. For example $y = \sqrt{x}$ is defined by the polynomial equation $y^2 - x = 0$. Every function $y = f(x)$ defined by a polynomial equation between x and y, such as $x^2y^3 - x^3y + x = 1$, is called an algebraic function. Transcendental functions may be defined by other types of equations. For example, if the function $\sin x$ is known, the function $y = \cos x$ is defined by the equation $\sin^2 x + y^2 = 1$ if we take the solution y which has the value $+1$ when $x = 0$. The solution of $x = e^y$ for y gives the inverse function $y = \log_e x$, which is a multiple-valued function having infinitely many values when x is complex. Sometimes functions are most conveniently defined by means of differential equations. For example $y = \sin x$ is the solution of the differential equation $d^2y/dx^2 + y = 0$ having $y = 0$, $dy/dx = 1$ when $x = 0$; also, $y = \cos x$ is the solution of the same equation having $y = 1$, $dy/dx = 0$ when $x = 0$. In special cases the solution of a differential equation may be represented as a line integral; for example, $\log_e x = \int_1^x \frac{dx}{x}$. The value for this integral may be shown to depend on the number of times the path encircles the origin in the complex plane. Some functions are more conveniently defined by means of definite integrals; for example,

$$\Gamma(x) = \int_0^\infty e^{-t}\, t^{x-1}\, dt$$

It may be shown that when n is a positive integer $\Gamma(n) = (n-1)!$ integral equations may also be used to determine functions. Thus the function $f(x) = \sin x$ for x on the interval from 0 to π is a solution of the integral equation

$$f(x) = \int_0^\pi G(x, t)\, f(t)\, dt$$

where the kernel $G(x, t) = (\pi - x)t/\pi$ for $t \leqq x$ and $G(x, t) = (\pi - t)x/\pi$ for $t > x$. Very frequently the various properties of a function are most conveniently studied by using several methods of representing it.

Abstract Function Theory.—Many of the advances in the modern theory of functions have been made possible by proceeding from the basis outlined above to a more abstract and general point of view. The functions considered in the calculus of variations (*q.v.*) are integrals such as

$$\int y\sqrt{x'^2 + y'^2}\, dt$$

whose values depend on the shape of a curve $x = \phi(t)$, $y = \psi(t)$. The calculus of variations was one influence which led to the consideration of functions whose arguments and values range over domains defined only by descriptive properties. These abstract ideas have been found to have value in such fields as ballistics and quantum mechanics. Mention should also be made of the more general theories of integration known by the names of Lebesgue and T. J. Stieltjes. These theories have been very useful in modern mathematics and its applications.

See also references under "Function" in the Index volume.

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FUNCTIONALISM, a term used in architecture to describe an attitude toward design which holds that the form of a building should be determined by practical considerations such as planning and structure, as distinct from the attitude which postulates a preconceived picture in the designer's mind to which plan and structure have to conform.

Although functionalism is most closely associated with modern architecture and to some extent with modern furniture (much of which is designed by architects), it is by no means an exclusively modern conception. Apart from the fact that even the most fanciful architecture has a practical function to fulfill, there have been times in the past when functional considerations have been unusually dominant, and the artistic character of the buildings of such times has been directly derived from the way the challenge of function has been met. Examples familiar to students of European culture are the military architecture of the early middle ages, certain periods of Gothic church architecture and the industrial architecture of the early 19th century. The expression "the functional tradition" is applied to this emphasis on functionalism which appears and reappears throughout the history of architecture independently of changes in style.

The functionalist creed is especially associated with the modern style of architecture which developed during the second quarter of the 20th century as a result of changes in building technique and the new types of buildings required, and also as a result of changing cultural and aesthetic ideals. In fact, since architects began to show discontent with the historical revivalism that had been paramount in the 19th and early 20th centuries, a clear outward expression of the function of the building had been regarded as the basis on which architecture was bound to develop. The slogan "form follows function," coined in the 1880s by one of the pioneers of modern architecture, Louis H. Sullivan, and the famous dictum of the architect Le Corbusier (*q.v.*), "a house is a machine for living," which dates from 1920, both state the idea uncompromisingly. The latter assertion, however, although typical of the polemical statements made in the 1920s when the battle for a more functional approach to architecture was being most strenuously fought, was not meant literally, as other statements of Le Corbusier indicate. The supporters of functionalism in architecture have on occasion asserted that good architecture is automatically produced by the fulfillment of practical needs, yet experience indicates that in the fulfillment of these there remain many alternatives among which the architect must choose, and that his choice may determine the difference between good and bad architecture.

Le Corbusier's and similar statements do nevertheless reflect the insistence of the modern architect that the process of design begins with an analysis of the function of the building and of the best technical means of meeting it, and that aesthetic character, instead of being superimposed, emerges as a part of the same process. For this reason the emphasis on functionalism in modern architecture implies a reunion of architecture and engineering, which had become separated in the 19th century.

See also ARCHITECTURE; MODERN ARCHITECTURE; INDUSTRIAL ARCHITECTURE.

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FUNCTIONAL PSYCHOLOGY: *see* PSYCHOLOGY, HISTORY OF.

FUNCTIONS, ANALYTIC. A function $f(z)$ is said to be analytic in a two-dimensional region if, at each point of the region, the derivative $f'(z)$ exists. Analytic functions are also called holomorphic, monogenic, regular or regular-analytic functions.

HISTORICAL BACKGROUND

The theory of analytic functions was created by A. L. Cauchy, who, in 1814, began the task of integrating between complex limits. His results were first made known in 1825. Cauchy's theory applies to functions having a unique derivative, and complex integration is the tool which gives the results. Cauchy used his new ideas to lay the foundation for a theory of ordinary and partial differential equations, including applications to problems in mathematical physics.

The other two founders of the theory of analytic functions were Bernhard Riemann and Karl Weierstrass. In 1851 Riemann outlined a theory in which the analytic function is defined by a pair of harmonic functions joined by the so-called Cauchy-Riemann equations, and in which the values of the function form a geometric entity that later came to be known as a Riemann surface. In the same paper the problem of conformal mapping was formulated.

Weierstrass lectured in Berlin from 1864 on, and by 1876 his fame was well established. He replaced intuition by logic and introduced a careful study of real numbers and limiting processes. His basic point of view was that analytic functions are defined by power series which are linked by a method of analytic continuation. Both he and Riemann devoted considerable effort to the theory of abelian functions and integrals. *See* COMPLEX NUMBERS; FUNCTION; FUNCTIONS, SPECIAL.

FOUNDATIONS

Complex Numbers and the Complex Plane.—The complex numbers form a field (*see* FIELDS). The elements of this field are ordered pairs of real numbers (a,b) for which equality, addition, multiplication and scalar multiplication are defined by

(i) $(a,b) = (c,d)$ if and only if $a = c$, $b = d$

(ii) $(a,b) + (c,d) = (a + c, b + d)$

(iii) $(a,b) \cdot (c,d) = (ac - bd, ad + bc)$

(iv) $c \cdot (a,b) = (ac,bc)$

The associative, commutative and distributive laws hold; $(0,0)$ acts as zero, $(1,0)$ as unity. From (iv) the result

$$(a,b) = a \cdot (1,0) + b \cdot (0,1) = a + bi \tag{1}$$

is obtained, using the classical notation. The numbers $(a,0)$ are identified with the real numbers a so that $(1,0) = 1$, and $(0,1) = i$ may be written.

The notation (a,b) suggests the geometric representation of the complex number $a + bi$ by the point (a,b) in an ordinary Euclidean plane. The x-axis is then called the real axis, and the y-axis the imaginary one. An alternate representation is by the vector joining $(0,0)$ with (a,b). The length r of this vector is called the absolute value of the complex number $c = a + bi$ and is written $|c| = r$. The angle θ which the vector makes with the positive real axis is called the argument, $\theta = \arg c$. Thus

$$c = r(\cos\theta + i\sin\theta) = re^{i\theta} \tag{2}$$

The point $a - bi = \bar{c}$ is called the conjugate of c. In the geometric representation of complex numbers, addition becomes vector addition. The absolute value of a product is the product of the absolute values, and the argument is congruent to the sum of the arguments (mod. 2π).

The plane used for this representation is known as the complex plane. The complex variable is usually denoted by $z = x + iy$. There is an extensive geometry of the complex numbers based on this representation. For the following discussion it is important to realize that the equation $|z - c| = r$ represents a circle with centre at c and radius r and that the inequality $|z - c| < r$ defines the interior of the circle, often called a disk.

Functions.—The idea underlying the function concept is that of a correspondence, or of a mapping of one set of objects D, called the domain, upon another set of objects R, called the range. If there is a unique definite object Q of R corresponding to every object P of D, then Q is said to be a function of P and is written $Q = f(P)$. In the present case D and R are sets of complex numbers and D will be a domain in a narrower sense, namely, an open connected set (often called a region). This means that for every point of D there is a small neighbourhood which is also in D, and that any two points of D may be connected by a broken line in D.

A function $f(z)$ defined in D may be continuous there. This means that if z is near to z_0 in D, then $f(z)$ is near to $f(z_0)$ in R. The differentiable functions form a subclass of the continuous functions. In the present case $f(z)$ is said to be differentiable at a point z_0 in D if the ratio

$$\frac{f(z) - f(z_0)}{z - z_0} \tag{3}$$

approaches a finite limit when z approaches z_0, the limit being independent of how z approaches z_0. This limit is known as the derivative of $f(z)$ at $z = z_0$ and is denoted by $f'(z_0)$ (*see* CALCULUS, DIFFERENTIAL AND INTEGRAL). If $f'(z)$ exists everywhere in D, the function $f(z)$ is said to be holomorphic or analytic in D. The term analytic, however, will be used below in a more general sense.

The formal rules of the calculus apply to complex-valued functions. Thus, sums and products of functions holomorphic in D are also holomorphic in D, although in the case of a quotient the points where the denominator is zero must be excepted. If n is a positive integer, z^n is holomorphic in the finite plane; this implies that every polynomial is a holomorphic function and that rational functions are holomorphic except at the zeros of the denominators.

If $f(z) = U(x,y) + iV(x,y)$ is holomorphic in D, then the real-valued functions U and V have partial derivatives with respect to x and y which satisfy the Cauchy-Riemann equations

$$U_x = V_y,\ U_y = -V_x \tag{4}$$

where the subscripts indicate differentiation with respect to x and y. Conversely, if a pair of real-valued functions has continuous partials in D which satisfy (4), then $f = U + iV$ is holomorphic in D. The functions U and V are known as conjugate harmonic or logarithmic potential functions. They satisfy Laplace's equation

$$F_{xx} + F_{yy} = 0 \tag{5}$$

This is the two-dimensional analogue of the equation satisfied by the Newtonian potential.

Power Series.—The basic class of holomorphic functions is formed by the power series; *i.e.*, series of the form

$$\sum_{n=0}^{\infty} a_n(z - a)^n \tag{6}$$

Such a series converges for a given z if the sequence of partial sums converges to a finite limit (*see* SERIES). This may happen only for $z = a$ or, at the other extreme, for all values of z. In general there exists a positive number R, known as the radius of convergence of the series, such that (6) converges (even absolutely) for $|z - a| < R$ and diverges for every z outside the circle $|z - a| = R$, known as the circle of convergence. The value of R is given by

$$\frac{1}{R} = \limsup |a_n|^{\frac{1}{n}} \tag{7}$$

The sum of the series in $|z - a| < R$ is a holomorphic function $F(z)$, whose derivative can be obtained by termwise differentiation of (6). The resulting power series has the same radius of convergence and may be differentiated as often as desired. Thus $F(z)$ has derivatives of all orders. According to Weierstrass, the power series defines an element of an analytic function. Further elements can be obtained by elementary rearrangements of (6).

If $|b - a| < R$, write $z - a = (z - b) + (b - a)$, expand the nth power of this expression by the binomial theorem, multiply by a_n and add. Collection of terms results in a Taylor's series

$$F(z) = \sum_{k=0}^{\infty} \frac{F^{(k)}(b)\,(z-b)^k}{k!} \tag{8}$$

which converges at least for $|z-b| < R - |a-b|$. If the radius of convergence of (8) exceeds this value, then the new series defines a holomorphic function in a disk which overlaps the old one. In the intersection of the two disks the functions coincide; outside, each function defines the analytic continuation of the other. The new element (8) can be rearranged in the same manner and gives rise to further new elements. The totality of such elements (with some adjunctions, *see* below) constitutes the analytic function defined by (6). In this process, it is possible to get back to the starting point with an element distinct from (6). The number of distinct elements having the same centre $z = a$ is at most countable.

It may happen that (6) is not continuous outside its circle of convergence, which in this case is said to be the natural boundary of the function $F(z)$. In a certain sense this is the rule rather than the exception; the phenomenon is apt to present itself if the coefficients exhibit recurrent nonperiodic irregularities, such as very long gaps between terms, or if the coefficients have only a finite number of distinct values which do not recur periodically.

THE CAUCHY THEORY

Cauchy's Integral Theorem.—A rectifiable curve C is given by $z = g(t)$, $0 \leqq t \leqq 1$, where $g(t)$ is continuous and of bounded variation. If $f(z)$ is continuous on C, then the Riemann-Stieltjes integral

$$\int_C f(z)dz = \int_0^1 f[g(t)]dg(t) \tag{9}$$

exists. If D is a simply connected domain with $f(z)$ holomorphic in D, and if C is a simple, closed, rectifiable curve in D, then

$$\int_C f(z)dz = 0 \tag{10}$$

This basic theorem, announced by Cauchy in 1825, is the source of most of the results in analytic-function theory. First, it gives a representation of $f(z)$ in terms of its boundary values on C. If z is interior to C, then

$$f(z) = \frac{1}{2\pi i}\int_C \frac{f(t)dt}{t-z} \tag{11}$$

The integral can be differentiated with respect to z under the sign of integration as often as desired, and

$$f^{(n)}(z) = \frac{n!}{2\pi i}\int_C \frac{f(t)dt}{(t-z)^{n+1}} \tag{12}$$

Thus the existence of a first derivative implies the existence of derivatives of all orders.

Representation Theorems.—Cauchy's formula (11) can also be used to obtain expansions of $f(z)$ in infinite series. The Cauchy kernel $(t-z)^{-1}$ is expanded in a series of the desired type; multiplication by $f(t)$ and termwise integration then gives the corresponding series for $f(z)$. In this manner, for instance, Taylor's series (formula [8] with F replaced by f), which converges in the largest circle with centre at b in which $f(z)$ is holomorphic, is obtained. Laurent's series is obtained in an analogous manner:

$$f(z) = \sum_{-\infty}^{\infty} a_n(z-b)^n,\ a_n = (2\pi i)^{-1}\int_C f(t)\,(t-b)^{-n-1}dt \tag{13}$$

it is valid in the largest annulus $0 \leqq R_1 < |z-b| < R_2 \leqq \infty$ in which $f(z)$ is holomorphic. Various expansions of holomorphic functions in so-called interpolation series are obtainable by the same method.

If in (13) $R_1 = 0$, the point $z = b$ is an isolated singularity of $f(z)$. This singularity is removable if $a_n = 0$ for $n < 0$. It is a pole of order m if $a_{-m} \neq 0$ but $a_{-k} \equiv 0$ for $k > m$; it is an essential singularity in the remaining case. The coefficient a_{-1} is known as the residue of $f(z)$ at $z = b$. In the case of a pole, $|f(z)|$ is uniformly large in the neighbourhood of $z = b$. The function $f(z)$ is assigned the value ∞ at $z = b$ and the expansion (13) is adjoined to the elements which define the analytic function. At an essential singularity no value can be assigned to the function; in fact, $f(z)$ assumes every value infinitely often, with at most one exception, in every neighbourhood of $z = b$ (Émile Picard, 1880).

Residue Theorem.—Formula (10) must be modified if $f(z)$ is not holomorphic inside C. Suppose that the only singularities are isolated and that none are on C. Then

$$\int_C f(z)dz = 2\pi i \sum a_{-1,k} \tag{14}$$

where the summation extends over the residues of the integrand inside C. This residue theorem of Cauchy also has a large number of applications. Cauchy used it to evaluate definite integrals—a problem of considerable practical importance. For example, in electrical engineering the desired solution of a system of linear differential equations with constant coefficients occurring, for instance, in network analysis, may turn out to be an inverse Laplace transform

$$f(t) = (2\pi i)^{-1}\int_{a-i\infty}^{a+i\infty} e^{st}F(z)dz$$

where $F(z)$ is a rational function. The value of the integral is the sum of the residues of the integrand in the domain to the left of the line of integration. Cauchy also used his residue theorem for the first rigorous discussion of series expansions arising in boundary value problems of mathematical physics, and this is still a valuable method. The residue theorem also plays a central role in the theory of elliptic functions.

Another important application of the residue theorem is the principle of the argument. Suppose that inside C there are no singularities other than poles of $f(z)$ and that no pole or zero lies on C. If the residue theorem is applied to the logarithmic derivative of $f(z)$, it is found that the change in the argument of $f(z)$ as z describes C in the positive sense equals 2π times the difference in the number of zeros and poles of $f(z)$ inside C.

SELECTED APPLICATIONS

The following paragraphs outline a few other central topics in the theory of analytic functions. Many others could be added.

Principle of the Maximum.—Let $f(z)$ be holomorphic in a domain D and let $M < \infty$ be the supremum of $|f(z)|$ in D. Then either $|f(z)| < M$ everywhere in D or $f(z)$ is a constant C, with $|C| = M$. If $f(z) \neq 0$, the same alternatives hold for the infimum of $|f(z)|$. If $U(z)$ is harmonic in D, it can have neither a maximum nor a minimum in D. Let $M(r;f)$ be the maximum of $|f(z)|$ in $|z| \leqq r$. If $M(r;f)$ is bounded for all r, then $f(z)$ is a constant (J. Liouville). In 1908 the principle of the maximum was extended by E. Phragmén and E. Lindelöf to give information on the boundedness and rate of growth of $f(z)$ near singular points.

Entire and Meromorphic Functions.—A function $f(z)$ is entire (integral in British terminology) if it is holomorphic in the finite plane. It is transcendental if it does not reduce to a polynomial. In 1876 Weierstrass showed how to construct an entire function of given zeros. An entire function without zeros is of the form $\exp[g(z)]$, where $g(z)$ is also entire. Entire functions are classified according to their order

$$\rho(f) = \limsup_{r\to\infty} \frac{\log\log M(r;f)}{\log r} \tag{15}$$

where $0 \leqq \rho \leqq \infty$. The order is closely related to the asymptotic behaviour of the coefficients of the defining power series and imposes an upper bound on the frequency of the zeros.

An entire function takes on every value infinitely often, with at most one exception. This theorem, proved by Picard in 1879 by use of the elliptic modular function, has been in the centre of attention ever since. Elementary proofs have been found by E. Borel and by E. Landau, and the theorem also follows from a mapping theorem due to A. Bloch (1924). It is now a simple consequence of an elaborate theory of the distribution of the values assumed

by an entire or meromorphic function developed by F. Nevanlinna and R. Nevanlinna starting in 1924.

A function having only polar singularities is said to be meromorphic. The representation of such a function by partial fractions was given by G. Mittag-Leffler in 1877.

Normal Families.—A uniformly convergent sequence of holomorphic functions converges to a holomorphic limit. It suffices that the uniform convergence holds on the (rectifiable) boundary of the region. A sequence of functions $\{f_i(z)\}$ holomorphic and uniformly bounded in a domain D which converges in a point set with a limit point in D also converges to a holomorphic limit everywhere in D (G. Vitali, M. B. Porter, 1903). A uniformly bounded family of holomorphic functions contains a uniformly convergent sequence. The study of such "normal families" is largely due to P. Montel.

Conformal Mapping.—Every simply connected domain D having at least two boundary points can be mapped conformally onto the unit disk. This is Riemann's mapping problem, formulated in 1851 and completely solved around 1913. Such a mapping is one-to-one and angle preserving. There are important applications to the theory of wing profiles and to other problems of fluid mechanics as well as to electric and magnetic fields. A multiply-connected domain can be mapped conformally on various canonical domains of the same connectivity. *See* also ANALYSIS; ANALYSIS, COMPLEX; GROUPS, CONTINUOUS.

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FUNCTIONS, SPECIAL. In mathematics this term is commonly reserved for those functions frequently applied in various branches of mathematics, physics, chemistry and other sciences (*see* FUNCTION). It is customary to divide them into elementary and higher transcendental types; frequently they include only the latter. The most important elementary functions are the exponential, logarithmic and trigonometric, combinations of these, and others that are related to them (*see* EXPONENT; LOGARITHMS; TRIGONOMETRY).

In the past, some of the most illustrious mathematicians took a hand in the investigation of higher transcendental functions; in the 20th century, E. T. Whittaker (1873–1956) and those influenced by him developed special functions as a valuable means of attacking problems in applied mathematics. Special functions continue to be used as a valuable tool, although their importance has declined somewhat with the advent of high-speed electronic computers.

Higher transcendental functions vary greatly as to their origin, nature and applications and no adequate classification of them exists. The one large group showing some degree of unity consists of the hypergeometric functions and others that are related to them. These arise from ordinary linear differential equations of the second order, and their principal applications occur in connection with partial differential equations of mathematical physics.

In the following discussion some of the more important higher transcendental functions will be considered.

Elliptic and Abelian Functions.—The integral $\int R(x,y)\,dx$ can be evaluated in terms of elementary functions if R is a rational function of x and y, and y^2 is a polynomial of degree two or less in x. An evaluation in terms of elementary functions is impossible in general if y^2 is a more involved function of x.

If y^2 is a polynomial of degree three or four, the integral is known as an elliptic integral and the functions arising in the inversion of such integrals are elliptic functions (*q.v.*). These are doubly periodic and thus generalizations of the (simply periodic) trigonometric functions. If y^2 is a polynomial of degree higher than four, the integral is a hyperelliptic integral; and the integral $\int R(x,y)\,dx$ is an abelian integral if R is a rational function of x and y, while y is an algebraic function of x, *i.e.*, a root of an equation $P(x,y) = 0$ where P is a polynomial in x and y. The systematic study of such integrals was initiated by Niels Abel in 1826. Karl G. Jacobi solved (1832–34) the inversion problem for hyperelliptic integrals, and G. F. B. Riemann, Karl Weierstrass and others developed the theory of $2p$-fold periodic functions of p complex variables which are needed to solve the inversion problem for abelian integrals. The resulting functions are called abelian functions and were found to have many applications in algebraic geometry, topology, the algebraic theory of numbers and other fields of mathematics; they also influenced the development of the general theory of functions of complex variables.

The Gamma Function and Related Functions.—The gamma function originated in an attempt to generalize the factorial function (*see* COMBINATORIAL ANALYSIS) $n! = 1\cdot 2\cdot \ldots \cdot n$ to nonintegral values of n. Leonhard Euler defined (1729) the gamma function as the limit of a product from which Euler's integral of the second kind, $\Gamma(z) = \int_0^\infty e^{-t}\,t^{z-1}\,dt$ can readily be derived. $\Gamma(n+1) = n!$, $\Gamma(z+1) = z\,\Gamma(z)$. The gamma function is a meromorphic function with simple poles at $z = 0, -1, -2, \ldots$. Karl F. Gauss investigated the function $\pi(z) = \Gamma(z+1)$ (also denoted by $z!$). Weierstrass represented $1/\Gamma(z)$ by an infinite product (1856); this is an entire function with simple zeros at $z = 0, -1, \ldots$.

The gamma function is applied in combinatorial analysis, in the evaluation of infinite and improper integrals, in the solution of differential and difference equations and in many other branches of mathematics. It and related functions are ubiquitous in probability theory and statistics, and in mathematical physics and engineering mathematics.

Some of the functions related to the gamma function are (1) the beta function $\beta(p,q) = \int_0^1 t^{p-1}(1-t)^{q-1}\,dt$ (Euler's integral of the first kind) $= \Gamma(p)\,\Gamma(q)/\Gamma(p+q)$; (2) the logarithmic derivative $\psi(z) = d\log\Gamma(z)/dz$ of the gamma function; (3) the incomplete gamma functions

$$\gamma(z,x) = \int_0^x e^{-t}t^{z-1}dt, \qquad \Gamma(z,x) = \int_x^\infty e^{-t}t^{z-1}dt;$$

(4) the exponential integral, sine integral and cosine integral, which are related to $\Gamma(0,z)$; and (5) the error functions and Fresnel integrals, which are related to $\gamma(\frac{1}{2},z)$ and $\Gamma(\frac{1}{2},z)$.

Riemann's Zeta Function.—The zeta function was known to Euler (1737). The first great discoveries relating to it were made by Riemann (1859). Many results have been extended to A. Hurwitz' zeta function $\zeta(s,a) = \sum_{n=0}^{\infty}(a+n)^{-s}$, related to Riemann's zeta function $\zeta(s)$ by means of $\zeta(s) = \zeta(s,1)$.

$\zeta(s)$ has a simple pole at $s = 1$ and is regular at all other points. Euler's product, $\zeta(s) = \pi\,(1-p^{-s})^{-1}$ in which p runs through all primes and $Re\ s > 1$, shows that $\zeta(s)$ has no zeros when $Re\ s > 1$, and this in conjunction with Riemann's functional equation $2^{1-s}\,\Gamma(s)\,\zeta(s)\cos(s\pi/2) = \pi^s\,\zeta(1-s)$ shows that the only zeros of $\zeta(s)$ for $Re\ s < 0$ are the "trivial zeros," $s = -2, -4, -6, \ldots$. All nontrivial zeros of $\zeta(s)$ must lie in the strip $0 \leq Re\ s \leq 1$ of the complex plane, and Riemann conjectured (in 1859) that these zeros lie on the central line, $Re\ s = \frac{1}{2}$, of this strip. In investigating this problem mathematicians tremendously enriched mathematical analysis, discovered many important properties of $\zeta(s)$ and made some progress toward a solution; yet a full proof of Riemann's hypothesis about the zeros of the zeta function has not been given.

Arithmetical Functions, $f(n)$, are defined for all positive integers n. Examples of such functions include the number of distinct primes dividing n; the number of (positive) divisors of n; the number of ways in which n can be represented as a sum or a product of a given number of positive integers; the number of integers between 1 and n which are prime to n (Euler's function); $\mu(n) = 1$ for $n = 1$, $= (-1)^m$ if n is the product of m distinct primes, $= 0$ if n is divisible by the square of a prime (Möbius' function). Such functions have important applications in number theory, combinatorial analysis, and counting problems. Bernoulli numbers (*q.v.*), Euler numbers (*q.v.*), Stirling numbers (*q.v.*),

and other numbers defined as coefficients in the expansion of generating functions are also arithmetic functions, with applications in mathematical analysis as well as in the fields mentioned above.

Hypergeometric Functions.—The hypergeometric series

$$1 + \frac{a\cdot b}{c\cdot 1}z + \frac{a(a+1)\,b(b+1)}{c\cdot(c+1)\cdot 1\cdot 2}z^2 + \frac{a(a+1)(a+2)\,b(b+1)(b+2)}{c(c+1)(c+2)\cdot 1\cdot 2\cdot 3}z^3 + \cdots$$

was known in 1769 to Euler, who discovered many of its properties; it was investigated by Gauss (in 1812, in the first adequate discussion of the convergence of any infinite series), by Riemann (in 1857), and by many other outstanding mathematicians. This series is of great historical importance since its investigation initiated far-reaching developments in the theory of convergence and the general theories of analytic functions and ordinary linear differential equations; and it is of great importance in modern mathematics since a large number of the most important special functions are related to the hypergeometric function $F(a,b;c;z)$, which is defined by the hypergeometric series.

The hypergeometric series satisfies the differential equation

$$z(1-z)y'' + [c-(a+b+1)z]\,y' - aby = 0$$

which is called the hypergeometric equation and is an important source of information for properties of the hypergeometric function. Twenty-four solutions of the hypergeometric equation can be expressed in terms of hypergeometric series, and the relations between these solutions lead to transformations of hypergeometric series. Two distinct hypergeometric series whose corresponding parameters a, b, c differ by 0, 1, or -1 are called contiguous. Any three contiguous hypergeometric series are connected by a linear relation. The derivative of the hypergeometric series is a multiple of a contiguous series and is linearly connected with the original series and a contiguous series. Of the numerous integral representations of the hypergeometric function the oldest and best known is Euler's,

$$F(a,b;c;z) = \frac{\Gamma(c)}{\Gamma(b)\Gamma(c-b)}\int_0^1 t^{b-1}(1-t)^{c-b-1}(1-zt)^{-a}dt \qquad (Re\ c > Re\ b > 0)$$

Generalized hypergeometric series,

$${}_pF_q(a_1,\cdots,a_p;\,c_1,\cdots,c_q;\,z) = 1 + \frac{a_1\cdots a_p}{c_1\cdots c_q\cdot 1}z + \frac{a_1(a_1+1)\cdots a_p(a_p+1)}{c_1(c_1+1)\cdots c_q(c_q+1)\cdot 2!}z^2 + \cdots$$

and in particular the confluent hypergeometric series ${}_1F_1\,(a;c;z)$, have also been extensively investigated. ${}_pF_q$ satisfies the generalized hypergeometric differential equation

$$[\delta(\delta+c_1-1)\cdots(\delta+c_q-1) - z(\delta+a_1)\cdots(\delta+a_p)]y = 0$$

in which $\delta = z\dfrac{d}{dz}$. Among other generalizations and related functions are the hypergeometric series of several variables and basic hypergeometric series; a sample of the latter is

$$\Phi(a,b;c;z) = 1 + \frac{(1-a)(1-b)}{(1-c)(1-q)}z + \frac{(1-a)(1-aq)(1-b)(1-bq)}{(1-c)(1-cq)(1-q)(1-q^2)}z^2 + \frac{(1-a)(1-aq)(1-aq^2)(1-b)(1-bq)(1-bq^2)}{(1-c)(1-cq)(1-cq^2)(1-q)(1-q^2)(1-q^3)}z^3 + \cdots \cdot(|q|<1)$$

Among the tremendous number of higher transcendental functions related to the hypergeometric series we mention: Legendre functions (*see* SPHERICAL HARMONICS), Bessel functions and the classical orthogonal polynomials (*cf.* below), and among those functions arising out of differential equations related to the hypergeometric equation, Lamé, Mathieu and spheroidal functions (*cf.* below).

Bessel Functions.—These are solutions of the Bessel differential equation

$$z^2y'' + zy' + (z^2 - p^2)y = 0$$

and are sometimes called cylinder functions. They first appear in the investigations by Daniel Bernoulli (in 1732) and Euler (in 1764) on vibrations of a heavy chain and a stretched membrane; they are named after Friedrich W. Bessel, who used them in the theory of planetary motion. In modern times they frequently occur in connection with wave propagation problems in optics, electromagnetic theory, elasticity, fluid motion and many other fields; also in potential and diffusion problems. They are among the most useful higher transcendental functions, and many volumes of numerical tables are available for them.

One solution of Bessel's differential equation is the Bessel function of the first kind (sometimes called "Bessel function"),

$$J_p(z) = \sum_{n=0}^{\infty}\frac{(-1)^n(z/2)^{p+2n}}{n!\,\Gamma(p+n+1)}$$

which can be expressed in terms of generalized hypergeometric series, either in terms of ${}_1F_1$ or in terms of ${}_0F_1$; it also can be expressed as a limit of Legendre functions or of hypergeometric series. A second solution is the Bessel function of the second kind, or Neumann function,

$$Y_p(z) = \frac{\cos(p\pi)J_p(z) - J_p(z)}{\sin p\pi}$$

and two further solutions are the two Bessel functions of the third kind or, Hankel functions, $H_p^{(1)} = J_p + i\,Y_p$ and $H_p^{(2)} = J_p - i\,Y_p$. If z is replaced by iz, the resulting differential equation is called the modified Bessel equation and its solutions are modified Bessel functions. These also have been extensively tabulated. If z is replaced by $i^{\frac{1}{2}}x$, the real and imaginary parts of the resulting functions are known as Kelvin functions.

When p is the half of an odd integer, the Bessel functions can be expressed as (finite) combinations of elementary functions, and this is the only case when such an expression is possible. When $p = \pm\frac{1}{3}$, the Bessel functions can be expressed in terms of Airy functions, $Ai(z)$ and $Bi(z)$, which were encountered, about 1838, by George B. Airy in his researches in optics.

Many functions can be expanded in series or integrals involving Bessel functions. Some of these expansions have a direct significance in physics, as in the representation of a plane wave by superposition of cylindrical waves.

Orthogonal Polynomials.—A system of polynomials $p_n(x)$, $n = 0, 1, 2, \ldots$, where p_n is a polynomial of degree n in x, is said to be orthogonal on the interval (a,b) with respect to the weight function $w(x)$ (which is assumed to be nonnegative) if

$$\int_a^b p_m(x)p_n(x)w(x)dx = 0, \text{ where } m \neq n$$

and the system is called an orthonormal system if it is orthogonal and so normalized that

$$\int_a^b [p_n(x)]^2w(x)dx = 1$$

There is a well-developed general theory of orthogonal polynomials. Among the many special polynomials of great importance, the best known are the classical orthogonal polynomials, which are enumerated in the following table together with their intervals of orthogonality and weight function.

Classical orthogonal polynomials	Intervals of orthogonality		Weight function
	a	b	$w(x)$
Legendre or spherical	-1	1	1
Chebichev	-1	1	$(1-x^2)^{\pm\frac{1}{2}}$
Gegenbauer or ultraspherical	-1	1	$(1-x^2)^{\lambda-\frac{1}{2}}$
Jacobi or hypergeometric	-1	1	$(1-x)^{\alpha}(1+x)^{\beta}$
Hermite	$-\infty$	∞	$\exp(-x^2)$
(generalized) Laguerre	0	∞	$x^{\alpha}e^{-x}$

Of these, Chebichev polynomials can be expressed in terms of trigonometric functions, Jacobi polynomials (and their special cases including Legendre and Gegenbauer polynomials) in terms of hypergeometric series and Laguerre and Hermite polynomials as confluent hypergeometric series.

The importance of orthogonal polynomials is derived largely from the possibility of expanding "arbitrary" functions in series of orthogonal polynomials. Such expansions are frequently used both in pure mathematics and in problems of physics and engineering (*see* FOURIER SERIES).

Lamé, Mathieu, and Similar Functions occur mainly in connection with partial differential equations of mathematical physics (potential equation, wave equation, etc.) when the boundaries involved are elliptic cylinders (Mathieu functions), spheroids (spheroidal functions) or ellipsoids (Lamé functions, Lamé wave functions). They satisfy linear ordinary differential equations of the second order which may be considered generalizations of the hypergeometric equation. The theory of these functions is much less complete than that of the functions more directly related to the hypergeometric series, and with the exception of Mathieu functions and spheroidal functions no extensive numerical tables exist.

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FUNDAMENTALISM. The term Fundamentalism is used in the United States and Canada in two related but clearly distinguishable senses: (1) to designate what is more generally called a conservative type of Christian thought, as opposed to the liberal or modernist tendencies which became influential in the latter part of the 19th century and still more so in the first part of the 20th; and (2) as the name of a specific conservative movement with its own organizations and agencies devoted to the propagation of a definite doctrinal program (the Five Points of Fundamentalism) which, it was claimed, constitute the indispensable elements of the true Christian faith. In the first of these senses, the term is more often used by liberals to describe conservatives than by conservatives to describe themselves. In the second sense, it lost the wide currency that it had in the first three decades of the 20th century and, though what it stands for is by no means extinct, the movement it describes changed its methods and less frequently used that name. These two aspects of Fundamentalism will be treated separately.

Classical Orthodoxy.—In Fundamentalism considered merely as a reaction against the liberalizing tendencies of modern thought, there was nothing new except that it was a reaction against something new. The content of its teaching was identical with that of classical Protestant orthodoxy. Its purpose was nothing more than to preserve unchanged the presuppositions and convictions of Reformation Protestantism and also of Roman Catholicism in regard to the nature of Christianity as a redemption religion, the place of the supernatural and the miraculous in Christianity and the nature of the Bible as being in every part an authoritative revelation of the mind and purposes of God. With rare exceptions, all Christian thinkers prior to the middle of the 19th century had been Fundamentalists in this sense. The exceptions are important in the total history of religious thought, but their immediate influence was not sufficiently widespread to invalidate this generalization, especially when applied chiefly to preaching and the life of the churches.

New and disturbing elements began to enter the religious situation with the critical study of the Bible by the methods of historical and literary analysis ("higher criticism"), the popularization of the concept of evolution and its application to the interpretation of the whole process of human culture including religion, and the delayed impact of Kantian and post-Kantian philosophy on theological thought. In addition to these, or including them all, was the enhanced prestige of the scientific spirit and scientific method. It was not simply the existence of these forces and tendencies but their infiltration into the religious thought of both clergy and laity that gave alarm to those who adhered to what was now coming to be called the "older view" of the Bible and Christianity. The actual divergence of views was most clearly marked with reference to views of the nature of the inspiration of the Bible and consequently of its authority. Liberal evangelical theologians did not deny the divinity of Christ (though most of them thought "deity" was too strong a term), nor did they doubt the reality of the supernatural or of God's redemptive purpose, but they rejected the presupposition that the entire Bible is the inerrant "word of God," and insisted that, as William Newton Clarke put it, the most reverent attitude toward the Bible is to take it for what the critical and scientific study of its text and its history indicates that it actually is. The trial (1892) of Charles A. Briggs by the New York presbytery for heresy in his espousal of "higher criticism" was a landmark in this controversy concerning the two views of the Bible. Briggs was a scholar of established reputation who had been professor at the Union Theological seminary for 17 years. The trial, though it ended in his acquittal on the heresy charge, was followed by his suspension from the Presbyterian ministry. The Union Theological seminary responded by severing its connection with the Presbyterian Church.

Fundamentalism Proper.—The specifically Fundamentalist movement was foreshadowed by a series of conferences in which a strict view of biblical inerrancy and a literalistic interpretation of the Bible were applied to emphasize the premillennial second coming of Christ. A Bible conference at Swampscott, Mass., in 1876 was followed in 1877 by a Prophetic conference at New York city. The notable Niagara Bible conferences had been held annually for nearly 20 years before putting forth the Five Points that were to become the fundamentals of Fundamentalism. The Five Points, the hard core of Fundamentalist doctrine as long as that term was used in its strict sense, were: the plenary inspiration and inerrancy of Scripture; the deity of Jesus; the virgin birth of Jesus; substitutionary blood atonement; the bodily resurrection and premillennial second coming of Christ. This Bible conference movement, with its strong "prophetic" coloration, was vigorously evangelistic and revivalistic. A volume entitled *Jesus Is Coming*, by "W. E. B.," was given a subsidized circulation of about 2,000,000 copies in the United States and 1,000,000 abroad. Beginning in 1909 a series of 12 books under the general title *The Fundamentals* was published and widely circulated at the expense of two brothers, Lyman and Milton Stewart, who also established and endowed the Los Angeles (Calif.) Bible institute. Other Bible institutes, notably the Moody Bible institute in Chicago, Ill., took up the task of training preachers, evangelists and Christian workers who would be untouched by the modern influences which, it was believed, were contaminating the standard theological seminaries. This phase of Fundamentalism was strictly undenominational. As liberal thought permeated the seminaries, the literature and the missionary agencies of leading denominations, the conservative forces within these denominations organized themselves for resistance and a second phase of fundamentalism began, while the first still continued.

Baptists.—A. H. Strong, president emeritus of Rochester Theological seminary, visited Baptist foreign missionary stations and in *A Tour of the Missions* (1918) reported his alarm at lapses from orthodoxy, especially in regard to the inerrancy of the Bible. The weekly *Watchman-Examiner* followed with a demand for an investigation of the seminaries. Suspicion in regard to the divinity school of The University of Chicago had already led to the founding of the Northern Baptist Theological seminary in Chicago (1913), and the Rochester seminary also was regarded as suspect. In May 1930 a Pre-Convention Conference on Fundamentals of Our Faith was called by 150 members of the Northern Baptist convention. At the immediately subsequent convention the Fundamentalist group, with J. S. Massee as principal spokesman, continued to urge scrutiny of the seminaries and the adoption of a

strict statement of faith, which was substantially the Philadelphia and New Hampshire Confessions. The majority of the convention, however, following Cornelius Woelfkin, affirmed confidence in the seminaries and the sufficiency of the New Testament as a statement of Baptist faith. The Fundamentalists formally organized their forces in the Baptist Bible Union of America (1923), which adopted 18 articles of faith. Its triple presidency was J. Frank Norris in the south, W. B. Riley in the north and T. T. Shields in Canada. John R. Straton led in the east with his Baptist Fundamentalist League of Greater New York and Vicinity. State chapters were formed. Attack was centred largely on the boards of missions. The union disavowed any intention to "disturb existing Baptist affiliations," but at the same time it recommended the undenominational "Bible Institutes and Bible Conferences conducted by Christian Fundamentalists." The Southern Baptist convention, more conservative than the northern, contained more Fundamentalists but had less conflict because the liberal forces on the other side were so few. The energies of the Baptist Bible union as an organization were spent by 1929. In the north, however, the Fundamentalists, after several years of agitation and preconvention sessions, separated in 1947 from the Northern Baptist convention and organized the Conservative Baptist Association of America.

Presbyterians.—The strain of Fundamentalism that appeared in the Presbyterian Church was, for the most part, only a stanch adherence to classical Protestant orthodoxy. The tensions resulting from the infiltration of biblical criticism had already been felt and the storm period passed before the campaign of the Fundamentalists as such had begun to affect deeply the organized life of the great denominations. A long controversy over the revision of the Confession of Faith was ended (1903) by the adoption of 11 amendments. The conservatives were pleased that the revisions were so slight and the liberals were gratified that there was any revision at all; peace prevailed, though the basic issues remained. On May 21, 1922, Harry Emerson Fosdick, a liberal Baptist then preaching regularly for the First Presbyterian church, New York city, delivered a sermon entitled "Shall the Fundamentalists Win?" This precipitated lively controversy. The general assembly of 1923 directed the New York presbytery to see to it that the pulpit should conform to the church's Confession of Faith and reaffirmed its own Five Points of 1910. The same assembly defeated the candidacy of William Jennings Bryan for the post of moderator. The 1927 general assembly adopted a report of a special commission which denied that the assembly had the constitutional right to set up such formulas as the Five Points as tests of orthodoxy. This is regarded as a crucial action, since it left room for a considerable degree of liberalism in the church. Differences both theological and administrative in regard to the policies of Princeton Theological seminary led to the withdrawal of a highly conservative group headed by J. Gresham Machen and to the organization of Westminster seminary, Philadelphia (1929), an Independent Board for Presbyterian Foreign Missions (1933) and, in 1936, a separate denomination, the Presbyterian Church in America, which later (1939) took the name the Orthodox Presbyterian Church; it remained very small.

Methodists.—Having recently had unhappy experience with two heresy cases—H. G. T. Mitchell, a professor at Boston university (1895), and Borden P. Bowne (1904–08)—the Methodists were generally indisposed to a resumption of hostilities when the Fundamentalist movement arose. A definite tendency toward a more liberal view of the Bible and toward stress upon the "social gospel" was seen in the church's publications and in the courses of study for ministers. An organized group of militant "essentialists" opposed but could not check this tendency. The New Jersey conference was the storm centre of protest. The question of maintaining a strict ban on "sinful amusements" was an issue, as well as biblical criticism. A conservative Methodist League for Faith and Life (1925) functioned with diminishing effectiveness for a few years. A rather high degree of theological conservatism has gone along with the denomination's characteristic emphasis on evangelism, but the antagonisms of the Fundamentalist controversy did not leave deep scars.

Disciples of Christ.—The influence of new views of the Bible and of more liberal theology was scarcely felt in this communion before 1895 and produced no wide response until several years later. There has been strong, but generally unorganized, resistance to the liberal movement. The conservatives never called themselves Fundamentalists, and the issues did not prove to be identical with the Five Points of Fundamentalism. The biblical question has been central. In place of a specific doctrine of the atonement and a premillennial second coming—in neither of which they took much interest—conservative Disciples substituted renewed insistence on immersion and opposition to open membership; *i.e.*, the admission of the unimmersed.

In 1916 a Bible College league was organized to clear the new learning out of the College of the Bible, Lexington, Ky., and to instigate scrutiny of other institutions. This campaign failed. About 1920 there was the beginning of heated criticism of certain missionaries, especially in China, and of the missionary society which supported them, chiefly on the ground that open membership was being practised. A Christian Restoration association became the agency of this opposition; an annual North American Christian convention, the rival of the International Convention of Disciples of Christ; and a New Testament Tract society (later merged with the Restoration association), its publishing agency. Many conservative so-called Bible colleges and institutes have been organized to train ministers opposed to co-operation through the general missionary and benevolent agencies. A large percentage of the nearly 2,000,000 members claimed by the Disciples does not co-operate with the International Convention of Christian Churches (Disciples of Christ) or with the agencies that report to it. The ground of their dissent is a special form of theological conservatism stressing the early Disciple slogans, "restoration of primitive Christianity" and "loyalty to the New Testament," which, they say, the agencies do not properly exemplify.

Protestant Episcopal Church.—Fundamentalism in its stricter meaning had little to do with such disharmonies as have arisen in this communion. Planes of cleavage appeared between the Catholic and the Evangelical party, and between those who insist on rigid adherence to the Thirty-Nine Articles and those who do not. Bishop William Lawrence's plea (Oct. 1923) for theological freedom in the church was promptly answered by a pastoral letter from the house of bishops (Nov. 1923) insisting on strict conformity. The more conservative group has so little in common with the Fundamentalists that the term has no proper application in this connection. The Episcopal Church has schools of thought and there have been tensions between them, but in general it has been able to contain them without disastrous conflict.

Antievolution.—Interdenominational Fundamentalism reached its climax of intensity and publicity in the decade during and after World War I. A huge World Bible conference (1919) in Philadelphia, Pa., led to the organization of the World Christian Fundamentals association. A campaign of great intensity was directed toward drawing a sharp line between Fundamentalists on one side and all non-Fundamentalist Christians and non-Christians on the other. Stress on the literal inerrancy of the Bible in matters of science and history inevitably brought the theory of evolution under discussion. Antievolution had long been a position held by ultraconservatives generally. The Fundamentalists attacked the teaching of evolution in the schools. In Tennessee it was made a criminal offense (*see* Scopes Trial,). Antievolution laws were passed by three other states—Mississippi (1926), Arkansas (1928) and Texas (1929).

Later History.—Although the Fundamentalist associations continued to exist for several years, interdenominational Fundamentalism of this type had lost its drive. What remains is a strong body of theological conservatism in most of the great denominations, an important "neo-orthodox" movement (*see* Neo-Orthodoxy) which many regard as providing a scholarly middle way between liberalism and Fundamentalism, and a considerable number of independent Fundamentalist churches. Many of these last were loosely united in the Independent Fundamental Churches of America, organized at Cicero, Ill., in 1930. This association required its member churches to sever every connection with any

denomination and to subscribe to 16 articles of faith which include the original Five Points of Fundamentalism.

Conservative organizations of current importance are the National Association of Evangelicals and the American Council of Christian Churches. The term Fundamentalist is avoided in both names and by all but four very small churches among their constituent denominations. It is, however, accepted as descriptive by the General Association of Regular Baptist Churches, who constitute almost half of the membership of the A.C.C.C.

The name of the American Council of Christian Churches is sometimes confused with that of the National Council of the Churches of Christ in the U.S.A. (whose constituent churches have a membership of 40,000,000) and suggests some approximation to equality between them. The A.C.C.C., however, has 14 member denominations with a total membership of 280,000. The three member denominations with more than 25,000 members are: General Association of Regular Baptist Churches (126,000), World Baptist Fellowship (68,000) and Evangelical Methodist Church of America (26,000). The A.C.C.C. also has affiliated local churches and affiliated individuals.

The National Association of Evangelicals has 38 member churches with a total membership of 1,400,000. Those member churches having more than 50,000 members are: Assemblies of God (*q.v.;* 506,000), National Association of Free Will Baptists (200,000), Church of God (Cleveland, Tenn., 163,000), Pentecostal Church of God (104,000), International Church of the Foursquare Gospel (80,000), Free Methodist Church of North America (56,000) and Pentecostal Holiness Church (52,000). Leaders of the N.A.E., with headquarters at Wheaton, Ill., specifically say that they are Evangelical rather than Fundamentalist as that term is commonly understood. *Christianity Today* (source for the above membership figures) is the able journalistic voice of the conservative Evangelical movement.

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FUNDY, BAY OF, an inlet of the North Atlantic between the south coast of New Brunswick and the west coast of Nova Scotia. It was first explored by the sieur de Monts in 1604 and named by him La Baye Français. It is 94 mi. long and 32 mi. wide at the mouth, but narrows toward the head where it divides into Chignecto bay to the north (which subdivides into Shepody bay and Cumberland basin) and Minas basin to the south. The Bay of Fundy is remarkable for the great rise and fall of the tide, which at the head of the bay has been known to reach 70 ft. The incoming tide creates the well-known reversing falls at the mouth of the St. John river, and rushes up the Petitcodiac river to beyond Moncton in a bore from 3 to 6 ft. high. There is a 25-ft. rise and fall of the tide in Passamaquoddy bay, which forms part of the boundary between New Brunswick and the state of Maine. The large areas of tidal marshlands at the head of the Bay of Fundy attracted Acadian settlers before 1750, and have since been diked for agricultural use. The bay has numerous harbours, of which the chief are Saint John and St. Andrews in New Brunswick and Digby (on an inlet known as Annapolis basin) and Hantsport in Nova Scotia. *See* also FUNDY NATIONAL PARK. (C. W. RD.)

FUNDY NATIONAL PARK, in New Brunswick, Canada, covers 80 sq.mi. on the Bay of Fundy, famous for its high and fast-running tides. Along the shores of this historic bay began the earliest settlement in Canada with the arrival of Champlain and the sieur de Monts. Skirting the rugged coast for eight miles and extending nine miles inland, the park rises to an elevation of 1,000 ft. It is richly forested, and in autumn its maple-covered ridges and great expanses of rolling hills become a sea of crimson and gold. The park was established in 1948.

There are no natural bathing beaches, but a large heated salt-water swimming pool was built in the park. Other facilities include an open amphitheatre for plays, concerts and other activities, a golf course overlooking the bay, and a recreation and sports centre. Accommodations include cottages of French chalet design and a number of campgrounds and trailer parks. (J. G. P.)

FUNERARY RITES AND CUSTOMS. Rites and customs connected with the disposal of the dead are as universal as the phenomenon of death itself. Since the conscious realization of death as the inevitable end of every human life is one of the most distinctive and central features of human experience, it is only natural that every actual occurrence of death should be an occasion for the living to react to this fact by appropriate behaviour. Structures and mechanisms that may well derive from the ultimately biological instincts of self-preservation and fear of death acquire, on the human level, an "existential" significance: our very experience of life itself is determined by our awareness of its finality and its orientation toward death. The corpse, representing the human subject suddenly becomes a mere object, confronting every man with his own ultimate alienation from his subjective individuality. Man must deal with this threat to his existence on a psychological level; he must readjust and reaffirm himself by actualizing appropriate attitudes and by expressing them in corresponding behaviour. Not in vain has man been described by many writers as the "eternal protestant" against death, desperately and often pathetically refusing to accept its inexorable finality. On the sociological level, death represents the destruction of extant sets of intersubjective, social relationships, necessitating readjustments in various spheres. Roles of authority as well as positions of political and family status become vacant and have to be filled, wives become widows, and redistribution of property becomes necessary. Thus, against the elements of disruption and change introduced by death, society has to emphasize the permanence of its values, institutions and culture patterns (including the place accorded to the transitory and mortal individual).

Hence, death customs are susceptible of both psychological and sociological interpretations. It is the culture—often more particularly the religion—of any particular group that defines and institutionalizes the meaning of death, theoretically as well as behaviourally, by assigning specific roles to its various members and functionaries (priests, family, mourners) and by prescribing specific rites and practices. Death customs therefore generally form a complex involving a number of interrelated cultural traits which function together in a more or less consistent and meaningful way. Whatever the rituals may do for the deceased, they certainly also perform a function for the living; *i.e.,* for the surviving potential diers. The attitude toward death and the dead reflects on the general life of the individual and the group.

It is not surprising, therefore, that funerary customs in most societies by far exceed the practical, rational minimum required for the mere disposal of the body. Not only is the actual disposal more or less ritualized, at times even very elaborately so, but it is also surrounded by a great variety of preburial and postburial rites, some of them extending over a long period after death and burial (*e.g.,* mourning, memorial customs, ancestor worship).

Variety of Customs.—The variety of death customs is immense. Even on one small Melanesian island 21 different methods of disposal of the dead have been counted. There are many descriptive and comparative accounts of funerary customs available, as well as many speculative interpretations. Only a brief and schematic survey can be attempted here. To venture beyond description to interpretation would require detailed analyses of particular groups and culture areas. That the basic problem is the same in prehistoric, illiterate, ancient, medieval and modern societies is borne out by the fact that in the 20th century death "is big business in the U.S., where more money is spent upon funerals and accessories each year than is spent on all hospitals and sanitaria" (W. M. Kephart, "Status After Death," *American Sociological Review*, vol. 15, p. 636 [1950]).

The immense variety of death customs is due to many factors and influences—geographical, cultural and historical. It is the particular combination of these factors that is distinctive and decisive. Thus mummification could originate only in areas with a dry climate (Egypt) and with the necessary preservative materials

(*e.g.*, Tibet with its salt lakes or New Mexico with its saltpetre caves). In northern areas where the ground is frozen most of the year, burial obviously is most difficult. Prevailing notions regarding the origin of man ("dust to dust"; *cf.* Gen. iii, 19) or of the tribe or clan (hence, orientation of tomb in the appropriate direction), as well as beliefs concerning the individual's destiny and afterlife (reincarnation, judgment, reward and punishment, continued life in some faraway land or island), play an important part. Migrations, conquest and other forms of culture contact may lead to combinations of diverse or even conflicting patterns. Of course, the mythological or rational explanations offered by particular groups are not always or necessarily correct as accounts of the past origins or present functions of their mortuary customs. But whereas general interpretations of funerary rites as such are a matter of sociological theory, the specific interpretation of details, especially when they are very widespread, is more often than not in the nature of unverifiable speculation.

Two Main Interpretations.—The two main types of over-all interpretation can conveniently be labeled as functionalist and structuralist, respectively. The former, deriving mainly from the anthropologist Bronislaw Malinowski, considers death customs as a social mechanism for readjustment and release of tension. Violent and conflicting emotions (*e.g.*, horror of death and love for the deceased, the desire to break the ties with the dead but also to maintain them) find normative expression in the obsequies and mourning rites "which endorse and duplicate the natural feelings of the survivors; they create a social event out of a natural fact." The rituals with their underlying religious notions counteract "the centrifugal forces of fear, dismay, demoralisation" and provide "the most powerful means of reintegration of the group's shaken solidarity, and of the re-establishment of its morale" (Malinowski). The ultimately psychological basis of this approach is rejected by the structuralists, who emphasize that ritual tends to build up tension and not merely to provide release. Émile Durkheim, the father of the structuralist approach, noted that socially prescribed demonstrations of grief (wailing, self-laceration) might be out of all proportion to the actual strength of the individual emotions. The real function of ritual is not to release emotions but to create and manifest them and thereby to affirm the basic values of society. A widow's wailing provides no comfort, but it publicly reasserts the significance and value of the marital tie at the very moment of its suspension and dissolution by death. Even so, psychological factors no doubt also play their part, and depth psychology in particular has shown to what extent death customs may answer unconscious needs and attitudes arising out of feelings of guilt, desire for expiation, and fears (*e.g.*, due to death wishes or other repressed ambivalent relationships to the deceased, to oneself or to others).

Ambivalence Toward the Dead.—Almost all authorities have commented on the basic ambivalence underlying death customs, notably the horror of death and the dead on the one hand, and the desire to perpetuate the bond on the other. Defilement and pollution emanate from the corpse; yet a remarkable lack of dread and even positive familiarity are equally in evidence: mourners may lie down on the corpse, kiss it, or anoint themselves with the exuding fluid. However, even rites intended to assist the deceased in his afterlife, to provide for his variously conceived needs (food offerings, rituals, prayers) and to speed him on his way to his ultimate destination (the land of the dead, paradise, nirvana) often imply the concurrent intention to get rid of him and to prevent his return either as body or as ghost. The treatment of the corpse (burial, cremation, breaking of bones, tying of hand and feet), the tabu on mentioning the name of the deceased, and many other customs have been interpreted in this sense. Some tribes even have a special ceremony of "burying the soul." The soul or ghost likes to linger by the body or near the living; hence it must be chased or lured away and its return prevented. Doors or windows may be opened for a moment after death but then immediately shut again; in China and Basutoland a hole is made in the roof. The corpse may have to be carried out through a specially made hole or entrance so that the ghost may not find the way back. For the same reason the mourners may return along a different route from the burial or even efface their footprints. Special precautions may be taken against haunting or "walking." The severance of the ties is, at times, effected slowly and by degrees: there may be carousing "with" (*i.e.*, in the presence of) the corpse during the preburial wake; Koryaks (*q.v.*) (northeastern Siberia) even play cards on the corpse.

Rites of Passage.—Whatever specific ideas prevail regarding afterlife in the different cultures, death is generally regarded not as an absolute end but as the transition from one particular world or kind of existence to another. The attendant rituals are therefore passage rites (*q.v.*) consisting of rites of separation, rites of transition and, finally, rites of incorporation of the deceased in his new world. The burying of utensils and the destruction of property, in addition to simplifying problems of inheritance, also serve to complete the separation of the deceased from the world of the living. Yet although the purpose of mortuary rites often is to speed the ghost to the ghost-world and to implore him not to trouble the living, the opposite tendency is equally often at work. The bond, albeit on a different basis, between the quick and the dead is ceremonially re-established, the latter granting protection and blessings to the former (*see* ANCESTOR WORSHIP). Hence the deceased may also be preserved in whole (mummification of holy men in Tibet and their preservation in chortens as objects of veneration) or in part (*e.g.* relics, ancestor skulls kept in places of honour [Melanesia] or worn as amulets [Andaman Islands]). The dead may return and visit the living as recognized "supernaturals" or as ghosts; on such occasions they may be welcomed and entertained, either gladly or with fear accompanied by precautionary measures (Zuñi pueblo dances, Greek *anthesteria*, Trobriand *baloma* feasts). Many death customs represent a compromise between the conflicting tendencies. Hence it is often difficult to be sure of the exact significance of a rite; *e.g.*, to decide whether a particular funerary amulet was meant to protect the dead or the living. Coins placed on the corpse or in the grave may ensure that the deceased suffers no penury or can pay the boatman's fare when he is ferried over to the land of the dead, but they also may be meant to prevent him from returning and fetching his property.

PRE- AND POSTBURIAL RITES

It follows from the above that the actual disposal of the body is merely part of a larger sequence of actions, beginning with the onset or imminent expectation of death and ending with the final cessation of mourning (or even later). On the imminence of death, a strictly regulated procedure, varying in different cultures, is followed: family and friends are notified, and priests are called in to assist with prayer, confession or other ministrations. In many parts of Europe it is customary to stop all clocks in the house at the moment of death, to cover all mirrors (or even windows), and to extinguish the hearth fire and light a new one. The corpse may be washed, shrouded, dressed up, dyed, or laid on the ground or in state; often lights and ritual objects (*e.g.*, a crucifix among Roman Catholics) are placed near it. The time that has to elapse between death and disposal is generally regulated by religion, social custom and (in some countries) law; it may be waited with wailing and other prescribed manifestations of grief, religious ceremonies, a banquet or a wake (*q.v.*). The manner of exit from the house and the procession to the place of disposal are similarly subject to detailed regulations. Religious obsequies may be celebrated at the house, at the place of disposal or—between the two—at a place of religious worship. The actual disposal of the body may include the provision of the dead man's necessities, such as amulets, food and grave goods (weapons, tools, treasures). These may be given in actual fact, including the killing of a man's (usually a ruler's) wives and slaves to minister to his wants (in many ancient and some primitive civilizations) or merely symbolically (paintings or cheap imitations). Sometimes the objects or imitations are burned or destroyed so that the deceased may profit from their spiritual essence.

Disposal is followed by a more or less fixed time of mourning, varying for different mourners and relatives, and involving a number of prescribed actions and avoidances: a funerary banquet,

mourning, distinctive appearance and attire (disheveled hair, wearing of specific colours, such as the black crape in use in some parts of Europe), prayers and offerings, food and speech tabus (among many primitive tribes), abstention from certain forms of amusement and social life, purification ceremonies and the like. Society participates with the immediate mourners: there may be obituary notices and speeches, visits of condolence, attendance at the various ceremonies. The postburial rites formally end with secondary disposal, unveiling of the tombstone or similar ceremonies, though, in a sense, they may continue as long as there is anyone to perform memorial rites at the tomb or elsewhere.

Almost everywhere the proper performance of the funerary ritual or, at least, the proper disposal of the body, is held to be of the utmost importance—either to ensure the admittance of the soul to the land of the dead and to save the living from his vengeance, or simply as an act of piety. For example, where interment is the traditionally required mode of disposal, its neglect may be considered as a great misfortune for the deceased (*cf.* Jer. xvi, 4), preventing his soul from finding rest (Suetonius, *Caligula* 59) or from entering the Elysian fields (Tertullian, *De anima* lvi). Interment was instituted by the gods as a sacred duty (Sophocles, *Antigone* 454 ff.), and God himself buried Moses (Deut. xxxiv, 6). Burial must be given even to enemies (Euripides, *Supplices* 524–7; Pausanias, *Description of Greece* ix, 32, 9) and to unbelievers (Muslim *fiqh*), indeed to all from whom it has been withheld (II Sam. xxi, 12–14). It is a particular act of charity to bury remains found in a desert or when traveling; according to Judaic law this duty even suspends the rigid rules of levitical purity applying to priests. At least a symbolic gesture of burial should be made by throwing some earth on a corpse which one happens to find (Horace, *Odes* i, 28, 23–5). The Greeks used to give ceremonial burial "in empty clothes" to those who died at sea (Euripides, *Helen* 1241–43).

DISPOSAL OF THE DEAD

Different methods of disposal are practised not only by different cultures but, occasionally, also among a single people. Where this is so, the mode of disposal is usually determined by cultural and social differences: membership in a particular social group, totem or clan association; degree of initiation in a secret or ritual society; rank as commoner or chief; sex; achievements and ethicosocial status (criminal, hero, saint); manner of death (suicides and women who died in childbirth are given different treatment in most primitive societies), and special rules often also apply to those who died by an extraordinary "act of God," (*e.g.*, being struck by lightning); special circumstances (*e.g.*, twins, among the Nuer, are not buried but placed in the fork of a tree); religious persuasion (Muslims and Orthodox Jews insist on inhumation; a pious Buddhist may forego cremation and prefer his carcass to be fed to the animals and birds); and various other factors. Also, the details of any one particular method, the elaborateness of the funerary ritual as well as of the preburial and postburial rites, and the time taken over the ceremonies, vary according to the afore-mentioned differences. Those who do not "belong" to a recognized group or class (*e.g.*, unbaptized children or excommunicates) are treated differently from full members of the community. Among some tribes the social ascription determines even the classification "alive" and "dead": the very aged or those who have been ill very long are considered as dead and may be buried even though still alive. The main methods of disposal are as follows:

Inhumation.—Interment is one of the oldest methods, practised at least from the Mousterian (Middle Paleolithic) onward. Usually in contracted or extended position, though at times even sitting or standing, the corpse may be placed in immediate contact with the earth or protected by matting, stone slabs, pottery jars or urns (*pithoi*), or a coffin (among seafaring people also in the form of a canoe). Alternatively the tomb may be lined with matting, bricks, etc. Orientation varies according to religious and other social traditions; *e.g.*, views about the direction and location of the land of the dead, or traditions about the direction from which the ancestors (or totemic ancestor) of the clan of the deceased had come—the land of the ancestors and that of the dead being often identical. Muslims are laid on their right side, facing Mecca; Buddhists (where they bury) lie face upward with the head to the north, like the Buddha when he died; Christian tradition preferred the feet toward the east, ready to rise and to meet Christ when he appears on the Mount of Olives. Burial usually takes place singly, though in collective cemeteries near the settlements, more rarely in the settlement or even in the house, and occasionally in sites chosen for special reasons (crossroads, churches).

Similar to inhumation is cave burial. Natural or artificial caves (burial chambers and niches or shafts with side vaults hewn into the rock) are known from prehistoric, present-day primitive and some ancient civilizations (*e.g.*, Knossos, Sicily, Fiji Islands, South American Pueblos). Mass graves are dug only in wartime or after major catastrophes. Memorials, varying from a simple stone or wooden board to sumptuous mausoleums, may be erected over the tombs. (*See* also CEMETERY; COFFIN; MONUMENTS AND MEMORIALS; SCULPTURE, SEPULCHRAL; TOMB.)

Cremation.—Destruction of the body by fire is world-wide in incidence. Appearing in Europe with the late Neolithic banded-pottery culture, it began to displace inhumation toward the later Bronze Age. Since then the two alternative methods have coexisted. Ousted by Christianity in the late Roman empire, cremation experienced a revival in more recent times. In many societies cremation is associated with rank and status; it may be accorded to chiefs only or, conversely, to criminals. It is the usual method of disposal among Hindus and frequent among Buddhists. In ancient Egypt, China and Israel, cremation was excluded by the respective beliefs; *e.g.*, the view that immortality depended on the preservation of the body, veneration for the dead ancestors or belief in the resurrection of the body. Cremation may be partial only; the remains (bones, ashes) are then buried, scattered or preserved. Only rarely is it complete, in which case the bones are ground, mixed with combustible matter and burned again. The details of the procedure (place, time, kinds of fuels used) are generally regulated by tradition, in modern countries also by sanitary requirements. Explanations of the origins of cremation are speculative: to prevent magic being performed with the corpse, to prevent "walking," or to liberate the spirit and speed it upward (India).

In the same way as tombs were originally conceived as houses for the dead (tomb chambers, house-shaped sarcophagi), urns too could be given the shape of a house (as among the Etruscans), thus indicating that the idea of a dwelling for the dead may have persisted even in cremation cultures. (*See* also CREMATION.)

Conservation.—The preservation of the whole body is generally regarded as the most extreme form of the denial of death. Known particularly from ancient Egypt (*see* MUMMY), it was also practised by many other groups, among them some of the most primitive (Australia, Torres strait), though usually reserved for high-ranking persons only (chiefs, priests, kings). The methods used vary from simple desiccation (*e.g.*, smoke-drying) or treatment of the body with mineral or vegetable preservatives (usually after evisceration), to the most modern techniques of embalming (*q.v.*). The custom originated in countries with a suitably dry climate. Surprising similarities have been noted in the more highly developed techniques used in distant areas (*e.g.*, Egypt and Central and South America). Where only parts of the corpse are to be preserved (*e.g.*, skulls for ancestor cults) or to be disposed of in some other way, decomposition may be artificially hastened.

Water Burial.—Next to exposure, the simplest way of disposing of a corpse is to fling it into the water. Hence this is often the method applied to slaves, foreigners and people considered to be of no account. In some islands, parts of the coast are reserved as "cemeteries"; corpses are wrapped up to protect them against fishes and weighted with stones. (In the Solomon Islands, however, they are laid on the reef to be eaten by sharks.) In the western world, water burial is the usual practice for those who die on board ship.

The custom of placing the body in a canoe and pushing it into the sea cannot strictly be called water burial; it was practised by

people who were probably the descendants of immigrant tribes and was thus essentially a method of dispatching the deceased to the land of his ancestors. Disposal by launching on the water may be practised symbolically and combined with other methods: burial in boat-shaped tombs or coffins (*e.g.*, the boat-shaped Bronze Age stone arrangements in Bornholm, the Sutton Hoo boat or those found at Oseberg, Gokstad and Tune in Norway) or cremation on a blazing ship (as in the Germanic saga of Balder). The underlying idea seems to be that of a "voyage" to the land of the dead.

Exposure.—Exposing the corpse where it is left to decompose (on the ground, in trees, on rocks, on special platforms), to be devoured by animals or to await further treatment, is a method widely practised. In hot, dry climates exposure may result in desiccation and thus become a method of preservation. The Vedda (Ceylon) and the ancient Chinese left the bodies in rock caves or in the jungle, protecting them slightly by a covering of leaves or brushwood. Some Buddhists prefer exposure as an act of charity toward the hungry animals and birds, and it is still the accepted manner of disposal among orthodox Parsees, who place their dead in their dakhmas ("towers of silence") to be devoured by vultures, lest they defile the earth or the fire. In the arctic region, where the ground is frozen, exposure is the nearest alternative to burial; some tribes (*e.g.*, the North American Naskapi) leave the body on a scaffold during winter until burial becomes possible. Actual platform burial (on artificial scaffolds or in trees) is frequent in Indonesia, Melanesia, Australia and America, but rare in Africa. According to one school of ethnology (W. Schmidt and W. Koppers), the method is related to totemistic ideas of immortality and is designed to facilitate the flight of the soul to the realm of the dead, but the explanation is doubtful.

Cannibalism.—Endocannibalism (*i.e.*, the devouring not of prisoners or strangers but of relatives) is a method ensuring that the deceased remains in the closest possible union with his tribe and does not fall prey to hostile demonic powers. Often the old and the sick are dispatched before death comes to snatch them. The flesh is ceremonially eaten; in some tribes even the bones are pulverized and mixed with food or drink. (The same is done by some American Indian tribes with the ashes of cremation.) The method is held by some ethnologists to have originated among primitive matriarchal agriculturalists (*e.g.*, in Melanesia); it is found in Australia, South America and Africa.

Secondary Disposal.—With the exception of water burial, most methods of disposal leave room for subsequent secondary treatment of the remains; in the case of cremation it is a necessity. Even where interment is the rule, the bones may be exhumed for reasons of space economy (*cf.* the medieval charnel houses) or as part of a prescribed ritual (as in modern Greece). This secondary treatment may be accorded to parts (*e.g.*, the skull) or all of the remains. The interval between the two stages of the disposal varies from a few weeks (*e.g.*, the Trobriand Islands) to 10 or 12 years (*e.g.*, the North American Hurons). Secondary burial may be individual (as in eastern South America) or collective (as in the great Neolithic barrows). The ceremonies too may be related to the individual dead or to all the deceased of the tribe. In the former case they mark the close of the period of mourning and function as the passage rite whereby the soul is finally integrated in the community of the dead and the mourners are finally reintegrated into the community of the living.

HISTORICAL SURVEY

As mankind passed through the stages of culture marked by the discoveries of the crafts and techniques of stone polishing, copper-, bronze- and ironworking, a variety of funerary customs developed, conditioned partly by natural and cultural resources and partly by beliefs about the kind of life after death and the relationship between the dead and the living. Whereas the death customs of historic cultures are known from their mortuary remains as well as from a wealth of literary testimonies, our knowledge of prehistoric culture as a whole is largely provided by funerary monuments. Prehistoric man made his arrangements for the dead with permanency in view. The evidence yielded by the tombs (mode of disposal, type of burial, objects deposited), in conjunction with related evidence (geological stratification, contemporary fauna), is our sole source of information concerning the nature and significance of the funerary remains, as well as the period and race to which they should be assigned.

Paleolithic.—Interment of the body together with ceremonial implements is attested at least from the Middle Paleolithic onward (in France at Le Moustier, La Chapelle, La Ferrassie). The provision of food and implements suggests some kind of belief in continued life and a conception of the tomb (cave or rock shelter) as a dwelling. Funerary equipment (personal ornaments of bone and shell, amulets, figurines) increases in the Upper Paleolithic period (Grimaldi, Barma Grande, Cro-Magnon, Brno, Solutré) and there is a striking and lavish use of red colour—possibly as a vitalizing agent. The body may be placed in ochreous earth or smeared or sprinkled with red ochre (*e.g.*, the "Red Lady of Paviland," Wales). The "sleeping" position and the even more tightly flexed position ("contracted burial") were most frequent in Upper Paleolithic Europe, as they still are with many primitive tribes. Flexing and tying the body have been explained as a return to the fetal position (thus implying some kind of idea of rebirth), as a measure to prevent the dead from walking, and to conserve space. Upper Paleolithic tombs also yield remarkable indications of a cult of the skull. Skulls would be severed from the body and prepared as "bowls," or buried separately. The Ofnet (Bavaria) deposits—two scooped-out "nests"—contained over 30 richly ornamented skulls, all facing west.

The Paleolithic practices continued into Mesolithic times, as witnessed by the Ofnet skull burials and the Téviec (Brittany) tombs as well as the Mas d'Azil and similar ossuaries. Many of these show that the bones were deposited after the flesh had decayed or had been scraped off. In Denmark extended burial (as distinct from the contracted position) was practised, the tombs being surrounded sometimes by large stones (Ertebolle). These, again, could be covered with earth (mound burial) or with single capstones. The latter type, known as dolmens or (Danish) *dysser*, became a prominent feature of the megalithic culture that spread in Europe during the Neolithic period (*see* ARCHAEOLOGY: *Neolithic and Bronze Ages in Europe*).

Egypt.—The transition from food gathering to food production, which is generally considered as one of the turning points in the history of human societies and their cultures, also had profound effects on mortuary ritual, which became increasingly elaborate, reaching a climax in the funerary cult of Egypt. Egyptian Neolithic cemeteries were situated nearby (only rarely in) the settlements. The bodies were buried in flexed position, clothed, and provided with ornaments and various means of sustenance. Often they were turned toward the west—possibly the first sign of the subsequently very important notion of a western land of the dead. With the unification of Egypt soon after 3000 B.C., the early dynastic tombs underwent rapid elaboration: the pit was undercut on one side to allow for more tomb furniture; the sand mound over the tomb became a rectangular stone mastaba; doors, niches and steps were added; and finally the cult offerings were transferred from the tomb itself to a nearby temple. The superimposition on each other of mastabas of decreasing size (stepped pyramid) finally produced the pyramid (*q.v.*) tomb.

Whereas burial in the dry sand of Egypt might result in the natural preservation of the body, this would not be the case in tombs, however elaborate. Permanence had to be assured by artificial mummification as well as by the use of effigies. The latter, placed in a temple, had the advantage of being more accessible for ritual purposes than the corpse which lay at the bottom of the funerary shaft. The effigy was "brought to life" by the ceremonial of the "Opening of the Mouth" (performed later on the actual mummy) and made the object of regular mortuary rituals. With the development of the worship of Osiris in the later dynastic period, the whole ritual became assimilated to the myth of the death, dismemberment and resurrection of Osiris: the dead man's body was reconstituted and his spiritual, *i.e.*, vital essences, the *ba* and the *ka*, restored to him. This rebirth to immortality or "Osirification" was, at first, the privilege of the king

—himself divine. Later it became accessible to nobles and even to commoners.

To assist the deceased in his "resurrection," to protect him from demons and other dangers, and to ensure a favourable verdict at the judgment of the dead (presided over first by the sun god Ra, and since the 11th dynasty by Osiris), he was also provided with suitable texts and magical formulas. These texts, of different ages and varied contents and known as the *Book of the Dead*, were inscribed on papyrus or on the walls or the coffins (Pyramid texts). In the New Kingdom the papyri were put into the coffin together with the mummy to increase their efficacy. (*See* also EGYPT: *History: Ancient Religion.*)

Mesopotamia.—Unlike Egypt, Mesopotamia never had a highly developed mortuary cult. The outlook for the dead was gloomy: a kind of shadow existence in a House of Darkness, the "Land of No Return," similar to the underworld of the Hebrews (Sheol) and the Greeks (Hades). Grave goods, though meagre, nevertheless indicate some kind of belief in survival. The exception to the general rule are the sumptuous royal tombs at Ur (2900–2700 B.C. according to C. L. Woolley) with their wealth of funerary furniture. The Sumerian kings took to their graves not only priceless vessels and ornaments but also their retinue of wives, courtiers, attendants and guards. However, this royal funerary cult is not characteristic of subsequent development in Babylonia.

Eastern and Western Mediterranean.—Burial in stone structures of different shapes and kinds and various degrees of elaboration (vaults, passageways, etc.) spread throughout Europe during the Neolithic period. The earliest *tholoi* (circular stone structures) in Cyprus have been found similar to those discovered in Iraq near Nineveh (Tell Halaf period). Groups of tholoi came to be enclosed with dry-stone walls and roofed with corbeled vaults, thus producing the vaulted "beehive tombs." Some tholoi (Hagia Triada, tholos B at Koumasa) have yielded the remains of hundreds of interments; clearly, many generations were being "gathered to their fathers" in community tombs. The same applies to the stone-built or rock-cut tombs in Crete and the Aegean Islands (*see* AEGEAN CIVILIZATION). Megalithic and rock-cut tombs of similar layout and constructions have been found in Sardinia (the gallery tombs known locally as *tombe di giganti*), Malta, Spain, the Pyrenees and Atlantic Europe; *e.g.*, Brittany (the famous passage grave at Carnac [*q.v.*]) and the British Isles (barrows and cairns [*qq.v.*]). In northern Europe the megalithic tradition, deriving from the Mediterranean, met with other cultures coming in from other directions and practising different types of burial. However, the contents of all these tombs (ornaments, trinkets, animal bones—possibly remains of funerary sacrifices—female figurines perhaps representing some kind of mother goddess, designs) clearly suggest ceremonial treatment of the dead involving certain beliefs.

Bronze Age.—Although some Neolithic and Early Bronze Age tombs contain evidence of whole or partial cremation, this mode of disposal became general only from the Middle Bronze Age onward. Characteristic of the period is the appearance in Europe, from western Asia Minor to Ireland, of cremation cemeteries in the form of urn fields. Particularly well-known examples are the "terramara" and Villanova urn fields in Italy, and the great Hallstatt cemetery in the Austrian Alps. The precise reason for the correlation of cremation with Bronze Age culture is unknown. (*See* also VILLANOVANS; HALLSTATT.)

Greece.—From the earliest times in Greece, when inhumation still was the sole mode of disposal, different types of tombs are known: circular dome tombs, rectangular chamber tombs, shaft tombs and pit tombs. Burial often took place in the village or even under the house. There is evidence of human sacrifices having been offered as part of the funerary ritual, in addition to the regular tomb furnishings (treasures, vessels, etc.). Funeral games in honour of the dead were no longer held in later periods. Exposure of the corpse before burial, sometimes for ten days or more, was not unusual. Violent expressions of grief (wailing, self-laceration, beating the breast) were customary though disapproved by lawgivers and moralists (Solon, Plato).

Proper burial rites were essential for the soul's admission to the realm of the dead, and sacrifices were performed at the tomb at prescribed dates (the third and the ninth day after burial). Mourning included abstention from pleasures and wearing black. There were also annual commemorations of the dead and festivals at which the dead were supposed to return in order to be welcomed and entertained (*anthesteria* [*q.v.*]). These visits were occasions of considerable uneasiness: precautionary measures were taken, and there was great relief at the end of the festival.

By the time of Homer cremation had become fairly general, and his detailed account of the obsequies of Patroclus (*Iliad* xviii, xxiii) gives a good idea of the pomp and costliness of the elaborate ceremonial as performed for outstanding persons. For ordinary folk the rituals of cremation and (more generally) burial would, of course, be simpler.

Rome.—In ancient Rome, funerary ceremonial varied with the times as well as with the rank, wealth, occupation, place and religion of the dead person. Most of our evidence dates from the late republican and imperial periods. As a man breathed his last, his name was called out (*conclamatio*)—a ceremony that is still performed at the death of a pope. When the deceased failed to respond and to return (*conclamatum est*), the corpse was bathed, washed, perhaps also embalmed, and arrayed in a toga. Formal announcement of the decease and the impending obsequies was made, and at the appointed time the funeral procession (which sometimes included actors and jesters) made its way to the Forum where the departed citizen was eulogized (*laudatio*), and thence, through the city gates, to the place of inhumation or cremation. This was not in a public cemetery but in family holdings which lined the roads. The best known of these is the line of tomb ruins along the Via Appia. Tombs were of various types: mausoleum, tumulus, columbarium (*q.v.*). The latter, which derives its name from the dovecot type of chambers with niches, is usually found in plots belonging not to families or *gentes* but to co-operative funeral associations (*collegia funeraticia*). It was as such an association that the early Christians in Rome were organized (*see* CATACOMBS). The tomb would be marked by an epitaph giving biographical information about the deceased, and often also by a portrait bust. Incised in the stone there might also be a request for remembrance or a more general exhortation, couched in the form of an address to the passing stranger. Even when cremation had become fairly general, at least among the upper classes, the earlier form of disposal still survived symbolically in the burial of some minor part of the body (*os resectum*), usually the little finger. Lower-class funerals were, of course, much simpler, and slaves and the poor were buried in a general cemetery, the "potter's field" of Rome.

Mourning lasted for nine days, followed by offerings at the tomb (*sacrum novendiale*) and a banquet at the house. There was a further period of mourning—eight or ten months, according to the relation of kinship. The Roman rituals imply a general belief in some kind of survival and a wide solidarity between the quick and the dead. The latter exist and participate, albeit in a ghostly manner, in the affairs of the living. Hence scrupulous care had to be taken for the correct regulation of mutual contacts. Ancestors enjoyed a divine cult (*di paternales*, later the *di manes* generally), and the Parentalia were celebrated every year from Feb. 13–21, the last day of the festival having a public character (*see* MANES). During the feasts of the dead, no marriages could be concluded and all temples were closed. Spirits, if dissatisfied or unpropitiated, could become dangerous, bloodsucking, vampirelike ghosts (lemures); to propitiate them the Lemuria were held, during which the *pater familias* performed certain ceremonies and finally chased the ghosts away.

THE MAJOR RELIGIONS

Islam.—At the approach of death a Muslim (or those around him) pronounces the profession of faith, which may then be recited again, together with *sura* 36 of the Koran, over the dead body. The body is laid on a stretcher in the direction of Mecca (*kibla*) and reverently and carefully washed (*ghusl*) according to very precise regulations. The orifices of the body are stuffed with cot-

ton and the body sprinkled with camphor and rose water. The eyes are closed and the feet tied. About the sort and number of shrouds (in any case an odd number), their colour, and other details there are many differences of opinion and custom. Next, the prayer for the dead (*salat al-djinaza*), the formula of which is minutely prescribed, is recited. Martyrs, however, are not washed and not prayed over. A watch by the corpse is customary, though not prescribed, and the Koran is recited by hired readers.

Details of the procession to the cemetery vary. In Egypt the poor and the blind may precede the bier, chanting the *kalima*, followed by the relatives and someone who carries a reading desk with the Koran. The bier is borne by men only, even if the deceased is a woman. It is held desirable to follow a funeral procession (on foot, because the angels of death go on foot), and it is considered a particular act of merit to help carry the bier. The grave is of ample size, to enable the deceased to sit up when interrogated about his orthodoxy by the angels Munkar and Nakir. The body is laid on its right side, propped by bricks, with the face toward Mecca. There is no further service. A shawl is rent, three handfuls of earth are cast on the grave by the bystanders, and *sura* 112 of the Koran is recited (though not by the Wahhabis and some others). Before the tomb is closed, the correct answers for the angelic examination on the catechism ("Who is your God, Who is your prophet?" etc.) are prompted into the dead man's ear by two *fikis* (tutors); the Malikites, however, disapprove of this custom. The tomb is closed and the mourners depart reciting the *fatiha*.

A good many popular death customs are practised in spite of the disapproval of tradition; *e.g.*, wailing or declaring the praises of the dead man, burning a light near the bier, the ornamentation of graves and the placing of inscriptions on the tomb. On returning from the funeral to the house the *fikis* may hold a repast, recite *sura* 67 and perform the ritual of the *sabha* (the rosary of 1,000 beads), transferring the merit of the recitation to the deceased. Visits of condolence to the mourners are prescribed by religious law. Wailing is resumed by women every Thursday for three weeks; on the Fridays they visit the grave and perform various rituals. Visits to the graves take place also on other occasions.

Judaism.—Many of the death customs mentioned in the Bible were ancient Semitic practices (rending of garments, self-mutilation, walking barefoot, funeral meals; *see* Jer. xvi, 5–8; Ezek. xxiv, 17), and some of them were prohibited because of their pagan associations (Lev. xix, 28; Deut. xiv, 1). Inhumation, if possible in one's country and "with one's fathers," was the generally practised mode of disposal. To be deprived of proper burial was considered a major disaster, and exposure was a disgrace which even convicted criminals must be spared (Deut. xxi, 22 ff.; Jer. vii, 33; Ezek. xxix, 5; Ps. lxxix, 3). To be properly lamented and mourned over was almost as important as burial, and the Old Testament contains many references to the ritual of wailing and keening.

Postbiblical Judaism has preserved many biblical funerary customs, modified by later developments. At the approach of death the confession of sins and the confession of faith are recited (the latter also by those present). The dead body is then laid on the ground, and Psalms (particularly Ps. xci) are recited by the watchers. The corpse is washed with decency and reverence according to a prescribed ritual, and wrapped in a simple white linen shroud. (Since the ordinance of Gamaliel II, 2nd century A.D., all Jewish burials have been of equal simplicity.) For climatic reasons the original custom required immediate burial. All ministrations connected with the washing and burying of the corpse are performed by voluntary or professional organizations known as "holy brotherhoods." These ministrations, as well as the attendance at a funeral and the comforting of the mourners are considered as meritorious acts of charity. The corpse is buried in extended position, either in a plain wooden coffin or immediately in the grave lined with stone slabs. Usually a handful of dust or earth from the Holy Land is laid in the grave or coffin. The funeral service consists of Psalms, the "acknowledgment of the justice of God's decree," funeral speeches in praise of the deceased, prayers for the repose of his soul, and the Kaddish doxology. Those present throw earth on the grave and then stand in two rows through which the next of kin walk out of the cemetery.

The ancient funeral banquet has fallen into desuetude, but on returning from the burial, mourners eat a simple meal served to them by friends and neighbours. The next of kin manifest mourning by rending their upper garment and staying indoors for seven days (*cf.* Gen. 1, 10 and I Sam. xxxi, 13), sitting on the floor or on low stools. Since the mourners cannot leave the house to attend synagogue, morning and evening services may be held at the house. Mourning varies according to the degree of kinship (strictest for the death of parents) and is graded in stages: the first seven days after the funeral, the first month after the decease, the first year. These stages of the mourners' return to normal life correspond to the stages of the soul's progress in the hereafter (final separation from the body in the grave, purgatory, admission to celestial repose). During the latter part of the middle ages, the idea gained currency that prayers and merits accruing from good works might profit the departed souls, and some earlier customs (*e.g.*, the recital of the Kaddish) were reinterpreted in that sense. The development of more ideas and customs of this kind (*e.g.*, for protecting the soul from hostile demonic powers) was stimulated by the kabbalistic movement of the 16th century.

Christianity.—When discussing the funerary customs of Christian people, a distinction must be made between the essentially Christian elements, deriving from specifically Christian beliefs and liturgical traditions on the one hand, and general, folkloristic elements on the other. The latter, which may combine in sundry ways with the Christian element, will not be considered in this section (but see *Pre- and Postburial Rites*, above).

The starting point of all Christian mortuary rites is the faith that by Christ's death on the cross and by his resurrection man has shed his old condition, spiritual death (*i.e.*, sin), as well as its outward expression, physical death (Rom. vi, 23). The individual incorporated in Christ, *i.e.*, in the church of which Christ is the head, has gained immortality by sharing in the resurrection-life of Christ. This immortality will become fully manifest at the general resurrection.

Mourning over death was not an original Christian custom, since the deceased had merely left this temporary abode in order to join his Lord in glory and to expect the final resurrection. In the 4th century, funerals were still occasions of joy and those attending them wore white. Also, the Christian form of the "cult of the dead," *i.e.*, the cult of the martyrs, was not a matter of mourning; there was in it an element of triumph, and altars, chapels and finally churches were constructed by preference above or near the tombs of martyrs. By the 8th century, however, the realities and attitudes of the Christian world had changed. Funerals were now occasions of mourning (*i.e.*, the wearing of black), and prayers were said for the purification and deliverance of the soul from hell.

By the end of the middle ages the following sequence of rites had developed: At the approach of death, a priest is called in to confess and absolve the dying person, to administer Holy Communion (viaticum: spiritual food for the last journey of the soul) and extreme unction (anointing with olive oil blessed by a bishop) and to pray (*commendatio animae* of the western rite). Burial is preceded by the office of the dead, consisting of the usual canonical hours (vespers, matins, lauds; the special antiphon *dirige* (has given rise to the "dirge") and, in the morning, the Requiem Mass (*q.v.*) with prayers for absolution of the dead, and the censing and aspersing of the body. Requiem Masses are also said on the 3rd, 9th, 30th and 366th day. The burial service of the Anglican Book of Common Prayer is a modified version (sentences, psalm, lesson) of the dirge. Some modern Protestant liturgies do not have prayers for the dead, though there is no doubt that from very early times the eucharistic liturgy was offered for the dead as well as the living. All the souls of the faithful are commemorated on Nov. 2, All Souls' day (*q.v.*).

The actual inhumation is accompanied by a short committal prayer, sometimes also by censing and sprinkling with holy water. Interment has always been the traditional Christian practice. The

permissibility of cremation has given rise to discussion in recent times, and many churches have adapted their funeral service to cremation.

Tombs are usually marked by a cross or by (at times very ornate) tombstones incised with a cross.

The Roman Catholic doctrine of purgatory (*q.v.*), rejected by both the Eastern and the Protestant churches, has given rise to practices intended to obtain remission of (temporal) punishment for poor souls. Of these, the practice of indulgences (*q.v.*) is the best known because of the abuses to which it gave rise and the misinterpretations to which it was subject.

There are minor as well as major differences (*e.g.*, regarding liturgy, orientation of the corpse, vestments worn) in the burial rite, depending on whether the deceased is a priest, layman, infant, etc.

Hinduism.—The Hindu way of life, the Aryan *dharma*, is permeated by ceremonials and sacramental rituals (*samskaras*)—most of them domestic rituals. Considering the particular Hindu doctrines regarding the soul and reincarnation (*see* HINDUISM), ceremonies connected with death and afterlife are clearly of outstanding importance. In fact, every Hindu desires a son mainly because only a son can properly perform the regular funeral rites (*antyeshti*) which ensure a happy rebirth in the hereafter. Hindu death ceremonial is long and complicated. There are many variations in points of detail, some local, others due to the caste of the deceased, the particular school or sect to which he belonged, and other factors.

At the approach of death, relatives and Brahmans are summoned, *mantras* and sacred texts are recited and ceremonial gifts prepared. It is desirable that the dying person touch a cow (*vaitarani*) which is then given to a Brahman. The subsequent ceremonial is concerned partly with the deceased and partly with his relatives (particularly the chief mourner or *purohita*), who are all impure and consequently have to go through various purification rites. Since the time of the Rigveda, cremation has been the usual mode of disposal. It is performed, wherever possible, near a river, though some low castes usually bury their dead and the same is done occasionally with children and ascetics. The treatment of the corpse, the shrouding, the procession to the place of cremation with the attendant rituals (offerings, circumambulations, etc.), the location, size, orientation and arrangement of the pyre, the kind of timber used, the procedure of committing the body to the flames (sprinkling of the pyre, placing various utensils and offerings on the body), the postcommittal rites (lustrations, recitations, return to the home after sunset)—all these are strictly regulated. For ten days after the funeral the mourners are unclean and secluded from society. They are subject to certain tabus (*e.g.*, they must not study the Veda or cut their hair) and must perform daily ceremonies intended to provide the naked soul of the deceased with a new spiritual body with which it may pass on to the next life; otherwise the soul might become a ghost and haunt the living. Ceremonies include the setting out of milk and water, and the offering of rice balls (*pinda*). At a date fixed according to various rules, the secondary burial takes place. The bones are collected and placed in urns or barrels which may be either buried or thrown into the water; some schools command a second cremation after pulverizing the bones and mixing them with combustible material. Further rites are performed to ward off evil and to mark the return of the mourners to ordinary life (*santikarma* and *smasana*), including the kindling of a new fire in the house and the construction of a ritual hut for the disposal of the urn; viz., the bones. Other regular memorial offerings (*shraddha*) continue to be made on fixed dates in order to nourish the souls of the ancestors in the afterlife.

Buddhism.—There is no fixed funerary ritual characteristic of all Buddhists. Customs vary according to geographical and ethnocultural factors (southeast Asia, Ceylon, Tibet, China, Japan), local pre-Buddhist traditions, and the particular school of Buddhism concerned. Even in a single relatively homogeneous Buddhist area, *e.g.*, Japan, there are considerable differences in the rituals of the different sects (Shingon, Tendai, Jodo, Shinsho, Nichiren, etc.). Buddhism has generally countenanced popular superstitions. Hence animistic and magical beliefs as well as other folkloristic elements are much in evidence in the death customs of many Buddhist countries.

The most usual method of disposal among Buddhists is cremation, though burial, preservation and exposure also occur. Often the dead are kept—embalmed or buried—for a period of time before cremation (*e.g.*, in Thailand).

Death plays a central role in Buddhist theory and meditation. Death is painful and inevitable, and all men fear it. But its real sting is the fact that it is not an end but a new beginning; it is the birth of new existence. Hence meditation on death is necessary to enlightenment. For the truly enlightened man death is no longer the passing to another existence but the extinction of, and release from, existence: Nirvana. Buddhism rejects the notion of a substantial soul. Yet the notion of karmic rebirth presupposes that even after the dissolution of the combination of changing elements which constitute the empirical human organism, some kind of substratum or element remains which may become the point of crystallization for the emergence of a new set of mental states; *i.e.*, a new existence. Hence one's last thoughts before death determine the nature of rebirth: at death the "fundamental thought" (*bhāvanga*) is transformed into "emigrating thought" (*chyntichitta*) which, in its turn, determines the "rebirth thought," the nucleus of the new existence. Proper preparation for death, by meditation as well as by *puja* ceremonies, was therefore considered important and even provided for in the emperor Ashoka's instruction regarding criminals awaiting execution. But whatever determines in theory the nature of the following rebirth, whether the last thought at death or whether the total quality of a whole life's endeavours, these considerations affect popular Buddhist practice only little. The most conspicuous elements in popular funerary ritual are the fear of hell and the demons, efforts to reduce punishment by vicarious acts of merit and by magical formulas, and the assurance of bliss by invocation of the merciful beings. In some sects the corpse, after being washed, is shaved and "ordained" a monk; *i.e.*, a member of the *sangha*. Wakes and (at times very elaborate) temple rituals are held which may include burning of incense, chanting of the confession of faith, exhortation of the deceased, invocations of the Buddhas and the use of secret *mantras*. Great importance is attached to the recitation of sutras—before as well as after disposal—and to other works of merit. The idea underlying these vicarious acts of worship and charity is the accumulation of disposable merit which can be transferred to the deceased. As a matter of fact, many Mahayana rituals are simply "Masses for the dead."

See also references under "Funerary Rites and Customs" in the Index.

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(R. J. Z. W.)

FUNG (FUNJ; DARFUNG), a mixed Negroid people occupying parts of Sennar (*q.v.*) and the hilly country to the south between the White and Blue Niles in the Republic of the Sudan (*q.v.*). They traditionally come from west of the White Nile and are affiliated to the Negro Shilluks. The Fung became the dominant race in Sennar in the 15th century, assimilated the speech, religion and habits of the Arabs settled in that region, and until the 19th century were one of the most powerful of African peoples in the eastern Sudan. *See* AFRICA: *Ethnography (Anthropology): Northeast Africa*.

FUNGI. This term, Latin for "mushrooms," is applied not only to mushrooms but to all of the large and diverse group of plantlike organisms to which the mushroom family belongs.

Bacteria and slime molds, formerly grouped with the true fungi (as now restricted) in the class Fungi of the obsolete phylum Thallophyta, are still often loosely referred to as fungi. They are now, however, generally assigned to separate phyla as follows: bacteria (Schizomycota or Schizomycophyta); slime molds (Myxomycota or Mycetozoa); true fungi (Eumycota or Eumycophyta). (There are several other schemes of classification in currency.) (*See* BACTERIOLOGY; SLIME MOLDS.) This article deals only with the true fungi.

The following sections are included here:

I. Distribution of Fungi
II. Structure of Fungi
  1. Noncellular Fungi
  2. Cellular Fungi
III. Nutrition and Functions
  1. Saprophytic Fungi
  2. Parasitic Fungi
  3. Symbiotic Fungi
IV. Reproduction
  1. Asexual Reproduction
  2. Sexual Reproduction
  3. Types of Spores
V. Classification
  A. Phycomycetes (Algal Fungi)
    1. Archimycetes
    2. Oömycetes
    3. Zygomycetes
  B. Ascomycetes (Sac Fungi)
    1. Yeasts
    2. Blue and Green Molds
    3. Powdery Mildews
    4. Truffles
  C. Basidiomycetes (Club Fungi)
    1. Rusts
    2. Smut and Bunt Parasites
    3. Musbrooms and Toadstools

Fungi have no chlorophyll; they are not differentiated into roots, stems and leaves; and they reproduce by forming spores—reproductive cells that develop directly into new organisms. They range in size from microscopic single-celled forms to large and elaborate structures; in properties, from such useful organisms as yeasts and penicillin-producers to destructive plant rusts, mildews and molds.

Because of their lack of chlorophyll and other physiological means of synthesizing carbohydrates from carbon dioxide and water, fungi are dependent on other organic matter, living or dead, for their food. Lack of chlorophyll is not, however, a characteristic that is unique with fungi. Certain algae (*q.v.*) are devoid of chlorophyll and are parasitic; and most bacteria are unable to synthesize primary foods. Fungi cannot be defined with complete precision therefore; membership in the group is inferred from similarities to typical fungi.

The undifferentiated body of a fungus—lacking stem, leaf and root structures—is known as a thallus. In typical fungi the thallus consists of an extensive network of branching threads, the hyphae, collectively called the mycelium. However, many fungi are nonmycelial. In these the thallus may be an amoebalike structure, at first naked but later enclosed in a secreted membrane, or a simple cell with a permanent wall, or a more or less spherical structure with minute rootlike outgrowths.

From the earliest attempts at scientific classification all living things were held to belong to one of the two kingdoms, plant and animal. But at least since the early years of the 20th century it has been apparent that the plant kingdom consists of a number of independently evolving groups. The sorting of these groups into the two kingdoms is a matter of convenience rather than an indication of actual relationship. In this historical sense, and in everyday speech, fungi may be called plants.

I. DISTRIBUTION OF FUNGI

Fungi occur throughout the Earth, wherever organic material occurs on which they can subsist. Like other forms of life, they are most abundant in temperate and tropical lands. But they form an important part of the small number of living things inhabiting Antarctica, and are found in considerable numbers in most fresh waters and in smaller numbers in the sea; even at high altitudes and latitudes viable fungus spores occur in the air. It has been estimated that about 100,000 species exist. More names have been published for fungi, but more than half of these are duplicates. In a small area of limited vegetation (such as the Marshall Islands) the species of fungi outnumber by several times the seed plants, whereas in a larger area (such as the state of Iowa) the numbers are about equal. Since fungi are nowhere thoroughly known, estimates of their numbers are quite tentative.

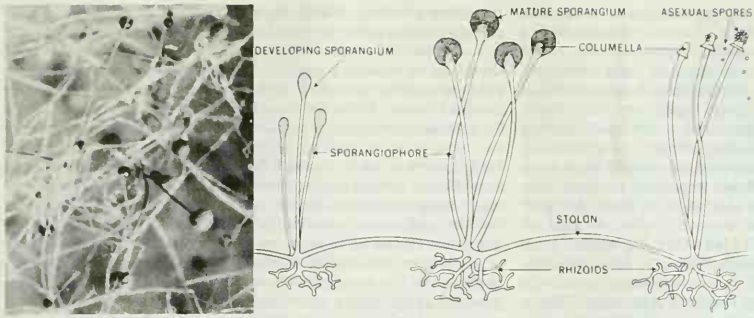
Because most fungal structures are unlikely to have been fossilized, their distribution in time is little known. The hyphae of fungi have been found within fossil plants of the Devonian period. Many fungus spores have been found mixed with fossil spores, pollen and other remains of higher plants, but although they have been given names suggesting their similarity to recent fungi, their correct classification, in the absence of the fruiting structures that produced them, is rarely possible.

II. STRUCTURE OF FUNGI

The visible mycelium of the simpler fungi forms a loose, cottony mass. Within the substratum (such as a parasitized leaf, decaying organic material, soil) it constitutes a similar loose, branching network of separate threads. In many of the more complex fungi there exist, in addition to assimilative mycelia of distinct fibres, massive structures in which the threads are felted together. In *Sclerotium* and *Rhizoctonia* lens-shaped or oval bodies the size of a small seed are formed by the branching, intertwining and compaction of the hyphae. When these are carried about they serve to disseminate the fungus. In various pore fungi (*Poria cocos*, *Polyporus tuber-regium* and others) hard oval bodies 20 cm. or more in diameter are formed in the soil, and serve as reservoirs of food from which fruiting bodies are developed. Whether small or large, these structures are sclerotia. Similar massive structures of sterile hyphae, often crustlike or nodular but frequently clublike or of various other shapes, may later produce conidia on their surface or inside spore-producing cavities within their substance. These are stromata. In other fungi many nearly parallel hyphae are united into long strands, resembling shoestrings (in the honey mushroom, *Armillaria mellea*) or flattened cottony cords (in the house fungus, *Serpula* [*Merulius*] *lacrymans*), two to ten millimetres in width. These strands, the rhizomorphs, have the central hyphae enlarged as conducting tubes, and serve to carry water and nutrients from the area in which they occur to a new area which the fungus may later penetrate. Thus these organs, once developed, facilitate the spread of the fungus.

The fruiting body of the higher fungi is similarly composed of a felt of large numbers of branching hyphae. A mushroom, which is one type of fruiting structure, is composed of threads as truly as is a mold. Most of the threads in the stalk run lengthwise. Many of those in the cap run from the centre toward the margins, and the surfaces are composed of variously oriented hyphae. These may be of three sorts: structural hyphae, often thick walled, sparsely branched, with little protoplasm; generative hyphae, thin walled, with abundant protoplasm; and binding hyphae, short celled, much branched, irregular and contorted, which serve to tie the others into a mass. However compact the larger fungus structures may be, the structural unit is a branching thread and the whole is a felt rather than a true tissue.

1. Noncellular Fungi.—If spores of one of the common black molds (*Mucor*, *Rhizopus*) are placed on a suitable nutrient (cooked corn meal, blotting or filter paper soaked in fruit juice, or nutrient agar) they will soon germinate. The outer spore wall is ruptured and the inner, colourless wall protrudes, swelling and elongating to become the wall of a hypha. The older, basal part of such a hypha soon becomes fixed and rigid, but the tip continues to push out, increasing the length of the hypha, and commonly branches. Soon there is formed a large and complex branched system (fig. 1). Where growing tips come in contact with each other they often fuse and thereby produce a network. Each hypha consists of a tubular wall of secreted material, lined with a layer of fluid protoplasm in which are embedded numerous nuclei, and enclosing a central stream of sap, containing in solution various salts, food substances and other metabolic products. The protoplasm (including the nuclei) is mobile within its wall and continually migrates from the older parts of the mycelium toward



FROM (LEFT) W. W. ROBBINS, T. E. WEIER AND C. R. STOCKING, "BOTANY: AN INTRODUCTION TO PLANT SCIENCE," 1957; REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.; (RIGHT) "THE MICROBIAL WORLD," SECOND EDITION, BY ROGER Y. STANIER, MICHAEL DOUDOROFF, AND EDWARD A. ADELBERG, 1963, PRENTICE-HALL, INC.

FIG. 1.—COMMON BREAD MOLD (RHIZOPUS NIGRICANS), A NONCELLULAR FUNGUS

(Left) photomicrograph of hyphae showing mature (black) and immature (white) sporangia; (right) stages in the development of sporangiaspores. Greatly enlarged

the growing tips. In a mycelium several days old the protoplasm entirely evacuates the hyphae first formed, and the abandoned segments are separated from the living by secreted partitions formed successively behind the migrating protoplasm. In most black molds true septa, which are partitions dividing one portion of the protoplasm from another, are not regularly formed except in the fruiting structures. Thus, except for injured areas or the oldest hyphae, the protoplasm and enclosed sap (the vacuole) are continuous throughout large masses of mycelium.

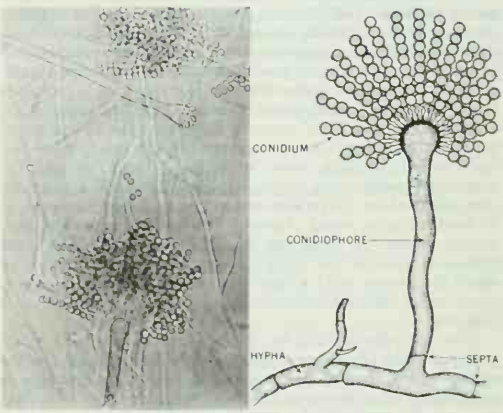
When a mycelium has attained sufficient size and sufficient reserve food it proceeds to reproduce. (*See* below for a fuller description of the reproductive process.) In the black molds the first step in this process is the formation of thicker and more rigid hyphae which grow not into the substratum but out into the air. Into these fruiting branches a large amount of protoplasm migrates, so that it is much denser there than in assimilative hyphae. After such a branch has reached its full length (from about 0.5 to 4 mm. in the genera under discussion, but up to 30 cm. in other black molds) the tip swells to form a more or less spherical vesicle (fig. 1), into which most of the protoplasm flows, and which is then separated from the stalk by a septum. This septum does not lie straight across the summit of the stalk, but arches into the vesicle so as to form a protrusion into it. The vesicle is the spore case or sporangium, the stalk is the sporangiophore and the protrusion is the columella. Within the sporangium, the protoplasm is divided into many blocks, each including one or more nuclei. These blocks then contract into a spherical or oval shape, secrete a dark-coloured external wall and become spores that are set free by the rupture of the sporangial wall. On a suitable substratum they germinate to repeat the cycle. These black molds exemplify the structure of a coenocytic (noncellular or nonseptate) mycelial fungus.

2. Cellular Fungi.—One of the green molds, *Aspergillus* or *Penicillium*, found on decaying fruits and vegetables illustrates a cellular or septate fungus. When its spores are sown on a suitable nutrient, such as one of those employed for the black molds, they germinate in similar fashion to form a short, branched hypha. But before the hypha has attained any great length it becomes divided into segments—*i.e.*, cells—by septa. These are begun by the deposition of wall material in a ring on the inner surface of the hyphal wall. The deposition continues toward the centre of the hypha until a circular partition is formed, complete except for a pore in the centre. Through these pores the protoplasm of each cell is continuous with that of the cells immediately above and below it in the hypha, so that even in a septate mycelium the cell contents form a continuous system. When the mycelium reaches the stage of fruiting it gives rise to stout aerial branches that are septate like the assimilative hyphae. In *Aspergillus* the apex of such a branch swells to form a vesicle that, rather than producing internal spores, pushes out from its surface a large number of fingerlike protrusions. These may branch once or twice; ultimately the outer portions are constricted just back of the end, a septum is formed at the constriction and the cell so formed develops a thick wall and becomes a spore. By constriction and septation a second spore is cut off just below the first, and later a whole series of spores is similarly formed, having to each other the relation of beads on a string. A single vesicle may bear scores or hundreds of these series (fig. 2). Such spores, formed from a specialized segment of a hypha, are conidia, and the stalk on which they are borne is a conidiophore. The other common green mold, *Penicillium*, is similar except that the branches of the conidiophore do not radiate from a conspicuous vesicle.

Composition of the Wall.—In a relatively small number of species of fungi the wall is composed of the carbohydrate cellulose, as in all young cells and most mature cells of green plants. In most fungi, however, the wall is chiefly chitin, a carbohydrate similar to that forming the integument (covering) of insects and many other animal structures. In some fungi (*Tremella* and other jelly fungi) the wall swells in the presence of water and becomes gelatinized. In others (*Fomes*) the wall is greatly thickened and hardened by the deposition of mineral compounds, resins and other metabolic by-products, becoming lignified as in the harder tissues of woody plants. Hyphal walls frequently are impregnated also by pigments. Nearly all the colours shown by fungi—and these include the whole spectrum as well as black—result from pigmented hyphal walls.

III. NUTRITION AND FUNCTIONS

The nutrient requirements of fungi are similar to those of bacteria, of animals and, except that fungi cannot synthesize carbohydrates, of green plants. According as they are able to produce the appropriate digestive enzymes, various fungi are able to utilize sugars, starches, cellulose and lignin as carbohydrate foods. Fats are suitable as food for a number of fungi. It is not certain



(LEFT) BY COURTESY OF DR. L. J. WICKERHAM, PRINCIPAL ZYMOLOGIST, U.S. DEPARTMENT OF AGRICULTURE, PEORIA, ILL.; (RIGHT) FROM N. J. FULLER AND C. TIPPO, "COLLEGE BOTANY," COPYRIGHT 1954; REPRODUCED BY PERMISSION OF HOLT, RINEHART AND WINSTON, INC.

FIG. 2.—GREEN MOLD (ASPERGILLUS), A CELLULAR FUNGUS

(Left) photomicrograph and (right) sketch showing production of conidia. Greatly enlarged

that any fungus can fix atmospheric nitrogen, as can some bacteria, to form proteins; therefore, some form of combined nitrogen is a necessary nutrient for fungi. Some species can use nitrates, others can use nitrogen in the form of ammonia, and many others require external supplies of organic nitrogenous substances such as proteins or amino acids. Apparently all fungi need phosphorus, potassium, sulfur, iron and magnesium, and at least some species must have zinc, manganese, copper, molybdenum and gallium, although in minute quantities. The required amounts of these trace elements are so small that it is difficult to prepare nutrient solutions sufficiently free from them for the fungus to show the effect of deprivation. It is probable that ultimately other mineral requirements will be demonstrated. Like other organisms, fungi also require in minute quantities certain vitamins. Thiamin (vitamin B_1) is probably needed by all fungi, but some are able to synthesize an adequate supply from simpler compounds. Many, however, can grow only if an external source of thiamin is provided. Other vitamins are similarly required by some fungi although none, apparently, need riboflavin (B_2). Like all living things, fungi need water, and all need at least a low concentration of atmospheric or dissolved oxygen.

The surface of the living mycelium absorbs water and water-soluble mineral and food substances. These diffuse through the hyphal wall into the protoplasm and may be passed on to the central vacuole. There they are moved to other portions of the mycelial network not only by the relatively slow process of diffusion, as in organisms divided into cells, but also by the flow of the sap through its enclosing protoplasmic tubes. The mycelium also secretes enzymes through the wall into the substance on which the fungus is growing. By their action a part of the nutrient substratum is digested outside the fungus, the soluble products of digestion then being absorbed.

With respect to their sources of food, fungi fall into three classes: (1) saprophytes, which feed on dead organic material; (2) parasites, which derive their food from living things, to the detriment of the host; and (3) symbionts, which live in association with other organisms with mutual benefit, each commonly contributing essential nutrients to the symbiotic partner and receiving nutrients from it.

1. Saprophytic Fungi.—Saprophytic fungi have an important place in nature. They reduce to a form usable by other organisms the dead bodies of plants and animals, freeing the carbon, nitrogen, hydrogen and minerals that otherwise would remain forever locked up in the corpses. This function they share with bacteria. Although there is no sharp dividing line, the fungi do most of the work of digesting complex carbohydrates and the bacteria digest mostly proteins. The black and green molds usually live as saprophytes. Another familiar saprophyte is the meadow mushroom, *Agaricus* (*Psalliota*) *campestris*, which grows wild in meadows and pastures where the dung of grazing animals is added to the organic matter in the soil, and is also cultivated in prepared beds composed largely of partially decomposed manure. In either situation the mycelium, starting from spores or from commercially prepared masses of mycelium (spawn), spreads through considerable volumes of soil, breaking down, by enzymes that it secretes, the organic soil components to simple carbohydrate and nitrogenous compounds which can be absorbed by the mycelium and serve as its food. After a period of growth and food storage, which may involve weeks (in mushroom beds) or years (in nature), the mycelium forms at the surface of the substrate (substance on which the enzyme sets) a crop of mushrooms, its fruiting structures, which immediately shed spores from which new mycelia may arise.

Other saprophytic fungi are those that produce bracket mushrooms or conks (*Fomes applanatus*, *Polyporus sulphureus*) on the surface of tree trunks (*see* BRACKET FUNGUS). The tree may be standing or fallen, living or dead. Although any part of a dead tree may be attacked, the mycelium in living trees penetrates, digests and destroys only the dead heartwood. House fungi, especially *Serpula* (*Merulius*) *lacrymans* and *Poria incrassata* can reduce timbers to a weak, friable mass. The yeast fungi, minute single-celled forms, belong to the same biological class. They live in watery solutions, chiefly those containing sugar, such as fruit juices, ensilage, plant sap and the moist component of bread dough.

2. Parasitic Fungi.—These are numerous in species. Many of them are facultative parasites; that is, they can live at the expense of a living host until it dies, and then continue to feed on the dead tissue. Often the mycelium on the living host reproduces by conidia, or asexual spores, and that on the dead host by other and more complex fruiting bodies. Parasitic fungi of animals include species of the water mold *Saprolegnia*, which grow on fish and amphibians; species of *Entomophthora*, which attack insects; and many fungi that cause disease in man.

Corn smut grows parasitically within tissues of the ears, tassels and other organs of Indian corn (maize), stimulating the host to produce large, tumourlike swellings whose soft tissues finally are absorbed by the mycelium whose cells then round off and become spores. These spores germinate in soil and there produce large numbers of cells capable of reinfecting the host. Other fungi are obligate parasites, unable to live apart from living tissues of a suitable host. Such species have never been cultivated. An example of this class is stem rust of wheat, which produces two types of spores while growing on wheat and certain grasses, and two other types on the leaves of barberry. Many parasites form their mycelia between the cells of the host, absorbing nutrients through the cell walls of both host and fungus. Others, of which the downy mildews are examples, send out short specialized hyphae that penetrate the cell wall of the host and sometimes its outer protoplasm, coming to lie near the nucleus of the cell attacked. These hyphae may form coils or branches within the cell, thereby increasing their surface, which facilitates absorption. Such intracellular absorptive hyphae are called haustoria.

A successful obligate parasite is necessarily one that does not kill, although it may cause dwarfing, enlargement, sterilization or distortion of, the living plant or animal on which its own life depends.

3. Symbiotic Fungi.—Lichens provide the most conspicuous examples of symbiotic fungi. Lichens are often mistaken for mosses, as the common name, reindeer moss, of one of the most important lichens indicates. However, a lichen is an association of a fungus and an alga, with the fungus forming a leaflike, crustlike or branched matrix enveloping large numbers of algal cells (*see* LICHENS). A similar beneficial relationship exists between fungi and many seed plants and ferns, whose roots are symbiotic with the mycelium. The two organisms together form a compound structure known as a mycorhiza (*q.v.*). An especially complex symbiosis exists between various scale insects and fungi of the genus *Septobasidium*, which is widely distributed in the warm temperate and tropical regions of both hemispheres. These fungi grow only on living parts of higher plants, most commonly on the smooth bark of various trees, where they form feltlike or lichenlike crusts. They appear to be parasitic on the tree, but actually each fungus covers a colony of scale insects. The insects suck the juices of the plant and in turn are infected with haustorium-bearing hyphae that extend from their bodies into the fungus crust. Such insects are not killed by the *Septobasidium*, although they remain sterile. The fungus is an obligate parasite upon them, as they in turn are upon the plant. Other insects of the same colony, however, live within an elaborate system of tunnels or houses developed by the fungus, within which they feed upon the host plant protected from most of their normal enemies. At the season when the uninfected insects are producing young, the fungus is producing spores on its outer surface. The immature insects that crawl over this surface may carry off a spore and become infected by it. If they move to another area of bark they establish a new growth of the fungus, and if they remain close by they add to the size of the old. Those insects that do not crawl over the surface, or that otherwise escape infection, may settle down within the protection of the old *Septobasidium*. The fungus thus parasitizes a part of the insect colony and protects the rest.

IV. REPRODUCTION

The spores of fungi serve the function of the seeds of higher plants but differ from them in their smaller size and simpler struc-

ture. Both sexual and asexual reproduction occur among fungi, and some species exhibit an alternation of generations, in which a sexual phase of the plant is followed by an asexual phase. In some fungi the mycelium can reproduce asexually of itself, but will reproduce sexually only when grown with certain other mycelia. This selective mechanism in sexual reproduction, known as heterothallism, functions to ensure the genetic heterogeneity of the offspring.

1. Asexual Reproduction.—Asexual reproductive spores, oïdia and conidia, are produced by the separation of cells from a mycelium. Oïdia commonly occur among various species of mushrooms. Conidia, which are distinguished from oïdia by their shapes, may be spherical, cylindrical or of other distinctive form; they may be one or many celled; and they may be formed directly on assimilative hyphae or borne on conidiophores. The conidium-bearing hyphae may be isolated or, in the more highly developed species, aggregated into crusts, cushions or clusters resembling sheaves of wheat. In many species the conidiophores arise within more or less pear-shaped cavities of special spore-producing structures (pycnidia). Other fungi produce minute pellets (bulbils), formed of a knot of intertwined hyphae, that serve for reproduction. The black molds and the water molds and their relatives are dispersed by specialized cells formed within and from the protoplasm of larger cells (sporangia). In the black molds these sporangiospores are provided with a firm wall, are resistant to desiccation and are scattered abroad by the air. In many water molds the spores are naked particles of protoplasm provided with threadlike flagellums by which they swim through water (zoospores). All of these types or reproductive bodies are usually (but not always) endowed with the same hereditary potentialities as the mycelium from which they arise.

2. Sexual Reproduction.—Most fungi exhibit the process of fertilization. This consists in the fusion of two bodies of protoplasm to form one, the zygote. The interval between cell fusion and nuclear fusion may extend through most of the life cycle; nuclear fusion is the final, critical event in fertilization. The gamete (fusing) nuclei have in any species a basic number of chromosomes, the haploid number; the zygote has the double (diploid) number; and nuclear fusion is the end of the haploid and beginning of the diploid phase. The reverse process is meiosis (*see* Cytology), by which the haploid condition is restored, marking the end of the diploid and beginning of the haploid phase. In many Ascomycetes and in Basidiomycetes there is a third phase, after the protoplasts have fused but before nuclear fusion has occurred, in which haploid nuclei from the two parents are associated in a common cytoplasm; if the nuclei are paired, this is called the dicaryotic phase. Few fungi have a diploid phase protracted beyond the zygote. In the black molds the fusing bodies are multinucleated branches (fig. 6); in the water molds (fig. 4[B]), they are an egg and one nucleus from a male hyphal branch (antheridium). In some Ascomycetes the gametangia are differentiated as males and females (fig. 8) but the fusing protoplasts are completely undifferentiated; in others the antheridium is missing and its function is assumed by an ordinary hyphal cell. In the Basidiomycetes, the most highly developed class of fungi, fertilization occurs between two hyphae, a hypha and a conidium, or even two conidia.

Heterothallism.—This phenomenon is best exemplified by the black mold *Rhizopus nigricans*. It had long been known that although any culture of this species produced sporangia, only rarely did one show gametangia and the zygospores (fig. 6[G]) resulting from their fusion. In 1904 the cause of this rarity became known when it was discovered that all mycelia of this species fall into two groups, such that any member of one fails to produce zygospores when grown together with any other member of the same group, but forms them when combined with any member of the other. The species is heterothallic. There are no constant differences between the members of the two groups other than their reciprocal behaviour when crossed, each stimulating the other to the formation of gametangia, and usually no differences are apparent in size of gametangia, rate of growth or biochemical properties. It is therefore impossible to designate one accurately as male and the other as female, and the complementary groups are called merely plus (+) and minus (−). A (+) mycelium produces only (+) sporangiospores, and a (−) only (−). The zygospore, upon germination, may produce either. Heterothallism has since been found in most other groups of fungi, as well as in algae. In many fungi, especially among Basidiomycetes, the mycelia fall into four rather than two groups in each of which the four will mate only with one other. Here the groups clearly are not sexually differentiated. Homothallic species, in which fusion of cells or nuclei from a single mycelium can occur, are frequent. Many of these are believed to have descended from heterothallic forms.

3. Types of Spores.—Fusion, whether of multicellular gametangia, of cells or of nuclei within a single cell, usually initiates the formation of distinctive spore types. In the Phycomycetes the typical spore is either the zygospore, usually thick walled, with a sculptured surface, and supported between the two similar gametangial branches, or the oöspore, a fertilized egg with thickened wall.

The Ascomycetes are characterized by ascospores (fig. 11), formed in limited numbers (usually eight) within a saclike cell in which fusion earlier occurred.

In the Basidiomycetes the typical basidiospore (fig. 14[C]) is formed on a slender stalk growing from the surface of the cell where fusion took place.

These four types of spores, formed directly after fusion, are known as perfect spores, and have been found to be the best indicators of relationships within the fungi. Classification accordingly is based on them. The fruiting structure that gives rise to perfect spores is called the perfect stage. Conidia, oïdia and the other types produced without change in the cytological or genetic state of the fungus are said to be imperfect, but the term must not be taken to indicate a failure in reproducing the parent. Fungi lacking perfect stages, or in which they are unknown, are called Fungi Imperfecti.

V. CLASSIFICATION

Most students of the true fungi now regard them as derived from colourless flagellates. They are placed in the phylum Eumycota or Eumycophyta of the plant kingdom. Three classes of Eumycota are universally recognized: Phycomycetes, Ascomycetes and Basidiomycetes. *See* also Plants and Plant Science: *Classification of Plants.*

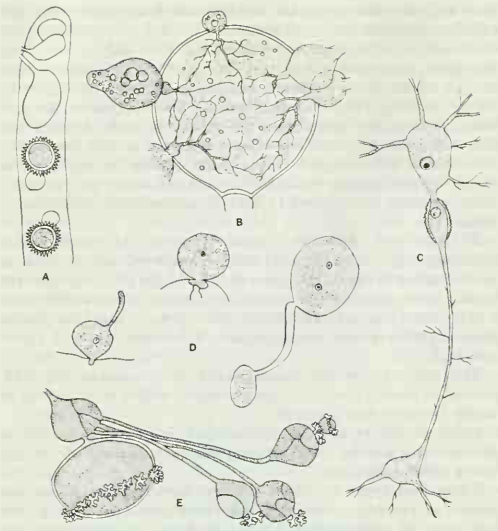
The basis of classification of the fungi, as mentioned above, is the mode of spore formation. The Fungi Imperfecti include members of all four classes—but mostly Ascomycetes—that lack or rarely produce the perfect stage, that is, the fruiting body that forms spores by fusion.

The following is one of several taxonomic schemes of the Eumycota:

Class Phycomycetes (algal fungi)
  Subclass Archimycetes
  Subclass Oömycetes
  Subclass Zygomycetes
Class Ascomycetes (sac fungi)
  Subclass Protoascomycetes
    Orders: Dipodascales; Saccharomycetales; Taphrinales
  Subclass Euascomycetes
Class Basidiomycetes (club fungi)
  Subclass Heterobasidiomycetes
    Orders: Ustilaginales (smuts); Uredinales (rusts)
      Auriculariales; Tremellales
  Subclass Homobasidiomycetes
    Orders: Agaricales; Gasteromycetes

A. Phycomycetes (Algal Fungi)

This large primitive group includes the fuzzy molds found on bread, jelly and preserved fruit, water molds, insect and fish parasites, the downy mildews parasitic on hops and other plants and destructive blights such as the potato blight that caused the Irish famine in 1846–47. Typically the mycelium is composed of nonseptate, branching hyphae, although cellular hyphae occur in some higher forms and in some lower forms hyphae are poorly developed or absent.



FROM E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER)

FIG. 3.—REPRODUCTIVE STRUCTURES OF VARIOUS PHYCOMYCETES

(A) Three emptied sporangia and two spiny resting spores of *Olpidiopsis saprolegniae* in the end of a hypha of *Saprolegnia*; (B) sporangia of *Rhizidiomyces apophysatus*, in various stages of development, attached to the oögonium of *Saprolegnia* and sending delicate rhizoidal threads into it; (C) conjugation of thalluses of *Polyphagus euglenae*, showing female nucleus about to enter the copulation tube; (D) *Zygorhizidium willei* showing the male thallus (at left) with developing copulation tube, the female thallus (centre) and the two in process of conjugation; (E) branching thallus of *Urophlyctis alfalfae*, the lower turbinate cell of which bears a single mature resting spore and three branches, each terminated by a turbinate cell in the early stages of resting-spore formation

In asexual reproduction, which is the more common form for the Phycomycetes, spores are formed in cells called sporangia. In sexual reproduction either zygospores, resulting from the conjugation of two like cells, or oöspores, resulting from fertilization of an egg cell by a sperm cell, may be formed. In lower forms the spores may be motile, animallike zoospores; in higher forms they usually are air-borne. Alternation of generations occurs in some members of this class.

1. Archimycetes.—In the separation of the Phycomycetes into the three major subclasses—Archimycetes, Oömycetes and Zygomycetes—a standard classification is used. The primitive Archimycetes are regarded by some students as degenerate Oömycetes and Zygomycetes. By others they are considered to be primitive forms such as those from which the Oömycetes and Zygomycetes are postulated to have arisen. In some modern classifications the Archimycetes and Oömycetes are merged, the former name being abandoned, and a primary division into two groups, Uniflagellatae and Biflagellatae, based on the number of cilia on the zoospore, is adopted.

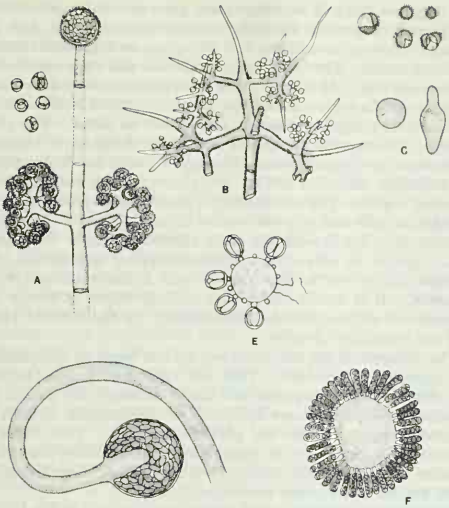
The mycelium is rudimentary or lacking; at maturity the thallus is transformed into a sporangium or differentiated to provide vegetative and sexual cells. In the simplest representatives of the Archimycetes, such as the genera of pond-scum parasites, *Olpidium* and *Synchytrium*, the thallus undergoes development in the cells of the host for a period as a naked protoplast. Later it assumes a wall and reproduces asexually as a sporangium or sorus of sporangia, freeing uniciliate zoospores. In sexual reproduction a pair of uniciliate, swarm-sporelike gametes fuse to form a motile zygote. The zygote after a period of vegetative growth encysts to form a resting spore. A similar morphology and mode of life are present in *Olpidiopsis* in which the zoospores are, however, biciliate. Here there are no motile gametes, a larger female and a smaller male thallus merely conjugating, with the passage of the content of one cell into the other. The receiving cell then forms a heavy wall and matures into a resting spore to which the emptied cell remains attached. In *Rhizophidium*, *Rhizidiomyces* (fig. 3[B]) and other related forms the parasite is enveloped in a visible membrane from an early stage and is attached to the outer surface of its host, into which it sends a short peglike haustorium or delicate branching mycelial threads. At maturity the whole thallus functions as a sporangium or acquires a thick wall and becomes a resting spore. A mode of sexual reproduction in which the conjugation of two individual thalluses creates a resting zygote is found in various genera; *e.g.*, in *Polyphagus* and *Zygorhizidium* (fig. 3[C, D]). In the former, which is parasitic on *Euglena*, the fungus possesses a highly developed system of haustorial threads, enabling it to attack a number of algal cells simultaneously. In certain other members of the group these threads are less delicate and resemble the hyphae of higher forms. In *Physodema* and *Urophlyctis* such hyphae develop large, swollen, intercalary, pluricellular vesicles, whose component cells not only serve as centres for fresh hyphal development, but also give rise to large, thick-walled resting spores (fig. 3[E]). In the case of species of these genera on alfalfa, beet and other plants, prominent warts or tumourlike swellings are formed on the host. The same is true of *Synchytrium* (*e.g.*, in black wart of potato).

2. Oömycetes.—These fungi have a well-developed mycelium of large coenocytic branching hyphae. The lower families (Monoblepharidaceae, Saprolegniaceae) are usually saprophytes, living in water on vegetable or animal remains, whereas the Peronosporaceae are chiefly highly specialized parasites on land plants. The

FROM (A) E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER); (B) G. MASSEE, "PLANT DISEASES" (GERALD DUCKWORTH); (C) GWYNNE-VAUGHAN & BARNES, "FUNGI" (CAMBRIDGE UNIVERSITY PRESS)

FIG. 4.—REPRODUCTION IN PHYCOMYCETES

(A) Uniciliate spermatozoids of *Monoblepharis macrandra* emerging from the basal antheridium and moving up over the surface of the oögonium. The single oösphere is fertilized by the entrance of one of these at the apex of the oögonium. (B) Globose oögonium of *Saprolegnia* containing two oöspheres, each of which is being approached by a fertilization tube sent in from a laterally applied clavate antheridium; (C) fertilization of the oöplasm of *Pythium debaryanum* by the entrance of a male nucleus from the antheridium; (D) sporangium of *Achlya* freeing swarm spores that encyst at the mouth before breaking out to swim away; (E) sporangia of *Phytophthora infestans*, the lower freeing swarm spores; below these, encysted spores germinating by tube. (F) Branched sporangiophore of *Peronospora schleideni* emergent from the stomate of an onion leaf; the sporangia, often termed conidia, germinating by tube without forming swarm spores



FROM (A, B, C, E, F) E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER); (D) AFTER F. MOREAU IN "LE BONTANISTE"

FIG. 5.—SPORES OF PHYCOMYCETES

(A) Sporangiophore of *Thamnidium elegans* bearing a large terminal sporangium and numerous lateral sporangiola; (B) conidophore of *Chaetocladium brefeldii*; (C) stages in germination of the monosporic sporangiolum of *Chaetocladium jonesii*; (D) sporangium and (E) sporangiola of *Blakeslea trispora*; (F) sporangia of *Syncephalastrum cinereum*, each containing a single row of spores

group exhibits structural modifications of both its asexual and sexual organs which are related to the gradual change from an aquatic to a terrestrial existence.

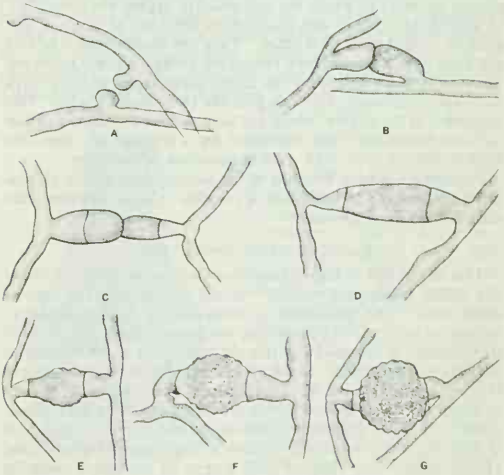
In the lower orders propagation is by zoospores, uniciliate in the Monoblepharidales, biciliate in the Saprolegniales and Peronosporales or downy mildews. The sporangium in the Saprolegniales may be merely a slightly enlarged terminal portion of the hypha (fig. 4[D]). In *Pythium* and *Phytophthora* of the Peronosporales it is usually spherical or oval in form and under certain conditions, following dissemination, may put out a germ tube that develops directly into a hypha. In other genera of the order (*e.g., Peronospora*) this direct mode of germination is alone possible, zoospores are no longer produced and the sporangium is now capable of germinating in moist air or in dew and thus adapted for a parasitic life on land plants (fig. 4[F]).

During sexual reproduction the group exhibits the tendency for replacement of the union of motile gametes by conjugation of walled gametangia. In *Monoblepharis* the female organ, the oögonium, contains a single, nonmotile, uninucleate egg, which is fertilized by a motile spermatozoid that closely resembles the zoospore in structure. The fertilized egg then surrounds itself with a thick membrane and forms a resting oöspore (fig. 4[A]). In the Saprolegniales the young oögonium contains many nuclei, potential gametes, only a few of which persist to function as the egg nuclei. There are usually several eggs (oöspheres) in the mature oögonium but there are no spermatozoids. Though parthenogenesis occurs in some species, the antheridium normally puts forth a fertilization tube that conveys the male nuclei to the eggs. Thus, even in members of this aquatic group, water is no longer the means by which the male nuclei reach the eggs. In *Albugo bliti*, of the Peronosporales, the egg has many nuclei and numerous male nuclei pass from the antheridium and fuse with them in pairs. There is thus multiple fertilization. The oöspore that results may be regarded as a coenozygote since it contains many zygote nuclei, each the result of a separate fertilization. In most of the higher Oömycetes, however, the mature egg is uninucleate and only one male nucleus passes into it from the fertilization tube. The assumption of the function of the gametes by the gametangia results in a single fertilization, made so as to ensure the production of the zygote. Many of the Oömycetes are parasites of cultivated plants and the cause of destructive diseases; *e.g.*, "damping off" disease of seedlings (*Pythium*), late blight of potato (*Phytophthora*), downy mildew of grape (*Plasmopara*).

3. Zygomycetes.—These fungi are largely saprophytic in habit and terrestrial. Reproduction by conjugation results in the production of zygospores. Zoospores are unknown; the characteristic sporangia contain thousands of walled spores. Certain higher genera, however, are reproduced by conidia (*e.g., Chaetocladium, Cunninghamella*), and there is a series of forms showing that in this family, as in the Oömycetes, transition of sporangium to conidium has taken place. In one series this has been brought about by the gradual reduction in the number of spores in the sporangium; *e.g., Thamnidium* has small few-spored sporangia (sporangiola) with sometimes only one spore, whereas in *Chaetocladium* a small sporangiolum in one species is completely filled by a single spore and hence appears as a conidium except at germination (fig. 5[A, B, C]), and in another no indication whatever of an endogenous spore is given. In *Blakeslea* multispored sporangia are normally accompanied by spherical heads bearing many sporangiola, each with only three spores. Between these types occasionally a complete series of intergrading forms exists. In the closely related genus, *Choanephora*, sporangiola are lacking and large multispored sporangia are accompanied by conidia borne over spherical heads as are the sporangiola of *Blakeslea*.

Members of the order Mucorales are saprophytes on organic substances or parasites on other molds. Among them are the genera *Mucor* and *Rhizopus*, common bread and jelly molds. In the complete life cycle of the Mucorales, conjugation of coenocytic gametangia occurs (fig. 6). The resulting structure, the zygospore, contains many zygote nuclei. The gametangia are usually morphologically indistinguishable. They may both arise on the same mycelium or on a specialized erect hypha or zygophore, as in *Sporodinia*. Such species are termed homothallic. In other cases the gametangia arise on two separate mycelia, differing in kind but not corresponding to distinct sexes, an example of heterothallism.

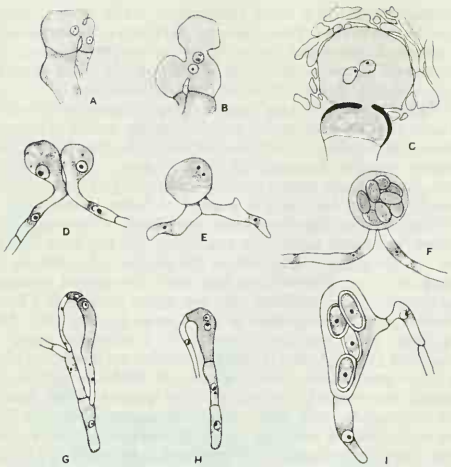
The germination of the zygospore usually results in the production of a germ tube bearing a germ sporangium, and in *Phycomyces nitens* it is in this structure that the zygote nuclei undergo the meiotic reduction divisions. The resulting spores are of two kinds, (+) and (−); but in any one germ sporangium only one kind is formed,



FROM GWYNNE-VAUGHAN AND BARNES, "FUNGI" (CAMBRIDGE UNIVERSITY PRESS)

FIG. 6.—CONJUGATION DURING SEXUAL REPRODUCTION IN MUCOR

(A, B) Progametangia formed as lateral branches of the hyphae grow toward each other; (C) each progametangium is divided by a septum to form a gametangium and a suspensor; (D) fusion of the two gametangia; (E–G) successive stages in the maturation of the zygospore



FROM (A) E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER); (B) GWYNNE-VAUGHAN AND BARNES, "THE FUNGI" (CAMBRIDGE UNIVERSITY PRESS), (C, D, E) LA REVUE GÉNÉRALE DE BOTANIQUE (E. ORLHAC, PARIS)

FIG. 7.—(A) FORMATION OF COPULATION OPENING IN A ZYGOMYCETES, ENDOGONE LACTIFLUA, (B) NUCLEAR MIGRATION; (C) FORMATION OF HYPHAL SHEATH AROUND ZYGOTE. (D–F) DEVELOPMENT OF ASCI IN EREMASCUS FERTILIS; (G–I) DEVELOPMENT OF ASCI IN ENDOMYCES

except for a few spores, presumably binucleate, which are homothallic. It is of interest to note that H. Burgeff experimentally produced similar mycelia by the admixture of the contents of hyphae from (+) and (−) mycelia and thus reached the conclusion that homothallic mycelia contain both (+) and (−) nuclei.

Insect Parasites.—The Entomophthoraceae are chiefly a family of insect parasites of which one, *Entomophthora muscae,* attacks the common housefly. They are reproduced asexually by conidia, which are shot off from the conidiophores in such numbers as to form a halo around the dead fly.

The small family of the Endogonaceae molds, with its chief genus *Endogone,* may be included here. The species form mostly underground stromata in which the reproductive organs are embedded. In *Endogone lactiflua* two conjugation branches of unequal size grow in contact with each other. They are multinucleate at first and from each a terminal cell containing a single nucleus is cut off. These cells unite and from the larger there arises an outgrowth that rapidly enlarges; into this pass the two gamete nuclei. This outgrowth is the zygote, which not only develops a thick wall but becomes surrounded and embedded by a number of vegetative hyphae (fig. 7[A, B, C]). Its germination is unknown.

Endogone has been included in the Ascomycetes and is of considerable interest as indicating a possible relation between that class and the Zygomycetes.

B. Ascomycetes (Sac Fungi)

This large class of higher fungi includes yeasts, molds, mildews and edible truffles and morels. Spores are produced in asci or spore sacs. The mycelium is composed of hyphae regularly segmented into portions containing one or several nuclei. Asexual reproduction is common and this class provides a rich variety of conidial fructifications. Many species may show several different types of conidia on the same mycelium. There are many species in which the ascus fruit is rarely produced and there may consequently be many generations reproduced entirely by conidia. It is not, therefore, surprising to find a large assemblage of fungi (Fungi Imperfecti) that are only known to reproduce asexually and many of which are believed to be incomplete forms of Ascomycetes.

The sexual reproduction of the lower Ascomycetes (Protascineae) may be compared with that of certain Phycomycetes such as *Endogone.* In *Eremascus fertilis* the sexual branches arise from two neighbouring cells of a hypha and grow up side by side. They each receive a nucleus from their parent cells and then fuse together. The two nuclei unite and the zygote enlarges and forms a spherical ascus. The fusion nucleus divides and eight ascospores are formed (fig. 7[D, E, F]). The main point in which *Eremascus* differs from *Endogone* is that the direct product of fertilization is in the latter a zygospore and in the former an ascus. This then is one of the essential differences that mark off the lower Ascomycetes from the Zygomycetes. The higher forms are distinguished by a further advance, in that every ascus in an ascocarp is a separate zygote. The ascogenous hyphae usually grow out from ascogenous cells and by proliferation form a number of crooks or crosiers and thus provide for large numbers of asci. In heterothallic species the cells of the ascogenous hyphae may contain only a single pair of nuclei each and so form a dicaryotic system or dicaryon. It is in the ascus that nuclear fusion is finally accomplished, to be succeeded immediately by the meiotic phase and the formation of spores.

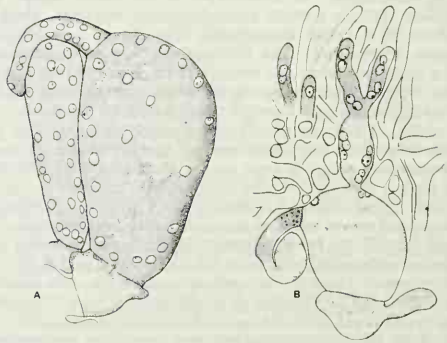
The ascogenous hyphae, however, do not form an independent self-supporting mycelium. They are dependent on the haploid mycelium for their nutrition, and this is accomplished by the enclosure of the ascogenous hyphae in a simultaneous growth of vegetative hyphae from the parent mycelium. Thus there is formed the fruit body or ascophore, one of the characteristic structures of the higher ascomycetes, showing in the different families great variety in structure and organization.

In *Eremascus* the two sexual organs are alike, but in the related *Endomyces* they are differentiated into a large female gametangium, the ascogonium and a smaller male, the antheridium (fig. 7[G, H, I]). In the Euascomycetes this differentiation in sex is maintained and the ascogonium is usually characterized by the development of a receptive portion, the trichogyne. Both structures may be divided by cross walls into several cells, the whole ascogonial branch (archicarp) thus consisting of a hypha of many cells, which is sometimes spirally coiled.

The antheridium shows no corresponding development, in fact it is possible to trace throughout the whole group the gradual dwindling in importance and final elimination of this organ.

It has been proved that macroconidia as well as microconidia (the so-called spermatia) may function in fertilization and that nuclei of opposite mating type may also be brought together as a result of nuclear migrations from one purely vegetative system to another. In *Neurospora* the microconidia also germinate readily to form perfectly normal mycelia. They are therefore asexual organs of dissemination, that may in addition function in place of gametes, rather than differentiated male cells.

In *Pyronema omphalodes* the large pear-shaped ascogonium bears at its upper end a tubular trichogyne, the tip of which fuses with the club-shaped antheridium. All these structures are multinucleate. The contents of the antheridium pass first into the trichogyne and then, by absorption of the intervening wall, into the



FROM "ZEITSCHRIFT FÜR BOTANIK" (GUSTAV FISCHER)

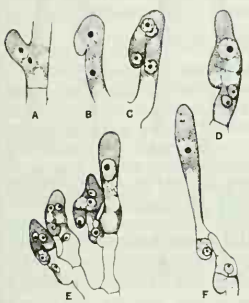
FIG. 8.—(A) ANTHERIDIUM (LEFT) AND ASCOGONIUM (RIGHT) IN PYRONEMA. (B) ASCOGENOUS HYPHAE GROWING FROM ASCOGONIUM

ascogonium, where the male and female nuclei become associated (fig. 8[A, B]). In *Humaria granulata* the trichogyne has disappeared though the ascogonium still has the form of those described above and like them gives origin to the ascogenous hyphae. Finally in *Humaria rutilans* the ascogonium itself has disappeared and with it, all trace of autogamous fertilization.

A parallel series can be traced in a related genus, *Ascobolus*, in which the ascogonium is many celled. In *A. magnificus*, which is heterothallic, normal conjugation takes place between antheridium and trichogyne; in *A. furfuraceus* antheridia are absent. In one species, *Ascobolus carbonarius*, the long and often coiled trichogyne comes into contact with one of the oval, stalked conidia, borne on the mycelium, and fuses with it and thus, apparently, fertilization is effected.

This process finds an interesting parallel in one of the lichen fungi, *Collema pulposum*. Here the archicarp, as in many lichen fungi, is a coiled thread terminating in a long slender trichogyne; the latter comes into contact with a conidium and fusion results. In other species of *Collema* the trichogynes, projecting above the surface of the thallus, get attached to their surface one or more uninucleate bodies, the so-called spermatia, which are formed in flask-shaped bodies resembling pycnidia. As the name implies, these spermatia have been regarded sometimes as male gametes.

These processes of modification and disappearance of the sexual organs should not obscure the fact that the essential feature of fertilization is the fusion of two haploid nuclei, and it is immaterial whether these nuclei are derived from different sexual organs, antheridium and ascogonium, from the ascogonium alone, from an ascogonium and a vegetative cell or from two vegetative cells. In every case the process that brings them together, whether fusion immediately results or not, marks the starting point of a new development, viz., dicaryotic growth, represented by the ascogenous hyphae. These hyphae eventually give rise to the asci and in the majority of the Ascomycetes they are formed in a characteristic way. As already stated the ultimate segments of these hyphae are binucleate and any one of them may grow out to a short branch, into which the two nuclei pass. This cell now curves over at the tip to form a hook, and the nuclei moving up to the summit divide there conjugately. The spindles are so arranged that when the two cross walls are formed, the summit of the crook contains two nuclei, one in the tip and another in the stalk (fig. 9).



FROM "ZEITSCHRIFT FÜR BOTANIK" (GUSTAV FISCHER)

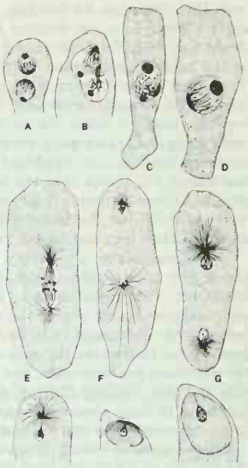
FIG. 9.—(A–F) FORMATION OF CROSIERS IN ASCOGENOUS HYPHAE OF PYRONEMA

In most cases the two nuclei at the summit fuse together and form the fusion nucleus of an ascus, which is the only truly diploid cell in the whole life cycle. The point of the crook and the stalk lie close together and either of them may now become binucleate by the migration into it of the nucleus from the other. The binucleate cell so formed may now originate a new crook and so the process may be repeated several times.

The young ascus now enlarges, the nucleus also increasing in size, and finally the latter divides; this is followed by two further divisions and thus eight nuclei are formed, which become the centres in forming eight ascospores (fig. 10). There is no doubt that the first division in the ascus is the heterotype or reducing division (*see* CYTOLOGY). The two following divisions have, for the most part, the characters of postmeiotic divisions.

There are a number of forms, however (*Sphaerotheca, Humaria, Lachnea, Ascobolus*), in which the nuclei in the ascogonium, however derived, have been described as fusing together. Obviously a double reduction would be necessary to produce haploid nuclei for inclusion in the ascospores, and the second reduction is said to take place during the second or third division. Genetic work on Ascomycetes disproves the whole theory of a double fertilization and a double reduction. Until one finds through hybridization experiments eight genetically different kinds of spores formed in certain asci of a cross, or that the spores alternate one and one for definite generic characters, the theory of double fertilization must be abandoned.

These genetic studies have shown also that heterothallic Ascomycetes can readily be hybridized, and it has been shown that genetic characters are inherited according to Mendelian principles. The Mendelian ratios, which are only approximated in experiments with higher animals and plants, occur precisely and regularly in breeding the mold *Neurospora*, which has the additional merit of permitting mating of cells of known genetic composition. Dominance, recessiveness, heterocaryotic vigour, lethal factors, which may be either dominant or recessive, as well as other genetic features well known in connection with genetic work with the common fruit fly, maize and other diploid organisms, are not known in the fungi.



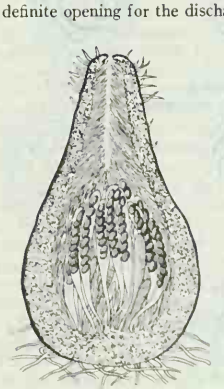
FROM E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER)

FIG. 10.—FORMATION OF ASCOSPORES IN PHYLLACTINIA CORYLEA

(A) Young ascus with dicaryon; (B–D) caryogamy; (E–G) division of primary ascus nucleus (*Erysiphe cichoracearum*); (H–J) spore formation

The mode of spore formation in the ascus is peculiar. The eight nuclei formed in the third division show delicate radiations, extending from a centrosome, which meet around the nucleus and thus delimit a portion of the protoplasm on which a wall is secreted to form a young spore (fig. 10[H, I, J]).

In the higher Ascomycetes, the developing ascogenous hyphae are enclosed by a development of the haploid mycelium, on which, in fact, they are parasitic. The whole structure that results is known as a fruiting body or ascocarp. In the simpler orders (Plectascales and Perisporiales) the enclosure is complete, the sterile hyphae compacting together on the outside to form a completely closed investment. Such a fruiting body is called a perithecium. In other orders (Hypocreales, Sphaeriales, Laboulbeniales) a perithecium is formed, often flask shaped and with a neck with a definite opening for the discharge of the spores (fig. 11).



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 11.—PERITHECIUM OF PODOSPORA FIMISEDA IN LONGITUDINAL SECTION SHOWING ASCOSPORES IN ASCI

The remaining orders have a fruiting body known as an apothecium. Here the numerous asci are assembled, together with sterile hyphae or paraphyses, in a continuous layer known as the hymenium. This is freely exposed on the surface of the ripe fruiting body, which may be a flat disk or a cup (Pezizaceae) or a convex, often stalked, structure (Helvellaceae).

1. Yeasts.—The Endomycetales are a small family in which (*Endomyces, Eremascus*) the asci result directly from the conjugation of the gametangia and are thus borne directly on the mycelium (fig. 7). The important family of the yeasts, Saccharomycetaceae, is included in this order. These are fungi that, living normally in liquid media, have the form of oval or spherical

cells that reproduce by budding. Some forms, when grown under certain conditions, can develop true hyphae and thus show their derivation from fungi of normal structure. Many genera have a sexual process represented by the conjugation of ordinary cells. The result is the formation of an ascus in which ascospores are formed (*Schizosaccharomyces, Zygosaccharomyces*). *Saccharomycodes ludwigii* forms the ascospores in the ordinary yeast cells and conjugation takes place between the germinating spores. The ordinary yeast cells so produced are thus diploid cells. Work on the yeasts has shown that the industrial yeasts may be, in fact, diploid in their nature. It has been proved that hybrids between various strains of the industrial yeasts may be obtained rather easily so that new and better races of yeasts can be developed.

The Exoascaceae is a family of parasitic fungi that grow on the higher plants, often producing malformation of the leaves, fruits, etc. The mycelium may develop in the deeper tissues, but eventually makes its way to the surface and the asci are produced between the epidermal cells, or more frequently they arise from hyphae that lie between the epidermis and the cuticle. The cells of the mycelium are binucleate, and in the young ascus the two nuclei fuse and then undergo division, eight spores resulting in the usual manner. In some species (*Taphrina*) the original spores may bud in the ascus and give rise to hundreds of small conidia.

When spores are sown in suitable culture fluids they bud after the manner of yeast cells and produce conidia. In two species of *Taphrina* it has been shown that these secondary conidia can conjugate in pairs by means of a short tubular process. The nucleus from one cell passes into the other and the binucleate cell so formed now puts out a germ tube. Moreover, when the eight spores from one ascus are carefully isolated and germinated apart, it is found that they fall into two groups, the conidia of one group will not conjugate together but do so readily with any member of the other group. They are thus, like many of the Mucorini, heterothallic, and the separation into the two mating types must take place during the divisions in the ascus.

2. Blue and Green Molds.—The Plectascales include the genera *Eurotium* (fig. 12) and *Carpenteles*, whose imperfect stages are the common saprobic molds *Aspergillus* and *Penicillium*, among the most ubiquitous and omnivorous of fungi. The ascocarps are closed and comparatively rare. Dissemination is chiefly by conidia, and for many of these molds perfect stages are unknown; these must be considered Fungi Imperfecti.

3. Powdery Mildews.—The Perisporiales include the Erysiphaeceae or powdery mildews and the Perisporiaceae or sooty molds. The Erysiphaceae occur as parasites on leaves and tender parts of living plants, forming a white mycelium dotted over with black fruiting bodies (the cleistothecia). They give rise to diseases on numerous plants in temperate regions, among them the mildew of hop, gooseberry and rose and many other cultivated plants. The Erysiphaceae rarely fruit in the tropics; the one and only species reported in fruit from Puerto Rico (*Erysiphe malachrae*) was later found to be the cause of the commonest cotton disease in Peru. There it is known as *manta blanca* or "white blanket" because of the frosted appearance imparted to the leaves of cotton in autumn. The Perisporiaceae in contrast are predominantly tropical, produce a black mycelium on leaves and other parts of living plants but occur as epiphytes, feed on honeydew and other materials excreted by sucking insects, disfiguring the hosts on which they grow. The Microthyriaceae also included here differ from the Perisporiaceae in having shield-shaped perithecia with an ostiole instead of closed cleistocarp or cleistothecium.

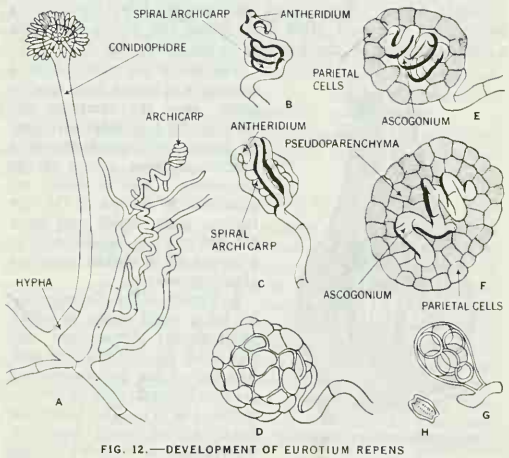
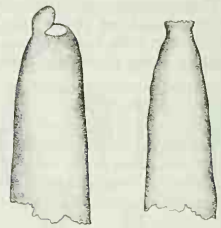


FIG. 12.—DEVELOPMENT OF EUROTIUM REPENS

(A) Hypha with conidiophore of the *Aspergillus* stage and young archicarp; spiral archicarp (B) with the antheridium, and (C) beginning to be surrounded by hyphae forming perithecium wall; (D) perithecium; (E, F) sections of young perithecia; (G) an ascus; (H) an ascospore

The orders Hypocreales and Sphaeriales (sphere fungi) include most of the families that frequently have been grouped together under the name of Pyrenomycetes. They have perithecia that, when mature, have a well-defined mouth (fig. 11). In some genera the fruiting bodies are borne directly on the mycelium (*Sordaria, Chaetomium*) or isolated in the host tissues (*Venturia*), but more often they are borne on a stroma (*Nectria, Cucurbitaria*) or embedded in it (*Epichloe, Claviceps, Valsa*). The stroma may be flat or cushion shaped or immersed in the tissues of the host. In the more specialized forms the stroma may show a sterile basal stalk, the perithecia being limited to the upper part, where they may more efficiently distribute their spores (*Xylaria*). The Pyrenomycetes is by far the largest group of the Ascomycetes, a conservative estimate of the number of species being 10,000. Though the majority are saprophytes some well-known diseases of plants are caused by members of this group; *e.g.*, canker in fruit trees (*Nectria*), ergot of cereals and other grasses (*Claviceps*), apple and pear scab (*Venturia*). Most species of Cordyceps are parasites on insects.



FRED J. SEAVER

FIG. 13.—(LEFT) TIP OF OPERCULATE ASCUS; (RIGHT) INOPERCULATE ASCUS

The Pezizales are divided into two sections, the operculates in which the asci open with a definite circular lid (the operculum), and the inoperculates in which the ascus opens with an irregular rupture (fig. 13). At maturity the spores are discharged from the asci like shot from a gun and in such numbers that they appear as a cloud of smoke. This phenomenon occurs in the operculates and inoperculates alike. The fungi of this order are called cup fungi because many of the species are disk- or cup-shaped.

The operculates include the larger and more conspicuous forms, the cups often reaching a diameter of several inches, although many are also minute. Two families are recognized—the Pezizaceae, in which the fruiting bodies are predominantly cup shaped, and the Helvellaceae, which comprise those with a stem and head of variable form. To this group belongs the May mushroom, *Morchella esculenta*. With few exceptions the operculates are saprophytic; and the conidial stage, though present in some forms, is inconspicuous and in most forms unknown. A few of these, such as *Pyronema* and *Ascobolus*, have definite sex organs, whereas in a large majority definite sex organs are obscure or absent, although heterothallism has been demonstrated in several.

The inoperculate cup fungi include some medium-sized forms, but a large majority are minute in size. Although perhaps a large majority are saprophytic, a much larger percentage of this group is strictly parasitic; in these latter the asexual or conidial stage is much more highly developed and is doubtless an adaptation to their parasitic habits. This is especially true of *Sclerotinia* and its segregates. The conidial stages take a variety of forms, such as *Monilia* and *Botrytis*. The genus *Monilinia* was established for

these species that have a *Monilia* as their conidial stages.

L. Tulasne in 1865 observed minute bodies in certain Discomycetes which he called spermatia or conidiola, which he believed to be male sperms. In 1832 it was definitely proven by F. L. Drayton that microconidia, which were found in many species of *Sclerotinia,* and which were probably morphologically identical with the spermatia of Tulasne, stimulated the production of apothecia when placed on certain structures that develop on another thallus of the same fungus. To this process is applied the term "spermatization," thus definitely proving heterothallism or the existence of (+) and (−) strains.

4. Truffles.—The Tuberales is a small group of fungi that includes the well-known delicacy truffles (*Tuber* sp.). They live underground in the neighbourhood of trees and may be concerned in the formation of mycorhizae. The hymenium lines internal chambers in the fruiting bodies.

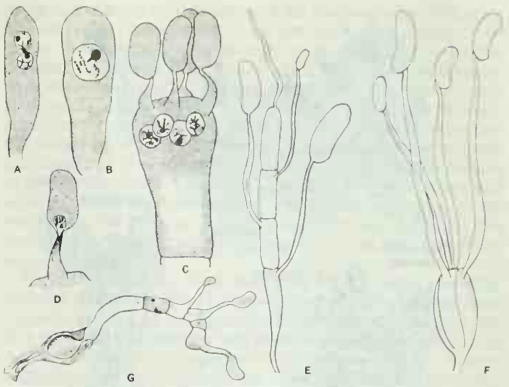
The Laboulbeniales is an order of peculiar fungi, whose manifold structure has been made known by the investigations of R. Thaxter in the United States. They are minute fungi, from one to ten millimetres in height, that grow attached to the bodies of insects, especially beetles. They are dark brown in colour and consist of a basal receptacle that bears appendages on which are the sexual organs. The female organ is fertilized by male cells or spermatia. The fertilized ascogenic cell (ascogonium) gives rise to asci, which are enclosed in a perithecial wall that develops around the female organ. Some species are probably heterothallic (*Amorphomyces*). They have been aptly described as ornamental parasites, and seem not to harm their hosts.

C. Basidiomycetes (Club Fungi)

The mycelium, like that of the Ascomycetes, is fully segmented, but in the haploid mycelium the segments are uninucleate. They differ from the Ascomycetes in the absence of sexual organs, whose functions are performed by hyphal or conidial fusions. The dicaryotic (binucleate) mycelium that results is extensively developed, has an independent existence and in the higher forms, is, in fact, the only mycelium that can normally be distinguished.

Though gametangia are absent, the haploid mycelium is often differentiated for mating type. Heterothallism occurs in the Uredinales and Ustilaginales, and is widespread in the higher forms. In the latter, pseudogamous fusions presumably occur between hyphae of the mycelia of different kinds, though in only a few cases have these actually been observed. Asexual reproduction by conidia and oïdia occurs in both types of mycelia.

In the lower families the basidia are borne directly on the dicaryotic mycelium, but in the vast majority of forms they are borne on fruiting bodies or sporophores. These are not formed, as in most Ascomycetes, as the immediate result of a sexual process (*see* above), but arise from dicaryotic mycelium at a time and stage in its development that are determined by physiological factors such as nutritive conditions, humidity, light, etc. The basidium, like the ascus, is the gonotocont. In it the reduction of the chromosomes is effected, but the daughter cells (usually four) resulting are exogenous; *i.e.,* borne on short stalks (sterigmata) outside the mother cell (fig. 14[D]). Two kinds of basidia occur. Those characteristic of the subclass Homobasidiomycetes are, like asci, undivided (holobasidia). Most of those of the subclass Heterobasidiomycetes have the basidia divided by septa into four cells (phragmobasidia) (fig. 14[E]). The dividing walls may run transversely, *e.g., Auricularia,* or longitudinally as in *Tremella* (fig. 14[F]). The fertilization that takes place in the young basidium is followed immediately by the reducing divisions and the development of spores, but in the Uredinales and Ustilaginales, after the nuclear fusion, a resting stage, often prolonged, may intervene. This may be accompanied by a thickening of the wall of the mother cell, which may even become set free from the mycelium as a spore (teleutospore, chlamydospore). These probasidia, as they are called, germinate by a short hyphal outgrowth (promycelium) that bears the four basidiospores (sometimes termed sporidia). The probasidium and promycelium together constitute two successive developmental stages and two morphological divisions of the complete basidium. In these forms



FROM (A, B, C, D) W. RUHLAND, "KENNTNISS DER INTERCELLULAREN KARYOGAMIE BEI DEN BASIDIOMYCETEN" (ARTHUR FELIX); (E, F) W. G. SMITH, "BRITISH BASIDIOMYCETES"; (G) GWYNNS-VAUGHAN AND BARNES, "FUNGI" (CAMBRIDGE UNIVERSITY PRESS)

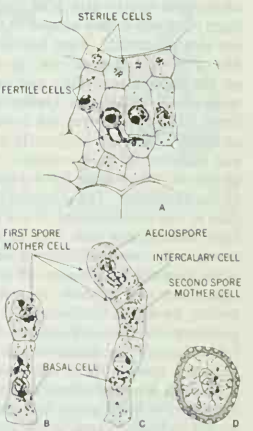
FIG. 14.—FORMATION OF SPORES IN VARIOUS BASIDIOMYCETES

(A) *Armillaria mellea:* young basidium with the two primary nuclei; (B) *Hypholoma appendiculatum:* after fusion of the two nuclei; (C) basidium before the four nuclei, derived from the secondary nucleus of the basidium, have passed into the four basidiospores; (D) passage of a nucleus through the sterigma into the basidiospore; (E) *Auricularia auricula:* basidium and spores; (F) *Exidia glandulosa:* basidium and spores; (G) *Uromyces:* probasidium producing basidiospores

the probasidium is concerned with the distribution and perennation of the fungus as well as with the production of the basidiospores (fig. 14[G]).

The basidiospores may be thin walled and adapted for immediate germination, and this is the case in the Heterobasidiomycetes and in some of the lower families of the Homobasidiomycetes. These thin-walled spores when germinated in water or nutrient solutions may sprout like yeast cells and produce gemmae or secondary conidia. In the higher families many are thick walled and are resting spores. In the majority of Basidiomycetes the spores are discharged from the sterigmata, but only for a short distance (0.1–0.2 mm.). They are, for the most part, distributed by air currents.

Within the subclass Heterobasidiomycetes is the family Auriculariaceae of mostly parasitic forms of which the simpler representatives, *e.g., Helicobasidium,* bear the basidia scattered on a loosely woven mycelium, but in the more typical forms, *e.g., Auricularia,* the hyphae, which have gelatinous walls, are compacted to form fruiting bodies, often of considerable size. The basidia are borne on the lower surface of these fruiting bodies and are the terminal portions of hyphae that do not reach the surface, become somewhat wider and divide transversely into four cells. From each of these arises a long filament that projects beyond the surface of the thallus and develops a spore at its tip (fig. 14[E]). The spores can germinate at once and bud off small curved conidia. The fruiting body is formed throughout of binucleate cells. The Jew's-ear (*Auricularia auricula*) is a well-known representative of this order.



AFTER BLACKMAN IN STRASBURGER "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 15.—DEVELOPMENT OF AECIOSPORES IN PHRAGMIDIUM VIOLACEUM

(A) Portion of young aecium; (B) formation of the first spore mother cell from the basal cell of one of the rows of spores; (C) further stage in formation of aeciospore, intercalary cell and second spore mother cell; (D) ripe aeciospore

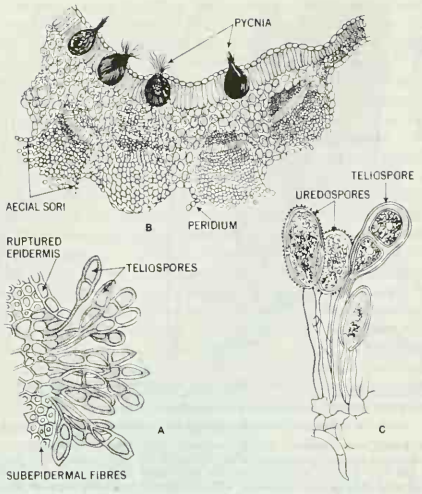
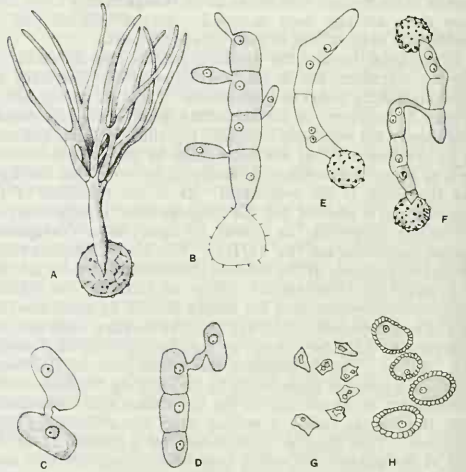


FIG. 16.—PUCCINIA GRAMINIS, BLACK RUST OF WHEAT

(A) Mass of teliospores on a leaf of couch grass (after De Bary); (B) part of vertical section through leaf of common barberry (*Berberis vulgaris*) showing aeciel sori, peridium and pycnia (after Sachs); (C) several uredospores with one teliospore (after De Bary)

1. Rusts.—The Uredinales is a large order of parasitic fungi, in the subclass Heterobasidiomycetes, known as the rusts, that are responsible for the diseases of many of the higher plants—ferns, conifers and flowering plants. There are two kinds of mycelium, haploid and dicaryotic. Both are parasitic and may be found on the same host (autoecious) or on different hosts (heteroecious), sometimes belonging to widely different families. They are intercellular, highly specialized parasites, producing haustoria that penetrate the living cells of the host and often stimulate the tissues to increased growth and the formation of galls. They are often short-lived—attacking the leaves of the host and falling with them; but when they extend to the stems of perennial plants, they are also perennial. Four kinds of spores may be produced in the life cycle of a species, viz., pycniospores (called also spermatia) on the haploid mycelium and aeciospores (aecidiospores), uredospores and teliospores (teleutospores) on the dicaryotic mycelium. The aeciospores are borne in fructifications (sori) known as aecia, which are frequently cup-shaped receptacles surrounded and enclosed by an investment (peridium), and containing chains of spores, which arise from a primordial layer of cells at the base of the aecidium. The spores are binucleate, and it has been shown that in the development of the aecium the basal cells are formed from uninucleate cells that either become binucleate by the migration of a nucleus from a neighbouring cell or, by uniting in pairs, give rise to a fusion cell with two nuclei (fig. 15). In either case there is a process, regarded by some workers as sexual in nature, by which the dicaryotic generation is initiated, whose first products are the aeciospores. The pycniospores are thin-walled cells of small size borne in sori known as pycnia (spermogonia). In many species these are flask-shaped structures with the base sunken in the host tissue and with protruding ostiolar filaments. Attempts to bring about infection of the host by means of pycniospores were unsuccessful and they long were regarded as functionless. It has been discovered that the pycniospores are functional. They are exuded from the pycnia in drops of sweet fluid (nectar) that is sought by flies and other insects. When drops of this nectar are transferred from the pycnia on one mycelium to those on another mycelium, pycniospores are thereby transferred and the formation of aecia follows. When such transfer of pycniospores is prevented by the exclusion of insects, which serve to transfer the nectar in nature, aecia do not form. It seems clear that the dicaryotization that is effected in the aecial primordium is initiated by the transfer of pycniospores by insects. The details of the mechanism by which the invading pycnial nuclei finally reach the deep-seated aecial primordium are less clear. Evidence indicates the ostiolar hyphae as the place of entry and that nuclear migration follows. These facts explain how new races of rust may arise through hybridization in the development of the aecial stage.

The aecidiospores germinate readily on the surface of the appropriate host, and the germ tubes enter the tissues by way of the stomata. They give rise to a binucleate mycelium and on this in due course appear the uredospores. These are so-called "summer" spores, *i.e.*, conidia of the diploid mycelium, and can infect fresh hosts and so spread the disease. Later in the year and on the same mycelium teliospores are formed. These are typically thick-walled and resting spores. The uredospores are binucleate, and so are the young teliospores, but in the latter the two nuclei fuse before their development is completed. The teliospores are thus the probasidia. They germinate in due course and give rise to the promycelium; on the sterigmata of this organ after its division into four cells the four basidiospores, known as sporidia, are produced. These are uninucleate and can at once infect the proper host and develop the haploid mycelium. This is the life history of one of the most complicated forms, the so-called euforms, of which the black rust of wheat (*Puccinia graminis*) is an example. In this species the host of the haploid mycelium is the common barberry (fig. 16). In other species one or more of the spore types may be absent. The -opsis forms have no uredospores (*Gymnosporangium* sp.). In the brachy- forms the aecia are absent but the pycnia are accompanied by sori of uredospores, which in some cases arise as the result of a fertilization like that already described as taking place at the base of the aecium. These primary uredospores thus appear to be homologous with aeciospores. Other species have neither aecia (or primary uredospores) nor pycnia and are known as hemi- forms; there are micro- forms in which teliospores alone occur. In the latter the binucleate condition is established at an early stage—probably by the migration of a nucleus from one cell to another of the haploid mycelium. The most reasonable interpretation of these forms with a shortened life history is that they have been derived from the more complete forms. The teliospore is the spore form almost invariably present and the classification of the



FROM (B-H) E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER); (A) VINE, "STUDENT'S TEXT BOOK OF BOTANY" (ALLEN & UNWIN)

FIG. 17.—SMUT AND BUNT FUNGI

(A) Germinating resting conidia of bunt of wheat (*Tilletia caries*); (B) germination of smut spores (*Ustilago scabiosae*); (C, D) copulation of sprout cells (*Ustilago violacea*); (E, F) germinating and copulating promycelia (*Cintractia montagnei*); (G) young binucleate spore fundements; (H) mature uninucleate spores (*Ustilago holostei*)

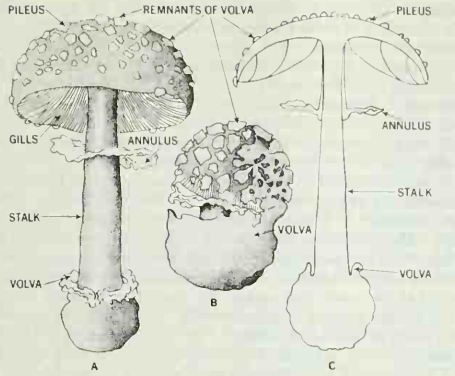


FIG. 18.—AMANITA MUSCARIA, A POISONOUS HIGHER FUNGUS
(A) Mature fruiting body; (B) young (button) stage; (C) longitudinal section

family is based largely on its structural peculiarities.

2. Smut and Bunt Parasites.—The Ustilaginales were regarded by O. Brefeld as showing a halfway stage in the evolution of the class Basidiomycetes from the lower fungi and he placed them in a separate group, the Hemibasidiomycetes. The cytology of the group, however, leaves little doubt that they are true Basidiomycetes and form a parallel order to the Uredinales or rusts.

They are parasites on grain and fodder plants causing the well-known diseases smut and bunt. The mycelium, which is usually binucleate, often develops slowly at first and then grows rapidly at a particular stage of development of the host and produces its spores; *e.g.*, the smut of wheat (*Ustilago tritici*) attacks the wheat in the flower. The grains already infected are sown, the plant develops without external sign of disease and not until the ears are formed does the fungus develop in the flowers and give rise to a black powdery mass of spores. These chlamydospores are formed from binucleate hyphae that divide into short cells; these cells separate, round themselves off and form the thick-walled chlamydospores. The two nuclei fuse in the spore, which, like the teleutospore of the rust, is uninucleate (fig. 17) but diploid.

On germination the spores give rise to a promycelium. In the Ustilaginaceae the nucleus undergoes two successive divisions as in the Uredinales, and the promycelium (basidium) is divided by transverse walls into four cells. These may not form sporidia but may pair by conjugation tubes between genetically unlike (+) and (−) cells (*Cintractia montagnei;* fig. 17), or they may bud off sporidia, which sprout like yeast cells and eventually conjugate in pairs (fig. 17). The binucleate cells, however formed, can sprout secondary cells or give rise to hyphae, either of which can infect a new host. In one species (*Ustilago zeae*), the mycelium in the host is at first uninucleate and conjugation takes place at the appropriate time between cells of the hyphae, which then round off and form spores.

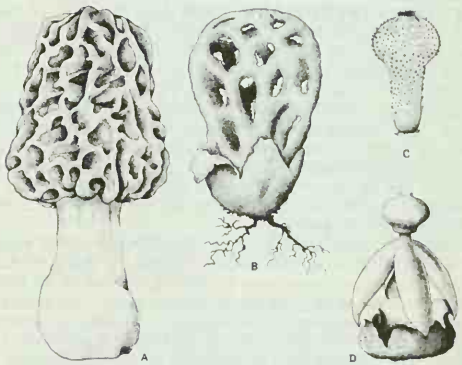
In the Tilletiaceae, the promycelium remains undivided, eight or more daughter nuclei are formed by division and a whorl of long curved sporidia arise at the tip of the promycelium. These fuse together in pairs, and from the fusion cell secondary sporidia may arise (fig. 17[A]).

The Tremellaceae is a family of mostly saprophytic fungi with gelatinous fruiting bodies. Their mycelium is binucleate and gives rise to nearly spherical basidia. In these the fusion nucleus undergoes the usual divisions and the cell becomes divided by four vertical walls into four daughters, from each of which a long filament grows up to the surface of the fruiting body and develops a spore (fig. 14[F]).

3. Mushrooms and Toadstools.—The general characters of the subclass Homobasidiomycetes have already been outlined. Their basidia are undivided and they are typically collected together in a continuous layer, the hymenium, in which are associated with them sterile hyphae or paraphyses. In the lower families the hymenium is borne on the surface of the fruiting body. This may be a flat crust of indeterminate form and extent or, in species growing on vertical trunks of trees, may be bracket shaped. In this case the hymenium is on the lower surface. A whole series of forms show that the bracket may narrow at its point of attachment and form a stalk; the fruiting body is then differentiated into the stalk or stipe and the broad cap or pileus. More advanced forms show the central stalk and caplike pileus characteristic of the common mushroom and its relations, the toadstools. A further modification of the hymenium-bearing surface is the development of spines and wrinkles, folds, thin plates (gills) and of pits and tubes, all of which have the effect of increasing manyfold the surface of the hymenium, without correspondingly increasing the size of the fruiting body (fig. 18).

In the higher families the fruiting body when young is a rounded spherical structure and the hymenial layers are differentiated from the inner tissues. In the Agaricales the fruiting body ruptures before the basidia are matured and so exposes the hymenium, but in the Gasteromycetes the opening of the fruiting body is delayed until the spores have been formed. In this last-named group the fungus fruiting body is often elaborately constructed and may be formed of fibrous tissue, gelatinous tissue, plectenchyma, etc. At maturity a rapid expansion of pseudoparenchymatous tissue forming the so-called receptaculum may rupture the outer covering and expose the mass of spores, embedded in the mucilaginous remains of the fertile tissue clinging to its surface (*Phallus impudicus, Clathrus cancellatus;* fig. 19).

For further discussion of the symbiotic relations of fungi with algae *see* the article LICHENS; for the symbiotic relations of



(B, C, D) FROM E. GAUMANN, "VERGLEICHENDE MORPHOLOGIE DER PILZE" (GUSTAV FISCHER)
FIG. 19.—FRUITING BODIES OF: (A) EDIBLE MOREL (MORCHELLA), (B) CLATHRUS CANCELLATUS (C) PUFFBALL (LYCOPERDON PERLATUM); (D) EARTHSTAR (GEASTRUM CORONATUM)

fungi with the higher plants, especially orchids, heaths and forest trees, *see* MYCORHIZA. For the role of the parasitic fungi in plant diseases *see* PLANT DISEASES.

For human diseases caused by fungi *see* FUNGUS INFECTIONS. *See* BLISTER RUST; DRY ROT; MUSHROOM; PUFFBALL; SMUT AND BUNT; TRUFFLE; YEAST; *see* also references under "Fungi" in the Index volume.

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FUNGUS GNAT, or mushroom fly, any member of the families Mycetophilidae and Sciaridae of the order Diptera (*q.v.*), small, mosquitolike flies almost all of which as maggots (larvae) feed on fungi. In the Sciaridae, or dark-winged fungus gnats, the eyes almost touch and the wings are usually dusky. The larvae are creamy white or grayish and sometimes occur in such large numbers that they migrate over the ground in snakelike lines that may be one-half inch deep, the migrations evidently occurring when the food in the leaf mold or humus is exhausted and a new source must be found. *Sciara tritici* damages the roots of wheat. Species of *Sciara*, and certain mycetophylids, attack mushroom beds and sometimes completely destroy them. In the Mycetophilidae there are a few injurious forms. One, *Pnyxia scabiei*, the female of which is wingless, bores into potato tubers and causes unsightly scabs; severe infestations occur. Larvae of several species are luminous. *Arachnocampa luminosa*, occurring in countless numbers in the caves of New Zealand, light the caves; they spin webs from which sticky strands hang down apparently to catch flying insects. (C. H. Cn.)

FUNGUS INFECTIONS. More than 50 species of fungi (*q.v.*) cause disease in man and animals. Superficial fungus infections of the skin, hair, and nails are called dermatophytoses; those of the deeper tissues and organs are called mycoses. Most fungus infections are mild, but 350 to 450 deaths from mycoses were reported annually in the mid-1960s in the United States alone. The mycoses do not respond to treatment with the antibacterial antibiotics, but some of the mycetomas (*see* below) are treated with sulfonamides and sulfones, and some of the systemic mycoses can be cured with a polyene antibiotic, amphotericin B. Several of the resistant dermatophytoses are effectively treated with the antibiotic griseofulvin.

Superficial Infections.—The dermatophytoses may be caused by any of about 20 species of dermatophytes, a group of fungi which obtain nourishment from keratin (the protein of the horny outermost layer of skin and of the hair and nails). Ringworm, a common dermatophytosis, is contagious and usually is acquired from other persons or from such animals as cats, dogs, horses, and cattle. The epidemic form of ringworm of the scalp, caused by *Microsporum audouinii*, occurs in children. Favus, a severe form of ringworm caused by *Trichophyton schoenleinii*, occurs in adults as well as children and may persist throughout life unless treated. Athlete's foot, caused by species of *Trichophyton* and *Epidermophyton*, is seen at all ages beyond infancy. Jockstrap itch, caused by *Trichophyton rubrum* and *Epidermophyton floccosum*, is seen most often in young males. Pityriasis versicolor (tinea versicolor) is a superficial skin infection caused by *Malassezia furfur*, which interferes with normal pigmentation.

Candidiasis (moniliasis, thrush), caused by *Candida albicans* (and rarely by other species of *Candida*), is an infection of the mucous membranes and skin folds. Vaginal candidiasis during pregnancy and oral thrush in the newborn are common manifestations. Rarely, the disease becomes systemic. The fungus is commonly present in the normal intestinal tract and in the sputum of persons suffering from any type of pulmonary disease. Prolonged intensive treatment with antibacterial antibiotics for various diseases sometimes results in pathological overgrowth of the normally restrained Candida in the intestines and other organs.

Actinomycosis, which occurs in cattle as well as in man, is caused by *Actinomyces bovis* and *A. israelii*. It may involve the skin, subcutaneous tissues of the jaw, including bone (the condition known as lumpy jaw), and the visceral organs: *e.g.*, the lungs, appendix, or liver. The disease is characterized by firm swelling with formation of sinus tracts that discharge pus containing small colonies of the fungus. The fungus is present in normal persons in the tonsils and on tooth surfaces, and infection sometimes follows dental neglect or injury.

Systemic Mycoses.—The superficial infections are caused by fungi that are frequently present on the surface of the body, in some instances without producing apparent disease. The fungi causing most of the more severe systemic mycoses, on the contrary, are not normal residents in or on man but grow and survive independently as saprophytes in soil and decaying organic debris. Man, therefore, is frequently unavoidably exposed to pathogenic fungi. The conditions under which such exposures are followed by infections are not fully known, but they include inhalation of air-borne spores, ingestion, and implantation of the fungus under the skin as the result of an injury. In respiratory mycoses, severity of the disease appears to increase with the intensity of exposure. The factors of individual immunity and susceptibility are of prime importance. For example, a person who recovers from an initial mild infection of coccidioidomycosis appears to be immune to reinfection.

Coccidioidomycosis, caused by *Coccidioides immitis*, occurs either as an acute but benign respiratory infection known as valley fever or as a progressive, generalized granulomatous disease called coccidioidal granuloma. Granulomata are growths consisting primarily of granular tissue surrounding a centre of irritation. The respiratory infection is primary and is usually self-limited; *i.e.*, eventually controlled by development of immunity by the host. However, in some cases (and more often in dark-skinned peoples) it may involve almost all organs with the usual exception of the gastrointestinal tract. Coccidioidomycosis is endemic in the southwestern section of the United States, in Mexico, in Argentina, and in intervening arid areas. The fungus has been isolated from soil and found to produce disease in dogs, rodents, and cattle as well as in man.

Histoplasmosis, caused by *Histoplasma capsulatum*, also has an acute respiratory form, usually self-limited; but occasionally it is a rapidly fatal infection involving the spleen, liver, lymph nodes, and other organs. Healed pulmonary lesions may calcify and then may be confused with those of tuberculosis. Histoplasmosis is endemic in many parts of the world. Cats, dogs, and other animals are often infected. The fungus is present in soil and in organic debris, especially in the enriched soil around chicken houses, under bird roosts, and in caves inhabited by bats.

North American blastomycosis, caused by *Blastomyces dermatitidis*, is a granulomatous disease involving the skin, the lungs, and many other organs. The fungus is simliar to *Histoplasma* in some respects, including its ability to incite the formation of similar antibodies in the blood of the infected person. It occurs in Africa as well as in America.

South American blastomycosis, caused by *Paracoccidioides brasiliensis* (*Blastomyces brasiliensis*), is a granulomatous disease involving the skin, the mucous membranes, the lymph nodes, and the gastrointestinal tract. It is an important fatal disease in South America. Infection is thought to follow ingestion of fungus spores.

Cryptococcosis (torulosis), caused by *Cryptococcus neoformans*, begins as a respiratory infection but usually produces meningitis (inflammation of the brain and spinal chord); the skin, bones, and visceral organs are often involved. It is worldwide in distribution. Unlike most pathogenic fungi, *Cryptococcus* usually produces little cellular reaction in the host. It has been isolated from soil and pigeon droppings. No other source of infection is known. The disease, like the other systemic mycoses, is not contagious.

Sporotrichosis, caused by *Sporotrichum schenckii*, is seen as a persistent ulcer at the site of a penetrating thorn wound with secondary lesions in the regional lymph nodes. It is rarely systemic. Unlike most of the deep mycoses it responds promptly to treatment with iodide drugs.

Chromoblastomycosis, caused by species of *Phialophora* and *Cladosporium*, is a chronic, slowly progressive, granulomatous disease of the skin and subcutaneous tissues, usually of the lower legs. Its more frequent occurrence in tropical and subtropical

regions is believed to be due to exposure of barefoot workers to thorn injuries, which permit implantation of fungus spores.

Mycetomas.—These are a group of clinically similar mycoses caused by about 15 species of actinomycetes and fungi, following implantation of spores on infected thorns or splinters. Infection is usually on the foot, hand, back, shoulders, or head, where penetrating thorn injuries are commonest. Mycetoma is characterized by swelling, destruction of tissues (including bone), formation of sinus tracts through which pus drains from the lesion, and the presence in the pus of "granules" which are dense colonies of the fungus. The granules vary in size, shape, consistency, and colour according to the species. The infection spreads to adjacent tissues and produces a chronic, crippling disease. Mycetoma is a major medical and public health problem in a belt that crosses Africa below the Sahara; and it occurs with varying frequency in many parts of the world.

Mycetoma caused by some of the actinomycetes responds to treatment with sulfonamides or sulfones. Since most patients come to the hospital only after there has been extensive spread to bone and other tissues, the only successful treatment may be amputation.

Phycomycoses.—These diseases are caused by at least 10 species of the fungi known as phycomycetes. Some of these mycoses are seen in diabetic persons, in whom the fungi cause infections of the facial sinuses that may spread to the brain. Coccidioidomycosis (*see* above) is caused by a phycomycete. Some types of nasal polyps are caused by *Rhinosporidium seeberi* and *Entomophthora coronata*. Subcutaneous phycomycosis, caused by species of *Basidiobolus*, is a newly recognized mycosis in Indonesia, Southeastern Asia, and Africa. It responds to treatment with potassium iodide.

See also RESPIRATORY SYSTEM, DISEASES OF; SKIN, DISEASES OF: *Fungus Infections*.

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FUR. Fur is the soft, downy, dense growth of fibres covering certain animals. Fur-bearing animals also have a covering of longer hairs above the fur; these, called the guard hair, or overhair, protect the underlying fur from injury and prevent it from matting or felting. Both guard hair and fur protect the animal from cold and storm.

The use of fur as apparel probably dates from the early stages of human history. Primitive man's chief needs in the colder regions of the earth were food and warmth, and it is reasonable to suppose that the use of animal fur for warmth was not long separated from that of animal flesh for food. To the barbarian in his northern forests fur was a necessity and as such had its value; but it is important to note that in almost every civilization of which history is cognizant fur was valued from early times as an ornament or decoration. The Chinese are said to have esteemed it highly 3,500 years ago; the Greek legend of Jason and the Golden Fleece may well have had its origin in some more than usually perilous and fortunate fur-trading voyage to the Euxine (Black sea); and the use of furs was one of the luxuries Rome adopted from Greece. In the narrowing of this distinction between fur as a necessity and fur as a luxury may be found the clue to the subsequent development of the fur trade. In the civilization of medieval Europe fur was emphatically a luxury. As such its use was forbidden by the church to monks and to all but the highest ecclesiastics, while among the laity the use was carefully regulated by frequent and severe sumptuary laws. None but those of royal blood were allowed to wear certain furs, and in general a man's social importance could be gauged by the amount and nature of the fur he wore. Fur, it should be observed, was mainly connected with male attire at that time and in certain instances it became almost a badge of office; *e.g.*, the judge's ermine. The only form in which fur seems to have been permitted to all who could afford it in the middle ages was as headgear, and in the English language the words "beaver" and "hat" seem to have been used almost interchangeably from the time of Chaucer.

Of the sumptuary legislation then in existence, that of Great Britain was the most extensive with reference to the use of furs as wearing apparel. The main purpose was to favour the nobility and at the same time to assist the sale of English products. Ermine, sable, marten and genet were reserved for the royal family and higher nobility, the less valuable furs were restricted to the middle class and the least valuable, such as lambskins, cony (rabbitskins) and cat, were set aside for the common folk. Regulations were also made as to size of the furs, where they were to be worn and even to kind to be used for edging. These laws, enacted during the period 1300–1600, were never very rigidly enforced. The chief sources of European fur in the middle ages were northern and central Europe; the Hanseatic league, with its chain of towns dotted round the Baltic sea, was a great power in the trade.

The modern age for the fur trade may be said to have begun with the discovery of America. In patents of discovery and charters to early settlements "trade in furs" is frequently mentioned, and much of the interior exploration of North America was the direct consequence of this trade. The French settlers in Canada were especially ardent fur traders; the more adventurous among them had penetrated to the Mississippi, and probably to Lake Winnipeg, long before the English had crossed the Alleghenies. The Hudson's Bay company (*q.v.*) entered the field in the latter half of the 17th century and eventually spread its trading posts and interests from Vancouver, B.C., to Prince Edward Island and northward to the Arctic ocean. The fur trade of the 18th and early 19th centuries, when an Indian trapper would barter his winter's catch for a blanket and a bottle of cheap spirits, was a highly profitable business; John Jacob Astor, among others, founded his fortune upon it. The supply of furs appeared inexhaustible and the demand steadily grew as the Industrial Revolution in Britain and western Europe created new desires and new wealth.

At the beginning of the 18th century the Russian fur hunters were very aggressive even as far east as the Kamchatka area in eastern Siberia. Fur trading was a Russian government monopoly under which the crown acquired all the furs (including sable, ermine, sea otter) at modest prices—particularly the sea otter. The hitherto secret breeding islands of the sea otter were disclosed and the animals were almost exterminated by ruthless hunters. The newer hunting grounds of Alaska were invaded by hordes of hunters and the northern fur seal was also almost exterminated. Furs became a fashion rather than a luxury by the middle of the 19th century and in the 20th century the United States emerged as the world's major user of furs.

THE MODERN FUR TRADE

Furs traded on the modern market originate primarily from ranches, or fur farms. For instance, about three-fourths of the mink fur used in commerce comes from ranches. At one time, about 99.5% of all silver fox furs were grown on farms. (For further discussion of ranch furs *see* the section *Fur Farming* below.)

Sources of Wild Furs.—Wild furs come not only from cold climates but also from temperate and tropical zones, although the most important sources of supply are the cold regions where the temperature ensures the growth of thick, luxuriant fur. More than 80 countries on all six continents contribute to the world supply of pelts for commercial use; almost 80 varieties of furs can be made into apparel.

North America is the home of the greatest variety of fur bearers. The frozen wastelands, forests and marshes of this continent are inhabited by mink, beaver, muskrat, skunk, American opossum, marten, fisher, ermine, silver fox, blue fox, red fox, white fox, cross fox, raccoon, bear, wolf, weasel, wildcat, fitch, otter, sable, lynx and wolverine. The United States has 40 different types of indigenous furs. The most important are mink, muskrat, beaver, raccoon, skunk and opossum.

Northern and central Europe and Siberia supply badger, beaver, ermine, fitch, fox, hare, lynx, marmot, marten, mink, muskrat, nutria, otter, sable, squirrel, wolf, goat and moleskin. The latter fur is found in the British Isles and in the Netherlands, France and parts of Africa.

China delivers marmot, kolinsky, marten, kid, goat and lamb. Korea supplies kolinsky; central Asia, Persian lamb and other lambskins. India contributes leopard, ocelot, tiger and some stone marten. Ceylon provides leopard. From Japan come mink or weasel and flying squirrel. South America is the home of chinchilla, nutria and chinchilla rats.

Tremendous quantities of rabbitskins were once pelted in Australia, France, Belgium and Great Britain, and big quantities came from New Zealand until 1953, when exports were halted. In the 1950s, myxomatosis, a virus disease, was introduced into Australia, Tasmania and New Zealand by livestock raisers to eradicate the rabbits, which were consuming vast quantities of forage. This reduced the supply from those countries.

The fur seal is the principal marine animal used commercially. The best type, known as northern fur seal, comes from the Pribilof Islands, 300 mi. W. of the Alaskan mainland. When the United States purchased Alaska in 1867, the seal herd was estimated at 3,000,000 animals. Uncontrolled slaughter of the seals cut the herd to 100,000 animals in 23 years. This indiscriminate slaughter came to an end in 1911 under an international conservation agreement; by 1954 the herd had been restored to 1,500,000 animals. The Pribilofs account for 80% of the world's seal population, and about 60,000 are killed annually. Other fur seals are found in the Commander Islands of the U.S.S.R. in the Bering sea, in Robben Island off the coast of the Republic of South Africa, in the Kuril Islands and in the antarctic islands belonging to Uruguay and South Africa. (*See* also SEALING.)

Fur Trapping Techniques.—Wild fur-bearing animals usually are obtained by catching them in baited traps. Trapping in almost all parts of the world is licensed by and subject to control of state, provincial or other governmental agencies. In order to preserve a reservoir of animals, the season in which animals may be trapped and the numbers in which they can be taken are generally restricted. Trapping should be done when the fur is prime; this time varies somewhat according to the seasonal variations from year to year.

The kind and size of trap selected for use depends on the animal to be taken, its habitat and weather conditions. Traps should be free of grease and usually are dyed and treated with orange shellac or a mixture of asphalt and varnish to make them less noticeable to the animals. Other equipment should be smoked for the same reason.

Lures must be specific for the animal to be taken. Fox urine is a common lure for foxes. When trapping the fox, the trapper must be certain that the gloves and other equipment he uses in handling the traps or bait are free of human odour; dirt should be sifted over the trap after it is set and all footprints should be brushed out. Extreme care is necessary in trapping the fox; other animals are not so intelligent or canny.

Traps should be placed in areas frequented by the animal, should be concealed or lightly covered and should be secured by a chain attached to a stake, tree or large stone. Traps for muskrat and mink often are set under water in such a way that the animals drown quickly. Traps for mink should be set along runways in order to take the more valuable males, who are tireless travelers and whose pelts are twice as large as those of the females. The females are apt to be in dens.

Collection and Distribution.—Fur skins reach the world's markets through two main channels. A large number are delivered or sold to collecting agents, who sell them to skin merchants in various fur centres. Skin merchants maintain stocks of furs, selling them to manufacturers or retail furriers. Most raw fur skins, however, are shipped to auction houses and are offered at public auction to skin merchants, manufacturers and commission brokers who buy for merchants and manufacturers. Fur auction houses act as marketing agents for shippers of fur skins and receive fees based on the prices received for the furs at auction.

The major fur auction centres are New York city, London, Leningrad and Montreal. Regular auctions of secondary importance are held in St. Louis, Mo., where dressed fur sealskins are sold semiannually; Seattle, Wash.; Minneapolis, Minn.; Winnipeg, Man.; Edmonton, Alta.; Vancouver, B.C.; Regina, Sask.; Copenhagen, Den.; Helsinki, Fin.; Oslo, Nor.; and Stockholm, Swed. Melbourne and Sydney, Austr., are the main centres for rabbitskin auctions, which are also held in London. The Hudson's Bay company is the dominant fur-collecting organization and marketing agent in the world, with auction houses in London, Montreal and New York city. The London Public Sales, comprised of Hudson's Bay company and two other firms, holds major auctions in the spring, summer, autumn and winter.

In New York city during the height of the season (December to March), few days pass without an auction sale at one of four firms, and occasional sales are held throughout the year. New York is the centre for American ranch mutation mink and ranks second to London as a seller of Persian lamb. Less frequent auctions are held in Montreal and other Canadian cities.

The important auctions in London, New York and Montreal draw an international audience and often last a week or longer. The annual Leningrad sale is usually held in July. It is conducted by Soyushpushnina, an official Soviet agency, which buys the skins from state and collective farms and controls domestic and foreign marketing. The auction runs a full week.

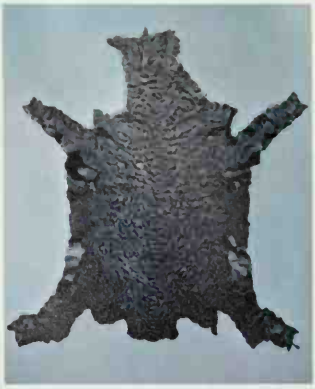
Fur Dressing and Fur Dyeing.—The function of the fur skin dresser is to make the skin suitable for use. The fur dresser aims at the creation of a soft, pliable leather; the removal of superfluous matter from the pelt; and the preservation and enhancement of the natural lustre of the fur. The details of the process vary widely with the nature and condition of the skin treated, but in most instances there are at least four distinct stages in the operation. First there is the preliminary cleaning and softening of the pelt; then fleshing (removal of fleshy matter from the skin) and stretching; then leathering (the formation of a leather on the skin; actually this is a form of tanning); and then a final cleaning. Separate processes in the fur dresser's art are unhairing (the removal of guard hairs where necessary), shaving the leather side and

BY COURTESY OF FUR INFORMATION AND FASHION COUNCIL, INC.

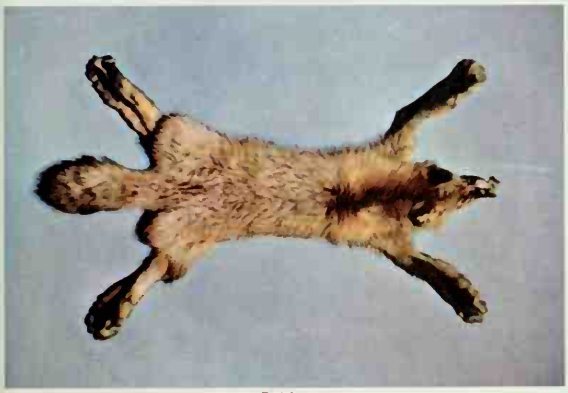
A CUTTER PERFORMING THE FIRST STEP IN THE LETTING-OUT TECHNIQUE OF SLICING THE SKIN INTO DIAGONAL STRIPS

Russian sable

Processed Argentina lamb



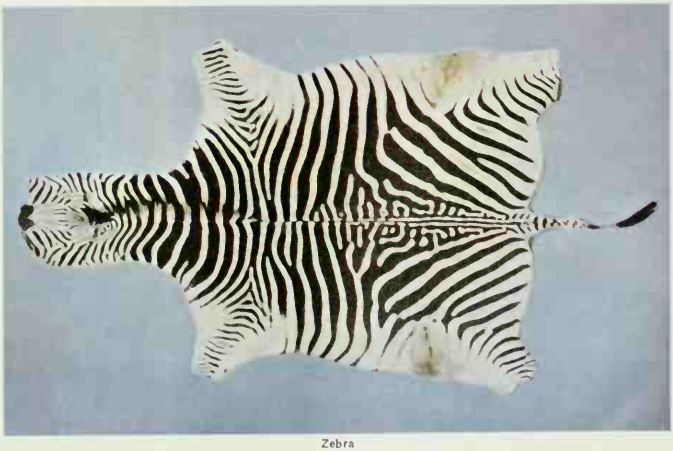
Black-dyed Persian lamb



Red fox

Raccoon

Fitch



Zebra

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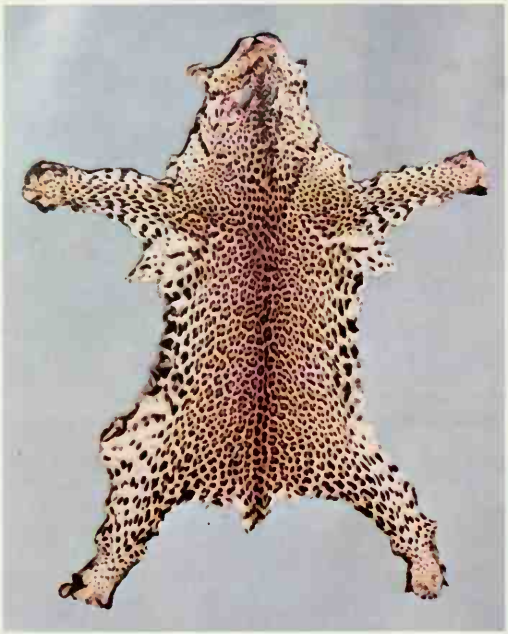
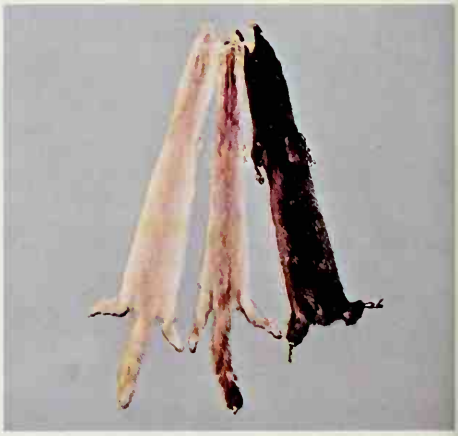
FUR



Leopard

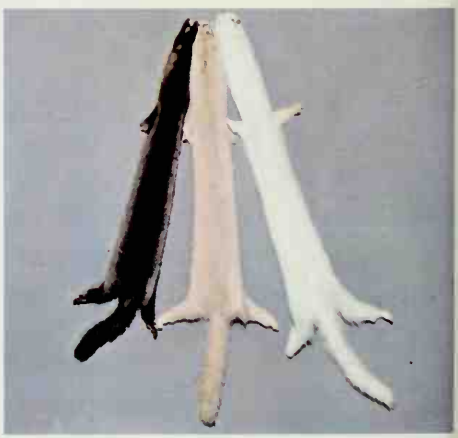
Nutria

Chinchilla



(Left) Two mutant shades of ranch mink, Autumn Haze* Dawn and Autumn Haze*; (right) natural brown mink

Ocelot



Three mutant shades of mink: Lutetia,* Tourmaline* and Jasmine*

PHOTOGRAPHS, HOBAN-GALLOB—RAPHO GUILLUMETTE, *TRADEMARK EMBA MINK BREEDERS ASSOCIATION

sometimes shearing the underfur to a desired depth; *e.g.*, fur seal, muskrat, raccoon and beaver. Though it originated in a primitive and haphazard manner, modern fur dressing is a highly developed process that requires considerable mechanical equipment.

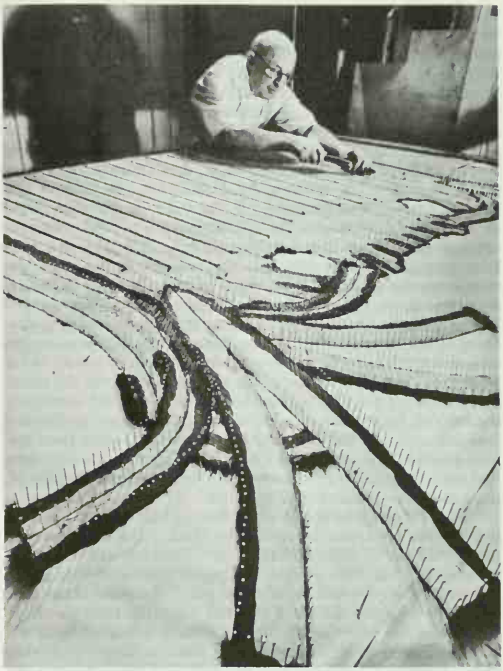
Fur dyeing is an ancient art but its modern development may be said to date from the latter part of the 19th century. Before that period the dyeing of furs was mainly carried out with vegetable or mineral colouring matters. Since then, however, various chemical compounds known as fur bases have come into general use and have largely superseded the older materials mainly because of the ease with which they can be applied. The use of these synthetic compounds has also enabled fur dyers to produce many new colours on furs, and new ones are added every year. This has led to the use of many skins that in their natural colours would be disdained by the public but when well dressed and dyed make attractive furs. New colours became an important selling point among fur retailers (mutation minks, however, are not dyed), marking the transition from the traditional browns and blacks of natural furs to such shades as blonde, beige, charcoal and platinum gray, blue, white and even pink and red. Typical of the innovations made possible by the fur processor's art was the case of raccoon. The long-haired, brown raccoon coat of the 1920s became a sheared, lighter-weight fur available in blonde, beige or white as well as the natural colour. Great secrecy is maintained on the techniques of fur dyeing, each dyer jealously guarding his methods from competitors. France, Belgium and London are the chief dyeing centres of Europe. Leipzig, Ger., was once supreme in this field but after World War II its experts relocated in Frankfurt, London and New York. The largest fur-processing industry is in New York.

Fur Manufacturing.—Furriery, or the making up of furs into garments, has progressed from the primitive sewing together of skins to a highly skilled and intricate occupation, and the modern manufacturing furrier often has a good claim to be recognized as an artist in the same sense in which a designer and creator of gowns is so recognized. Paris exerts great influence in originating fur fashions, and the ideas of Italian designers are also significant. New York city developed a highly respected corps of fur designers among its custom furriers, stylists who create for individual manufacturers and commercial designers who sell patterns to manufacturers and retailers.

Fur manufacturing remains, essentially, a handicraft industry. The cutter, for example, matches pelts according to colour and quality in order to achieve uniformity of colour and texture in the finished garment. He also cuts the skins to conform to the designer's pattern with a minimum of wastage. Sewing is performed on power-driven machines and is a task requiring much skill.

There are two main types of fur manufacture. One is the letting-out technique; the other, the skin-on-skin method. The first, usually applied to mink, involves slicing every skin into diagonal strips one-eighth to one-quarter inch in width and then sewing these strips together to make a longer and narrower skin that will run the full length of the garment without seams showing on the fur side. In more recent years the letting-out process has been used with furs other than mink, such as nutria, sheared raccoon, beaver, fur seal and others, but with certain modifications to enhance the beauty of the particular fur. The skin-on-skin method is less costly. It consists of sewing one full skin adjacent to another in a uniform alignment. Some firms specialize in sewing the leftovers of full skins, such as paws and flanks, into blanketlike "plates" that are then fashioned into garments. Manufacturers distribute their products either by selling directly to retailers, or to wholesalers or jobbers who sell to retailers.

The Fur Retailer.—There are three main types of fur retailers: (1) custom furriers who design and manufacture their own garments and also carry stocks of ready-to-wear furs; (2) women's apparel specialty stores that carry furs as part of a general stock of apparel; and (3) department stores. All these stores usually maintain fur-servicing departments that remodel and repair garments for customers and also store furs in refrigerated vaults. In the United States, department stores first became important factors in fur retailing in the 1920s. Previously, custom and specialty retail



BY COURTESY OF FUR INFORMATION AND FASHION COUNCIL, INC

WETTED SKINS BEING TACKED DOWN TO DRY IN THE EXACT SHAPE REQUIRED FOR THE FINISHED COAT

furriers had been practically the only sellers of furs; the thousands of smaller fur retailers, however, continued to do more than 50% of U.S. fur sales dollar volume.

When aggressive (and often exaggerated) advertising practices were introduced in the retail fur trade, certain restrictions in the form of industry trade practice rules were imposed by the U.S. Federal Trade commission. These were made more stringent in 1952, when congress passed the Fur Products Labeling act, designed to protect the consumer from misleading advertising and selling practices. The law forbade a store to describe a fur in terms of another. For example, marmot dyed to resemble mink could no longer be described as mink-dyed marmot but only as dyed marmot. A fur products name guide issued by the Federal Trade commission listed the true and permissible fur names. In addition, retailers were required to state the country of origin of fur skins produced outside the U.S. Thus, a garment made of Canadian muskrat, which has been sheared and dyed black to resemble fur seal, could no longer be called Hudson seal but had to be labeled, "dyed muskrat; origin: Canada." Government regulations in other countries vary but are generally less stringent than those of the United States. (E. C. L.; S. J. Gd.; C. E. K.)

FUR FARMING

The keeping and breeding of animals for their fur is one of the oldest occupations. The Chinese have farmed goats and dogs for an unknown number of centuries, using the flesh of the animals as food and their skins, fur or hair, according to species, for the purpose of trade; if the sheep is considered as a fur-bearing animal, the inception of fur farming must be considered of prehistoric origin. Though many of the animal husbandry practices of livestock raising were adapted to the raising of fur animals, some of the fur farming problems were peculiar to these wild species under confinement and necessitated specific research. The Canadian government, in co-operation with the Canadian National Silver

Fox Breeders association, established a research station at Summerside, Prince Edward Island, in 1920. The United States government started the U.S. Fur Animal experiment station at Saratoga Springs, N.Y., in 1923; in 1953 the station was moved to Ithaca, N.Y., where it functions in co-operation with Cornell university. By 1940 the U.S. government was conducting research on fur animals co-operatively with colleges and universities in the states of Wisconsin, New York, Pennsylvania, Washington and Alaska. The station at Pullman, Wash., does research on diseases of fur animals. The states of Michigan, Ohio and Oregon also are doing research of this kind. In the U.S., the National Board of Fur Farm Organizations, Inc., sponsors research work with educational institutions and commercial firms. The U.S. fur fibre laboratory at Beltsville, Md., conducts research on the origin, development and growth of fur fibres. Several provinces in Canada were also doing fur animal research, and Sweden, Norway and Denmark began similar research because of the increasing importance of fur farming in their economies. From all these sources has come much scientific and popular information of benefit to fur farmers. Though the raising of fur animals in captivity did not at first produce as fine a fur as could be trapped in the wild, eventually the research improved the techniques of management, feeding and breeding until the most beautiful furs of the trade came from animals raised in captivity. The thousands of glamourous mutations that become available could never have been produced in the wild, since controlled matings were essential.

Silver Fox Farming.—A silver fox is a mutation of a red fox in which the red colour is replaced by black. The white band on the guard hairs gives the silvery effect. The early captured foxes were nearly black, but by selective mating over a 20-year period the bright silver fox was produced in which the white bands were extremely wide and the black was free from the rusty brown so common in the early foxes. Since the black colour is dependent upon a single genetic recessive factor, black or silver foxes when mated together always produce silver-black foxes. Because the mating of two pure black foxes in the wild rarely occurs, only a very small percentage of wild foxes are of this colour.

On fur farms odd-coloured fox pups occasionally appear in a litter. At first such animals were quickly discarded for fear that the purity of the herd would be questioned. Some enterprising fox farmers, however, mated them and eventually several profitable mutant colours were developed, such as white face, platinum, pearl and glacier blue. The breeding of silver foxes in captivity was accomplished on Prince Edward Island in 1894. At first it was carried on with much secrecy until an especially beautiful silver foxskin brought £580 at auction in London. Charles Dalton, later knighted by the English crown for his contributions to fox farming, and R. T. Oulton (both Canadians) are considered to be the pioneers in fox farming. Such prices for skins made prices for breeding stock fabulous. The cost of a pair of foxes rose from $3,000 in 1910 to $35,000 in 1913, and extensive speculation took place even on options on newborn pups.

Peak production in the United States of 350,000 silver foxskins was reached in 1939. At that time more than one-third of the silver foxes produced in the U.S. were raised in Wisconsin. The largest fox farm in the world at that time, which produced as many as 35,000 pups a year, also was in Wisconsin. In 1939 Canada produced 230,000 skins and the Scandinavian countries somewhat fewer. By the early 1950s fewer than 10,000 silver fox pelts were being produced annually in the United States and production in other countries was also drastically reduced because of a drop in demand as fashion styles switched to mink. Many fox farmers reduced their operations or started to raise mink.

Though pair mating was at first deemed necessary, polygamous mating finally became the common practice. The one litter per year is whelped after a gestation period of 49–55 days. An average of four young per litter is considered satisfactory, and these are weaned when about eight weeks old. Silver foxes at about seven months of age weigh from 10 to 15 lb. The pups are pelted in November and December of the first year. Those pups selected for the herd are bred during late winter and early spring of the following year.

The early large ground-floored pens were replaced with smaller ones with raised wire floors to avoid parasite infestation and for better sanitation. A guard fence with an overhang is essential to prevent foxes from escaping. It also provides seclusion and prevents stray dogs and other animals from transmitting diseases to the foxes.

A desirable fox ration is composed of 25% to 50% of horse meat or various packing house by-products. The rest of the ration is composed of dry concentrates, vegetables and water. Continuous feeding of certain fish may cause losses in foxes. A fox ordinarily eats about one pound of food per day. A cubed feed developed for summer and fall breeding reduced materially the necessary refrigeration.

Blue Fox Farming.—Though some blue foxes are raised in pens—principally in Norway—the most interesting early development was in Alaska, where entire islands were leased and the foxes ran wild. The natural foods were supplemented during certain parts of the year. Parasitism and lack of controlled breeding, together with lower prices for pelts, finally put these operations out of business by the late 1940s.

Mink Ranching.—Though minks were raised in captivity for their fur as early as 1866, it was not until about 1930 that they were produced in quantity. Mink became the most popular fur by far and by the early 1960s accounted for about 75% of the fur trade. As fox farmers converted to the raising of mink, the production of ranch-raised mink in the U.S. increased from 1,500,000 animals in 1950 to slightly more than 5,700,000 by 1960. Wisconsin produced one-third of this total. The world production of ranch minks in that year was about 8,500,000.

A great deal of the growth in popularity of mink fur was because of the development of new and striking mutant colours. In the U.S. the leading colours, listed in the order of number of skins produced in 1958, were: pastel, sapphire, dark, gun-metal, platinum, pale brown, pearl, white, ruby-eyed pastel, winter blue and lavender. The newer mutations usually bring the highest prices until the volume of skins in the mutation is increased to meet demand. The Mutation Mink Breeders association rigidly controlled marketing in the U.S. Most skins were sold dressed. The underfur in minks should be about five-eighths of an inch long and the guard hair about one-half again as long.

A mature female mink weighs about one and one-half to two pounds and the males about four pounds. The sexes are kept separate and polygamous mating is the common practice—usually in March. There is a varying time of delayed implantation of the embryos, and consequently the gestation period varies from 40 to 76 days. A litter average of four is satisfactory. Weaning takes place at eight weeks and pelting about the last of November of the same year. Mink will breed when about 11 months old.

Minks are kept in individual pens having 10 to 20 sq.ft. of raised wire floor space. Small detachable nest boxes facilitate care of the animals. The mink ration requires a higher percentage of raw meat than that for foxes, and fish may replace most of this without harming the animals. Chicken waste (heads, feet, entrails, etc.) is a splendid mink feed but must be used with caution since a hormone used to increase growth in young chickens causes low fertility or even sterility when fed to breeding minks. The daily feed allowance is about one-quarter pound though animals to be pelted should be fed all they will eat.

Chinchilla Raising.—During the early 1900s many chinchilla furs from animals trapped in the wild were marketed. Overtrapping produced such a scarcity that an American, M. F. Chapman, was induced to start raising them in captivity. About a half century later, more than 500,000 chinchillas were being kept in captivity in the U.S., one-fourth as many in Canada and a small number in the rest of the world. Until 1954 operations were largely in selling breeding stock for several hundred dollars per pair, but in June of that year the first auction of a large quantity of chinchilla pelts from ranch-raised animals was held. The marketing is done through the Farmers Chinchilla Cooperative of America, Inc., by private agency. Chincilla raising is now based on the production of skins for the fur trade. Chinchilla is a luxury fur since it is extremely soft, fine and silky; it is blue-gray in colour

and may or may not have varying widths of white bands on the guard hair.

Martens.—This attractive and interesting forest fur animal is closely related to the sable and weighs from one and one-half to three pounds at maturity. Many attempts to raise martens in captivity have failed because only about 15% to 20% of the females produce young.

Martens breed in July and August and, after several months of delayed implantation, whelp in April. The delay in implantation can be shortened by artificial lighting that simulates early spring conditions and causes the martens to whelp in December instead of April. Martens thrive on about the same kind of feed as the fox and mink. They consume from six to eight ounces daily and particularly relish small fruits and berries.

Other Fur Animals.—Karakul sheep and somewhat similar breeds of sheep have been raised in Russia and the near eastern countries for hundreds of years. These produce the very desirable black Persian lambskins and other similar types. The best pelts are obtained from newborn lambs, for at that age the curl is in its prime (*see* also SHEEP). South-West Africa came to produce several million Persian lambskins annually after many years of selective mating of Karakul rams to their progeny originating from white sheep. Selected skins from white lambs are sheared, plasticized and usually dyed to be sold as mouton.

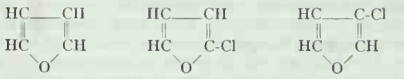
The raising in captivity of several other fur animals was initiated but did not materialize commercially because of availability of furs from the wild supply. Among these are beavers, nutrias, fishers, muskrats, fitches, raccoons and skunks. Possibilities of raising these animals in captivity for their fur depended upon fashion and the finding of new and desirable colours.

Rabbitskins from animals raised in hutches primarily for their meat have been used in the fur trade from time to time. Selected skins from the older animals of Europe have proved very satisfactory in the natural state or sheared and dyed, but only a small percentage of the skins from the eight-week-old "fryer" rabbits in the United States are suitable for fur garments. Very few rabbits are raised primarily for their fur. *See* also references under "Fur" in the Index volume. (C. E. K.)

BIBLIOGRAPHY.—F. G. Ashbrook, *Furs Glamourous and Practical* (1954); R. T. Wilcox, *The Mode in Furs* (1951); A. Samet, *Pictorial Encyclopedia of Furs* (1950); Max Bachrach, *Fur,* 3rd ed. (1953); Fredericka Martin, *The Hunting of the Silver Fleece* (1946); F. E. Baldwin, *Sumptuary Legislation in England* (1926); Cyril J. Rosenberg, *Furs and Furriery* (1921); Albert M. Ahern, *Fur Facts* (1922); A. C. Laut, *The Fur Trade of America* (1921); G. J. Lapick and Jack Geller, *Scientific Fur Servicing* (1952); U.S. Dept. of Agriculture, "Rabbits and Laboratory Animals" (1953); Kathrene Pinkerton, *Bright With Silver* (1947); R. K. Enders, "Reproduction in the Mink," *Proc. Am. Phil. Soc.,* vol. 96, no. 6 (1952); Artur Hansson, *The Physiology of Reproduction in the Mink* (1947). For current developments and production *see* also the *Britannica Book of the Year.*

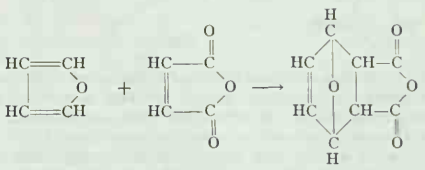
FURAN CHEMISTRY is that branch of organic chemistry that deals with the family of organic compounds known as the furans (*see* also FURFURAL). Furan itself (boiling point 31.3° C.; specific gravity 0.937) is a colourless liquid of strong ethereal odour which is relatively insoluble in water, but completely soluble in alcohol, ether and acetone. It has been found to occur in various wood oils, and it may be prepared conveniently in the laboratory by the decomposition by heat of furoic acid. Large-scale production is carried out by passing the vapours of furfural and steam over a suitable catalyst.

The constitution of furan (C_4H_4O) is generally represented as indicated below, and while the other members of the family retain the characteristic five-membered ring or nucleus, one or more of the hydrogen atoms is replaced or substituted by other atoms or groups of atoms—*e.g.*, C_4H_3O-Br, bromofuran; C_4H_2O-$(COOH)_2$, furandicarboxylic acid. Because of the asymmetry of the ring, however, these substitution products can exist in more than one form, and to distinguish these forms, or isomers, it is convenient to denote the location of the substituent(s) by numbering the five-ring atoms counterclockwise beginning with the oxygen atom as number one. Since it has been experimentally established that positions 2 and 5 and positions 3 and 4 are equivalent, two and only two monosubstitution isomers (C_4H_3O-X) of furan are possible, depending upon whether the new substituent (X) replaces a hydrogen atom on a carbon adjacent to, or once removed from, the oxygen atom. This is illustrated below by the case of chlorofuran (C_4H_3O-Cl). There are four possible isomeric disubstitution derivatives if the substituents are alike; if unlike, the number of isomerides is greater.



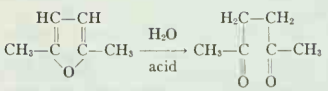
furan 2-chlorofuran 3-chlorofuran

The chemical behaviour of the furans is quite complex as a consequence of the combination, in one-ring system, of characteristics associated with dienes, with vinyl ethers and with benzene types. A great many addition reactions attest to the dienic behaviour of this class, including Diels-Alder syntheses involving the simple furans (*e.g.*, reaction of furan with maleic anhydride).

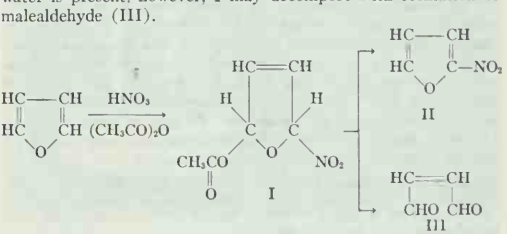


This dienic activity is suppressed in derivatives possessing electron-withdrawing substituents (CO, NO_2, etc.), so that furans such as furfural and nitrofuran fail to react in like manner.

Acid hydrolysis reveals the kinship of the furan ring to a vinyl ether. Furan and its alkyl-substituted derivatives are readily cleaved by aqueous acids to open-chain dicarbonyl compounds, as illustrated by the formation of acetonylacetone from 2,5-dimethylfuran.

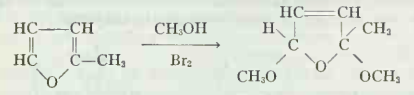


In general, furan types are more reactive and less "aromatic" in the sense of nuclear integrity than their benzene counterparts, and the usual substitution reactions have been applied with varying success. The reagents employed are acidic in nature and it is important, in most instances, to avoid moisture, and to control experimental conditions carefully in order to minimize resinification and cleavage of the ring. By appropriate modification the Friedel-Crafts reaction (*q.v.*) can be applied for the synthesis of alkylated and acylated derivatives. The related Gattermann aldehyde synthesis has also been carried out in a number of instances. Sulfonation, while not usually feasible with fuming sulfuric and chlorosulfonic acids, has been accomplished by use of the milder pyridiniumsulfonic acid. Halogenation may be carried out to obtain either addition or substitution products. Nitration is usually effected with nitric acid in acetic anhydride as the reagent. With furan itself, this gives rise to an intermediate nitro-acetoxy-dihydrofuran (I) which, by the action of pyridine, loses the elements of acetic acid to form 2-nitrofuran (II). If water is present, however, I may decompose with formation of malealdehyde (III).

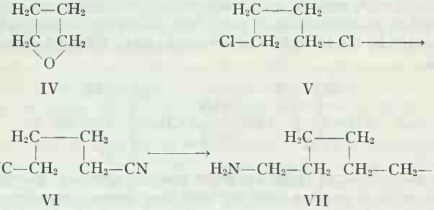


That the furan ring is less stable as a unit than the benzene ring is further reflected by the fact that the extensive chemistry of the phenols and aromatic amines has no complement in the furan series. The furanols and furylamines exhibit much more kinship to the aliphatic keto-enol and ketimine-enamine systems, respectively, than to the analogous benzene derivatives.

Furan compounds are very susceptible to nuclear oxidation, particularly in acidic medium. Under such conditions, it is difficult to find reagents that permit selective oxidation of a substituent group. In admixture with air over a suitable catalyst (vanadium pentoxide) at elevated temperature, furan or furfural give rise to maleic anhydride in excellent yield. Carefully controlled alkoxylation, electrolytically or with chlorine or bromine, permits the isolation of unsaturated acetals which are useful intermediates in organic syntheses. This is illustrated by the alkoxylation of 2-methylfuran to a cyclic acetal of acetylacrolein.



When furan compounds are subjected to the action of hydrogen in the presence of a nickel catalyst, the ring is reduced, and saturated cyclic ethers, the tetrahydrofurans, are obtained. In this way, furan gives rise to tetrahydrofuran itself (IV), and this represents another step in the industrially important synthesis of nylon from furfural. The further steps involve cleavage of IV to 1,4-dichlorobutane (V), treatment with sodium cyanide to obtain adiponitrile (VI), and reduction to hexamethylenediamine (VII). Nylon is made by reaction of VII with adipic acid.



See A. P. Dunlop and F. N. Peters, *The Furans* (1953); "The Chemistry of the Furans," The Quaker Oats Company, *Bulletin 202A* (1947). (A. P. D.)

FURETIÈRE, ANTOINE (1619–1688), French novelist, satirist and lexicographer, remarkable for the variety of his writing, was born in Paris on Dec. 28, 1619. He first practised law and was appointed procurator fiscal of the Royal abbey of St. Germain-des-Prés in 1652, but after a mysterious affair, not fully elucidated, in which he was probably falsely accused of venality, he abandoned his functions and obtained various ecclesiastical benefits, becoming, in 1662, abbé of Chalivoy in the diocese of Bourges. His burlesque work comprises a versified translation of *Aeneid* Book IV (1649), *Le Voyage de Mercure* (1653), and *Poésies diverses* (1655). In his *Nouvelle allégorique* (1658), he revealed himself as a defender of literary tradition. He was elected to the Académie Française in 1662 and, four years later, published his best-known work, *Le Roman bourgeois*, a portrayal of contemporary society remarkable for its realism. In 1684 he obtained permission to publish a dictionary. The academicians succeeded in having the permission withdrawn, and in 1685 they expelled Furetière, whom they accused of usurping their exclusive rights in this field. The remaining three years of his life were filled with his quarrels with the Académie. He died in Paris on March 14, 1688. His dictionary was published posthumously in Rotterdam in 1690 and obtained considerable success.

BIBLIOGRAPHY.—Modern editions of *Le Roman bourgeois* were published by G. Mongrédien (1956); illustrated by Jacques Boullaire (1958); and by A. Adam (1958). *Poésies Diverses* was edited, with introduction, by I. Bronk (1908). (F. E. Su.)

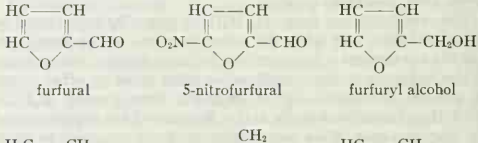
FURFURAL (2-furaldehyde, fural, furfurol) is the best-known member of the furan family and the source of the other technically important furans (*see* FURAN CHEMISTRY). It is a colourless liquid (boiling point 161.7° C.; specific gravity 1.1598) subject to darkening on exposure to air. It dissolves in water to the extent of 8.3% at 20° C., and is completely miscible with alcohol and ether. The chemical formula is C_4H_3O-CHO.

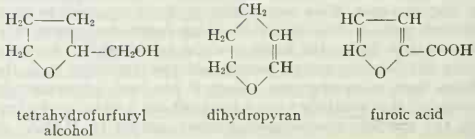
A span of about 100 years marked the period from discovery of furfural in the laboratory to the first commercial production in 1922. The subsequent industrial development provides an excellent example of the industrial utilization of agricultural residues. Corncobs, oat hulls, cottonseed hulls, rice hulls and bagasse are the major raw material sources, the annual replenishment of which ensures a continuing supply. In the manufacturing process, tenton lots of the raw material and dilute sulfuric acid are steamed under pressure in large rotary digesters. The furfural formed is removed continuously with steam, and concentrated by distillation; the distillate, on condensation, separates into two layers. The bottom layer, comprising wet furfural, is dried by vacuum distillation to obtain furfural of minimum 99% purity.

Furfural is used as a selective solvent for refining lubricating oils and rosin, and to improve the characteristics of diesel fuel and catalytic cracker recycle stocks. It is employed extensively in the manufacture of resin-bonded abrasive wheels, and for the purification of butadiene needed for the production of synthetic rubber. The manufacture of nylon requires hexamethylenediamine, of which furfural is an important source. Condensation with phenol provides furfural-phenolic resins for a variety of uses. Nitration gives 5-nitrofurfural.

When vapours of furfural and hydrogen are passed over a copper catalyst at elevated temperature, furfuryl alcohol is formed. This important derivative is used in the plastics industry for the production of corrosion-resistant cements and cast-molded items. The similar hydrogenation of furfuryl alcohol over a nickel catalyst gives tetrahydrofurfuryl alcohol, from which are derived various esters and dihydropyran.

In its reactions as an aldehyde, furfural bears a strong resemblance to benzaldehyde (*q.v.*). Thus, it undergoes the Cannizzaro reaction in strong aqueous alkali; it dimerizes to furoin, C_4H_3O-CO-CHOH-C_4H_3O, under the influence of potassium cyanide; it is converted to hydrofuramide, $(C_4H_3O\text{-}CH)_3N_2$, by the action of ammonia. It participates in the Perkin and Claisen condensations and related syntheses; with acetone, furfural gives rise to furfurylideneacetone, C_4H_3O-CH=CH-CO-CH_3; with acetaldehyde, it reacts to form furylacrolein, C_4H_3O-CH=CH-CHO. However, furfural differs markedly from benzaldehyde in a number of ways, of which autoxidation will serve as an example. On exposure to air at room temperature, furfural is degraded and cleaved to formic acid and formylacrylic acid. Behaviour similar to that of benzaldehyde would have given rise to furoic acid as the major product under these conditions. To obtain the latter in good yield, it is the practice to oxidize furfural in alkaline medium, the acid being subsequently liberated from the resulting salt. Furoic acid (formerly called pyromucic acid as a consequence of its formation by heating mucic acid) is a white, crystalline solid which is useful as a bactericide and preservative. Its esters are fragrant liquids which are used as ingredients in perfumes and flavourings.





See A. P. Dunlop and F. N. Peters, *The Furans* (1953); "Furfural" and "Q.O. Chemicals," The Quaker Oats Company, *Bulletins*, 201A (1953) and 203A (1955). (A. P. D.)

FURIES, from the Latin *furiae*, by which name the Greek Erinyes (*q.v.*) were known in Roman literature. The resemblance of name caused occasional confusion with the very ancient, but obscure, Roman goddess Furrina, whose functions and the derivation of whose name are unknown.

FURLONG, a measure of length, originally the length of a furrow in the "common field" system (from the O.E. *furlang, i.e.*, "furrow-long") (*see* LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS). Since the field in this system was generally taken to be a square, ten acres in extent, and since the acre varied in different districts and at different times, the furlong also varied. The side of a square containing ten statute acres is 220 yd. or 40 poles, which was the usually accepted length of the furlong. This is also the length of one-eighth of the statute mile. Furlong was used as early as the 9th century to translate the Latin *stadium*, one-eighth of the Roman mile.

FURNACE, ELECTRIC, a device used for heating material to change its state (*e.g.*, to melt it) or its physical, chemical and mechanical properties. In such furnaces electrical energy is converted into heat energy; the heat thus generated is proportional to the resistance encountered by the electric current and to the square of the current passed.

Electric furnaces are commonly classified as resistance, arc and induction types. The resistance medium for the resistance furnace is usually a solid wire, ribbon or rod or sometimes a liquid electrolyte; the resistance medium for the arc furnace is a gas, and for the induction furnace the medium is generally a solid or liquid.

Electric current usually does not flow through the material to be heated (*i.e.*, the charge) in resistance furnaces, although in certain electrolytic processes, such as those used in the production of aluminum, the current does flow through the electrolyte. Electric current may flow through the charge in certain arc furnaces, or the current flow may be confined to the gas phase above the charge. Finally, in induction heating electric current generally passes through the charge, except in the case of some melting furnaces in which current flows through the crucible and the charge is heated indirectly.

It is important to note in the study of furnaces that heating usually takes place by a subtle interplay of the three modes of heat transfer—convection, conduction and radiation.

Resistance Furnaces.—Most resistance furnaces are the indirect type—the current does not flow through the charge. Instead, separate resistors, which serve as heating elements, are provided. In furnaces for laboratory use, nichrome, graphite or molybdenum are the most commonly used resistors. Graphite and molybdenum oxidize readily in air and therefore can be used only in a protective nonoxidizing atmosphere, such as helium or oxygen-free nitrogen. Platinum resistors can be used in air but are, of course, expensive. For temperatures up to 1,200° C. (2,192° F.) iron-chromium-aluminum resistors are used; for temperatures up to 1,000° C. (1,832° F.) nickel-chromium is satisfactory. In industrial furnaces, and to a limited extent also in laboratory furnaces, rods and tubes of silicon carbide form satisfactory heating elements for temperatures up to 1,300° C. (2,372° F.), yielding resistor life of several hundred to several thousand hours, according to temperature and kind of service.

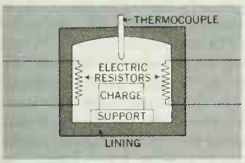


FIG. 1.—RESISTOR FURNACE

Laboratory furnaces usually consist of a refractory tube (*e.g.*, alumina), around which the resistor is wound. Tube and resistor are then embedded in appropriate insulating material, which in turn is held in an outside casing.

Resistor furnaces for industrial use are built in a large variety of shapes and forms. However, all consist essentially of resistors (heating elements) which usually, although not always, are located in the working chamber, electric insulators to support the heating elements, an inside wall, heat insulation and an outside shell. In some instances the electric insulators form part of the inside wall; on the other hand, frequently the inside wall and heat insulation coincide. Fig. 1 is fairly representative of a batch-type unit. However, many indirect heat resistor-type furnaces are provided with conveying means to carry the charge through the furnace; the variety of designs does not permit detailed description here. The majority of furnaces of this type are equipped with automatic temperature control, maintaining the furnace temperature constant within narrow limits.

In the listing of resistor materials one group of materials, fused salts, was not mentioned because it involves a totally different furnace design. In this type of furnace the electric current passes through a molten salt resistance, and heating of the salt bath occurs. In some cases technically pure salts such as barium chloride and potassium chloride are placed in metallic or nonmetallic containers; electrodes are placed in the salt, and the current passing from one electrode to the other provides enough energy to melt the salt. The charge can be placed in the liquid salt bath and heated to the desired temperature. Because of the intimate contact between the molten salt and the charge, heating of the latter is very rapid; moreover, the salt may prevent oxidation of the charge.

A type of direct-heating salt bath is characterized by the electrolytic furnaces used in the production of lithium, sodium, potassium, calcium, magnesium, aluminum, etc. In these furnaces the electrolyte is a fused salt heated directly by the passage of current through it. For example, in the production of aluminum, the fused salt is a mixture of aluminum oxide and sodium aluminum fluoride. During electrolysis of the fused salt aluminum metal collects at the bottom of the furnace on a graphite cathode and oxygen is set free at graphite anodes. Heating of the furnace is accomplished entirely by the passage of current through the resistance of the electrolyte.

Another direct-heating resistance furnace is employed in the production of silicon carbide. The raw materials are placed on a refractory base within a furnace and at each end the charge is connected to one or several electrodes which, in turn, are connected to the power supply. Current flows lengthwise through the charge, which may be several yards in length.

Resistance heating has been in use since the early 1900s and has undergone various developments. Infrared heating, for example, is carried out by exposing the surfaces to be heated to high-temperature sources. Banks of incandescent lamps, preferably with carbon filaments, are frequently used as heat sources; or common resistors (nickel-chromium type) may be designed to reach high temperatures. Infrared heating is useful mainly for rapid heating of surfaces. For example, in order to dry paint (a major field of application) at a temperature of 400° F. (204.44° C.), heat sources at 2,000° F. (1,093.3° C.) or even higher are used, but exposure times are short (from a few seconds to a few minutes).

Arc Furnaces.—Arc furnaces are used for melting or refining

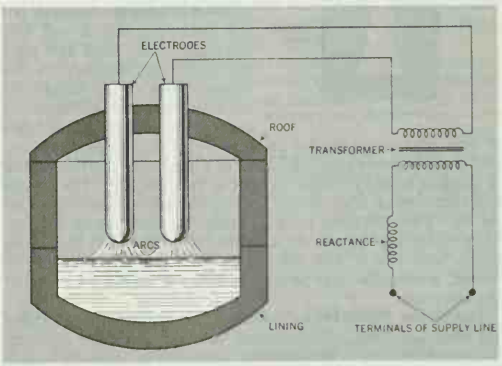


FIG. 2.—ARC FURNACE

ferrous (and, occasionally, nonferrous) metals and for the production of refractories and ferroalloys. One important type of arc furnace is the direct arc or open arc, characterized by the Heroult furnace in fig. 2. A direct arc furnace consists of a transformer, often a reactance, buses and the furnace proper. In the transformer, voltage is reduced from the supply system to that required by the furnace. The buses, consisting of heavy copper or aluminum bars, connect the transformer to the electrodes. The latter bring the current into the furnace chamber. Electric arcs extend from the tips of the electrodes into the bath.

In the United States electrodes are made exclusively of carbon or graphite rods or bars; in other countries such electrodes find competition with Soderberg, or self-burning, electrodes, consisting of steel sleeves filled with a carbonaceous mass, that are fed continuously into the furnace. The furnace proper consists of a steel shell, lined with a refractory (generally basic magnesite) and covered by a roof. Tapholes permit withdrawal of the molten product as well as the slag and the furnaces can usually be tilted. Charging of the furnace is done either through doors or from the top, after removing the roof.

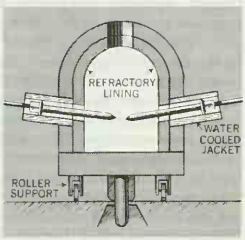


FIG. 3.—STASSANO ROTATING FURNACE

Over the years the size of furnaces as well as the power rating increased, both contributing to a decrease of energy consumption per ton of output. The maximum voltage used in open-arc furnaces for steel production increased gradually to about 300. High voltages make possible high production rates but present a safety problem for the operator and (since high voltage results in long arcs) reduce the life of the furnace roof.

Another type of arc furnace is the Stassano rotating furnace, essentially a cylindrical enclosure with two or three electrodes placed on a horizontal axis and facing each other. The arc is maintained between the electrodes and burns in the centre of the furnace, radiating toward the lining above and the charge below. This type of furnace is illustrated in fig. 3, which shows a vertical section through two of the electrodes. The electrodes are surrounded by water-cooled jackets. Gases from the reactions pass out through a vent in the top and the furnace is provided with a charging hopper and tapping spout (not shown). Slow oscillation of the furnace provides mixing of the charge. This type of furnace originally was used for the smelting of magnetite and hematite but is now built in small units for nonferrous alloys and gray iron foundry work.

Submerged arc furnaces are used for the production of ferroalloys. This type of furnace is illustrated in fig. 4. Transformer and buses are essentially the same as those in open arc furnaces, but the electrodes extend well into the charge, with short arcs playing from the electrode to the nearest parts of the charge and between various particles of the charge. In addition to the types of electrodes mentioned for open arc furnaces, European industry also uses composite electrodes, built of a number of discrete carbon or graphite blocks arranged in rows or cylindrically. The intense concentration of heat creates an odd-shaped reaction zone (*see* fig. 4). Some furnaces have no lining, the cold, nonmolten material protecting the side walls of the shell. Furnaces frequently do not have covers, and, since gases develop in the reactions involved, flames often may be seen burning around the upper end of the electrodes.

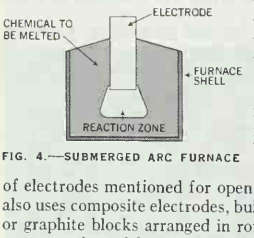


FIG. 4.—SUBMERGED ARC FURNACE

Induction Furnaces.—Furnaces of the induction type depend for their operation upon resistance heating. Although in induction furnaces there is no electrical connection between the electrical supply and the metal in the bath, there is an indirect connection by electrical induction similar to that prevailing in transformers between primary and secondary windings; in fact, induction furnaces may be understood as transformers with the coil as primary and the bath or crucible as a one-turn secondary winding. On the other hand, since heat generation occurs in the charge or in the crucible, induction furnaces are of the direct-heat type. The charge is generally the hottest point in the furnace.

Induction furnaces may be classed broadly into two groups, the core type and the coreless induction furnace. Induction furnaces are used for melting and induction heating appliances for heat-treating, brazing and soldering. Use of induction heating (or melting) is limited to good conduction materials, essentially metals.

Core-type melting furnaces are used almost exclusively in the nonferrous field. Fig. 5 shows a typical cross section. A V-shaped channel penetrates a coil, which is connected to the power supply; both legs of the V issue into a receptacle containing the batch of metal. This type of furnace must operate continuously; when pouring, the furnace is never emptied completely, enough metal being left to form a closed loop. The electromagnetic forces in the melt result in an energetic stirring; the forces are so strong that the same principle—of a liquid conductor surrounded by a coil—has been used successfully to pump hot liquid metals.

Core-type induction furnaces are rarely used for melting steel. For this purpose they have been replaced by coreless furnaces. Mechanically, coreless furnaces are very simple. They consist of a crucible surrounded by a water-cooled coil, the space between crucible and coil being filled with heat insulation. The coil is connected to a high-frequency power source. Up to 10,000-cycles-per-second rotating machinery can be used; beyond that value vacuum-tube generators or spark generators are used. The former make use of vacuum tubes of the same principle as, though larger than, those used in radio. Spark generators use the high-frequency oscillations occurring when a spark discharge across an air gap occurs. In view of the magnetic stray fields, any metal used in the construction of the furnace would heat up. Hence the outside shells are made of wood, plastic or similar materials. Coreless induction furnaces for melting have been built in sizes up to several tons. When melting a nonconducting material, a conducting crucible (*e.g.*, graphite) which transfers heat to the charge may be used. Theoretically there is no limit to the temperature which can be reached in a coreless induction furnace. Practically, temperatures beyond 1,500° C. are hard to achieve.

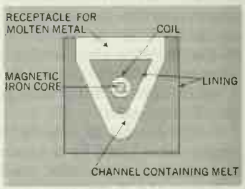


FIG. 5.—CORE INDUCTION FURNACE

As noted above, induction heating is used not only for melting purposes but also for heat-treating and brazing. The very rapid temperature rise, taking only seconds and occasionally only fractions of a second, and the possibility of localizing the points of heat generation are two of the main reasons for the rapid development of this technique. The arrangement is simple: a high-frequency power generator, of the same general type but normally of smaller rating than the generators used in melting furnaces, is connected to a water-cooled copper coil. The shape of the coil matches that of the piece to be heated. In view of the rapid temperature increase, control is frequently by time; power is disconnected after a preset length of time.

Because of the nature of energy transfer by induction (from the coil to the heated object); only a thin layer next to the surface is heated, the thickness of the layer decreasing with increasing frequency. From this shallow layer of heat generation heat is conducted to the inside of the piece. Basically in the same manner, but in technical execution quite different, induction heating at supply line frequency (50 to 60 cycles per second) can be used for raising the temperature of chemicals in pipes, bottles or other containers.

As stated, induction heating is applicable only to good conductors of electricity. Frequently confused with this method is one applicable only to very poor conductors, called dielectric heat-

ing. Fig. 6 shows schematically the arrangement for such heating. The piece to be heated is placed between two metal pieces, the electrodes. The latter must not touch the material. The electrodes are connected to a high-frequency (*e.g.*, 500,000 cycles per second) power supply, operating usually at more than 1,000 v. Under the influence of the high-frequency field, small (technically called "displacement") currents flow in the material, heating the latter, the heat being proportional to the electric resistivity of the material. This method of heating is used widely in the manufacture of plastic objects and finds increasing use in the curing of rubber and the drying and glueing of wood. *See* also HIGH-FREQUENCY HEATING.

FIG. 6.—SCHEMATIC ARRANGEMENT FOR DIELECTRIC HEATING

BIBLIOGRAPHY.—V. A. Paschkis, *Industrial Electric Furnaces and Appliances*, 2 vol. (1945–48); American Society for Metals, *Induction Heating* (1946); N. R. Stansel, *Induction Heating* (1949); G. H. Brown *et al.*, *Theory and Application of Radio-Frequency Heating* (1947); W. Trinks, *Industrial Furnaces*, 2 vol. (1951); J. L. Bray, *Ferrous Process Metallurgy* (1954). (V. Ps.; R. E. Ge.; X.)

FURNACE, METALLURGICAL. A metallurgical furnace is a structure in which a temperature in excess of 1,000° F. (537.78° C.) can be maintained without serious damage to the walls and in which one of the following operations can be performed: (1) the heating of solid pieces of metal to various temperatures in different atmospheres; (2) the melting of metals for making castings; (3) the extraction or reduction of metals from their ores; (4) the refining of metals; (5) the distillation of metals; (6) the roasting of metallic ores; (7) the carburization of steel; and (8) the brazing of metals.

In metallurgical practice, a structure that is designed for a temperature between 600° F. (315.56° C.) and 1,000° F. is called an oven. A furnace or an oven is called a kiln if a gas or vapour is driven off the solid material being heated. The term coke oven violates both definitions, however, because in the making of coke (which is not a metallurgical process) the temperature rises to 1,800° F. (982.22° C.) and gases and vapours are released.

The interior of a furnace is heated either by the combustion of fuel or by conversion of electrical energy into heat. All furnaces have access-openings (doors). A fuel-fired furnace has burner openings and vents (flue openings), usually in the side walls. Burners and vents are seldom located in the hearth or in the roof. If the furnace is heated by solid fuel that burns on a grate, a firebox is provided, which is separated from the hearth by a bridge wall.

If the charge remains in the same spot during the metallurgical operation, the furnace is called a batch furnace. If the charge moves progressively, the furnace is continuous. If solid pieces of metal are heated, the hearth is plane, horizontal or slightly inclined. If metals are smelted or refined on a hearth, the hearth is concave and is equipped with a taphole and a spout. The taphole is poked open at regular intervals or at the end of the operation. Furnaces with concave hearths are usually flame heated and are called open-hearth furnaces, reverberatory furnaces and (rather inaccurately) air furnaces. The term reverberatory arose from the fact that products of combustion transmit a large portion of their heat to the vaulted roof of the furnace, whence the heat is reflected (reverberated) to the hearth. Metals also are refined in externally heated pots, or crucibles, and in shaft furnaces that are charged at the top, the processed material being withdrawn at the bottom.

A furnace in which air or oxygen is blown into and through molten metal is called a converter. Underground furnaces in which long pieces are heated in a vertical position are called pit furnaces.

If the charge is in contact with the products of combustion, the furnace is said to be direct fired. In a muffle furnace, a separating wall lies between charge and products of combustion. Either the charge or the flame can be inside the muffle. If the flame is inside, the muffle is called a radiating tube.

Materials and Elements of Construction.—Furnaces are built of refractory material, of heat resisting metals and of metals cooled by air or water. The great majority of the refractories are oxides, such as silica, alumina, magnesite, dolomite, chromite and zirconia. Fire clay is a mixture of silica and alumina, with impurities that soften the bricks at high temperatures. Silicon carbide (which is not an oxide) has a high strength at elevated temperatures, but both silicon and carbon burn in oxidizing atmospheres if the protective skin of silica flakes off. The ideal refractory material has a high compressive strength at furnace temperature, a low thermal conductivity and a low coefficient of expansion. Refractory insulating bricks approach this ideal. These bricks, which are often called lightweight firebricks, are used up to 2,400° F. (1,315.6° C.). They resist temperature, but are destroyed by slags. Lightweight bricks have a lower compressive strength than dense bricks. Difficulties with refractories increase with temperature, with superimposed load and with chemical attack by liquids and gases. For heating solid metal up to 1,600° F. (871.11° C.), fire clay of medium quality is adequate. The higher the furnace temperature, the purer the clay must be. Bricks that are rich in alumina and low in impurities, formerly called "first quality firebrick," are known as "high-duty" bricks. If free from any impurities and very dense they are called "superduty" bricks.

Refractories are adapted to the chemistry of the metallurgical process. Silica is acid; magnesite and dolomite are basic; chromite is neutral. Carbon is an excellent refractory if no oxygen can contact it, as in the hearth of a blast furnace. In spite of all precautions, refractories wear away under extreme conditions. They are then water-cooled on the outside of the furnace. An example is the blast furnace of the steel industry. Its hearth is built of bricks that are water-cooled. When the furnace is shut down for relining, no trace of the bricks remains; they have been worn away and replaced by frozen slag. In the upper part of the blast furnace (for making pig iron), the walls are subjected to abrasion by ore and coke and to infiltration of carbon monoxide, which breaks up ($2\,CO = CO_2 + C$) at decreasing temperatures. Pressure by solid carbon disintegrates the brick. For both reasons, a hard and dense special brick is used.

Refractory bricks are available in many standard sizes and shapes. Special shapes, especially large tiles, are expensive and liable to crack during the burning process. (*See* also FIREBRICK.)

Depending upon furnace temperature, muffles are made of alloy steel, fireclay or silicon carbide. Whenever conditions permit, furnaces are insulated by insulating bricks, powder or cement.

In furnace walls, expansion and contraction are not reversible. Unless bound together, a furnace will become leaky and finally collapse. For that reason, furnaces are bound by structural material. The vertical members are called buckstays; the horizontal members are called tie rods. If a furnace is to be gastight, it is enclosed in heavy steel sheets.

Most furnace roofs are arches that are built up from arch bricks and straight (constant thickness) bricks. Roofs that are arched in two directions (turtleback arches) are rare except over electric-arc furnaces. Roofs on large heating furnaces are flat rather than arched. The roof tiles are suspended from overhead steel beams. The suspension members are either metallic or ceramic.

Because concrete is disintegrated by heat, furnace hearths are not set directly on concrete foundations, but are either ventilated by air passages (between hearth and foundation) or set on thick slag fills.

Furnace Stacks.—Metallurgical furnaces for roasting or smelting develop dust and gases. In densely populated sections, nonpoisonous dust is removed by filters or electric precipitation. Poisonous gases, such as sulfur dioxide, can be converted at high cost into commercial products. As a rule these gases are discharged at the tops of stacks several hundred feet tall, where wind velocity is many times greater than it is near the ground. When the gases reach the ground, miles away from the stack, they have diffused and are so diluted that they are not injurious.

Fuels.—Coal and coke are the usual solid fuels. In shaft furnaces for reduction of metal and in cupolas, solid fuel is a necessity. For metallurgical operations performed on hearths, solid fuels burning on a grate have been replaced by powdered coal and

by gaseous or liquid fuels, where available. Flame control with solid fuels burning on a grate is poor and the labour cost is high, even if mechanical stoking is employed. Finely powdered coal (95% through a sieve of 200 meshes per inch) is burned in large furnaces if the ash causes little trouble. Ash does no harm if it drops on a slag bath or an ash-cover in the furnace, but fly ash clogs ducts and wears nearby machines.

Early in the 20th century, coal was extensively gasified in gas producers; it is still so gasified to producer gas where more convenient fuels are not generally available. Producer gas has a low heating value; it contains soot, tar and dust. Its composition varies, and the gas ducts between producer and furnace must be burned out each week end. (*See* GAS INDUSTRY.)

In integrated steel works, blast furnace gas, coke-oven gas, tar and pitch are the principal fuels. In most other furnaces, powdered coal, natural gas, fuel oils and city (manufactured) gas are burned.

Fuel consumption per unit weight of processed metal varies within wide limits. If a component of the charge is burned in the process, the so-called fuel consumption may be zero. In some other processes, it is very great. In the blast furnace (for making pig iron) from 0.8 to 1.0 lb. of coke is required to make a pound of iron.

Electrical energy is utilized for metallurgical furnaces in three ways. In one method, electric heating elements (resistors) are fastened to the walls and the roof of the furnace. Metallic resistors are useful up to 1,900° F. (1,037.8° C.) furnace temperature. Resistors of silicon carbide are useful up to 2,500° F. (1,371.1° C.). In a second method, electric current passes through the charge, which then becomes a resistor and is heated by the current. This method is applied to both solid and liquid metals. In a third method, alternating current flowing in a coil induces eddy currents in the metal that is encircled by the coil or closely surrounds the coil. The eddy currents heat the metal. Metallic objects of less than 1¼-in. thickness are induction heated without being enclosed in a furnace. (*See* also FUELS; FURNACE, ELECTRIC.)

Furnaces for Heating Solids on Hearths.—If metallic solids are heated on a hearth or on a support immediately above the hearth, the furnaces are used for annealing or heating for carburizing, quenching, drawing (tempering), rolling or forging. Most of these are tube furnaces and are continuous (*see* ANNEALING). The charge is pushed through the furnace, either directly or while resting on trays, or is carried through the furnace on a rotating hearth. In other furnaces, the charge rests on live (driven) rollers, or on traveling chains, or on belts of woven wire. Shaking hearths and vibrating hearths also transport the charge through the furnaces. Metallic objects are also heated while suspended in furnaces. At temperatures approaching 2,300° F. (1,260° C.), strength of the means of suspension is of concern. If the furnace is continuous, tightness of the strips that cover the slot in the roof is very important.

Bright sheet strip and machined parts are heated in protective atmospheres to prevent discolouration and oxidation. Most protective atmospheres are prepared by partial combustion of a hydrocarbon, such as natural gas, in separate furnaces, and by removing water vapour and carbon dioxide from the products of combustion. Furnaces with protective atmospheres are heated either by electric resistors or by radiant tubes. Infiltration of air is prevented by furnace pressure and by vestibules at entrance and exit doors. "Atmosphere" furnaces, including vacuum furnaces, are enclosed in airtight steel shells.

Metal heating furnaces are precision heating machines with automatic transportation of the charge and automatic control of furnace pressure, temperature and atmosphere.

Shaft Furnaces.—In these furnaces air rises in the shaft and burns the fuel, which is either coke or sulfur, or both. As a rule air is blown into the shaft near its bottom. The required air pressure depends upon the height of the shaft, fineness of charge and rate of air flow desired per unit of cross-sectional area of shaft. Most shaft furnaces, such as the cupola which remelts iron in foundries, are cylindrical; but if the charge tends to hang to the walls and to vault, the shaft is conical, wide end down. Despite this precaution, "hanging" occurs occasionally in a blast furnace for smelting iron. The blast pressure then rises up to 30 lb. per square inch gauge. The air that is blown into cupolas or roasting furnaces is usually cold, but fuel economy requires that the air for iron blast furnaces be preheated. Beginning about 1945, the blast pressure was increased in some furnaces by throttling (restricting) the outflow of gases at the top. The throughput of blast furnaces is increased by this measure. Blast furnaces for smelting iron are about 100 ft. tall over-all and have hearth diameters up to 28 ft. or more. Furnace height, blast pressure and blast temperature can be reduced if the blast is enriched with oxygen. (*See* also BLAST FURNACE.)

Multideck (or multihearth) furnaces also are shaft furnaces. They consist of from 8 to 12 circular hearths (up to 25 ft. in diameter) on top of one another. Alternately, the hearths have drop holes at the rim and near the center. A vertical shaft moves rabble arms which are so shaped that they move the ore alternately in and out. The size of the drop holes is critical: if too small, dust fuses on the underside of the hearth above; if too large, the roaster runs cold.

Some hood furnaces resemble shaft furnaces. Coils of strip sheets that are to be bright annealed are stacked on top of one another and are covered by a metallic hood, through which a protective gas is circulated. The hood is surrounded by a cylindrical furnace.

Flame Furnaces.—This term includes all those furnaces in which a flame passes horizontally over the charge that is melted on a dished hearth. Flame furnaces are called open-hearth furnaces when used for the production of steel, reverberatory furnaces when used for the production of copper and nickel, and air furnaces when used to melt scrap cast iron. The dished hearth is made so dense and impervious by fusion that the heavy molten metal cannot penetrate into and through it. At the slag line, the walls are built of a material that resists chemical attack by the slag (silica for acid slags or chrome-magnesite and dolomite for basic slags).

Silica bricks are strong at high temperatures. For that reason, silica roofs are common even in furnaces with basic slags, although the silica is gradually worn away by vapours and spittings from the bath. Chrome-magnesite bricks last longer in basic processes, but (in most industrial districts) are more expensive.

Open-hearth furnaces are of the batch type. Reverberatory furnaces are continuous. The ore concentrate is fettled (charged) through lateral openings in the roof. Slag overflows continuously at one end, and metal is tapped at intervals at the deepest part of the bath.

With a few exceptions, the reaction heat released by the process does not suffice to maintain reaction temperature. In furnaces of this type, fuel is burned above the charge. Depending upon the required furnace temperature, the fuel is burned either in cold air or in preheated air. Air temperatures up to 1,300° F. (704.44° C.) are obtained in metallic recuperators, which are heat exchangers with a metallic wall between outgoing products of combustion and incoming air. Higher air temperatures up to 1,800° F. (982.22° C.) preferably are attained in regenerators, which are brick-filled chambers through which air and hot gases flow alternately in opposite directions. The result is that flame also flows through the furnace alternately in opposite directions. Direction of flow is controlled by reversing valves.

Since 1942, oxygen has been blown, through lances, into the bath of open-hearth furnaces. This is done in the latter part of the refining period, when the slag reactions are slow.

The first open-hearth furnace for steel (*c.* 1870) held five tons of metal. In the second half of the 20th century the standard size in steelworks was 250 tons, and furnaces of up to 600 tons capacity were in operation.

In flame furnaces for the reduction and refining of metals, wear by chemical action at high temperatures is so rapid that the furnaces must be rebuilt at regular intervals.

Crucible Furnaces.—For many years, steel of high quality was produced in crucibles, which are pots of refractory material. Crucibles of graphite or of high grade fire clay were heated by

the products of combustion of preheated producer gas and preheated air. Since about 1932, steel of highest quality and other metals have been refined in evacuated crucibles heated by induction. Crucible and ingot mold are then integral. The alloy is both melted and poured (by tilting) *in vacuo*. Metals such as titanium, which must be free from bases, are melted and annealed in hermetically sealed pots or crucibles.

Crucible furnaces for remelting nonferrous metals are of simple design. The crucible rests upon a support in a cylindrical furnace into which a flame is projected tangentially. (*See* also CRUCIBLE STEEL.)

Converters.—Converters are refractory-lined vessels into which a molten metal is poured for the purpose of changing the composition of the metal by burning undesirable elements and removing them in gaseous form. This aim is reached by blowing either air or oxygen into and through the metal. Converters are bottom-blown, side-blown or top-blown. In the operation of a bottom-blown converter the air enters from the windbox (under the hearth or bottom) and flows upward through many small openings (tuyères). In the blowing of steel the air pressure ranges between 20 and 30 lb. per square inch gauge. If the pressure is too low the air rises in bubbles containing improperly utilized oxygen. If the air pressure is too high, too much of the metal is thrown out, in the shape of pellets, through the mouth of the converter. The reactions are most intense immediately above the bottom, which wears away quickly. Converters rest in two trunions; they are tilted for receiving and for discharging metal. Bottom-blown converters must have, on one side, a pouch that holds the charge in the inclined vessel without the metal's spilling out of the mouth or flowing into the tuyères. Blowing begins before the vessel is righted. In converters constructed since 1950, oxygen is blown into the bath from above through a central pipe. Converters in steel works range from 15 to 50 tons holding capacity. Small steel converters are usually side-blown.

Converters in the metallurgy of copper and nickel are side-blown cylindrical vessels, with an average size of 13 ft. in diameter and 30 ft. in length, having from 46 to 52 tuyères of 1½ inch diameter. The air pressure is 14 lb. per square inch (gauge).

Depending upon the nature of the charge, converters are lined with acid (silicious) material, or with basic (dolomite) material. (*See* also CONVERTER STEEL.)

Electric Arc Furnaces.—Electric furnaces for making alloy steels are round or elliptical boxes, through the roofs of which carbon electrodes reach down to the charge. Electric arcs, combustion of the electrodes and heat generated by the current in the charge bring the charge up to reaction temperature and supply reaction heat. When the process has been finished, the furnace, including electrodes, is tilted. The electrodes are moved in and out automatically to maintain the current near a predetermined value. A transformer located close to the furnace is connected to the electrodes by heavy flexible cables. In steel making, electric furnaces have taken the place of crucible furnaces and of small open-hearth furnaces. Because heat is generated directly in the charge under the slag cover, the roof is protected so that higher temperatures can be obtained in the bath than in crucible or open-hearth furnaces.

Electric furnaces using direct current serve in the production of aluminum. Carbon electrodes reach down into a bath of molten salts (cryolite), which lies in a carbon-lined tank. Liquid aluminum collects on the carbon lining and is withdrawn at regular intervals through a taphole. Such furnaces are electrolytic cells operated at high temperature.

Salt Bath Furnaces.—Salt bath furnaces are containers filled with molten salts, the composition of which is such that the salt is liquid at the desired temperature. These furnaces heat fine tools uniformly and, in many cases, saturate the surface of the charged pieces with carbon and nitrogen, for imparting hardness after quenching. Low-temperature salt baths lie in suspended iron pots that are externally heated. High-temperature salt baths are contained in refractory pits, which are usually heated electrically through electrodes that dip into the bath. Some salt baths are flame heated from above.

Retort Furnaces.—Easily volatilized metals such as mercury, magnesium and zinc are produced in slightly inclined retorts that project outside the furnace at one end. The vapourized metals condense in the cold zone. Burners must be so arranged that all retorts reach the same required reaction temperature. Too low a temperature reduces the yield of metal; too high a temperature shortens the life of the retorts.

Recirculating Furnaces.—If metallic objects are to be heated to a uniform specific temperature below 1,500° F. (815.56° C.), fuel is burned in a separate combustion chamber. When leaving this chamber, the products of combustion mingle with other products that have already passed through the heating chamber. Circulation is obtained by mechanical means. The charge is safe from local overheating. For temperatures below 1,000° F. (537.78° C.), these furnaces are really ovens. They are often called air furnaces.

Tower Furnaces.—Strips of steel sheet and tin plate are delivered from the cold mill at speeds that exceed one mile per minute. Continuous bright annealing at a corresponding rate of speed requires a long time in the furnace, for heating, holding at temperature, and cooling, all in a protective atmosphere. The long time period is obtained in special furnaces by passing the strip up and down several times over graphite rollers, between heaters and, finally, between coolers. These furnaces are as tall as 40 ft.—hence the name "tower furnace."

Other Furnace Types.—Furnaces that do not fit into any classification appear from time to time. An example is the electric-arc crucible furnace with inert atmosphere (including vacuum). The walls are water-cooled copper; an induction coil is provided for stirring the molten metal and the bottom of the crucible is removable for dropping the ingot after solidification.

Laboratory and Portable Furnaces.—Most laboratory furnaces use gas, oil or electricity as the heating medium. The furnaces are small copies of the muffle, tube and crucible types. Small portable assay furnaces, using coke or coal and arranged so that they can be used either as muffle or crucible furnaces, are frequently used in situations where other methods of heating are not available, as in prospecting.

For related information, *see* BLAST FURNACE; COPPER; CUPOLA FURNACE; FUELS; IRON AND STEEL INDUSTRY; LEAD.

See also references under "Furnace, Metallurgical" in the Index.

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FURNARIIDAE, a family of small- to medium-sized birds commonly known as ovenbirds in reference to their usually oven-shaped, domed nests. *See* OVENBIRD.

FURNEAUX, TOBIAS (1735–1781), English naval officer and explorer, was born at Swilly, near Plymouth, on Aug. 21, 1735. He entered the Royal Navy and from 1757 to 1763, during the Seven Years' War, was employed on the West Indian station, in the English channel and off the coast of west Africa. He served under Samuel Wallis (to whom he was related) as second lieutenant of the "Dolphin" on her voyage round the world (Aug. 1766–May 1768), thus participating in the discovery of Tahiti. On Nov. 28, 1771, he was appointed captain of the "Adventure," to accompany the "Resolution" on Captain James Cook's second voyage to the Pacific (1771–75). On the voyage from the Cape of Good Hope eastward through the southern ocean the ships became separated on Feb. 8, 1773, and Furneaux went on to explore the south and east coast of Tasmania, drawing the earliest British chart of this region but failing to discover that Tasmania was an island. In Queen Charlotte sound, N.Z., he was joined by Cook and the ships sailed to Tahiti and the Friendly Islands (Tonga), but on Oct. 29–30, 1773, on the way back to Queen Charlotte sound, they separated for the second time. Furneaux, returning to England alone, became the first explorer to circumnavigate the globe in both directions and from west to east. He brought home

with him the first South Sea islander to visit the British Isles, Omai of "Ulietea" (Raiatea), whom Cook took back to the Society Islands in 1776–77. Furneaux was promoted to captain in 1775 and commanded the "Syren" in the British attack of June 28, 1776, upon Charleston, S.C. He died at Swilly on Sept. 19, 1781.

See J. C. Beaglehole (ed.), *The Journals of Captain James Cook*, vol. 2 (1961); Hugh Carrington (ed.), *The Discovery of Tahiti* (1948); Rupert Furneaux, *Tobias Furneaux, Circumnavigator* (1960).

(H. M. Ws.)

FURNESS, HORACE HOWARD (1833–1912), U.S. Shakespearean scholar, was born in Philadelphia, Pa., Nov. 2, 1833, the son of William Henry Furness (1802–96), minister of the First Unitarian church in that city. He graduated from Harvard in 1854 and was admitted to the bar in 1859 but soon devoted himself to the study of Shakespeare. He accumulated a collection of illustrative material of great richness and extent and brought out in 1871 the first volume of a new variorum edition, designed to represent and summarize the conclusions of the best authorities in all languages—textual, critical and annotative. The volumes appeared as follows: *Romeo and Juliet* (1871); *Macbeth* (1873; revised by his son, 1903); *Hamlet* (2 vol., 1877); *King Lear* (1880); *Othello* (1886); *The Merchant of Venice* (1888); *As You Like It* (1890); *The Tempest* (1892); *A Midsummer Night's Dream* (1895); *The Winter's Tale* (1898); *Much Ado About Nothing* (1899); *Twelfth Night* (1901); *Love's Labour's Lost* (1904); *Antony and Cleopatra* (1907); and *Cymbeline* (1913). For his first volumes he made an independent text, but beginning with *Othello* he used the first folio.

Few U.S. scholars have shown such single-hearted devotion to a formidable task, and few have so brightened erudition with gentleness, sanity and humour. Furness was conservative in his methods but sound in his judgments. He died at Wallingford, Pa., on Aug. 13, 1912. His wife, Helen Kate Furness (1837–83), compiled *A Concordance to the Poems of Shakespeare* (1874); and his son and namesake (1865–1930) was a partner in and successor to his father's work.

Furness' *Letters* were edited by his son in 1922.

FURNESS, a district of Lancashire, Eng., separated from the major portion of the county by Morecambe bay, though once easily accessible over the sands at low tide. It is bounded by Morecambe bay, the Irish sea, the Duddon estuary, Cumberland and Westmorland. Its area is about 230 sq.mi. It forms part of the Morecambe and Lonsdale parliamentary division of Lancashire and contains the county borough of Barrow-in-Furness (*q.v.*). Except for a coastal strip the surface is hilly and contains such eminences as the Old Man of Coniston and Wetherlam.

Apart from the Duddon, the principal rivers are the Leven (which drains Windermere) and the Crake (which drains Lake Coniston). They flow into a common estuary in Morecambe bay. Most of Furness is in the Lake District (*q.v.*) and Roudsea Wood Nature reserve was the first one to be declared within an English national park. It covers 287 ac. about 10 mi. W. of Grange-over-Sands. Several of the place names are suffixed with that of the district, as Barrow-in-Furness, Dalton-in-Furness, Broughton-in-Furness. Between the Duddon estuary and Morecambe bay lies Walney Island, 8 mi. long and 1 mi. wide, connected by a bridge to the mainland. The southwestern part of Furness is rich in iron ore, which has been worked from early times. Production reached its peak in the 1880s after which it declined. It was because of the existence of this ore that Barrow grew in the 19th century, at first as a port from which the ore was exported to south Wales; furnaces which were later established now depend upon imported ore.

Furness has an especial interest because of its famous abbey, the ruins of which, beautifully situated in a wooded valley to the north of Barrow, are extensive and mainly of fine transitional Norman and Early English date. The abbey of Furness, dedicated to St. Mary, was founded and built of fine red sandstone in 1127 by monks of the Benedictine order of Savigny in France. In 1124 they had settled at Tulketh, near Preston, but migrated in 1127 to Furness.

In 1148 the brotherhood joined the Cistercian order. Stephen granted to the monks the lordship of Furness, and his charter was confirmed by Henry II and subsequent kings. The abbot's power throughout the lordship was almost absolute. He had a market and fair at Dalton. The abbey became one of the richest in England and was the largest Cistercian foundation in the kingdom. At the dissolution of the monasteries its revenues alone amounted to between £750 and £800 a year. The abbot was one of the 20 Cistercian abbots summoned to the parliament of 1264 but was not cited after 1330. The abbey founded offshoot houses, the most important being Rushen abbey on the Isle of Man. In 1535 the royal commissioners reported four of its inmates, including the abbot, for incontinence; in 1536 the abbot was charged with complicity in the Pilgrimage of Grace and on April 7, 1537, surrendered the abbey to the king. In 1540 the estates and revenues were annexed to the duchy of Lancaster. About James I's reign the site and territories were alienated to the Prestons, from whom they descended to the dukes of Devonshire.

Conishead priory, near Ulverston, an Augustinian foundation of the reign of Henry II, has left no remains, but of the priory of Cartmel (1188), 6 mi. E., the fine church is still in use. It is a cruciform structure of transitional Norman and later dates, the design of the tower being unique in England. The chancel contains some superb Jacobean carved oak screens.

FURNISS, HARRY (1854–1925), British caricaturist and illustrator, best known for his political and social lampoons, was born at Wexford, Ire., March 26, 1854. Mainly self-taught, he settled in London in 1873 and, before turning wholly to free-lance work in 1894, became very popular as a staff artist on the *Illustrated London News* (1876–84) and *Punch*. In his parliamentary cartoons he never used the distortions of the Rowlandson-Gillray tradition, but drew in the less savage tone of a Richard Doyle or a "Phiz," rather emphasizing idiosyncrasies of face and dress: an amusing example is the strip cartoon "Getting Gladstone's Collar Up." He also designed a famous commercial "tramp" poster for a brand of soap ("I used your soap two years ago since when I have used *no other!*"). Strongly critical of the Royal Academy, he held in 1887 an exhibition of parodies of the work of leading Burlington House exhibitors, and in 1890 published *Royal Academy Antics*. He illustrated many books, including Lewis Carroll's *Sylvie and Bruno* (1889) and complete editions of Dickens (1910) and Thackeray (1911). In 1912–13 he worked as a film writer, actor and producer for Thomas Edison in New York and London; *Our Lady Cinema* (1914) outlined his hopes for that art. He also appeared as a novelist, essayist and writer of art instructional manuals. He died at Hastings, Sussex, on Jan. 14, 1925.

See H. Furniss, *Confessions of a Caricaturist*, 2 vol. (1901).

FURNITURE DESIGN is discussed in this article from the points of view of the use of furniture and the origin and development of styles in the west; there is also a section on the furniture of the far east. Material on the combination and arrangement of furniture with other decorative objects to form room arrangements will be found under INTERIOR DECORATION. Information on furniture production, construction and materials will be found under FURNITURE MANUFACTURE. *See* also articles on specialized furniture forms: CABINET FURNITURE; CHAIR AND SOFA; etc.

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I. INTRODUCTION

Not all civilizations have developed specialized furniture forms. Ancient Africa (other than Egypt) developed no forms more complex than the stool and rudimentary chair. Nor did the civilizations of America in pre-Columbian times develop highly specialized furniture forms. The same is true of the cultures of Micronesia and Melanesia, where furniture was relatively unknown until the 20th century. Among aboriginal peoples, such as the Eskimos, furniture was likewise unknown.

Thus the development of furniture forms cannot be regarded as an experience common to all of man. Conversely, it is not to be thought that the developments described here were always prevalent at one place or one time. The development of furniture design has been never-ending, one trend or tendency overlapping another. Style especially must be viewed in this light, for one style did not abruptly stop when another began, and often one style blended with another in a continuous development.

In every society there have been many variations of style in furniture. The style of an era and place generally was formed in large urban areas, usually through the influence of one influential patron. In Europe after 1600 style was often disseminated in book form with plates illustrating proposed designs for furniture. These books were intended for the guidance of purchasers and patrons (*i.e.*, the wealthy classes) and of cabinetmakers alike. These published designs, however, often were carried out by village craftsmen who, with a limited understanding of the style and only modest skills, produced individual variations of the pieces illustrated. Thus in many styles furniture is often found with personal and regional variations of forms.

In addition, the styles of one country have usually accompanied its colonists when they settled new territories. This removal from urban style centres, with new materials and a new class of patrons, led to the development of colonial styles that were different interpretations of the styles of the mother countries. These two factors, urban furniture as opposed to provincial furniture, and colonial interpretations of style, should be kept in mind during the following discussion of furniture design.

II. ANCIENT CIVILIZATIONS

1. Egypt.—Beds, stools, throne chairs and boxes were the chief forms of furniture in ancient Egypt. Although only a few important examples of actual furniture survive, models made as funerary offerings, stone carvings and fresco paintings offer rich documentary evidence. The bed may have been the earliest form; it was constructed of wood and consisted of a simple framework supported on four legs. A flax cord, plaited, was lashed to the sides of the framework. The cords were woven together from opposite sides of the framework to form a springy surface for the sleeper. In the 18th dynasty (*c.* 1587–1375 B.C.) beds sloped up toward the head, a painted or carved wooden footboard preventing the sleeper from slipping down.

The great beds found in the tomb of Tutankhamen were put together with bronze hooks and staples so that they could be dismantled or folded to facilitate storage and transportation; furniture existed in small quantities and when the Pharaohs made tours of inspection throughout their lands they took their beds with them. In the same tomb was a folding wooden bed with bronze hinges.

Pillows were not used; in their stead were wooden or ivory headrests. These were so essentially individual, being made to the measure of the owner, that they were often placed in tombs to be used by the dead man on his arrival in the land of eternity. Folding headrests were probably for the use of travelers.

Early stools for ceremonial purposes were merely squared blocks of stone; people ordinarily squatted on the ground. When made of wood the stool had a flint seat (later shaped concavely) covered with a soft cushion. In time the stool was developed into the chair by the addition of a back and arms; the legs were held in position by crossbars, but in the 18th dynasty angle pieces of wood also fastened the seat to the legs; such angle pieces had been forced to grow artificially at right angles and were therefore exceptionally strong. Such throne chairs were reserved for use by personages of great importance. Footstools were of wood. The royal footstool was painted with the figures of traditional enemies of Egypt so that the Pharaoh might symbolically tread his enemies under his feet. Carvings of animal feet on straight legs were common, as were legs shaped like those of animals. Boxes or baskets were used for keeping clothes or other objects, the boxes often being elaborately painted. Tables were almost unknown; a pottery or wooden stand supporting a flat basketwork tray held dishes for a meal and wooden stands held great pottery jars containing water, wine or beer. Wooden furniture was usually put together by dovetailing or with dowels.

The Egyptians used thin veneers of wood glued together for coffin cases; this gave great durability. Egyptian furniture in general was light and easily transportable; its decoration was usually derived from religious symbols, and stylistic change was very slow.

2. Mesopotamia.—The furniture of Mesopotamia and neighbouring ancient civilizations of the middle east had beds, stools, chairs and boxes as principal forms. Documentary evidence is provided chiefly through relief carvings. The forms were constructed in the same manner as Egyptian furniture except that members were heavier, curves were less frequent and joints were more abrupt. Ornament was richly applied in the form of cast bronze and carved bone finials and studs, many of which survive in museums. Mesopotamia originated three features that were to persist in classical furniture in Greece and Italy and thus were transmitted to western civilizations. First was the decoration of furniture legs with sharply profiled metal rings one above another, like many bracelets on an arm; this was the origin of the turned wooden legs so frequent in later styles. Second was the use of heavy fringes on furniture covers blending the design of frame and cushion into one effect; this was much lightened by classical taste and was revived in neoclassicism. Third was the typical furniture grouping which survived intact into the dark ages of Europe: the couch on which the main personage or personages reclined for eating or conversation; the small table to hold refreshments, which could be moved up to the couch; and the chair, on which sat an entertainer—wife, hetaera, musician, or the like—who looked after the desires of the reclining superior personages. From this old hierarchy of furniture derive the cumbersome court regulations concerning who may sit and on what, persisting in the palaces and ceremonies of 20th-century monarchs.

3. Greece.—Principal furniture forms were couches, chairs (with and without arms), stools, tables, chests and boxes. Much more is known about Greek furniture than about that of Egypt, through extant examples, the depiction of furniture on vases and in relief carvings and literary descriptions. At Knossos a built-in throne of stucco, much restored, is often considered to represent pre-Hellenic furniture in the Aegean area. Primitive Aegean pottery shows rounded chair forms perhaps indicating basketry, and Cycladic sculpture shows complex-membered chair frames.

In ancient Greek homes the couch, used for reclining by day and as a bed at night, held an important place, and the earliest couches probably resembled Egyptian beds in structure and pos-

sibly in style. The legs occasionally imitated those of animals with claw feet or hoofs, but usually they were either turned on the lathe and ornamented with moldings or were cut from a flat slab of wood sharply silhouetted and decorated in various ways—with incised designs or with volutes, rosettes and other patterns in high relief. From about the 6th century B.C. the legs projected above the couch frame; these projections became the headboards and footboards, the latter eventually being made lower than the headboards. In Hellenistic times headrests and footrests were carved and decorated with bronze medallions carrying busts of children or satyrs or heads of birds and animals in high relief. Turned legs largely replaced the rectangular ones. Although a bronze bed of the 2nd century B.C. has been found at Priene and marble couches sometimes occur in tombs, the usual material was wood. The legs often terminated in metal feet and sometimes were encased in bronze moldings, and the rails also were sometimes covered with bronze sheathing.

From the Greek archaic period onward many varieties of individual seats are known, the most imposing, perhaps, being the high-backed ceremonial chairs of wood or marble, elaborately adorned. Like the couches, they were supported on turned legs, legs cut from a rectangular piece of wood or legs with animal feet; they frequently had arm rails. Another type of boxlike seat with no feet and with or without a back is also found. The *klismos* chair was lighter and had a curved back and plain, sharply curved legs, indicating a great mastery of woodworking. The *diphros*, a stool standing on four turned legs, was popular. The convenience of folding stools was realized at an early date and the crossed legs are sometimes connected by stretcher bars, while in another form they terminate in hoofs or claw feet.

Greek tables were usually small and easily portable. An interesting type had an oblong top supported by three legs, two at one end and one at the other. These legs usually tapered from the top and terminated in claw feet, and the bronze and stone examples which are occasionally found show carved flutings on the front of the legs and scroll ornament at the side below the table tops. Rectangular tables with four legs were also used, as were round tops.

4. Rome.—Principal furniture forms were couches, chairs with and without arms, stools, tables, chests and boxes. Excellent documentary evidence was found in mural paintings, relief carvings and literary descriptions. Extant examples are more common than those of the ancient near east, particularly a wealth of bronze furniture recovered at Pompeii; at Herculaneum even wood pieces were partly preserved.

As in Greece, the couch was a principal furniture form. At Pompeii were found couches with bronze frames that closely resemble Greek examples. Gold, silver, tortoise shell, bone and ivory were used for decoration, with veneer of rare woods. Later couches, found in Italy and in distant parts of the empire, are characterized by the high back and sides.

Roman chairs developed from Greek models. The Greek throne chair evolved into a small armchair with solid rounded back made in one piece with the sides, set on a rectangular or semicircular base. This armchair was often of wickerwork, wood or stone. The Greek *klismos* chair was given heavier structural members by the Romans and was called the cathedra.

The Romans developed a decorative type of stool, often made in bronze. This was supported by four curved legs, ornamented with scrolls. The folding stool, with cross legs sometimes connected by stretcher bars, was used both by Roman officials and in households. Remains of folding stools are known from such sites as Ostia, Italy, the British Bartlow barrows on the Essex-Cambridgeshire border and Holborough, Kent. This developed into a stool which had more solid double curved legs; examples of this were found at Pompeii. An example in iron with bronze decorations, even heavier in form, was found at Nijmegen, Neth.

Tables with round and rectangular tops and three and four legs were common. Tables with round tops and three legs of animal form became increasingly popular from the 4th century B.C. onward. A nearly complete wooden table, found in Egypt and now in the Palais du Cinquantenaire, Brussels, is decorated with swans' heads with graceful necks rising out of a band of acanthus foliage, below which are very realistic antelope legs, with hoofs instead of claw feet. This type of table seems to have been popular throughout the Roman empire, as it often appears on tombstones depicting funerary banquets. Fragments of table legs and tops are sometimes discovered; a remarkable series of them were produced in Britain and made of Kimeridgian shale. From references in Pliny and other authors it is known that citrus wood was another favourite material. Several complete tables found at Pompeii and Herculaneum, usually in gardens or open courts, are made of marble and decorated with beautifully carved heads of lions and panthers. Another type of smaller table is round or rectangular with only one central leg. Also found are pairs of solid slabs ornamented in high relief, carrying carved tops of marble or wood.

Pompeian wall paintings show that plain, undecorated wooden tables and benches were used in kitchens and workshops, and some household possessions were kept in cupboards with paneled doors. Rectangular footstools, sometimes with claw feet, were used with the high chairs and couches. Small bronze tripods and stands are further items of Roman furniture. Clothes and money were stored in large wooden chests with paneled sides, standing on square or claw feet. Roman treasure chests were covered with bronze plates or bound with iron and provided with strong locks. Jewelry and personal belongings were kept in caskets, in small round or square boxes or even in baskets.

III. MEDIEVAL EUROPE

1. Early Middle Ages.—With the collapse of the Roman empire during the 4th–5th centuries Europe sank into a period when little furniture, except the most basic, was used: chairs, stools, benches and primitive forms of chests were the most common items. It was several centuries before the invading peoples evolved forms of furniture that approached the Roman standard of domestic equipment.

Comparatively little furniture of the medieval period in Europe has survived, and only a handful of these pieces date from before the end of the 13th century. One reason for this is the perishable nature of wood, but more important is the fact that furniture was made in relatively small quantities until the Renaissance. Much of the earlier history of furniture has to be drawn from contemporary literature, illuminated manuscripts, Romanesque and Gothic sculpture and later inventory descriptions.

There is evidence that certain ancient traditions of furniture making, particularly that of turnery, were still known to and an influence upon early medieval craftsmen. Turnery was used in making chairs, stools and couches in Byzantium, and it seems that this technique was known across Europe as far north as Scandinavia. The Anglo-Saxon epic poem *Beowulf*, which gives some glimpses of the domestic economy of western Europe in about the 7th century, mentions no furniture other than benches and some kind of seat or throne for the overlord.

2. Later Middle Ages.—In the 14th and 15th centuries there were many developments both in construction and design of furniture throughout Europe, and a range of new types, among them cupboards, boxes with compartments and various sorts of desks, was slowly evolved. Most of the furniture produced was such that it could be easily transported; both the French *meuble* and the German *Möbel* retain this sense of furniture as "movables." Any nobleman who owned more than one dwelling place did not have furniture for each of his establishments but instead had one set of furnishings that he carried with him from house to house. Anything that could be moved, and this frequently included the locks on the doors and the window fittings, was carried away and used to furnish the next house en route. Furniture was so scarce that it was quite usual for a visitor to bring his own bed and other necessities with him. These conditions had a double effect on medieval furniture, not only making it difficult for men to possess more than the basic types of furniture but also affecting the design of the furniture itself. Folding chairs and stools, trestle tables with removable tops and beds with collapsible frameworks were usual.

The religious houses were an exception to this in that they

enjoyed a certain security denied to the outside world. Much of the best furniture of this period was therefore made for use in churches and monasteries, and many of the ideas and developments that were later to add to the domestic comfort of Europe originated in the cloister. An example of this can be seen in the early development for ecclesiastical use of the various types of reading and writing furniture, such as lecterns and desks, that show ingenuity in construction. Throughout the middle ages and well on into the 16th and 17th centuries all types of furniture remained scarce, and any reasonably good furniture belonged to the nobility and the wealthy merchants. The household equipment of the peasantry throughout Europe, even as late as the 18th century, was frequently crude in design and roughly constructed.

Framed paneling had been used in ancient times as examples found at Herculaneum testify; its reintroduction in the Burgundian Netherlands at the beginning of the 15th century was an improvement that soon spread throughout western Europe. Paneled construction solved the problem of building large surface areas, as on the front of a chest or cupboard, which before this time had been limited by the size of individual planks. These planks, usually hewn by an adz, were heavy and liable to warp and split. Panels could be cut thinner, the main strain being taken by the framework, and the furniture was therefore lighter; moreover, if the panels were not fitted too tightly in their stiles, the wood was less likely to split if it did warp. Now that it was possible to construct larger surface areas, a new range of case furniture, cupboards and chests in particular, was developed; paneled construction was also used for chairs.

Other constructional improvements of the 15th century included the introduction of drawers into cupboards and similar case furniture, and neater and more efficient joints, such as the mitre and the mortise and tenon. Paneling was frequently decorated with a flat form of ornament called linen fold or parchment, since it resembled folded sheets of these materials laid on the surface of the wood. Linen fold was widely used in the north of France, Flanders, low Germany north to the Baltic, Scandinavia and England. It is noticeable that the linen fold of France, the Low Countries and Germany is carved with a sharper definition and greater delicacy than was usual in England and elsewhere. Both paneled furniture and room paneling were decorated with linen fold. Other forms of carved decoration on furniture became commoner during the 15th century and surfaces were carved with tracery and other Gothic motifs. During the middle ages a great many pieces of furniture, including those with carved decoration, were painted and sometimes gilded, a practice that continued well on into the Renaissance; the present state of existing pieces, with their plain wooden surfaces, is misleading. Chairs, tables and various types of cupboards were also frequently draped with bright fabrics while chairs, settles and other seat furniture were provided with cushions.

The chest was the basic type of medieval furniture, serving as cupboard, trunk, seat and, if necessary, as a simple form of table and desk. It was from this versatile piece of furniture that several other types, such as the cupboard and the box chair, were evolved. Chests were made of six planks, crudely pegged or nailed together and frequently strengthened with iron banding. Examples of this sort, dating from the 13th century and in many instances found in churches, are among the earliest pieces of European furniture that exist. The chest remained one of the most important pieces of furniture until the end of the 15th century when on the continent the cupboard began to compete with it in usefulness.

Chairs remained scarce throughout the middle ages. Occupation of a chair long symbolized authority or a mark of honour and even a large house might possess only chairs for the lord and his wife and perhaps another for a distinguished visitor; the use of the word "chairman" is a modern reflection of this medieval custom. Early chairs constructed of turned spindles, seen in Romanesque sculpture, have already been mentioned. Later there were two main types. One was a variety of folding chair, with X-shaped frame, made of both wood and metal, the seat and back consisting of rectangular strips of some strong fabric or leather. Eventually there evolved a heavier type of chair. This was basically a development of the chest and in many cases the seat was hinged, allowing the base to be used for storage; paneling, often carved with linen fold and sometimes with other Gothic motifs, was used on the back, arms and base. Many of these chairs had exaggeratedly high backs terminating in elaborately carved canopies; some were freestanding while others had their backs fixed to the wall in the manner of a church stall. Settles were also used for seating during the 15th century. An innovation on the continent was the settle with a pivoted bar forming the back rest, which could be swung over to allow a person to sit on either side—evidence of the weight of the furniture of this period.

Tables were mainly of trestle construction with long rectangular tops that could be dismantled. During the 15th century on the continent smaller tables were made which could be more conveniently moved and, especially, drawn up to the fire. Various forms of cupboards, ambries and *dressoirs* were developed at this time, paneled and decorated with linen fold or Gothic carved ornament. All these types were basically a chest with doors, raised on legs of simple rectangular form; elaborations of construction and decoration soon followed as did the specialization of their functions. Cupboards, *dressoirs* and credence tables were used for the storing of plate and for serving at banquets, the plate being displayed on the top and on shelves above and below the main serving surface. Top shelves were sometimes cantilevered on brackets to free the front corners of this surface for use. Other cupboards were made to hold food and day-to-day provisions; in the case of food or dole cupboards, as they were called, the front and sides were pierced for ventilation.

Medieval beds are known from documents and a few late examples. Throughout most of this period a diagonal surface, lifting the head high, was common, recalling Egyptian usage. Some beds had daringly cantilevered ceilings supported from the headboards.

Little English furniture survives from medieval times and, as on the continent, information must be sought in contemporary references and from the pictures of domestic interiors in illustrated manuscripts. Most of these manuscripts are of French or Flemish origin but they furnish reliable evidence on English interiors because the governing classes, who were practically the sole possessors of proper furniture, copied the domestic habits of the continent. English oak was the chief material but softer woods also were used. A certain amount of furniture was imported from abroad, providing new ideas for the English carpenter and joiner. The furniture usually found in important houses consisted of beds, chests, cupboards, tables, benches and stools.

IV. THE RENAISSANCE

1. Italy.—From the beginning of the Renaissance in the early 15th century there were changes in furniture forms that were to spread over Europe. The growth of a wealthy and powerful *bourgeoisie* caused the building of more substantial houses and a demand for good furniture. Italian Renaissance furniture shows a strong architectural bias and the purpose of the piece, as in Roman furniture, was subordinated to its form. The furniture of the early Italian Renaissance is often restrained, with beautiful, simple designs carved in walnut. For more elaborate work, sculpture in low relief and stucco modeled in intricate patterns were much used. The stucco was usually gilded all over and picked out in bright colours.

The *cassone* or marriage coffer was a form on which the craftsman's skill was lavished. In addition to elaborate relief work and gilding, these coffers often were painted on the front and sides, and occasionally inside the lid as well, with appropriate biblical or mythological scenes. Motifs popular with the Italian carver included cupids, grotesque masks, scrolled foliage and strapwork. The fixed writing desk is the forerunner of the writing bureau, which became an indispensable article of furniture as writing became more general.

A type of chair called a *sgabello* was much favoured at this time in Italy. The seat was a small wooden slab, generally octagonal, supported at front and back by solid boards cut into an ornamental shape; an earlier variety was supported by two legs at the front and one in the rear; a solid piece of wood formed the back.

Another chair of the period was the folding X-shaped chair, sometimes called a Dante chair. Tables were generally oblong, supported by columns, consoles or terminal figures, with a long central stretcher running from end to end. The influence of Italian furniture forms of the Renaissance spread abroad, reshaping the furniture of the remainder of Europe.

2. France.—The furniture of France was among the first to be influenced by the Italian Renaissance. Louis XII and many of his court visited Italy and soon brought Italian artists and craftsmen and works of art into France. The French Renaissance of furniture can be divided into two stages. First was a period of transition and adaptation, during the reign of Louis XII and the first part of the reign of Francis I, when the pieces were basically Gothic in form and Gothic ornament was mixed with the cupids, medallion heads and grotesque decorations of the incoming Renaissance style. During the second phase, from the end of the reign of Francis I, the new style displaced the Gothic. But the more exuberant arabesque shapes of Renaissance decoration gave way to increasingly architectural design, and oak was almost entirely superseded by walnut. Centres of furniture making were established at Fontainebleau, where Francis I employed several Italian artists and craftsmen; in Île-de-France, headed by the work of Jacques du Cerceau; and in Burgundy where, led by the craftsman and designer Hugues Sambin, design was influenced by the Renaissance style evolved in the Netherlands.

French furniture of the 16th century was remarkably graceful and delicate; it was enriched with inlay of small plaques of figured marble and semiprecious stones, sometimes with inlay or marquetry of ivory, mother-of-pearl and different coloured woods.

Chairs began to be lighter in design; the back became narrower, the paneled sides and base were replaced by carved and turned arms and supports, and legs were joined by stretchers at their base. A specialized chair known as a *caquetoire* or conversation chair, supposedly designed for ladies to sit and gossip in, had a high, narrow back and curved arms.

Elaborately carved oblong tables were supported by consoles or fluted columns connected by a stretcher surmounted by an arched colonnade. Chests decorated in the new style were still widely used, though they were frequently replaced by the armoire, which was now sometimes made in two stages, the upper compartment containing numerous small drawers.

3. Spain.—Because of the long occupation of Spain by the Moors a style called Mudejar evolved. While furniture in this style remained in form essentially European, decoration had an oriental flavour. A type of cabinet known as vargueno was typically Spanish. The upper part, in chest form, had a fall front, often elaborately mounted in wrought iron and backed by velvet, with a massive iron lock and with drawers inside. The cabinets were richly carved, painted and gilded and inlaid with ivory in a Moorish manner. There was a tendency for Italian models to be followed in the furniture of the 16th and 17th centuries.

4. Low Countries.—In the 16th century, Italian Renaissance ornament was adopted and transformed by the artists and designers of northern Europe, particularly in northern Germany and the Low Countries, who created an independent style of decoration. Strapwork, cartouches and grotesque masks are characteristic features of this northern Renaissance style, and are found repeatedly in the pattern books of such German and Flemish artists as W. Dietterlin and V. de Vries—books of ornament which circulated among and influenced metalworkers, carvers, plasterers and furniture makers throughout the north.

Heavy oak tables, sometimes draw tables, had massive legs and solid stretchers. Beds were heavily draped to provide privacy, since the bed might be located in any room in the house. Folding wooden chairs and low stools, with more or less elaborate turnery, were still used, besides a new type with baluster-formed or twisted legs and arms, and straight backs heightening through the 17th century.

5. England.—The Italian Renaissance did not affect the design or ornament of furniture in England until about 1520. Evolution from the Gothic style was a gradual process, influence coming first from Italy and in the second half of the 16th century from the Low Countries. In the early stages furniture remained Gothic in form, though Italian motifs slowly replaced the older Gothic ornament. Many pieces of early Renaissance English furniture combined linen fold paneling with medallion heads and Italianate cupids, but by the middle of the century both new ornament and new forms had replaced the medieval style. About the middle of the century the direct influence of Italy weakened and its place was taken by that of the Low Countries. The northern style of Renaissance ornament was propagated in England by pattern books, immigrant workmen and imported Flemish and German furniture, and before long it was adapted by English craftsmen into an individual and peculiarly English style.

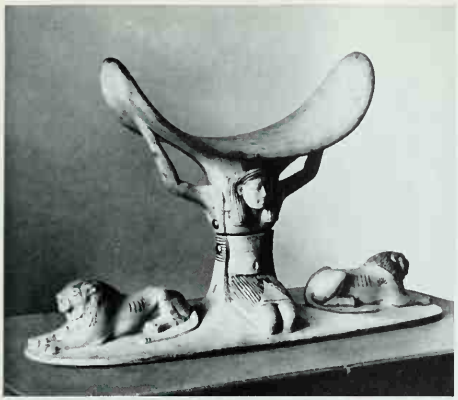
Characteristic of this style is the enrichment of every surface with flamboyant carved, turned, inlaid and painted decoration, an exuberance which strongly reflects the spirit of the English Renaissance. During Elizabeth I's reign there was a considerable and fairly widespread increase in domestic comfort, to be seen in improved construction, a multiplication of types and the tentative beginnings of upholstered furniture. A series of inlaid chests with perspective architectural scenes, often called nonesuch chests, were either imported from Germany or made by German workmen in England. They were strongly influential in propagating the technique of inlaid decoration, which by the end of the century was being applied to every type of furniture.

Apart from the gradual change from Gothic to Renaissance ornament, the 16th century produced several changes in the design and construction of individual types. Chairs became slightly more common, though even in Elizabeth's own palaces stools were the usual form of seating. From the box chair evolved a type in which the arms and legs were no longer filled in with paneling but which had plain or turned legs, with shaped arms resting on carved or turned supports. The backs of chairs were still paneled and decorated with carving and inlay or surmounted with a wide and richly carved cresting. Folding chairs, X-shaped and of varying construction, were also used. Chairs without arms, called farthingale chairs, were introduced in the early 17th century, to accommodate the wide skirts, called farthingales, that were popular at the time. Farthingale chairs had upholstered seats and a low rectangular upholstered back raised on short supports a little above the seat. Armchairs of similar design were made. Turkey work and velvet were usually employed for upholstery.

Early in the 16th century a new style of bed design appeared; the greater part of the frame was left exposed and was enriched with carving and other decoration, making the frame itself an important part of the general design. Favourite carvers' motifs for beds and other types of furniture included strapwork, grotesque masks and caryatids, bulbous turned pillars and supports, arcading and patterns of scrolled foliage. The heavily turned cup and cover motif is frequently found on bedposts in the later 16th century. The cumbersome Gothic trestle tables were replaced by "joyned tables" with their tops fixed to their frames. Draw tables, which could be conveniently lengthened by pulling out the two leaves concealed under the top, were also introduced. Table legs and the friezes of the frames were decorated with carving and inlay, and the cup and cover motif is often found on the legs. Various types of cupboards were made, usually in two stages. In court cupboards both stages were left open. A simple form of chest of drawers was introduced about 1620.

V. THE BAROQUE STYLE

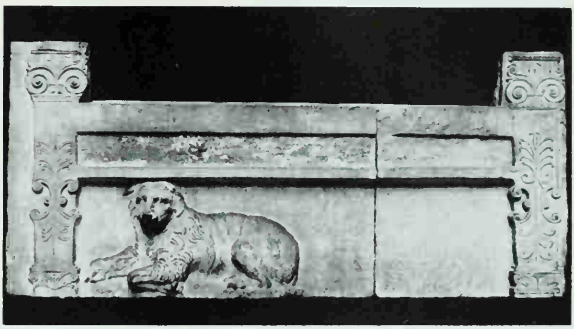
During the 17th century the baroque style had a marked effect upon furniture design throughout western Europe. Large wardrobes, cupboards and cabinets had twisted columns, broken pediments and heavy moldings. In baroque furniture the details are related to the whole, and instead of making the piece into a framework of unrelated surfaces, each detail contributes to the harmonious movement of the over-all design. The baroque style was adopted in the Low Countries in the 1620s and extended late into the 17th century when Germany and England began to develop it. It owed much to the oriental influence that swept over Europe in the 17th century when several maritime countries, particularly Portugal, Holland and England, established regular trading rela-



Carved ivory headrest, Egyptian; 14th century B.C. From the tomb of Tutankhamen, Thebes. Griffith institute, Ashmolean museum, Oxford university

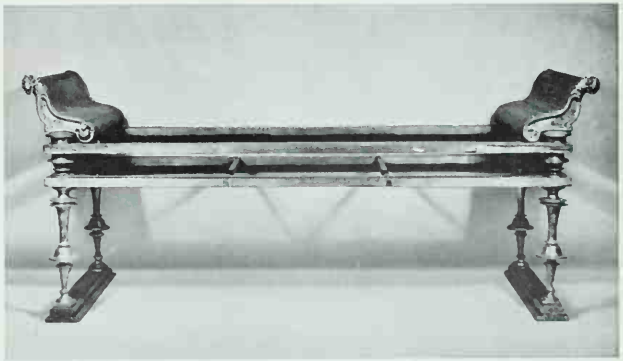
Egyptian folding camp bedstead of wood, from the tomb of Tutankhamen, Thebes. Griffith institute, Ashmolean museum, Oxford university

Mesopotamian chair, detail from obverse of stele of Ur-Nammu, 3rd dynasty of Ur, beginning *c.* 2130. University museum, Philadelphia



Marble funeral couch, Greek. From Macedonia. The Louvre, Paris

Roman table support from Pompeii. Museo Nazionale, Naples

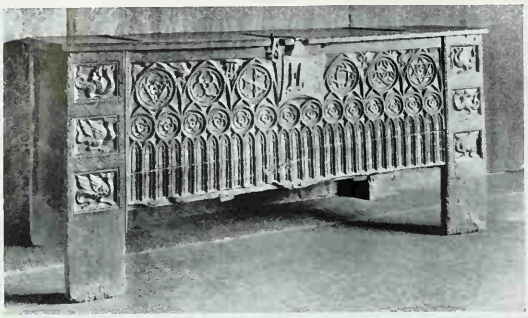


Bronze couch, Roman; 1st century B.C. Walters Art gallery, Baltimore

FURNITURE OF ANCIENT CIVILIZATIONS

BY COURTESY OF (TOP LEFT AND RIGHT) GRIFFITH INSTITUTE, ASHMOLEAN MUSEUM, OXFORD UNIVERSITY; (CENTRE LEFT) THE UNIVERSITY MUSEUM, PHILADELPHIA; (BOTTOM RIGHT) WALTERS ART GALLERY, BALTIMORE; PHOTOGRAPHS, (CENTRE RIGHT) GIRAUDON, (BOTTOM LEFT) ALINARI

FURNITURE DESIGN

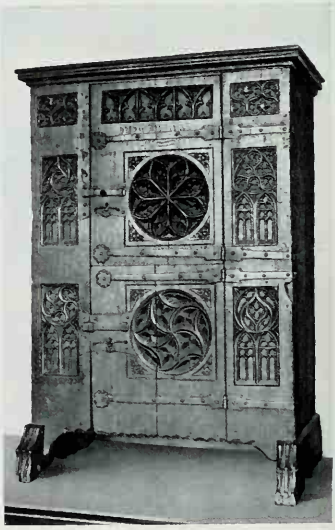


Carved oak chest from collection of Sir Edward Barry; English, late 14th century

Carved oak cabinet; Flemish, late 16th century. Victoria and Albert museum

Sideboard carved with Gothic tracery; Spanish, 15th century

Folding armchair; Italian, 16th century. Victoria and Albert museum



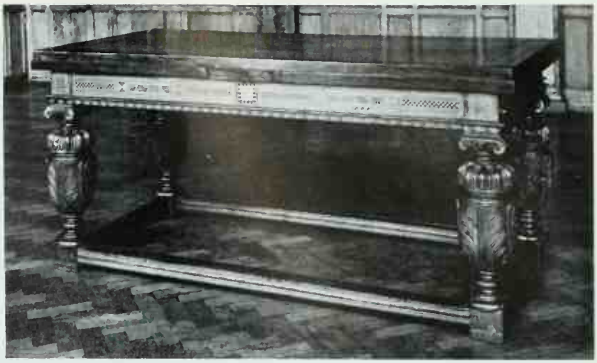
Oak cupboard with Gothic tracery; German, 15th century. Victoria and Albert museum

Marriage coffer (*cassone*) of carved walnut; Italian, 16th century. Victoria and Albert museum

EUROPEAN FURNITURE OF THE RENAISSANCE

BY COURTESY OF (TOP LEFT) "COUNTRY LIFE," LONDON, FROM "DICTIONARY OF ENGLISH FURNITURE," (TOP RIGHT, CENTRE, BOTTOM LEFT AND RIGHT) VICTORIA AND ALBERT MUSEUM, (CENTRE LEFT) THE SPANISH ART GALLERY, LONDON

Press cupboard of carved and inlaid oak; 17th century. Victoria and Albert museum



Draw table of oak, with inlaid frieze and carved legs; about 1600. Victoria and Albert museum

Oak armchair inlaid with various woods; about 1600. Victoria and Albert museum

Carved walnut armchair; about 1680. Victoria and Albert museum

Walnut cabinet with floral marquetry; late 17th century. Victoria and Albert museum

Turned oak gate-leg table; about 1660. The legs have wooden hinges

Bedstead of carved oak with painted shields and floral motifs; about 1610. Victoria and Albert museum

ENGLISH FURNITURE OF THE 16TH AND 17TH CENTURIES

BY COURTESY OF (BOTTOM LEFT) "COUNTRY LIFE," LONDON, FROM "DICTIONARY OF ENGLISH FURNITURE," (OTHERS) VICTORIA AND ALBERT MUSEUM

FURNITURE DESIGN

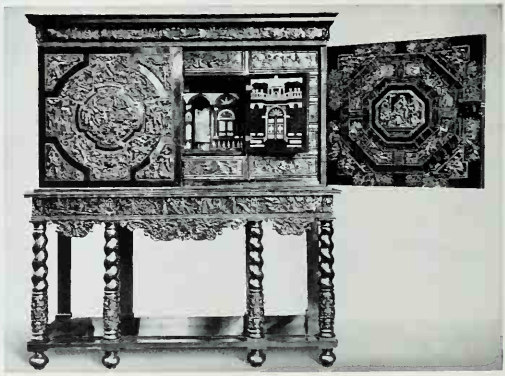
Venetian chair of carved walnut, upholstered in velvet; 17th century. Victoria and Albert museum

Dutch side chair of walnut; 2nd half of 17th century. Rijksmuseum, Amsterdam

Dutch armchair of walnut; late 17th century. Rijksmuseum, Amsterdam

Dutch table of oak; 1st half of 17th century. Rijksmuseum, Amsterdam

Dutch cupboard of oak with ebony veneer and ivory decoration; 1st half of 17th century. Rijksmuseum, Amsterdam



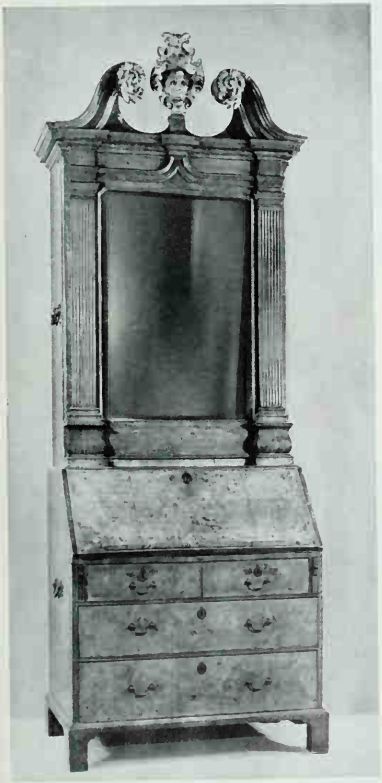
Dutch cabinet and stand of ebony, carved and edged with moldings; middle of 17th century. Interior ornament composed of inlaid ivory and coloured woods. Victoria and Albert museum

ITALIAN AND DUTCH FURNITURE OF THE 17TH CENTURY

BY COURTESY OF (TOP LEFT, BOTTOM RIGHT) VICTORIA AND ALBERT MUSEUM, (OTHERS) RIJKSMUSEUM, AMSTERDAM

Carved walnut armchair, upholstered in red velvet; about 1720. Victoria and Albert museum

Marble-top side table, carved and gilt. In centre is figure of a child seated on a shell. Designed by William Kent; about 1730. From Houghton hall



Walnut secretary with marquetry of various woods. Designed by Samuel Bennett. Victoria and Albert museum

Commode chest of drawers of carved mahogany; about 1760. Victoria and Albert museum

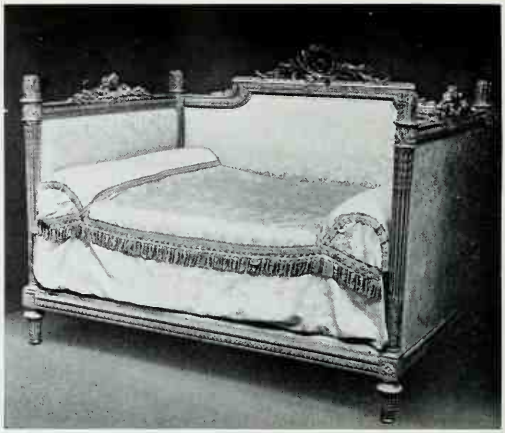
Side table with classic decoration, carved and gilt. Designed by Robert Adam; about 1770. From 20, St. James's square, London

ENGLISH FURNITURE OF THE 18TH CENTURY

BY COURTESY OF (TOP LEFT, CENTRE RIGHT, BOTTOM LEFT) VICTORIA AND ALBERT MUSEUM, (OTHERS) COUNTRY LIFE, LONDON

FURNITURE DESIGN

"Bureau du Roi" made for Louis XV by Jean Oeben and J. H. Riesener between 1760 and 1769. The Louvre, Paris

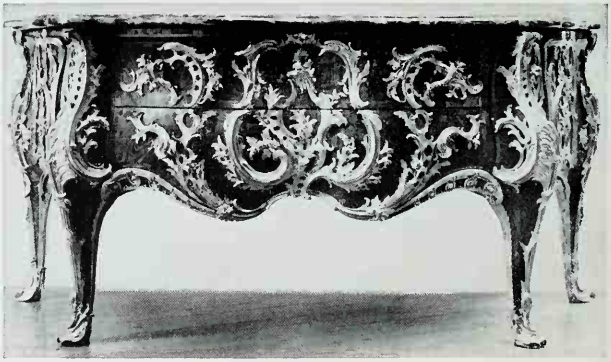


Bedstead of carved and gilt wood with coverings of blue silk damask; period of Louis XVI. Victoria and Albert museum

Louis XVI armchair. Collection of M. Fersen, Paris

Commode in Louis XVI style signed by Weisweiler. Collection, Connaissance des Arts, Paris

Louis XV armchair. Collection of M. Fersen, Paris



Marble-top commode with marquetry of coloured woods and gilt bronze mounts. By Jacques Caffiéri, from the room of Louis XV, Versailles. Wallace collection

FRENCH FURNITURE OF THE 18TH CENTURY

BY COURTESY OF (TOP RIGHT) VICTORIA AND ALBERT MUSEUM, (BOTTOM RIGHT) THE KEEPER OF THE WALLACE COLLECTION; PHOTOGRAPHS, (TOP LEFT) COLLECTION ARCHIVES PHOTOGRAPHIQUES, PARIS, (CENTRE LEFT, BOTTOM LEFT) CONNAISSANCE DES ARTS, PARIS, COLLECTION OF M. FERSEN, PARIS, (CENTRE RIGHT) CONNAISSANCE DES ARTS, PARIS

Oak and pine chest with drawers, Connecticut type; dated 1704. Art Institute of Chicago

Bible box and table of oak and pine; 1660–80. Art Institute of Chicago

Side chair by Benjamin Randolph, Philadelphia; c. 1760–75. Museum of Fine Arts, Boston

Turned armchair, Carver type; late 17th century. Art Institute of Chicago

Walnut armchair attributed to the workshop of William Savery, Philadelphia; about 1725–50. Art Institute of Chicago

Side chair, transitional Queen Anne type, probably by John Gaines of New Hampshire; about 1720. Art Institute of Chicago

Mahogany sideboard with satinwood inlays, attributed to Matthew Edgerton, New Jersey; about 1790. Art Institute of Chicago

AMERICAN COLONIAL FURNITURE OF THE 17TH AND 18TH CENTURIES

BY COURTESY OF (CENTRE LEFT) MUSEUM OF FINE ARTS, BOSTON. (OTHERS) ART INSTITUTE OF CHICAGO

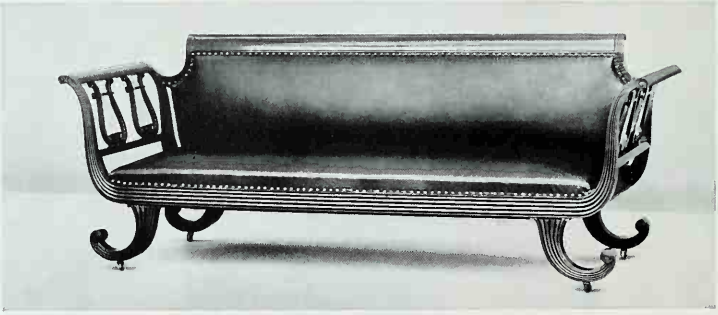
FURNITURE DESIGN

19TH-CENTURY REVIVAL STYLES IN THE U.S.

Gothic revival side chair by Alexander J. Davis. Museum of the City of New York

Armchair in the style of Louis XVI; 1875. Museum of the City of New York

Rosewood side chair in the Elizabethan style. Museum of the City of New York



Mahogany sofa with lyre ends by Duncan Phyfe, a revival of the Greek style. The Metropolitan Museum of Art

Walnut desk, a simplified factory-made piece typical of the post-Civil War period in the midwest; about 1870. The Art Institute of Chicago

Marble-top rosewood parlour table by John Henry Belter, an example of the rococo revival of the mid-19th century. Museum of the City of New York

BY COURTESY OF (TOP LEFT, TOP CENTRE, TOP RIGHT, BOTTOM RIGHT) MUSEUM OF THE CITY OF NEW YORK, (CENTRE) THE METROPOLITAN MUSEUM OF ART, (BOTTOM LEFT) THE ART INSTITUTE OF CHICAGO

Patent spring chair; U.S., about 1850.
Owned by Elinor Merrell

Cast-iron and walnut reclining chair designed by C. B. Sheldon;
United States, patented 1876. The Henry Ford Museum

Painted iron rocking chair attributed
to Peter Cooper; U.S., about 1850–60.
Cooper Union Museum for the Arts of Decoration

PROGRESSIVE FURNITURE DESIGN OF THE 19TH AND EARLY 20TH CENTURIES

Art nouveau armchair of mahogany and leather
by Richard Riemerschmid; Germany, 1899. Museum of Modern Art

Bent beechwood armchair by Gebrüder
Thonet; Austria, about 1870. Museum
of Modern Art

Pear wood side table by Hector Guimard in the *art nouveau* style; France, c. 1908. Museum of Modern Art

BY COURTESY OF (TOP RIGHT) THE HENRY FORD MUSEUM, DEARBORN, MICH., (CENTRE) COOPER UNION MUSEUM FOR THE ARTS OF DECORATION, NEW YORK, (BOTTOM ROW) COLLECTION, MUSEUM OF MODERN ART, NEW YORK (BOTTOM LEFT) GIFT OF DUNBAR FURNITURE CORP. OF INDIANA, (BOTTOM CENTRE) GIFT OF THONET INDUSTRIES, (BOTTOM RIGHT) GIFT OF MME HECTOR GUIMARD; PHOTOGRAPHS, (TOP LEFT) ELINOR MERRELL, (BOTTOM ROW) GEORGE BARROWS

FURNITURE DESIGN

FURNITURE OF INDIA AND CHINA

Chinese wooden bed; Ming dynasty (1368–1644). Honolulu Academy of Arts

Indian ivory table, carved in relief; late 18th century. Victoria and Albert museum

Indo-Dutch mirror cabinet, wood inlaid with bone; early 18th century. Victoria and Albert museum

Chinese barrel stool; Ming dynasty. Honolulu Academy of Arts

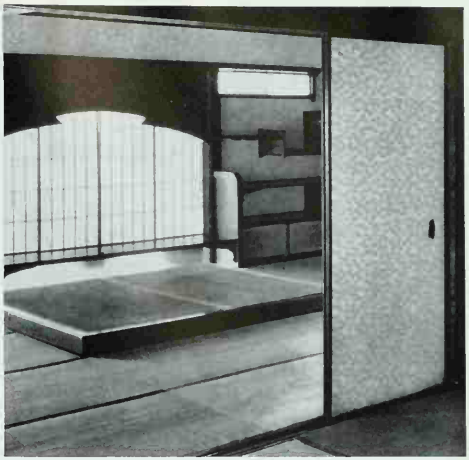
Chinese hardwood chair; Ming dynasty. Honolulu Academy of Arts

Ming tabletop cabinet. Honolulu Academy of Arts

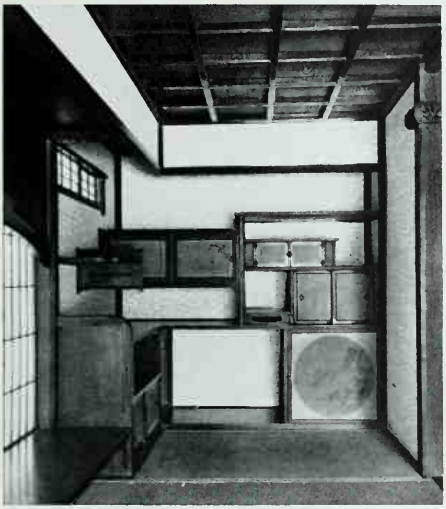
Indo-Portuguese cabinet, veneered and inlaid with light and dark woods and bone; 17th century. Victoria and Albert museum

BY COURTESY OF (TOP LEFT, CENTRE, CENTRE RIGHT, BOTTOM LEFT) HONOLULU ACADEMY OF ARTS, HONOLULU, HAWAII, (TOP RIGHT, CENTRE LEFT, BOTTOM RIGHT) VICTORIA AND ALBERT MUSEUM

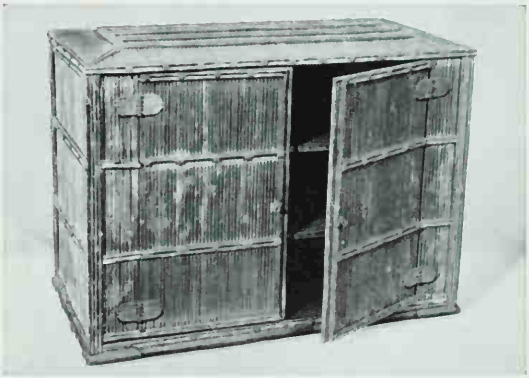
Kodansu (incense cabinet) made of wood and lacquered in *maki-e* (spray painting) decoration; Momoyama period, 1574–1603. Tokyo National museum



The main room of the New Goten, Katsura imperial villa, Kyōto, 17th century, showing the *shoin* (bay window) from which extends a fixed desk used for reading. *Tatami* (rice straw mats) cover the floor

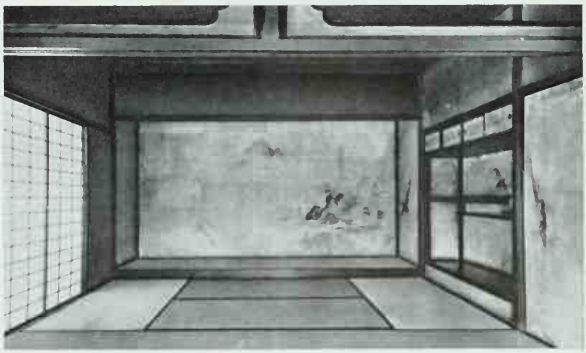


Section of the main room of the New Goten, Katsura imperial villa, showing the shelves and cabinets of the *chigai-dana* (alcove) to the right of the *shoin*



Small bamboo cabinet of the 8th century. Tokyo National museum

Wood *kendai* (reading stand) lacquered with a gold *maki-e* design of autumnal grasses; Momoyama period. Tokyo National museum

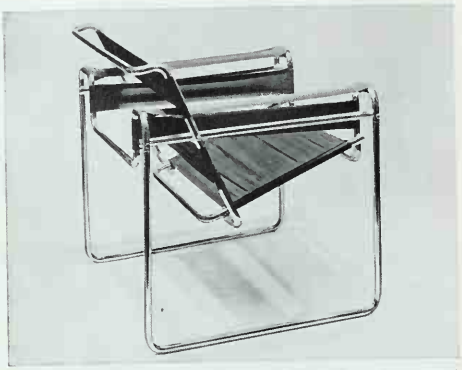


Tokonoma recess in a reception room in the Middle Shoin of the Katsura imperial villa, with a *chigai-dana* to the right. The tokonoma is decorated with a painting attributed to Kanō Tanyū (1602–74), court painter to the Tokugawa shogunate, Edo period, 1603–1867

JAPANESE INTERIORS AND FURNISHINGS

BY COURTESY OF (TOP LEFT, CENTRE RIGHT, BOTTOM LEFT) TOKYO NATIONAL MUSEUM; PHOTOGRAPHS, (OTHERS) THE DENRIOD COMPANY, LTD., KYOTO, JAPAN

FURNITURE DESIGN



Tubular chair with suspended fabric seat, back and arm rests. By Marcel Breuer, Germany; designed 1925. Museum of Modern Art

Chair and ottoman of upholstered molded sheet plastic with loose cushions and metal rod support. By Eero Saarinen, U.S.; designed 1948

Lounge chair (Barcelona chair) of polished steel with leather cushions and supporting straps. By Ludwig Mies van der Rohe, Germany; designed 1929. Museum of Modern Art

Molded plastic chair, reinforced with glass fibres. By Charles Eames, U.S.; 1949

Chair of bent, laminated beech with webbed seat and back. By Bruno Mathsson, Sweden; designed c. 1940

Laminated wood; rubber cushioning is used between component parts. By Charles Eames; designed 1946

Welded metal rods with detachable leather sling seat. Argentina; c. 1938. Museum of Modern Art

Armchair of solid mahogany with leather seat. By Jacob Kjaer, Denmark; designed 1950

FURNITURE DESIGN: FIRST HALF OF 20TH CENTURY

BY COURTESY OF (TOP RIGHT) KNOLL ASSOCIATES, INC., (SECOND ROW CENTRE, BOTTOM LEFT) HERMAN MILLER FURNITURE CO., (SECOND ROW RIGHT) SCANDINAVIAN DESIGN, (TOP LEFT, SECOND ROW LEFT, BOTTOM CENTRE) COLLECTION, MUSEUM OF MODERN ART, NEW YORK; (TOP LEFT) GIFT OF HERBERT BAYER, (SECOND ROW LEFT) GIFT OF EDWARD M. M. WARBURG, (BOTTOM CENTRE) [illegible]

tions with India and the far east. Lacquered furniture and domestic goods were imported from the east and, also, the oriental craftsmen worked in a pseudo-European style from designs supplied by the traders. Before the end of the 17th century oriental decorative techniques were being widely imitated in Europe and the roots of the "Chinese taste" were firmly entrenched. Heavy tropical woods were also brought to Europe, and from these furniture was made that borrowed much from the prevailing taste for oriental elaboration.

1. Flanders and Holland.—The early Flemish baroque furniture, dating from the second quarter of the 17th century, was but a slight adaptation of the late Renaissance style. Typical are the oak cupboards with four doors and the chairs with seats and backs of velvet or leather held in place by nails.

In Holland the baroque style did not encroach on late Renaissance furniture until nearly 1640. Dutch furniture of this period can be distinguished by its simpler design and a preference for molded panels over carved ornament. Later, marquetry decoration and walnut veneer surfaces became the commonest decorative treatments. At the end of the century lacquered furniture became popular.

2. Italy.—Though it was in Italian architecture, painting and sculpture that the baroque style was evolved, Italy was not the first to apply this style to furniture. But by the mid-17th century Italy was producing flamboyantly carved, painted and gilded furniture, decorated with such typical motifs as cupids, acanthus, shells and boldly drawn scrolls, and was further enriching chairs and stools with fine-cut velvets and table tops with marble, *pietra dura* and scagliola. Chairs and stools with exaggerated scrolled arms and legs (exemplified by the work of A. Brustolon in Venice) and handsome walnut and ebony cabinets and cupboards with carved decoration on the pediments, friezes and corners and sometimes inlaid with marble or *pietra dura* set in molded panels typify the Italian furniture of the later baroque phase.

3. France.—In France the Italian influence of the 16th century was gradually assimilated and a national style of furniture was evolved which soon spread its influence into neighbouring countries. The reign of Louis XIII, covering most of the first half of the 17th century, was a time of transition. The Gobelins factory was founded by Louis XIV for the production of *meubles de luxe* and furnishings for the royal palaces and the national buildings. Charles Lebrun was appointed the director in 1663. Furniture was veneered with tortoise shell or foreign woods, inlaid with brass, pewter and ivory, or heavily gilded all over. At times it was even completely overlaid with *repoussé* silver. The name of André Charles Boulle (*q.v.*) is particularly associated with this style of decoration. His cabinets and tables were completely covered by sheets of tortoise shell and brass cut into intricate patterns so as to fit into one another, the tortoise shell alternately forming the pattern and the ground; hence the two types, boulle (buhl) and contreboulle. The light fanciful designs of Jean Bérain were much used for this work. Heavy gilt bronze mounts protected the corners and other parts from friction and rough handling and provided further ornament.

4. England.—After the Restoration, from 1660 onward, there was almost revolutionary progress in English cabinetmaking, as it came to be called at about this time. The exiled court on its return introduced French and Dutch fashions and the English craftsmen were considerably helped in supplying the tastes of the nobility by a large influx of foreign workmen. Furniture became lighter, more highly finished and better adapted to varying needs. The general increase in technical skill of the cabinetmaker between 1660 and about 1690 is astonishing. Walnut was the favourite wood, though the use of oak continued in the country districts for many generations. New processes appeared, notably veneering wide surfaces with thin sheets of wood into which, in many cases, floral patterns in marquetry were inserted. In the earlier period of the Restoration these patterns were large, but toward the end of the century they grew smaller and more intricate, leading eventually to the type of marquetry made up of numerous small scrolls and called seaweed marquetry.

The passion for colour found an outlet in lacquer decoration in England as in other European countries. The importation of works of art from the east had begun in Tudor times but was of little account until after the Restoration. Then the taste became widespread. The diarist John Evelyn and others reported their friends' houses to be furnished with Indian screens or paneled in the finest japan—descriptions implying oriental lacquer. The process which imitated oriental lacquery was called japanning in England. Toward the end of the century John Stalker and George Parker published an elaborate treatise outlining in detail the various techniques of this craft.

New forms of furniture began to develop at this time. Day beds, a form of couch with an adjustable end and winged armchairs served for repose. The upholstered armchair had its origin at this time, and a pair of chairs at Ham House, Surrey, called in the 17th century sleeping chairs, are among the earliest of this type. A little later, toward the end of the century, sofas with backs and arms carried comfort a step further. Velvet, silks and needlework were the usual materials for upholstery. Various kinds of writing furniture were rapidly developed, including the bureau with enclosed desk and interior fittings of small drawers and pigeonholes that was made toward the end of the century.

Chests of drawers came into more general use. Mirrors were no longer rarities, though glass remained expensive. The frames were carved, lacquered or decorated with marquetry. Fashions succeeded each other with great rapidity. Chairs show these changes most clearly, developing in a brief period from mere seats into movable decorations. Scrolled legs were common in the reign of Charles II, while later straight tapering baluster forms were used. In the grander beds of this period the tester, back and posts are covered with material and match the hangings. These state beds were strongly influenced by the designs of Daniel Marot, who went from France to England to work for William and Mary. These beds were of enormous height with elaborately molded cornices, and had ostrich plumes or vase-shaped finials at the corners of the tester.

During the late 17th century and on into the first half of the 18th century, a certain amount of elaborately carved and gilded furniture, much influenced by the style of Louis XIV, was produced in England. Foremost among the makers of this de luxe furniture were three cabinetmakers, J. Pelletier, G. Jensen and James Moore. Toward the end of the 17th century, during the reign of William and Mary, baroque furniture tended to become simpler and the use of ornament was somewhat restrained. At the beginning of the 18th century, during the reign of Queen Anne, a new and simpler style arose, much influenced by the contemporary furniture of Holland. Carving and applied ornament were reduced to a minimum, the beauty of a picce relying on carefully designed curved lines and the colour of fine walnut veneers. The cabriole leg, originally devised in classical times and based on the curve of an animal's leg, was introduced into England from the continent about 1700. Terminating in a claw-and-ball or paw foot and soon discarding the stretcher, it was widely used on chairs and tables and for every kind of support. The stretcher had now become obsolete because of improved joining and gluing. Chairs had hooped uprights and fiddle-shaped splats curved to support the back. Tallboys, or double chests of drawers, cabinets fitted with shelves and bureaus in two stages met the demand for greater convenience, as did a new range of dining, card and other tables.

5. The American Colonies.—As in all colonial settlements, the furniture of the American colonies reflected the style preferences of the individual national groups. This influence, coupled with the existence of new materials and the time lag in transmitting styles and tastes from the home country, in some instances produced highly individual furniture.

Information about 17th-century furniture of the English colonies can be found in inventories and wills. It existed in its simplest forms—stools, benches, tables, cupboards and a few chairs. This furniture, often made of oak, recalled the tradition of Elizabethan England and was turned and decorated with chip carving, often picked-out in earth colours. By the end of the century pine, maple and other woods were used.

The Dutch and Scandinavian settlers brought with them indi-

vidual furniture forms whose influence remained local.

By 1700 the effect of French and Dutch fashions on late Stuart furniture in England had become evident in the American colonies. Fashion consciousness appeared, though for decades to come the furniture of the average colonial home kept to the earlier tradition evolved from medieval joining. The box chest was succeeded by the chest of drawers, often placed on a stand with turned legs. Chairs began to replace stools and the early heavy, turned and wainscot types gave way to simplified versions of the high-backed scrolled forms of the English Restoration fashion. The day bed appeared with its upholstered pad. Small folding tables, cabinets and the tiered dresser to store and display tableware testify to the rapidly increasing standard of comfort among the more prosperous. Carved surface decoration was largely replaced by colour, through the use of paint or veneers or inlays of contrasting wood.

These innovations accompanied the use of the cabriole or reverse curve, which by about 1725 became the favoured form for legs of chairs, tables, cabinets and stands. At first it had little or no carving and a simple paw foot but the design was elaborated, and this cabriole leg became the principal feature of the so-called Queen Anne style that dominated colonial furniture designs until the Revolution. Walnut became the principal wood of the early 18th century.

VI. THE ROCOCO STYLE

The influence of French furniture was predominant in Europe during the 18th century. In the second half of the century England played a leading role in establishing the neoclassical style, and for supreme craftsmanship provided an inspiration to workshops in several countries; but in the diffusion of the two styles of that century, the rococo and the neoclassic, French designs were universally imitated, with varying degrees of success.

1. France.—The transitional phase in French furniture from baroque to rococo is called regence, though in fact this phase started just before the regency of Philippe d'Orléans (1715). The heavy, monumental style of the earlier part of Louis' reign was gradually replaced by a lighter and more fluent curvilinear style. The leading exponent of the regence style was Charles Cressent (1685–1768), *ébéniste* ("cabinetmaker") to the regent. In his work the ormolu mounts, so important a part of the design of French furniture in the 18th century, became equally if not more important than the marquetry decoration of the carcass. The curvilinear form was introduced, not only to externals such as legs and supports but, in the *bombé* commodes which first appeared during this period, to the case itself. High-quality marquetry in coloured woods replaced ebony.

The rococo style, a development of the regence, affected French furniture design from about 1735 to 1765. The word is derived from *rocailles,* used to designate the artificial grottoes and fantastic arrangements of rocks in the garden of Versailles; the shell was one of the basic forms of rococo ornament. The style was based on asymmetrical design, light and full of movement. The furniture of this period was designed on sinuous and complicated lines. The designs of Juste Meissonier, goldsmith to Louis XV, sculptor and architect, were instrumental in creating the rococo. The repertory of ornament was large, but it centred around subtle arrangement of the C-scroll with ragged edges, combining with scrolled foliage, floral motifs, ribbon and, on occasion, trophies formed of musical instruments or gardening implements. The rococo Chinese taste had conventions of its own: pagodas, exotic birds, Chinese figures, icicles and dripping water. The graceful *bombé* commode, often with marble top and with two or three drawers, the surface enriched with finely modeled ormolu mounts, was popular. Under Cressent's influence the importance of the mounts predominated, though later in the century the marquetry decoration gained first importance. Commodes and other pieces were decorated with marquetry of floral or geometrical patterns, or sometimes with lacquer decoration, again combined with ormolu mounts. The most celebrated makers of mounts during Louis XV's reign were Jacques Caffiéri and his son Philipe. Jean Oeben was made *ébéniste du roi* in 1754; a pupil of Boulle, he was the most celebrated *ébéniste* of the period.

2. England.—About 1720 mahogany was imported into England and slowly superseded walnut as the fashionable wood for making furniture. The Palladian interiors demanded furniture more striking and larger in scale than the walnut-veneered pieces of the early 18th century. Inspired by the interiors of French and Italian palaces, architects such as William Kent began to design furniture. The design was classical, in keeping with the traditions of Andrea Palladio and Inigo Jones; the ornament was baroque. At Holkham in Norfolk, Rousham in Oxfordshire and elsewhere, Kent's furniture may be seen in its proper environment, gilt mirrors and side tables with sets of chairs and settees covered with patterned velvets matching the grandeur of elaborate architectural Palladian interior decoration.

During the 1740s, despite the resistance of the Palladian classicists who deplored its asymmetrical principles, the rococo style crept into English decoration and furniture design. During this decade pattern books of ornament in the full rococo style by Matthias Lock and Henry Copeland were published in London, and in 1754 Thomas Chippendale published his *Gentleman and Cabinet Maker's Director* which provided patterns for a wide range of English furniture in the rococo style and its two offshoots, the Chinese and Gothic tastes. During the following years several similar works were published by such craftsmen and designers as William Ince and Thomas Mayhew, Thomas Johnson and Robert Manwaring. The rococo style was firmly established in England throughout the 1750s and into the 1760s. Chippendale and other cabinetmakers borrowed not only ornament from the French *rocaille* but designs for individual types. Chippendale's fame rests largely on his publication, though in fact it has now been more or less conclusively proved that he himself was not responsible for the designs, but employed two other designers, Lock and Copeland. There were several cabinetmakers, *e.g.,* William Vile and John Cobb, whose only memorial is a small quantity of furniture attributable to them. Though it has become the practice to speak of a Chippendale chair or a Vile commode, this does not imply that the pieces were actually made by these craftsmen but that they were made in their workshops.

By mid-18th century every act of the day that necessitated the use of furniture was catered for by some specialized piece, while the basic furniture such as chairs, cupboards, beds and tables were designed and decorated in innumerable forms. The number of variants on the rococo chair splat runs into several hundreds. The ingenuity of the cabinetmaker and carver knew few limitations.

The Gothic taste was an offshoot of the rococo style which was particularly well-developed in England. Starting early in the century as a literary device, in the 1740s it began to take more solid shape in architecture, interior decoration and furniture. As with furniture in the Chinese taste, Gothic furniture bore no relation to its medieval equivalents, but borrowed Gothic ornaments, such as tracery and cusped arches, and applied them to furniture. The Gothic taste was much publicized by Horace Walpole's celebrated villa, Strawberry Hill, Twickenham, Middlesex. Chippendale included designs for furniture in the Gothic taste in all three editions of his *Director.*

3. The American Colonies.—Shortly after 1750 the earlier cabriole style was transformed by two factors. One was the rapidly increasing popularity of mahogany. The other was the influence of the English version of free rococo ornament, as reflected in the publication of Chippendale's book of patterns.

While the southern planter still depended largely upon London for his fine furnishings, the merchants of Philadelphia, New York, Newport and Boston were well rewarded by their patronage of local craftsmen. In Philadelphia a local version of the Chippendale style was brought to the highest mastery by such craftsmen as Thomas Affleck, Jonathan Gostelowe, Benjamin Randolph and William Savery. In Newport, R.I., the genius of the Goddard and Townsend families evolved an equally distinctive style by developing the block front, decorated by the patterns of the wood grains instead of carving as used by their contemporaries in Philadelphia. In spite of the Philadelphians' evident desire to match the works of the best London shops, they actually created their own style as distinct from that of England as the innovations of their New-

port colleagues. The cabinetmakers of Boston, New York and the Connecticut valley also produced work of high quality and a definitely local flavour. Maintaining its hold on popular taste until well after the Revolution, this colonial Chippendale retained more of the sturdy elegance of the earlier cabriole style than did its English equivalent. The tendency of English design to massiveness and surface decoration contrasts with the vertical and linear tendency in much colonial design.

VII. THE NEOCLASSICAL STYLE

1. France.—The neoclassical style, sometimes called Louis Seize, began in the 1750s. Tiring of the rococo style, craftsmen of the 18th century turned for inspiration to classical art. The movement was stimulated by recent archaeological discoveries, by travel in Italy, Greece and the near east and by the publication, all over Europe, of works on the classical monuments. The neoclassical style, based on straight lines and rectilinear forms and using a selection of classical ornaments, was first applied to French furniture during the 1760s. The classical motifs at first were sparingly applied to furniture of unchanged form, but slowly the curved line of rococo was replaced by a simpler and more severe rectilinear design; chair legs became straight, tapered and fluted, and the commodes and other case furniture were no longer of *bombé* form. Marquetry was still widely used for decoration, while some cabinets were made of ebony inset with panels of Japanese lacquer. Boulle, which had not been employed in Louis XV's reign, returned to fashion. A greater number of pieces were signed during this period (signing had been made compulsory in Paris) and Jean Henri Riesener, Martin Carlin and J. Saunier were a few of the leading *ébénistes*. Several German craftsmen migrated to France because of the royal patronage, among them Abraham and David Roentgen, Adam Weisweiler and Guillaume Beneman. Of the workers in bronze mounts Pierre Gouthière was supreme.

These craftsmen were often directly under the patronage of the king, having their workshops in the cellars of the Louvre. Within the shop there was a division of labour with one craftsman specializing in furniture construction, another in lacquering, etc. The craftsmen and the shop were licensed by the government.

2. England.—The classical reaction, which set in shortly after 1760, reimposed a classical discipline on design, though of a lighter and more delicate touch than that of the previous classicists, the Palladians. Robert Adam, whose name is inseparably associated with this movement, had, like earlier architects, studied in Italy. There he sought inspiration in the monuments of both classical times and the Renaissance. When given a free hand he included interior decoration and furniture in his architectural schemes, one of the best examples being his alterations and redecorations at Osterley, Middlesex, where he provided harmonious designs for even the lock plates and chimney pieces. His furniture makes a restrained use of classical ornament, but paterae, husks, rams' heads and urns are less eloquent of the change than the symmetrical structural lines. Marquetry, ormolu mounts and painting were employed as decoration. Adam's furniture was copied and modified by contemporary cabinetmakers such as George Hepplewhite in his *Cabinet-Maker and Upholsterers' Guide* (1788).

In the last 20 years of the 18th century there was a tendency toward greater refinement, lightness and delicacy in furniture design. Symmetry of form and excellence of proportion were retained for the most part. Heart- and shield-shaped backs on chairs and settees and tapered and fluted supports for tables and other pieces are characteristic; feathers, wheat ears and shells are prominent in the painted or inlaid decoration. This refinement, strongly feminine in character, is found represented in Thomas Sheraton's *The Cabinet-Maker and Upholsterers' Drawing Book* (1791).

3. The United States.—The new classicism introduced into England by Robert and James Adam in the 1760s came into vogue in the new republic during the last years of the century. The shipowners and merchants of Salem, Boston and New York equipped their mansions with the work of Samuel McIntire, John Seymour and Duncan Phyfe, each of whom produced individual interpretations of the Hepplewhite-Sheraton mode. This early federal style, which also shows some influence of the French directoire, is characterized by small-scale rectangular design and by a preference for light-toned wood finishes. Surfaces are generally unbroken, but decorated with bandings and inlays of contrasting woods, or in Phyfe's case with low relief carvings in the Adam manner. The most typical pieces are the sideboard and the small secretary desk, both of which developed a peculiarly American form.

VIII. THE EMPIRE STYLE

The empire style began in Paris about the time of the Revolution and quickly spread throughout Europe, each country adapting it to its own national taste. In England it is commonly called the regency style. The two French architects, Charles Percier and Pierre Fontaine, who designed the furnishings for the state rooms of Napoleon, contributed in great measure to the creation of the style. Their ideas were incorporated and propagated in their *Recueil de décorations intérieures* (1801 and 1812).

Basically the new style was a continuation of the neoclassical style, with a much stronger archaeological bias, leading to direct copying of classical types of furniture; to this was added a new repertory of Egyptian ornament, stimulated by Napoleon's campaigns in Egypt. Mahogany-veneered furniture with ormolu mounts assumed the shapes of Roman, Greek and Egyptian chairs and tables, with winged-lion supports and pilasters headed with sphinxes' busts or palm leaves; where no classical prototypes existed contemporary designs were enlivened with classical ornament.

In England the regency style is seen in the books of furniture designs by Thomas Hope (1807) and George Smith. Hope, an amateur designer with some knowledge of antiquities, was the chief exponent of the style and entirely decorated his country house, Deepdene, Surrey, in it. When the fashion was taken up by cabinetmakers the results were often woefully incongruous. Mahogany and rosewood were used with bronzed or gilt ornament, and metal inlay, a cheaper technique, replaced inlay and marquetry. Along with this style came a renewed enthusiasm for the Chinese taste, as best exemplified in the furniture and decoration of the Brighton pavilion. Between the 1820s and 1830s, in the final stages of the regency style, both the design and construction of furniture in England and on the continent showed signs of heaviness and overelaboration which heralded the general decline throughout Europe in the 19th century.

In the United States the style was widely adopted. Its chief native practitioner was the New York cabinetmaker, Duncan Phyfe, who in the first decade of the century produced furniture for the wealthy of his city. His designs gave a unique interpretation to empire conceits. French cabinetmakers, such as Charles Honoré Lannuier, emigrated to the United States at this time and produced furniture in a stricter French style.

IX. THE 19TH AND EARLY 20TH CENTURIES

By the 19th century, with increases in the efficiency of transportation and communication, styles became more universal in their adoption but still maintained national and regional differences.

The empire style, which carried over into the 19th century, began a series of styles which revived form and decoration from the past. This reinterpretation often resulted in a product removed from the principles of the original style. The introduction of the machine and of the factory method sometimes brought about a decline in quality in furniture production.

The Biedermeier style, which originated in Germany and Austria, flourished in the prosperous middle-class homes of Europe from about 1815 to 1848. This style is characterized by classical simplicity. Chairs had curved legs, and sofas had rolled arms and generous upholstery. Mahogany veneers and light birch, grained ash, pear and cherry were used. The design and much of the ornament were influenced by the empire style, in particular the Grecian element. The style took its name from "Papa Biedermeier," a fictitious character whose column appeared in Austrian newspapers and offered opinions on taste in furniture.

In the 1820s there was a revival of the Gothic style, which in England was partly stimulated by romantic literature such as the

novels of Sir Walter Scott. Losing all the lightness and humour of the mid-18th-century Gothic revival, heavy medieval motifs were profusely and indiscriminately applied to every type of furniture.

A series of other revival styles followed the Gothic revival. The rococo revival was one of the most popular; it borrowed the curvilinear elements of the French Louis XV style, especially the cabriole leg, and restated them in a heavier idiom. Entire suites of this furniture were fashioned in mahogany, rosewood and walnut, the price being highly dependent upon the amount of carving on the frame.

During the first half of the 19th century (the exact date being unknown), metal springs were introduced into furniture construction. This made chairs and sofas much more comfortable than had the stuffing employed by cabinetmakers during the 18th century.

Another technical improvement introduced into furniture design was the use of plywood. A series of thin layers of wood were glued together with the grain alternating at right angles. Plywood had great strength and stability and could be more intricately curved than a natural piece of wood. One of the chief exponents of this technique in the United States was John Henry Belter, who was born in Germany in 1804 and served his cabinetmaker's apprenticeship in Württemberg. He was first listed in the *New York Directory* in 1844 and reached a height of popularity in the 1850s. Belter's work is predominantly in the Louis XV revival style.

Michael Thonet (1796–1871), an Austrian craftsman, experimented with bending layers of veneer in Boppard, Germany, from 1836–40. Thonet was successful in perfecting a process for bending solid beechwood by heat into curvilinear shapes. His chairs were popular during the latter half of the 19th century and continue to be made.

Elizabethan and Louis XIV revival furniture was also very popular. The baroque twisted upright was one of the chief elements employed. The straight, turned leg was also reintroduced. This furniture was produced in suites and was elaborately upholstered. It might be said to have been blocky and square in its over-all form, in contrast to the rococo revival form.

The Louis XVI style was reintroduced in suites of furniture with round tapering legs, oval backs on chairs and sofas and elaborate upholstery. The Louis XVI leg was often used on comfortable upholstered furniture whose structure was primarily composed of a flexible metal or "Turkish" frame. The only wood visible on this furniture was in the legs, the remainder of the frame being completely upholstered. In such furniture the art of the upholsterer reached its height through the use of elaborate tufting, tassels and braids.

A group of designers during the middle of the century became uninterested in the revival styles and turned to new sources for inspiration. The English civil servant, Henry Cole (*q.v.*), who played an important role in organizing the Great exhibition of 1851 (Crystal palace), brought around him a group of men who were interested in reintroducing good design and handcraftsmanship into art manufactures. *The Journal of Design*, which Cole edited from 1849 to 1852, dealt with almost every branch of manufacture.

William Morris has been called the "father of the modern movement." Sickened by the shoddiness of the machine-produced goods of his own day, he turned for inspiration to the handcraftsmanship of the middle ages and, basing his own work on their designs and methods, attempted to revive a respect for fine craftsmanship and to stir the aesthetic sense of his contemporaries. His influence, though important, would have been greater if, instead of turning away from the machine, he had applied his high ideals to discovering a way in which machines might be used to the best advantage. Morris' followers in the field of cabinetmaking included such designer-craftsmen as Ernest Gimson and the Barnsley family who, working with a few assistants, produced small quantities of high-quality handmade furniture, the craftsmanship of which has never been rivaled. The example of Morris and his followers was so widely copied on the continent that many people believe modern furniture design originated exclusively there.

In England, during the third quarter of the century, there was a movement toward greater simplicity and aesthetic beauty in furniture. The straight and simple lines of Japanese design served as a source of inspiration. The result was the aesthetic or artistic style; its chief exponents were Edward Godwin and Christopher Dresser, who produced both designs and furniture in this style.

Henry van de Velde, who was born in Antwerp in 1863, followed in the footsteps of William Morris and was the conscious propagandist of the *art nouveau* style, which flourished from about 1893 to 1910. It found its inspiration in organic and natural forms and in the Japanese prints that were so popular in Europe during the third quarter of the 19th century. The style is characterized by moving, sinuous curves. Van de Velde's furniture was often designed *en suite* so that it would give an effect of totality to a room.

Another Belgian, Victor Horta, in fact anticipated van de Velde in architecture and furniture of *art nouveau* style. His interiors of the house at 12 Rue de Turin, Brussels, well illustrate the sinuous curves and natural forms employed by the *art nouveau* designers. The movement was also adopted in France where Hector Guimard was one of its chief exponents.

The *art nouveau* style in furniture design was not so popular in England or in the United States as it was on the continent. A variant of the style can be seen in the furniture produced by the Scottish architect Charles Rennie Mackintosh.

X. THE ORIENT

1. China.—Remarkably little systematic study has been made of Chinese furniture. Its origins remain comparatively obscure, its workshops mostly unrecorded, its designers unknown; consequently its dating is extremely difficult. Certainly most of the forms of Chinese furniture such as the low table and the covered bed are found in the oldest Chinese paintings in existence and can even be recognized in the early forms of the Chinese characters dating prior to 1000 B.C. The designs have been remarkably conservative throughout the ages—a factor which greatly hinders the historian in his attempts to date pieces.

Chinese furniture can be divided into two main types: lacquered wood pieces either inlaid with mother-of-pearl or elaborately carved, and plain hardwood pieces.

Of the first almost nothing is known and dating of pieces is possible only from the designs of decorative motifs such as dragons, peonies, etc., and by their background motifs. The most important historically in this class are the black lacquer pieces inlaid with mother-of-pearl which have been preserved in the imperial repository (Shosoin) in Japan from the 8th century. Of the red lacquers, such as seats and tables, the earliest pieces date from the Ming dynasty (1368–1644), their workmanship being characterized by softer contours and freer, more spirited designs than the later pieces of the Ch'ing dynasty (1644–1912). These lacquered objects influenced European cabinetmakers.

The plain hardwood furniture is frequently encountered. Its deserved popularity both in China and the west has been gained by its classical simplicity, reserved ornament and lack of pretense. In these products of the finest workmanship, purity of line, plastic strength and a flawless polish combine to produce a harmonious, solid effect.

A Chinese house requires less furniture than a western house. Correspondingly, the types of furniture are fewer, being limited mainly to wardrobes, chests, tables both high and low of all types and shapes, altar tables, stools, beds sometimes testered with curtains, screens and stools for use by the bed, chairs and couch tables.

Although the fundamentals of Chinese joinery must have been formed a millennium before the modern era, the great development in Chinese furniture took place with the introduction of Buddhism from India into China during the first centuries A.D. Before that time the Chinese had sat cross-legged, or knelt on the floor or on stools. Buddhism introduced a more formal kind of sitting on stiff, higher chairs with back rests and with or without side arms. The chests and armoires are superb examples of careful joinery and often have finely worked metal mounts which greatly

enhance the beauty of their solid design. These mounts, which often adorn wardrobes, cabinets and chests, can sometimes provide a clue to their dating.

A number of hardwoods were used for the plain furniture. Their names and equivalents are difficult to render in English and no agreement has been found for them—purple sandalwood (the most distinguished); rosewood of many varieties, mostly imported from Indochina and called "old," "new" and "yellow"; redwood; burl (especially for inlay); and a kind called "chicken-wing" wood. Rosewood in its many varieties is perhaps the most frequently encountered and the most popular for its seeming translucence and satin-soft finish. It is above all the faultless workmanship, so typically Chinese, and the fine polish of Chinese furniture that attracts the westerner. It was the Chinese respect for the spirit of wood, the command of line, curve and cubic proportions which became the ideal of the 18th-century cabinetmaker.

2. Japan.—This was one of the few civilizations that did not develop many specialized furniture forms. Instead, the interior architecture of the house, with the garden as its focal point, served the aesthetic and social requirements that furniture has served in many societies. The chief requirement for the few forms that were developed was that they be movable.

Thin mats made of rice straw called *tatami* covered the floors and were used for sitting. These *tatami* utilized only natural patterns for decoration although they often were bound in cloth. Cloth cushions were also used. Small tables of wood or lacquer, which were either folding or rigid, were developed. Dressing tables and writing tables were specialized forms which evolved from the simple table. The folding screen also acted as an indispensable adjunct to the other furnishings as it could be moved to change the entire aspect of the room (*see* SCREEN). One stationary piece was the *shoin*, a type of bay window from which extended a fixed desk used for reading.

Japanese furniture forms have changed little for centuries. There are few extant pieces from the early periods; information about early furniture was gleaned from literary descriptions, engravings on mirrors or clay images and graphic representations.

3. India.—India's place in the history of furniture is that of an adapter or transformer of imported western styles rather than a creator of independent styles of its own. Domestic furniture in the sense in which it is known in Europe was not traditional in India before the 16th century, and even such familiar objects as tables and chairs were rarely used until the spread of Portuguese, Dutch and English furniture.

It was precisely the difficulty of obtaining suitable furniture locally for their settlements that encouraged the European traders to export western prototypes for copying. It was soon found, however, that the Indian craftsman, although an inaccurate copyist, was a skilled and imaginative adapter of foreign decorative detail. This led to the emergence of an independent Indo-European style of furniture which was much admired for its own sake and subsequently exerted fresh influences in the west. Early Indo-European furniture can be divided into two distinct groups, according to whether the influence was primarily Portuguese or Dutch. (The English did not exert a national influence on styles until the late 18th century.)

The Indo-Portuguese group includes a northern Indian or provincial Mogul style and a southern or so-called Goanese style. The former is artistically the more interesting and includes a variety of furniture decorated with inlaid bone or ivory on ebony and other dark woods. Tables and writing cabinets in the Italian Renaissance form are found in this category because this was the dominant style in Portugal.

The second Indo-Portuguese style, sometimes called Goanese (though in fact more probably made on the Malabar coast, south of Goa), is more stereotyped in form and in decoration. It is distinguished by large and rather cumbersome cabinets of a type known in Portugal as *contador*, the inlay ornament being either geometrical or semiabstract. The Indian contribution to this style is more inhibited and lacks altogether the charm and fancifulness of northern Indo-Portuguese furniture.

Indo-Dutch furniture is easily distinguishable from Indo-Portuguese, since it reflects contemporary Dutch taste as clearly as the latter reflects Portuguese. There are two types of Indo-Dutch furniture. The first, which was made on the Coromandel coast, was mainly in light-coloured woods, the decoration being inlaid bone, incised and lacquered. The second is a style of carved ebony furniture which, although commonly found in India and often thought to be Indian in origin, was in fact made at Batavia (modern Jakarta) in Java, the Dutch administrative headquarters in the east. The carved relief decoration of the ebony furniture is floral in character and closely related to the flowering-tree style of contemporary Indo-Dutch embroidered bedspreads and hangings in which the tulip is prominent.

With the growth of British power in India in the 18th century all Indo-European furniture styles came increasingly under English influence. Whole suites were made in ivory in the manner of Chippendale and Sheraton, not only for European buyers but also for Indian native rulers who increasingly favoured European styles of furniture.

In the 19th century Indian artistic standards degenerated and furniture of the period reflects this clearly. The emphasis was on decorative elaboration for its own sake and although much 19th-century Indian wood carving shows great technical skill, this rarely compensates for formlessness and stereotyped ornament.

(J. T. BR.)

XI. CONTEMPORARY DESIGN

After the late 19th century, furniture design in the west was divided into two main categories: revivals of past styles—only occasionally precise reproductions, more often free adaptations—and various expressions of changing modern life. The latter category absorbed the best as well as the most progressive talents of the era.

Modern furniture design after World War I proceeded along a three-lane way: functionalist modern—progressive, adhering to an aesthetic of the machine, and often designed by leading architects; transitional modern which came to be called "contemporary"—infused with elements from the past; and commercial modern (called "Borax" because hawkers of that cleanser used to offer premiums, and the word became associated with "extra" values which commercial furniture often offered by the manner in which it was advertised or in overblown forms and gaudy veneers). All three levels were subject to the social and economic trends of the era: formal living declined, mechanization of household labour mushroomed; living spaces shrank, particularly in height; and home entertainment became important. After World War II especially, people married at a younger age, total population growth accelerated and a generally rising standard of living was enjoyed by a vastly enlarged middle-income group. Furniture became smaller, lighter, easier to maintain and more widely distributed.

1. Functionalist Modern.—About 1925 a new rationality began in furniture design, due to the emergence of progressive experiments typified in the works and theories of the Bauhaus, a revolutionary German school of arts and crafts established in 1919, and staffed by leading architects, designers and painters until Hitler closed it in 1933. Bauhaus instruction used crafts as experimental techniques and trained students to design for mass production. Low price levels, maximum utility, good quality and simple, clear forms were considered essentials of well-designed consumer goods. The celebration of modern technology in progressive design was the most effective accomplishment of the Bauhaus. Forms, colours and materials hitherto confined to shops and laboratories were introduced into homes and offices with programmatic earnestness and considerable stylishness. Tubular chrome-plated metal, black Bakelite and large unframed planes of glass were typical. Much furniture used at mid-century in reception rooms, front porches, kitchens or dining alcoves derived from Bauhaus originals. The availability of wood in Scandinavia led to similar rational, modern furniture, launched in the 1930s, using a variety of laminating techniques. Related, more ambitious experiments in three-dimensional molding of wood laminates were undertaken in the United States around 1940. Then wartime austerity enforced a salutary simplicity.

After World War II earlier design activity resumed. Scandinavian designers abandoned advanced technology for a time and launched a victorious campaign for sculptured, solid-wood furniture in matte finishes that notably enlarged the vocabulary of progressive design. Italian furniture was similar in trend, more open to structural and technological experiments but more accented and less acceptable generally. American modern furniture achieved its first international influence in molded plywood and plastic chairs and in semiarchitectural storage units.

Functionalist modern furniture consciously related itself to progressive architecture. This aided its steady growth in the third, fourth and fifth decades of the 20th century; at the same time it was also encouraged by friendly periodicals, shops and museums. Educational and cultural agencies earlier in the century had generally opposed modern design, but gradually there was a change in attitude and in the latter part of the 20th century it was widely accepted.

2. Transitional Modern.—Conservative in style (but not imitative), well-constructed and carefully finished, the best contemporary furniture earned its reputation of being in good, correct taste. Often relying on handcraft details and on wood, most factories used speeded-up variations of earlier cabinetmaking operations. This, along with the United States' emphasis on artificially stimulated obsolescence, affected all modern design between World Wars I and II. As in the case of stylistic revivals, favourite sources of inspiration for transitional modern were late 18th- and early 19th-century court and country house furniture, with variations in Chinese and rococo taste. This furniture served a very wide public that felt the forms and materials of the avant-garde were too cold and "clinical."

3. Commercial Modern.—Most modern furniture designed between 1930 and 1940 was bulky, bulbous, glowingly coloured, glossily finished, and rich with hardware or shiny fabric. It pleased the public but not critics and connoisseurs. Gradually, and more noticeably after 1945, stylistic details filtered down from more progressive design levels to appear as commercial fads, such as sectional seating and storage units, spidery metal frames and plastic-shell seats; the whatnot was revived, freestanding and rectilinear, as the room-divider. Convertible sofa beds and radio and television cabinets were almost all designed in the commercial manner. The innovation of foam upholstery was bitterly fought by union workmen around 1940 but in fifteen years became commonplace in sleeping and seating furniture.

In time a continual flow of new production methods effected basic changes. Lighter masses, thinner silhouettes and new forms made possible by new materials as well as new technologies seemed to put modern furniture design on the threshold of a new era of design.

See DESIGN, 19TH-CENTURY; DESIGN, 20TH-CENTURY; FUNCTIONALISM; and articles on various styles: ART NOUVEAU; etc.; *see* also references under "Furniture Design" in the Index volume.

(E. J Wo.)

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FURNITURE MANUFACTURE. This article discusses the materials, production methods and types of construction used in furniture manufacture. For related information on style and design *see* FURNITURE DESIGN; CABINET FURNITURE; CHAIR AND SOFA.

MATERIALS

Wood.—Solid wood is traditionally associated with high quality in furniture and such woods as mahogany, walnut, cherry, maple, birch and oak are prized as furniture manufacturing materials, especially for exposed surfaces. Oak and maple, and also ash and beech, are characterized by straightness and an ability to hold nails and tacks; consequently they are much used in constructing furniture frames that are to be covered by upholstery. The most widely used imported wood is mahogany (*q.v.*), Honduras mahogany being the preferred variety; other red-coloured woods that are called mahogany because of their resemblance to true mahogany come from the upper Amazon, Africa and the Philippines. Imported woods of exceptional rarity and high cost, such as teak, are used chiefly for furniture that is custom designed and built. When inferior woods, such as gum, are used in furniture manufacture they are usually finished to simulate the finer varieties.

Drying.—Before wood can be used in furniture production it must be dried thoroughly. The boards into which the felled trees are cut at the sawmill may be air-dried out-of-doors, but this process may require two to three years to dry one-inch lumber even when the layers of boards are separated by strips that permit air to circulate freely. Drying time can be reduced to a few days by placing the lumber in a kiln, or heated room, where temperature and humidity can be controlled. In a kiln, air is forced through stripped stacks by large fans that change the direction of air flow periodically.

The most efficient method, however, of drying either solid wood or plywood is the application of heat by high-frequency electricity. Electric current alternating in direction more than 1,000,000 times a second produces molecular activity in wood and resins (such as those in plywood glue); part of the molecular energy is converted into heat that greatly reduces the time required to dry the wood thoroughly and evenly. Solid wood or plywood assemblies to be dried are placed in a press between two metal plates through which electric current is transmitted. Great thicknesses of material can be dried thoroughly and evenly by this method; the process is not affected by distance from the metal plates. Moist areas and the synthetic resins heat more quickly than the drier portions of the wood and dry out first; the drying then proceeds at a uniform rate.

Bentwood.—An early development in the economical utilization of wood in furniture production and a pioneering effort in standardization of parts is represented by the bentwood chair, of which the 18th-century Windsor chair is a classic example. The craftsman cut the wood part precisely to size and, after steaming the wood to soften it, cramped it around a wooden form and restrained it in position until it was dry. Parts thus accurately cut and uniformly produced could later be assembled into chairs. Hand methods of wood bending are still used to some extent, but for quantity production such machines as the hydraulic bender are employed since they can bend a number of identical parts simultaneously. In these machines, steamed wood held by a flexible metal band is bent to the form desired and the metal strap is securely fixed in its bent

position by restraining wires. The strapped bentwood is oven dried and then cooled at a carefully controlled rate. Thin pieces of wood may be bent with ease and little expense by passing the wood around a path of pegs fixed to a backplate in positions that produce the form required. The production of bentwood permits utilization of pieces of wood that are too small for other purposes and otherwise might be wasted.

Plywood.—The development of plywood has been of particular importance in furniture manufacture. The origin of plywood, or "veneered wood" as the material was called for many years, lies in the ancient art of applying thin wood veneers as ornamental facings on furniture. Beautiful examples of veneered work were produced by European craftsmen of the 17th and 18th centuries; veneered wood, however, did not come into wide use in the furniture industry until the second half of the 19th century. In the 1860s, bent and perforated thin sheets of veneered wood were produced under U.S. patents for use as chair seats and backs, and during the late 19th and early 20th centuries manufacturers of inexpensive furniture used flat sheets of cheap, inferior veneered wood as backing for chests and mirrors, and as drawer bottoms and chair seats. Because of its poor quality the material fell into an ill repute that unfortunately attached persistently to the superior plywood subsequently developed. The term plywood itself was brought into use during the 1920s to dissociate a much-improved product from its shabby precursor. (For details of plywood manufacture *see* PLYWOOD.)

Plywood veneers are united in such a way that the grain of each layer lies at right angles to that of the next succeeding layer and the material is thus endowed with strength that is equal in two directions. Plywood lacks sufficient thickness, however, to give it rigidity and where this is a requisite in furniture building a "sandwich" plywood, consisting of a core of wood or other material between two outer sheets of plywood, is used. An early sandwich construction having a core of solid wood faced with plywood and termed lumber-cored board appeared during the latter half of the 19th century and was satisfactorily used as table and desk tops, although the solid wood core made the material excessively heavy. Types of sandwich plywood developed later were blockboard and laminated board. Blockboard has a core of small wooden blocks laid down with their grains running alternately left and right while the core of laminated board is made up of narrow strips of thin wood with their grains opposed in a left and right pattern. Two other types of sandwich plywood that successfully combine lightness of weight with strength and stiffness are those in which expanded sponge rubber and balsa wood are used as the sandwich filler.

Plywood may be produced in bent form by subjecting adhesive-treated veneer assemblies to pressure between curved molds. In a simplification and extension of this method, flat plywood bonded with waterproof resin and softened by steaming is pressed between shaped molds. Plywood may also be produced in tubular form by applying pressure to veneers assembled around a shaped core.

Plywood can be bent in both single and double curves. This is done by first preparing metal templates from a pattern made of paper or thin veneer. The templates, when fastened to a set of veneer strips, serve as guides when the veneers are cut to shape. All the layers of veneer required in making a piece of furniture can be processed in this way, each succeeding layer being made from a mold pattern slightly larger than that for the preceding layer. The veneers are assembled with the grain of each sheet at right angles to that of adjacent sheets, alternate veneers being coated with a resinous adhesive. A satisfactory method of producing curved plywood involves the use of the vacuum bag. A rubber bag that is airtight at its base is placed over the entire surface of the assembly; air inside the bag is pumped out so that the rubber presses firmly against the veneers assembled on the mold. The rubber-covered veneer and mold are then placed in a large autoclave where heat and pressure produce a shaped plywood that possesses exceptional strength and an integral unity comparable to that of a homogeneous material. A considerable depth of curve and practically any curved form can be produced by this method, regardless of whether the veneers are assembled on a convex or concave mold. The vacuum bag can also be used in the production of bent plywood.

Laminated Wood.—Laminated wood is used to make arms and legs of chairs. Unlike laminated board, in which the grains in the outer covers of thick veneers run at right angles to the core, laminated wood is constructed so that the grains of all the component laminations follow the same direction. This is consonant with the purpose for which laminated wood is used, since the stresses borne by chair arms and legs are parallel to the length of the wood. Wood laminations, which are somewhat thicker than plywood veneers, are rotary cut and are bonded together with a synthetic resin cement. The bonded laminations may be bent as desired by clamping them in a form. Impregnation with resinous adhesive makes laminated wood remarkably strong and durable.

Hardboard.—Hardboard, or fibreboard, is sometimes used as drawer bottoms and chest backing in the manufacture of inexpensive furniture. This material is prepared by subjecting wood chips to high pressure in a steam vessel and then exploding them by suddenly releasing the pressure. This abrupt and violent action rearranges the wood fibres and produces a fresh activation of the lignin, a natural plastic substance present in the wood. The reactivated lignin binds the fibres together in their new orientation and holds them in a fixed position.

Plastics.—Among the newer materials used in the furniture industry are plastics (*q.v.*). The most useful plastics are those that are thermosetting, or permanently "set;" *i.e.*, once they have been cast or molded in a definite form, their shape cannot be altered by a fresh application of heat and pressure. They are remarkably durable and are suited to the production of small cabinets and such accessory furniture items as drawer handles and knobs. Plastics are molded by introducing the material in powder form into steel molds and heating it under pressure. Plastics are cast by pouring the material in liquid form into a mold and heating it under pressure in an autoclave. Casting is perhaps more economical than molding since the molds used in casting may be made of materials such as glass or rubber whereas more expensive steel molds are required in molding.

More widely used in the furniture industry than cast or molded plastics are laminated plastics in which a phenol or amino plastic is combined with a fibrous reinforcing material, such as cotton or linen cloth, or even paper. At the start of the process, the reinforcing material is run through rollers coated with plastic until it is thoroughly impregnated. When the plastic-treated cloth or paper is dry it is cut into sections and placed in layers in a press and heated under pressure to produce lamination.

Fibres may be used as reinforcing material if the fibres and plastic are thoroughly mixed. The mixture may be rolled out in flat sheets or molded to the desired shape. The material, whether in flat or molded form, is "cured" by heating it under pressure.

Layers of thin wood veneers treated with plastic may be united by heating them under pressure; the product resembles plywood. It has the appearance of a fine wood but its strength is superior to wood; since it is highly durable and stain-resistant it is widely used as table tops.

Plastics may also be extruded in sections, cut to size and machined into desired forms by conventional wood- or metalworking methods. Plastics are used extensively in combination with wood and metal in furniture manufacture and the range of shades of colour in which they may be produced is almost unlimited.

Metal.—*Sheet Steel.*—Office furniture constructed of light sheet steel has come into almost universal use, and some home furnishings, particularly utility items, are also built of this material. The individual parts of steel furniture are produced in quantity since design is standardized to obviate the need for costly retooling and resetting of machines to accommodate variations in form. Large sections are cut to size by a guillotine press and the edges are turned on a bending press, while a notching machine is employed to punch holes and notch corners. Small sections may be blanked out, notched and punched in a single operation on a blanking press. Guillotine and blanking presses can be used only to cut straight edges, but a curved edge, if desired, can be produced by the scissorslike cutting action of a nibbling machine. If sheet steel furni-

ture is assembled at the factory, the parts may be welded together; great economy in packing and shipping can be effected, however, by constructing the parts so that they can be assembled after delivery to the retailer or purchaser by springing small projections into receiving slots or by bolting the components together through matching holes. Shapes that cannot be produced by cutting and bending, such as the formed parts of steel chairs, may be made by pressing a sheet steel blank into a die of the required shape.

Tubular Steel.—Tubular steel also is used in furniture manufacture. Steel tubing may be shaped by bending it around a "former" grooved to the diameter of the tube. Loading the tube with a resinous filler supports the walls of the tube and lessens the danger of distortion during the bending process. After the tube has assumed the desired bent shape, the tube is heated so that the filler becomes molten and can be removed by pouring. The walls of the tube are supported more efficiently by the mandrel-bending method in which the tubing is slipped over a solid steel mandrel and adjusted to the point of bending. The tube is held in place between a lever or power-rotated semicircular former and a backplate. The former and backplate are grooved to the outside diameter of the tube while the diameter of the mandrel accommodates the inside diameter of the tube. The forming and supporting elements of the bending machine are removable and different sizes of mandrels, formers and backplates are used according to the tube diameter. Tubular furniture components may be welded together and finished by being plated with chromium or painted with either brightly coloured enamels or metallic coatings. Both canvas and plastics are widely used as covering for tubular chairs, and wood, glass or laminated plastics are used as tops for tubular tables.

Alloys.—Lightweight but strong alloys containing aluminum or magnesium as main constituents are used in making metal furniture, especially garden or lawn furniture. These alloys lack the resilience and stiffness of steel; their lesser degree of stiffness may be compensated for by increasing the dimensions, particularly the thickness. Offsetting their inferior resilience and stiffness, however, are the advantages of lightness, resistance to corrosion, and the ease and economy with which these metals can be worked. They are more easily bent, stamped and pressed than steel, and ordinary woodworking machines can be adapted to handle them. Moreover, they can be applied as outer coverings in sandwich constructions similar to those used in making sandwich plywood.

Upholstery.—The upholstering of furniture is largely a handicraft, for the skill of the trained and experienced craftsman is needed in turning out quality pieces. The standard upholstery foundation consists of a system of coiled steel springs resting on a webbing of burlap and tied to the furniture frame. The springs are embedded in a filling material, such as rubberized hair, foam rubber, palm fibre or Spanish moss, and the spring system is topped by a thick padding of cotton or foam rubber in sheet form. Muslin is frequently employed as an inner covering for this assembly while a durable upholstery fabric is used as an outer and finishing cover. Loose cushions are filled with special spring units in a bedding of foam rubber or down; the springs are covered with layers of cotton, and the entire assembly is encased in upholstery fabric.

Only a few mechanical aids have proved satisfactory in upholstering. Multiple layers of fabric can be cut efficiently and economically by machines in production-line operations, and staples are used instead of tacks on less expensive pieces. But the mass production of such components as the basic coiled spring system and the mechanical handling of such materials as the bedding, or filler, have not proved efficient and economical. Some useful substitutes have been found, however, for the coiled spring supporting unit; they include the modern nonsagging springs that may be clipped to the frame and the steel bands that are held to the frame by helical springs. Sponge rubber may be molded to constitute a complete seat that is firm and comfortable. Webbed seat frames also are used and the natural resiliency of wood is utilized in building springy plywood supporting structures. (E. L. Y.)

FACTORIES AND PRODUCTION

The Cabinet Shop.—A cabinet shop is usually a very small organization where the skilled chief cabinetmaker develops or lays out the design and, with a few assistants, produces a finished piece of furniture. This type of shop specializes in custom and repair work; consequently, many hand tools are used and the power-driven machines are of the kind that can be easily adjusted to a wide variety of operations. In the U.S. only a small amount of furniture is still made in cabinet shops.

A Typical Furniture Factory.—The average U.S. furniture plant has fewer than 100 employees. Such plants operate many semiautomatic machines but are not conveyorized so completely as the mass-production plant. It is in these factories that most of the fine furniture is manufactured. This type of furniture requires considerable handwork to add refinements not found in inexpensive mass-produced furniture.

The design for a piece of furniture is sketched and after the sketch is approved by the manufacturer a full-size drawing is made. Then a sample is made to check the design and production problems. If revisions are required, the drawings are corrected and then patterns and detailed cutting orders are sent to the production department. There the proper species of well-seasoned lumber is brought in. The lumber is usually planed on two sides so defects such as knots, cracks and colour variations can be detected.

Straight rails are cut from the boards by straight-line ripsaws and cutoff saws. The stock for parts, which must be flat and straight, is usually faced or jointed after being cut to rough size. Curved parts are traced on boards, following patterns, and are cut out by a band saw. When curved parts are too large to be cut from boards received from the lumber mill, the board defects are ripped out and the resulting narrow pieces are glued together into large panels from which the parts will be cut. Covered back legs are often made in this way to save lumber. If the piece is a table or chest of solid wood construction, the panels that form the top or sides may also be glued in a similar manner.

In most case goods such as chests and tables veneered lumber-core plywood is used for the large panels. If 100 or more pieces of the same kind are to be made, panels are purchased cut to exact size from plywood manufacturing companies. Then all that is necessary is to edge-band and cut the joints.

When parts must be cut exactly alike, they are clamped in forms having the proper contour and are then brought in contact with high-speed rotating knives that shape the part to proper size as the form rides against a guide on hand or automatic shapers and routers. Intricately carved pieces such as legs are roughly carved on multiple-spindle carving machines. These duplicate a master leg by means of a follower point that is guided along the surface of the model and imparts the same motions to as many as 32 high-speed rotating knives as they whittle the leg blanks. After being rough carved the legs are machine-sanded, and fine detail is added by the hand carver. The next operation is performed in the fitting department, where the ends are cut to the desired angle, bored for dowels or tenoned. Automatic machines often combine these operations. Exposed parts are sanded on edge belt sanders, three-drum traveling-bed sanders or belt sanders. Rounded parts are sanded on soft pneumatic drums and carved parts are sanded on a buffer, a machine in which shredded sandpaper is supported by brushes on a revolving wheel. The parts are then glued and assembled. Often the side or back of a piece is assembled in air-driven clamps.

After the glue has set the parts may be returned to the machine department for machining that could not be performed before assembling, such as sanding the joints and shaping the edges. Then it goes back to the assembly department for final assembly. Air-driven clamps are used when the design permits; otherwise the piece can only be pressed by hand clamps. Unless electronically cured glues are used, clamps must be applied long enough to ensure a good bond. The completed article is then cleaned to remove excess glue, inspected and hand-sanded to provide a smooth surface for the finish. Application of the finish as well as upholstering is sometimes done in another factory.

The Mass-Production Factory.—Mass-production factories are located in Grand Rapids, Mich., Jamestown, N.Y., and High Point, N.C. In the mass-production plants it is possible to produce a small dinette chair in 35 minutes. The lumber is brought from

the kiln to the rough mill department by motorized lumber carriers. There it is often lightly surfaced on both sides. Then power-fed cutoff saws remove defects and cut the boards to length. Conveyors carry the boards to high-speed ripsaws that remove remaining defects and trim the board to widths suitable for gluing. These narrow boards are glued into large panels, using resin glue in high-frequency quick-drying machines. The panels then go to a double surface planer. Such parts as chair back posts are rough-cut on a band saw in multiples and then shaped to exact size on an automatic shaper. The ends are trimmed and all holes bored in one operation by a front and back post-boring machine. Such parts as seat rails have both ends cut off, on plain or compound angles, and are chucked or bored in one cycle of a double-end sawing, boring and chucking machine. Glue is shot into the dowel holes and the dowel driven in on a gluer and dowel driver. The exposed parts such as legs are then sanded on various types of automatic sanding machines before the chair is assembled and clamped in air-driven presses. The chair is now cleaned and sanded with 6/0 or 7/0 sandpaper to provide a smooth base for the finish.

FURNITURE CONSTRUCTION

Wood Case Goods.—In most high-quality case goods the sides and tops usually are made of panels $\frac{5}{8}$ in. or more thick. Panels may be made of solid woods or veneered lumber core. Back panels, dust panels and drawer bottoms usually are $\frac{1}{4}$-in. plywood. Drawers are separated by dust panels and slide on guide rails. The corner joints of the drawers are of a locking type such as the dovetail. If the design permits, numerous glue blocks reinforce the corners of the case. On well-constructed furniture the joints are neatly made, well glued and tightly fitted.

Wood Chairs.—Good chair construction requires that the main rails be made of well-seasoned hardwoods having sufficient width and thickness to provide rigidity. Joints should be well machined to provide complete wood contact for the glue whether they are double-doweled or mortised and tenoned. Corners should be reinforced with fitted corner blocks glued and grooved or screwed in place. Cross members are added so that the tension of the springs and upholstery will not bend the long rails. Long legs of chairs are glued and doweled between the rails or are notched out, glued and double-doweled to the rails, with the attachment reinforced by screws, bolts or glue blocks. Short legs are usually double-doweled to the bottom of the rails. On some modern furniture the legs are pegged and glued into fitted corner blocks that are glued and screwed in place. A well-constructed piece of furniture is a rigid structure; arms should not be loose nor should the frame creak when someone sits on it. Cabinetmakers sometimes test the frame of an upholstered sofa by lifting the right front leg and watching the left front leg, which should lift when the right leg is about two inches off the floor.

Finishing Wood Furniture.—The purpose of finish is to stabilize and preserve the wood as well as to enhance the beauty of the wood texture. A typical operation necessary to produce a quality finish of walnut wood is as follows: after the final machine sanding with 4/0 sandpaper just prior to finishing, the piece is hand-sanded with 5/0 paper. Light sapwood is stained to match the darker heartwood. Next a wash coat of lacquer thinned with three parts of thinner is sprayed on and after drying is sanded with 8/0 paper. A filler is then sprayed or brushed on and padded into the pores of the wood. A coat of sealer is applied and sanded with 8/0 paper; one or two coats of lacquer are then applied and are allowed to dry overnight or are quickly dried in heated chambers. The finish is then rubbed, using 360-grit wet-or-dry sandpaper and naphtha as a lubricant. Fine steel wool or special rubbing compounds also can be used.

On tight-grained wood such as maple, a good-quality finish can be obtained by using nongrain-raising stain and lacquer sealer. This is well sanded and followed by two coats of lacquer, each one rubbed down after being applied. On much inexpensive furniture the finish consists of a coat of coloured sealer followed by only one coat of lacquer. Some fine modern furniture is finished by applying several coats of boiled linseed oil. This gives a mellow satin appearance.

After World War II a scratch-resistant group of synthetic lacquers was introduced to the furniture industry. In the United States lacquers have almost completely replaced the so-called French finish and varnishes and shellacs, which are used only in repairs or restorations of antiques.

Metal Furniture.—A great step was taken in metal furniture when a chair of tubular steel was designed by Marcel Breuer in 1925 at the Bauhaus school in Germany. From his basic idea came large-scale production of low-priced steel and aluminum furniture designed for use in factories, hospitals, offices and outdoors. Rod, wire and tubular metal shapes also came to be used in making complete furniture pieces or as supporting members of wood and upholstered furniture. Tubular steel is well adapted to furniture manufacture because it is lightweight, strong, flexible and more easily shaped than solid metal.

Metal furniture can be finished in several different ways. It can be painted with various coloured enamels applied over specially adapted primers. Steel can be chemically treated to produce a black or green rust-resistant finish or it can be chrome-plated.

Plastic Furniture.—Molded plastics opened a great field for new design in sculptured forms. The largest use of plastic is in the form of laminated sheets, which are easily bonded to plywood panels by special adhesives. These sheets are made with durable finishes in various colours and wood imitations. They are used extensively for table tops, kitchen-counter tops and bathroom furniture. Other plastics, either woven or in sheet form, are used in place of cloth fabric and conventional upholstery webbing.

(PL. R. B.; L. J. G. B.; M. D. F.)

FURNIVALL, FREDERICK JAMES (1825–1910), English philologist and editor known for his editions of early English texts, was born at Egham, Surrey, Feb. 4, 1825. He assisted Frederick Denison Maurice in the Christian Socialist movement and was one of the founders of the Working Men's college, London. He promoted the study of early English literature, partly by his own work as editor and partly by the foundation of learned societies, especially the Early English Text society (1864), the Chaucer, Ballad, New Shakespeare and Wyclif societies and, at a later period, societies for the special study of Browning and Shelley.

Furnivall edited texts for the Early English Text society, for the Roxburghe club and the Rolls series. His most important work was his "Six-Text" edition of the *Canterbury Tales*. He was honorary secretary of the Philological society and one of the original promoters of the *Oxford New English Dictionary*. He cooperated with its first editor, Herbert Coleridge, and after his death was for some time principal editor during the preliminary period of the collection of material.

He died in London on July 2, 1910.

See *Frederick James Furnivall: a Volume of Personal Record* (1911).

FURPHY, JOSEPH (pseudonym, TOM COLLINS) (1843–1912), Australian novelist, whose works proclaim nationalist social equality and were written with typical Australian raciness and broad humour. He was born at Yering, near Yarra Glen, Victoria, on Sept. 26, 1843, the son of an Irish immigrant. Educated by his mother, he worked at Kyneton, the Riverina and Shepparton, Victoria, where in 1884 he accepted a position in a foundry. There he began to write a lengthy novel, completed in 1897 and eventually published in three parts: *Such Is Life* (1903); *Rigby's Romance* (serialized in *The Barrier Truth*, 1905; published in book form, 1921); and *The Buln Buln and the Brolga* (1948). His *Poems* were published in 1916. A lean, shrewd, kindly man, Furphy was interested in schemes of social regeneration. He died at Claremont, Western Australia, on Sept. 13, 1912.

See K. Baker and M. Franklin, *Joseph Furphy* (1944).

(C. M. H. C.)

FURSE, CHARLES WELLINGTON (1868–1904), English romantic painter, was born at Staines, Middlesex, on Jan. 13, 1868. He entered the Slade school in 1884, winning the Slade scholarship the following year, and completed his education at Julian's academy in Paris. "Cain" was the first painting he exhibited at the Royal Academy (1888). He regularly showed work at the New English Art club. Among his pictures are: "Diana of

the Uplands," "Lord Roberts" and "The Return From the Ride" (London). Elected an associate of the Royal Academy in 1904, Furse died in London on Oct. 16, 1904. (D. L. Fr.)

FUR SEAL, any of the two kinds of eared seals, or sea lions (family Otariidae), that provide the fine, almost silky fur known as sealskin. *See* Sea Lion; Sealing.

FURSEY (Furseus), **SAINT** (d. before 652), Irish monk and visionary. Of his early years nothing certain is known. After 630 he left Ireland for England and founded the monastery of Cnoberesburgh in the dominions of King Sigebert of East Anglia. After the king's death he crossed to France (before 644) and founded a monastery at Lagny on the Marne. When Fursey died (perhaps in 649) Erchinoald, mayor of the palace in Neustria, took possession of his body and 30 days later had him buried in his newly founded church at Péronne in Picardy. The earliest life of Fursey, written shortly after his death, has considerable historical value. His feast day is Jan. 16.

Fursey was said to have had visions of the other world, which became widely known through the account in Bede's *Ecclesiastical History;* they had considerable influence on the vision literature of the later middle ages. The shrine of Fursey at Péronne attracted many pilgrims, especially from Ireland, and the monastery of Péronne retained its Irish character until (and possibly beyond) the end of the 8th century. Fursey's brothers, St. Foillan (who had succeeded him at Cnoberesburgh) and St. Ultán, stayed at Péronne for some time, then went to Brabant and established themselves at Fosses. Later Ultán seems to have been abbot of Péronne.

See J. F. Kenney, *Sources for the Early History of Ireland,* pp. 500–505 (1929); L. Gougaud, *Christianity in Celtic Lands,* pp. 146–148 (1932). (L. Br.)

FÜRSTENBERG, a family distinguished in German history, members of which first became princes of the Holy Roman empire in 1664. On the extinction of the male line of the ducal house of Zähringen in 1218, its possessions on the right bank of the Rhine passed to Count Egino V of Urach (d. *c.* 1236). While his elder son, Konrad, inherited Breisgau and became the founder of the line of counts of Freiburg (extinct in 1457), the younger son, Heinrich (d. *c.* 1284) obtained possession of the Baar (a plateau on the southern verge of the Black Forest) and of the Kinzig valley and styled himself count of Fürstenberg (the name of his ancestral seat, the castle Fürstenberg, south of Donaueschingen). His descendants augmented their possessions by inheritance and by purchase, acquiring in the 14th century the lordships of Wartenberg, of Wolfach and of Hausach (the latter two serving to round off their frontiers in the Kinzig valley); in the 15th century the lordship of Donaueschingen; and in the 16th century the countship of Heiligenberg, with the lordships of Trochtelfingen and of Jungnau; and in the 17th century the lordships of Werenwag on the Danube, of Messkirch and Gundelfingen and of Stühlingen and Hewen. The aggregate of lands, which was centred round the valley of the Kinzig and the upper Danube and which, through Heiligenberg, reached close to the Lake of Constance, was frequently divided among collateral branches of the family.

Wilhelm (1491–1549) stands out among the counts of Fürstenberg. With his domains in the Kinzig valley he combined, from 1504 onward, the *Reichslandvogtei* (imperial bailiwick) of Ortenau, obtained in pledge. He maintained, moreover, close contact with the city of Strasbourg and with the leaders of the Protestant cause. He took an active part in securing the restoration of Württemberg to the dispossessed Duke Ulrich and then introduced the Reformation into his own territory; and this led the neighbouring imperial cities of Offenburg and Gengenbach to adopt the same doctrine. In the War of the League of Schmalkalden, in the service of the city of Strasbourg, he raised 2,000 men to fight for the league; but on its defeat he had to resign his authority to his Catholic brother, Friedrich II (1496–1559), who subsequently—with great moderation and tolerance—brought the Kinzig valley back to Roman Catholicism.

The Heiligenberg line began with Friedrich II's third son Joachim (d. 1598), whose grandsons, the brothers Franz Egon (1625–82), Hermann Egon (1627–74) and Wilhelm Egon (1629–1704), were made princes of the Holy Roman empire in 1664. Franz Egon, however, bishop of Strasbourg from 1663, identified himself entirely with French interests (*see* Alsace; also Dutch Wars) and was in 1675 put under the ban of the empire; not until 1681 could he recover his bishopric, when the French took Strasbourg. Wilhelm Egon likewise served French interests, for which he was sentenced to death in Vienna in 1674, being saved only by the papal nuncio's intervention; yet he succeeded his brother as bishop of Strasbourg in 1682 and became cardinal in 1686.

On the extinction of the Heiligenberg line (1716), the princely dignity was transferred to the lines of Messkirch and of Stühlingen, descended from Friedrich II's eldest son Christoph I of Fürstenberg (d. 1559). The extinction of the Messkirch line (1744) enabled Prince Joseph Wilhelm Ernst (1699–1762), of the Stühlingen line, to gather all the Swabian possessions of the Fürstenbergs into his own hand. He became the real organizer of the principality, by instituting a common government at Donaueschingen and dividing the lands into four chief administrative districts (*Oberämter*) and ten stewardships (*Vogteiämter*); and he also carried out decisive reforms in education.

When Karl Joachim, last son and heir of Joseph Wilhelm Ernst's elder son, died in 1804, the Fürstenberg possessions in southern Germany passed to Karl Egon (1796–1854), head of the Bohemian branch of the family (descendants of Joseph Wilhelm Ernst's younger son). In 1806, however, the principality lost its political independence on the formation of the Confederation of the Rhine; most of its territory fell to Baden, though smaller parts went to Württemberg and to Hohenzollern. Karl Egon, however, was still able to play a role of some importance as a mediatized prince in Baden and as a member of the upper chamber, where he made his conciliatory influence felt. He was moreover a great lover of music: the composer Konradin Kreuzer and the conductor J. W. Kalliwoda were engaged at his court; and this tradition survives in the Donaueschingen festivals of contemporary music. Karl Egon's son Karl Egon (1820–92), like many of his ancestors, was also a great patron of the arts and sciences. The treasures collected in the library and in the museum at Donaueschingen bear eloquent witness to this aspect of the Fürstenbergs' activity.

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FÜRSTENWALDE, a town of Germany which after partition of the nation following World War II became a regional capital in the Frankfurt an der Oder *Bezirk* (district) of the German Democratic Republic, lies on the Spree, near its junction with the Oder-Spree canal, about 31 mi. E. of Berlin. Pop. (1961 est.) 31,313. Fürstenwalde, which received civic rights in 1285, was the seat of the bishops of Lebus from 1385 to 1598. The town's many small enterprises include the manufacture of lamp bulbs, shoes and steel castings. The largest factory is the nationally owned tire plant and there is also a school for rubber technology.

FÜRTH, a town of Germany which following the partition of the nation after World War II became part of the *Land* (state) of Bavaria, Federal Republic of Germany, lies at the confluence of the Pegnitz with the Rednitz (which there form the Regnitz), 5 mi. N.W. of Nürnberg. Pop. (1961) 98,335. The town was originally a Franconian settlement dating from the mid-8th century. The royal palace of Furti (known as "the *Furt*") was first mentioned in a record of 1007, when the village was assigned to the newly founded bishopric of Bamberg. In the following centuries both the margraves of Ansbach and the imperial city of Nürnberg claimed seignorial rights over Fürth. The town, largely destroyed in the Thirty Years' War (1618–48), was passed to Prussia and in 1806 (with the duchy of Ansbach) to Bavaria.

The Fürth-Nürnberg line (the Ludwigsbahn, 1835) was the first railway in Germany. The Frankfurt-Passau and Munich-Berlin main lines now pass through the town, which is near the Nürnberg-Munich *Autobahn* and the Nürnberg airport. Formerly a centre of the goldbeaters' craft, Fürth still produces gold leaf and other

beaten metals, aluminum and bronze powders. It also manufactures radio, television and tape-recording apparatus, mirrors, glass, furniture, toys, precision and optical instruments, furs and clothes.

FURTHER EDUCATION (GREAT BRITAIN): *see* HIGHER EDUCATION; EDUCATION, HISTORY OF; TECHNICAL EDUCATION.

FURTWÄNGLER, ADOLF (1853–1907), German classical archaeologist, a noted authority on early Greek art, was born on June 30, 1853, at Freiburg-im-Breisgau. He studied at the universities of Freiburg and Leipzig, and at Munich under Heinrich von Brunn, who inspired his interest in classical art. After three years of study and travel in Italy and Greece, at a time when the epochal discoveries at Troy, Mycenae, Olympia and Pergamum were first becoming known, he returned to Germany to become director of the Berlin Antiquarium, a post he held for 14 years. In 1894 he succeeded Brunn as professor of archaeology at Munich. There his research on the Aeginetan marbles led him, in 1901, to direct an expedition to the Greek island of Aegina (*q.v.*) and renew exploration of the sanctuary of Aphaia. It was at the close of this campaign and while making plans for further excavation that he fell ill of a fever and died at Athens on Oct. 10, 1907.

Furtwängler's chief contributions to classical archaeology are his catalogues of ancient sculpture, vase painting and gems, which have brought into historical order literally thousands of works of ancient art; and his *Meisterwerke der griechischen Plastik* (1893; Eng. trans., *Masterpieces of Greek Sculpture*, 1895).

For an appreciation of his life and work, *see* W.-H. Schuchhardt, *Adolf Furtwängler* (1956). (M. I. W.)

FURTWÄNGLER, (GUSTAV HEINRICH ERNST MARTIN) WILHELM (1886–1954), German conductor who was one of the great exponents of romantic music, was born in Berlin on Jan. 26, 1886, the son of the archaeologist Adolf Furtwängler. He studied in Munich with J. Rheinberger, M. von Schillings and others, and acquired experience in conducting under the direction of F. Mottl in Munich (1907–09) and later under H. Pfitzner in Strasbourg. He became director of the opera at Mannheim in 1915. In 1920 he succeeded Richard Strauss as conductor of the Berlin Opera concerts, and in 1922 followed A. Nikisch as conductor of the Gewandhaus concerts in Leipzig. Other appointments included directorships of the Berlin Philharmonic orchestra (1922), with which he traveled widely; the Vienna Philharmonic orchestra (1930); the Bayreuth festival (1931), and the Berlin State opera (1933). He first conducted in England in 1924, at the Royal Philharmonic society, and in the United States in 1925 with the New York Philharmonic orchestra. He published a volume of essays, *Gespräche über Musik*, in 1948 (Eng. trans. by L. J. Lawrence, *Concerning Music*, 1953).

Known for his passionate, romantic style, Furtwängler excelled in the works of Beethoven and Wagner, though he was equally commanding in 20th-century works. He died near Baden-Baden, Ger., on Nov. 30, 1954.

FURZE, GORSE or WHIN, common names for showy flowered thorny shrubs belonging to the genus *Ulex*, family Leguminosae (*q.v.*). *Ulex* comprises about 20 species, confined to west and central Europe and northwest Africa. Common furze, *U. europaeus*, is found on heaths and commons in western Europe from Denmark to Italy and Greece and in the Canaries and Azores, and is abundant in the British Isles. It grows to a height of two to six feet; it has hairy stems, and the smaller branches end each in a spine; the leaves, sometimes lanceolate on the lowermost branches, are mostly represented by spines from two to six lines long, and branching at their base; and the flowers, about three-quarters of an inch in length, have a shaggy, yellowish-olive calyx with two small ovate bracts at its base, and appear in early spring and late autumn. They are yellow and sweet scented and visited by bees. The pods are few seeded; their crackling as they burst may often be heard in hot weather. This species has spreading branches and strong, many-ridged spines. An Irish variety has erect branches and slender four-edged spines.

Dwarf furze, which includes *U. nanus* and *U. galli*, are generally distributed throughout the British Isles and are found in Belgium, Spain and the west of France; they are procumbent plants, less hairy than *U. europaeus*, with smaller and more orange-coloured flowers, which spring from the primary spines and have a nearly smooth calyx with minute basal bracts. Furze or gorse is sometimes employed for fences.

Notwithstanding its formidable spines, the young shoots yield a palatable and nutritious winter forage for horses and cattle. To fit it for this purpose it must be chopped and bruised to destroy the spines. There are a variety of machines by which this is done rapidly and efficiently, and which are in use where this kind of forage is used to any extent. The agricultural value of this plant has often been overrated by writers. In the case of poor, dry soils it does, however, yield much valuable food at a season when green forage is not otherwise to be had. It is given to horses and cows in combination with chopped hay or straw.

This plant is invaluable in mountain sheepwalks. The rounded form of the furze bushes in such situations shows how diligently the annual growth, as far as it is accessible, is nibbled by the sheep. The food and shelter afforded to them in snowstorms by clusters of such bushes is also of much importance. Young plants are so kept down by the sheep that they can seldom attain to a profitable size unless protected by a fence for a few years. In various parts of England furze is cut for fuel. The ashes contain a large proportion of alkali and are a good fertilizer, especially for peaty land.

FUSARO, LAKE (LAGO DEL FUSARO), a coastal lagoon in Campania, Italy, ½ mi. W. of Baiae and 1 mi. S. of the acropolis of Cumae, is the ancient Acherusia Palus, separated from the sea on the west by sand dunes. It may have been the harbour of Cumae in early antiquity. In the 1st century A.D. an outlet was dug at its south end, with a tunnel under the hill of Torre Gaveta; another tunnel was dug in 1859. This hill is covered with the remains of a large villa, almost certainly that of Servilius Vatia, described by Seneca. Oyster cultivation is carried on and there is a hydrobiological station in the former royal casino on an island, in the building designed by Carlo Vanvitelli (1782). (G. KH.)

FUSE, a city of Japan, in Osaka prefecture, east of Osaka city of which it is essentially an industrial and residential satellite. Pop. (1960) 212,754. Cotton textiles and metal casting were locally important during the feudal period and provided the foundation for modern industrialization after rail lines were built to Osaka in 1914 and 1924. In addition to metals and machinery manufacturing, Fuse specializes in such consumer goods as textiles, toys, leather and rubber goods, medicinals and chemicals.

(J. D. EE.)

FUSE (FUZE), an appliance for firing explosives in military shells, missiles, mines and bombs, in blasting operations, in fireworks and, in an entirely different form, to protect electrical circuits from the effects of overloads. (*See* BLASTING; AMMUNITION, ARTILLERY; FIREWORKS.)

The word is one of the forms in which the Latin *fusus* ("spindle") has been adapted into English, early forms of the military shell fuze having taken the form, ordinarily, of a spindlelike tube. Spelling of the word for detonation of explosives was originally with an "s." United States military forces found it desirable to adopt the "z" spelling to avoid confusion with the verb fuse, to melt by heat, or with the electrical fuse derived from the verb, or the fuse of blasting operations and fireworks.

In ammunition and other ordnance-type munitions, fuze denotes a device that causes the munitions to function under desired conditions. It regulates the final functioning of the munition, and should not be confused with either the primer or the firing pin which initiate launching of a rocket or artillery shell, nor with such items as a detonator or striker which are initiating components of a fuze.

Normally, a fuze has elements to set off the munition, to prevent its premature functioning and to cause it to perform only under predetermined conditions. These conditions determine the general type to which a fuze belongs, there being, broadly, five types: (1) impact fuze, which functions as it hits the target; (2) time fuze, which delays functioning for a certain period from a starting time; (3) command fuze, which acts upon some form of

signal from a remote-control point; (4) proximity fuze, which functions when the munition carrying it approaches to within a given distance of the target; and (5) inferential fuze, which recognizes conditions leading to the inference that a target is nearby.

In blasting operations and in fireworks, the term fuse denotes a device employed to fire explosives from a distance or after a delay. Safety fuse is a hollow cord filled with a composition resembling black powder and designed to propagate burning at a slow and steady rate. The far end of the fuse is usually crimped into a detonator (*q.v.*) embedded in the explosive charge. Instantaneous fuse, also called Cordeau and Primacord, is a hollow cord filled with powdered PETN (pentaerythritoltetranitrate). Fired by a detonator, it propagates detonation at a speed in excess of 6,000 m. per second and is capable of initiating the detonation of certain explosives.

In electrical engineering a fuse (always so spelled) is a safety device, commonly consisting of a strip or wire of easily fusible metal, which melts and thus interrupts the circuit of which it forms a part, whenever that circuit, through some accident or derangement, is caused to carry a current larger than that for which it is intended. In this sense the word derives from *fusus,* the past participle of Lat. *fundere* ("to pour") from which comes the verb fuse, to melt by heat. (F. D. McH.)

FUSELI, HENRY (Johann Heinrich Füssli or Fuessli) (1741–1825), Anglo-Swiss historical painter and author, one of the most exotic, original and sensual of painters, though not one of the greatest, was born at Zürich, Switz., on Feb. 7, 1741, the son of Johann Caspar Füssli, a court painter and town clerk. Educated at the Collegium Carolinum in Zürich, he was influenced by J. J. Bodmer, but later as a theological student he fled together with his friend Johann Caspar Lavater as the result of a political publication. He traveled to Berlin and, on the recommendation of the British ambassador, to London in 1764. In 1765 he translated J. J. Winckelmann's *Reflections on the Painting and Sculpture of the Greeks* into English. He was encouraged by Sir Joshua Reynolds to become a painter and went to Italy, arriving in Rome in 1770. In Venice in 1772 fever affected his right hand. He sent his first work, "The Death of Cardinal Beaufort" (Liverpool), to the Royal Academy in 1774. During his stay in Rome he studied Michelangelo and the antique, and visited Naples in 1775. He left for Zürich in 1778, where he painted "The Oath on the Rütli," returned to London in 1779 and painted "The Nightmare" in 1781.

In 1788 he was elected associate of the Royal Academy, becoming a member two years later. He contributed nine pictures for John Boydell's Shakespeare gallery. His own Milton gallery of 40 large paintings, opened in 1799, was only moderately successful. During 1799–1805 he was professor of painting at the Royal Academy. In 1801 the first of his *Lectures on Painting* were published, showing his continued admiration for the heroic and for Michelangelo. He was elected keeper of the Royal Academy in 1804 and edited Matthew Pilkington's *A Dictionary of Painters* in 1805, and wrote the introduction for William Blake's edition of R. Blair's *The Grave.* Although he said "Blake is damned good to steal from," he introduced him to Joseph Johnson, Blake's only commercial publisher.

In 1810 Fuseli was re-elected professor at the Royal Academy. His pupils included Sir Thomas Lawrence, Sir David Wilkie, William Etty, W. Mulready, B. R. Haydon, Sir Charles Eastlake and Sir Edwin Landseer, his "little dog-boy." He died on April 16, 1825, at Putney Hill, and is buried in St. Paul's cathedral. His diminutive size and bitter wit made him one of the best-known figures in London artistic life. His mannered drawings of elongated women and his dreamlike paintings had and still have an influence on European imaginative painting.

Bibliography.—*Life* by John Knowles, prefixed to the collected *Works* (1831); Eudo C. Mason (ed.), *The Mind of Henry Fuseli* (1951); Nicolas Powell, *The Drawings of Henry Fuseli* (1951); Frederick Antal, *Fuseli Studies* (1956). (C. N. P. P.)

FUSEL OIL, the term applied to the mixture of volatile, oily liquids of characteristic odour and taste produced during alcoholic fermentation processes.

The fusel oil alcohols and their esters find wide use as specialty solvents and plasticizers in the lacquer, plastic coating and pharmaceutical industries.

Constituent	Corn	Molasses	Potatoes	Rye
Isopropyl alcohol	—	0.6	—	—
n-Propyl alcohol	20.4—11.7	24.3	6.85	—
Isobutyl alcohol	23.9—12.2	7.4	24.35	15.7
n-Butyl alcohol	—	8.1	—	—
d-Amyl alcohol	14.6—23.4	55.3	68.76	77.8
Isoamyl alcohol	36.3—59.7	—	—	—
n-Amyl alcohol	—	4.3	—	—
Undetermined	4.8— 3.0	—	0.04	6.5

In industrial alcohol plants, fusel oil alcohols and ethyl alcohol are recovered from the fermented liquors and separated from each other by complicated distillation processes. Very little fusel oil is recovered by the beverage industry. In small doses fusel oil alcohols cause thirst and headache. In larger doses they are convulsive poisons.

The amount produced is comparatively small and is dependent on the raw materials used and the conditions of fermentation. The gallons of fusel oil produced per 1,000 gal. of ethyl alcohol for the principal fermentation raw materials are: blackstrap molasses 4–5; evaporated cane juice 1–2; corn 4–5; degerminated corn 2.5–3.0; wheat 2–3; rye 2–4; potatoes 5–11; sulfite liquor 2–3.

Fusel oil is a mixture of *n*-amyl, active amyl, isoamyl, isopropyl, *n*-propyl, *n*-butyl and isobutyl alcohols with traces of various esters. As indicated by the table the percentage composition varies with the raw materials used.

A typical fusel oil will contain 60%–70% of amyl alcohols, the remainder being lower alcohols, primarily *n*-propyl and isobutyl alcohol. Distribution of the amyl alcohols present is approximately 80%–85% isoamyl alcohol, 10%–15% active amyl alcohol, with perhaps a trace of *n*-amyl alcohol.

Unlike ethyl alcohol the fusel oil alcohols do not seem to be produced by the action of the yeast enzyme zymase on glucose, but rather by its action on the protein impurities and protein decomposition products (amino acids) present in the fermentation liquors. (D. G. Z.)

FUSHUN (Fu-shun, Fusung), an industrial city adjoining Mukden on the east, located on the Hsün river in central Liaoning province, China. Though coal has been mined there for over 600 years, and the Russians began mining operations in 1902, it was the Japanese South Manchuria Railway company that started modern development of coal mining in 1907. The Fushun beds are among the world's best coal beds, ranging up to 165 ft. thick, and overlain by oil shales up to 300 ft. in thickness. Covering an area of about 25 sq.mi., they are situated on an inclined plane with a surface exposure in the west, permitting open-pit mining and easy shaft-mining access in the east. The reserves of both coal and oil shale are tremendous.

The Japanese, after 1931, developed large-scale coal-mining facilities, shale-oil reduction plants, aluminum-processing plants, and the largest thermal power plant in northeastern Asia. The Chinese Communists expanded all industrial operations, and the Fushun mines led in Chinese coal production in the early 1960s.

The city has grown both in area and population. Its urban limits were expanded in 1953 to almost 1,200 sq.mi., and the 1953 census population was 678,000 with further growth in 1957 to about 985,000. (J. E. Sr.)

FUSIBLE ALLOYS, which generally are composed of bismuth, lead and tin, possess the property of melting at comparatively low temperatures, below the melting point of tin. They are used as soft solders and for safety plugs in boilers, oxygen tanks, sprinkler systems, etc. Newton's fusible alloy (named after Sir Isaac Newton) contains 50 parts of bismuth, 31.25 of lead and 18.75 of tin; that of Jean Darcet (1725–1801), 50 parts of bismuth with 25 each of lead and tin; and that of Valentin Rose the elder (1736–71), 50 of bismuth with 28.1 of lead and 24.1 of tin. These melt between 91° and 95° C. Mercury also is sometimes used as an ingredient. The addition of cadmium gives still greater fusibility; in Wood's metal, for instance, which is Darcet's alloy with half the tin replaced by cadmium, the melting point is lowered to 66°–71° C.; while another alloy containing 15 parts of bismuth, 8 of lead, 4 of tin and 3 of cadmium softens at about 55° and is

completely liquid a little above 60°. By the addition of mercury to Darcet's alloy the melting point may be reduced as low as 45°.

These fusible alloys have the peculiarity of expanding as they cool; Rose's alloy, for instance, remains pasty for a considerable range of temperature below its fusing point, contracts somewhat rapidly from 80° to 55°, expands from 55° to 35°, and contracts again from 35° to 0°. For this reason they may be used for taking casts of anatomical specimens, making impressions of woodcuts, etc., the expansion on cooling securing sharp impressions.

By suitable modification in the proportions of the components, a series of alloys can be made which melt at various temperatures above the boiling point of water; for example, with 8 parts of bismuth, 8 of lead and 3 of tin the melting point is 123°, and with 8 of bismuth, 30 of lead and 24 of tin it is 172°. With tin and lead only in equal proportions it is 241°. Such alloys are used for making the fusible plugs inserted in the furnace crowns of steam boilers, as a safeguard in the event of the water level being allowed to fall too low. When this happens the plug, being no longer covered with water, is heated to such a temperature that it melts and allows the contents of the boiler to escape into the furnace. In automatic fire sprinklers the orifices of the pipes are closed with fusible alloys which melt and liberate the water when an outbreak of fire in the room raises the temperature above a predetermined limit.

See also FIRE PROTECTION.

FUSION, in physics, refers to either (1) the process of melting (*see* HEAT) or (2) a nuclear reaction between lighter chemical elements in which the nucleus of a heavier element is produced, releasing substantial energy. Perhaps the most important fusion reaction is

$$4H^1 \rightarrow He^4 + 2 \text{ positrons}$$

in which four protons are transformed into a helium nucleus with an energy release of 26,700,000 ev, or 80,000,000 kw.hr. per pound of hydrogen. The reaction shown above does not proceed in one step, but represents the summation of a series of two-particle reactions. Although the net energy release in nuclear fusion is quite large, it nevertheless takes energy to bring the charged particles close enough together for them to react. In the sun this energy is supplied as thermal energy. For additional details *see* ATOMIC ENERGY. (J. R. RE.)

FUST, JOHANN (*c.* 1400–1466), early German printer, burgher of Mainz, founder with Peter Schoeffer of the first commercially successful printing firm and financial backer of Johann Gutenberg (*q.v.*), the inventor of printing in Europe. In about 1450 Fust lent Gutenberg 800 guilders to complete his process of printing from movable type, on the security of the equipment of Gutenberg's printing press. A further 800 guilders was lent *c.* 1452 "for their common profit," *i.e.*, on terms of business partnership. In 1455 Fust sued Gutenberg for 2,026 guilders of principal with interest, and on Nov. 6 judgment favoured the creditor. The 42-line Bible was now almost complete and the 1457 Psalter in all probability well in hand. Gutenberg would therefore soon have been able to pay his debt; Fust's foreclosure was clearly intended not to recover his money but, as was its result, to win possession of Gutenberg's invention and materials. The 42-line Bible was published about the spring of 1456, and the Psalter, with superb red-ink printing and two-colour initials, was finished on Aug. 14, 1457, by Fust and his new employee, Peter Schoeffer, who was among Fust's witnesses in the lawsuit; Schoeffer had been a scribe in the University of Paris in 1449 and later had become Gutenberg's foreman. The Fust and Schoeffer firm completed (besides broadsides and other minor pieces totaling 18) seven further works of particular magnificence, notably a Benedictine Psalter on Aug. 29, 1459; Clement V. *Constitutiones*, on July 25, 1460; the 48-line Bible on Aug. 14, 1462; and Cicero, *De officiis*, in 1465, the first classic and seemingly the first work containing Greek type ever printed. In a second edition of the Cicero, Feb. 4, 1466, Schoeffer is still called *puer meus* ("my servant"), implying that during Fust's lifetime Schoeffer was not his partner but only his employee, although their names generally appear together in their imprints. Although presswork was doubtless entrusted mainly to Schoeffer's technical and artistic skill, the business ability of Fust was equally responsible for the success of the firm. Fust died during a bookselling trip to Paris in 1466, perhaps of plague and presumably on Oct. 30, on which date Schoeffer and his associate, Conrad Henkis, afterward commissioned an anniversary Mass. In 1467 Henkis married Fust's widow, Margarete, who died before 1473, while Schoeffer, as Fust's heir, married his daughter Christina, probably in the same year (1467), and continued the business with success until his death in 1502 or 1503. (G. D. P.)

FUSTEL DE COULANGES, NUMA DENIS (1830–1889), French historian, was the originator of the scientific approach to the study of history in France. He was born in Paris on March 18, 1830, of Breton descent. After studying at the École Normale Supérieure he was sent to the French school at Athens in 1853, directed some excavations at Chios and wrote a historical account of the island. From 1860 to 1870 he was professor of history at the faculty of letters at Strasbourg, where he had a brilliant career as a teacher. Subsequent appointments included a lectureship at the École Normale Supérieure in Feb. 1870, a professorship at the Paris faculty of letters in 1875, the chair of medieval history at the Sorbonne in 1878 and the directorship of the École Normale in 1880. He died at Massy, Seine-et-Oise, on Sept. 12, 1889.

Fustel's historical thought had two main tenets: the importance of complete objectivity and the unreliability of secondary sources. By his teaching and example he thus established the modern idea of historical impartiality at a time when most French historians wrote like Chateaubriand and when few had any qualms about combining the careers of historian and politician, and his insistence on the use of contemporary documents led to the very full use of the French national archives in the 19th century. Fustel, however, was no paleographer and his fondness for manuscript sources was occasionally responsible for major errors of judgment. His work has long been superseded, but his influence on the development of historical studies in France will endure.

Apart from *La Cité antique* (1864), a study of the part played by religion in the political and social evolution of Greece and Rome, most of Fustel's work was related to the study of the political institutions of ancient France and of the Germanic invasions under the Roman empire. The first volume of the *Histoire des institutions politiques de l'ancienne France* appeared in 1875; it was subsequently recast and published in three volumes: *La Gaule romaine* (1891); *L'Invasion Germanique et la fin de l'empire* (1891); and *La Monarchie franque* (1888), to which were added *L'Alleu et le domaine rural pendant l'époque mérovingienne* (1889); *Les Origines du système féodal: le bénéfice et le patronat* (1890); and *Les Transformations de la royauté pendant l'époque carolingienne* (1892).

See J. M. Tourneur-Aumont, *Fustel de Coulanges, 1830–1889* (1931); J. Herrick, *The Historical Thought of Fustel de Coulanges* (1954). (B. J. R.)

FUSTIAN, a fabric originally of cotton woven on a linen warp, was popular during the middle ages. The term has come to be used to denote a class of heavy cotton fabrics, some of which have pile surfaces, including moleskin, velveteen and corduroy.

The weaving of fabrics composed of cotton yarn woven on a warp of linen probably originated in Egypt about A.D. 200. It eventually spread to Spain and Italy, where there were guilds of fustian weavers in the 13th century. As the material became popular, its production spread northward; south Germany and Switzerland had a rising fustian industry in the 14th century, and French weavers were making fringed and roughened fustians in the 16th. These early fustians appear to have been smooth fabrics with a soft raised nap; eventually a ribbed pile surface was developed. During the 18th century the manufacture of velveteen, a fustian with an allover pile surface, developed in England, France and Germany. It was also carried on to some extent in the United States in the late years of the century, and production increased rapidly after 1800 when American cotton supplies became plentiful. By this time the linen warp had generally been replaced by cotton, producing an all-cotton fabric.

Early European fustians were soft napped fabrics, the best grades of which were bleached white. The inferior and heavier materials were dyed red, black, blue or golden brown. Fustians were used for outer garments by clerics and women and for linings of woolen garments. The 18th-century fustians presented a dense, hard-wearing surface that was particularly suitable for work clothing for men and boys. They were printed or dyed in dark colours. During the 20th century they have been developed as lighter-weight corduroys and velveteens, which, dyed in light or bright colours, find extensive use in women's and children's wear.

All fustians are produced by weaving loosely floating weft picks across a strong warp, completely covering it. When a pile fabric is desired, the weft floats must be cut, a process originally performed by hand with a fustian knife but now done mechanically. The pile is brushed, sheared, singed and finally the fabric is bleached and dyed.

Swansdown and lambskin, fabrics closely resembling the original fustian, with a short raised nap, are no longer produced in quantity. Moleskin is a thick, strong texture of uncut velveteen which has a smooth surface and is especially suitable for heavy-duty work clothing for men. Beaverteen is a lighter-weight fabric of the same type. Corduroy has the weft-produced pile developed in lengthwise cords or ribs that vary in width; it is a substantial, long-wearing fabric and in its heavier grades is much used for men's and boys' clothing. Velveteen has a short weft pile formed on the face of the fabric, which, when finished, presents an even and level surface. *See* also CORDUROY; MOLESKIN; VELVETEEN.

(V. P. P.)

FUSTIC (YELLOWWOOD or OLD FUSTIC), the name applied to the heartwood, and the dye obtained from it, of a large tree (*Chlorophora tinctoria*) of the mulberry family (Moraceae; *q.v.*) growing in the West Indies and tropical America. The best quality comes from Cuba and the poorer from Jamaica and Brazil. It is still employed in the form of extract for wool dyeing, mainly in conjunction with other dyewoods, for the production of browns, olives and compound colours and for deadening the shade of blacks. The mordant mainly in use is bichromate of potash, and the olive yellow thus obtained is fairly fast to light. In other respects, the dyeing properties of this wood closely resemble those of quercitron bark (*q.v.*). It contains two colouring matters, morin and maclurin, of which the former is the more important.

The dyestuff termed young fustic, zante fustic or Venetian sumach, is derived from the wood of the smoke tree (*Cotinus coggyria*), a southern European and Asiatic shrub of the cashew family (Anacardiaceae). (A. G. P.)

FUTURE FARMERS OF AMERICA is the national organization of boys studying vocational agriculture in the public secondary schools under provisions of the national vocational education (Smith-Hughes) acts. Organized in 1928, it serves to motivate and vitalize the systematic instruction offered to students of vocational agriculture, and to provide further training in farmer-citizenship. It is a nonprofit, nonpolitical, farm youth organization of voluntary membership with dues of ten cents per member per year. The motto of the organization is:

"Learning to do
Doing to learn
Earning to live
Living to serve"

There are four grades or degrees of active membership: "Green Hand," "Chapter Farmer," "State Farmer" and "American Farmer." The first two of these grades or degrees are under the control of the local chapters. The state FFA organizations specify the requirements for "State Farmer" membership and the national FFA determines the requirements for the "American Farmer" title. In addition to the youthful officers of the local, state and national FFA organizations, teachers of vocational agriculture serve as local chapter advisers, and state and national supervisors of agricultural education serve as state and national advisers. The executive secretary and the treasurer of the FFA are adults, officials in national vocational agricultural education. The national adviser is the chief of the agricultural education service of the U.S. office of education.

Programs of work participated in by all members are set up annually by most chapters, each state association and the national organization. All FFA activities are boy-initiated and boy-directed. Local chapters often engage in crop and animal husbandry projects to supplement their class work. In many cases the crops and animals raised are sold at community auctions with financial benefits both to the individual members and to the treasury of the local group. In some cases FFA products are exhibited at local fairs.

An official statement of specific aims and purposes of the FFA lists 12 specific purposes as follows:

1. To develop competent, aggressive, rural and agricultural leadership.
2. To create and nurture a love of country life.
3. To strengthen the confidence of farm boys and young men in themselves and their work.
4. To create more interest in the intelligent choice of farming occupations.
5. To encourage members in the development of individual farming programs and establishment in farming.
6. To encourage members to improve the farm home and its surroundings.
7. To participate in worthy undertakings for the improvement of agriculture.
8. To develop character, train for useful citizenship and foster patriotism.
9. To participate in cooperative effort.
10. To encourage and practice thrift.
11. To encourage improvement in scholarship.
12. To provide and encourage the development of organized rural recreational activities.

National headquarters of the Future Farmers of America is located in the agricultural education service; United States office of education. National conventions are held annually in Kansas City, Mo., at the time of the American Royal Livestock show.

See also EDUCATION, HISTORY OF. (W. W. WX.)

FUTURES, a commercial term used to denote contracts to deliver or to receive a certain quantity of a commodity such as wheat or cotton at some stated time in the future. Price, quantity, grade and time of future delivery are all stated in the contract. The typical futures contract, such as one for September wheat, may provide that the seller will deliver to the buyer a specified quantity, perhaps 5,000 bushels of wheat, in an approved warehouse, sometime during the month of September, for $5,000. September wheat is then said to be selling at one dollar a bushel.

The main justification of the futures contract is that it permits specialization between two elements of the economic process—the function of holding commodities (or other assets) and the function of bearing the risk of price changes. Without the futures contract anyone who held stocks of goods in the course of business would have to take the risk of changes in the price of these goods. By selling futures that mature in the month when he expects to sell his stock, the holder removes from his calculations any uncertainty about the future price of the goods at the time when he expects to sell them. (*See* HEDGING.)

The prices on futures contracts differ from cash prices for immediate delivery, and prices on futures contracts differ from each other, depending on the month set for delivery. The future contract price may be higher or lower than the cash price but will always approximate the cash price as the date for delivery approaches because the prices are related. The basis of the relationship is the cost of holding commodities until the date of delivery. This cost includes storage, insurance and interest, and for wheat it approximates three cents per bushel per month. In addition, the dealers in commodities must take into consideration changes in demand and supply that may occur during the period covered by a futures contract. The uncertainties are such that a substantial degree of skill is necessary for successful operation in this market.

Practically all trading in futures is done on margin; *i.e.*, the traders advance only a certain percentage of the market price and borrow the rest. Futures trading on commodity exchanges takes place in an area where all buyers and sellers or their agents congregate during certain hours. Contracts are not valid unless executed on the trading floor and during those hours. Less than 1% of futures contracts are fulfilled by actual delivery; 99% are

cancelled by offsetting transactions before the delivery month. To facilitate this business by matching (or marrying) sales with purchases, a clearinghouse is established in every exchange. The clearinghouse, in effect, becomes the buyer and the seller of all contracts handled by the brokers. In the few instances where delivery of commodities is actually made, it is accomplished by means of warehouse receipts authorizing the delivery of the commodity from a terminal warehouse approved by the exchange.

The first grain futures exchange in the United States was the Chicago Board of Trade, organized for cash trading in 1848 and for futures in 1865. It remains the world's largest and most active futures market. Cotton futures trading began in New York city in 1870. Other futures markets exist in cities such as Kansas City, Mo.; New Orleans, La.; Winnipeg, Man.; Rotterdam, Neth., Singapore and Alexandria, Egy. Exchanges are generally located where transportation facilities are adequate and in cities through which a substantial part of the commodity being traded passes each year.

To qualify for futures trading on exchanges, a commodity should possess certain characteristics such as durability, adequate future supply, substantial demand, widely diversified supply and demand interests, and have some inevitable and natural price variation to encourage hedging and to attract speculators. Between 20 and 40 different commodities are regularly traded in world futures markets. They include such items as wheat, soybeans, rubber, flaxseed, eggs, tin and wool. Futures trading is most prevalent in staple agricultural products which are exposed to constantly fluctuating prices. The direction and the amount of price changes are uncertain, but speculators with confidence in their ability to evaluate skilfully all known factors are willing to accept the risks in the hope of earning a profit. Competent observers agree that the trader who assumes such risks provides an essential economic service comparable to that provided by insurance companies. Trading in futures tends to stabilize prices, to offer a wide and continuous market and to equalize national and international prices.

All futures trading in the United States on organized exchanges is under the regulation of the Commodity Exchange act of 1922. Under this law, the U.S. Commodity Exchange authority designates contract markets as such, licenses firms and brokers, and exercises powers over nonmembers using futures markets. Among the requirements imposed by the authority are the daily reporting by the exchange of all transactions and restriction on the aggregate amount of grain any one trader may control. Customers' funds, deliveries, market manipulation and member conduct are subject to rigid regulatory activity. Price manipulation and other speculative excesses were substantially minimized under the law.

In Great Britain there is no legislation comparable to the Commodity Exchange act of 1922, and no regulatory body such as the U.S. Commodity Exchange authority. The rules governing futures trading are laid down by the commodity exchange itself.

Futures contracts are also bought and sold for foreign exchange. This market has no centralized meeting place and no formal organization. Domestic and foreign banks, foreign-exchange brokers and other specialized foreign-exchange dealers make "forward exchange" contracts, the term used for buying and selling futures in exchange. Sterling, U.S. dollars and Swiss francs are typical of the currencies that are future traded in the financial cities of the world. The contracts usually mature in from three to six months although longer periods are available in inactive markets. *See* also COMMODITY MARKETS. (O. R. G.)

FUTURISM, a forcible Italian movement in the arts, first appeared in 1909 with the publication of a vehement literary manifesto in *Le Figaro*. On the one hand, it was an incitement to reject traditionalism and demolish all institutions concerned with preserving the past; on the other, it was an exhortation to glorify the present, to exalt speed, power, violence and the beauty of machinery. Its author Filippo Tommaso Marinetti (*q.v.*), poet and playwright, assembled round him a group of poets and painters and in 1910, the "Manifesto of the Futurist Painters" was issued in Milan signed by the painter and sculptor Umberto Boccioni (*q.v.*), and the painters Giacomo Balla, Carlo Carrà, Gino Severini and Luigi Russolo (who was also a composer of Futurist music). Thereafter the movement asserted itself with other publications and by provocative demonstrations.

In their painting, the Futurists were obsessed with a concept of universal dynamism. They held that, since all things are in perpetual movement and subject to continual transformation, form has no final state or fixed position, and that space is nonexistent except as a void in which form moves. The Futurists attempted to represent this state of flux either by arbitrarily disintegrating form and making a synthetic pattern of its movement, or by inventing linear equivalents for the forces that direct its movement.

Unlike the later nihilistic Dadaists, the Futurists, for all the excesses of their propaganda, expressed an eager appreciation of their era, its infinite diversity, its promise and achievement. Boccioni's sculpture and the paintings, notably of Balla, Carrà and Severini reflected this sensibility.

A Futuristic exhibition, showing the assimilation of certain Cubist elements, was held in Paris in 1912 and transferred later to London and Berlin. With the outbreak of World War I, the movement lost its creative momentum. Its influence, general rather than particular, was discernible in the short-lived Vorticism inaugurated in England by Percy Wyndham Lewis in 1914. *See* also PAINTING.

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FUX, JOHANN JOSEPH (1660–1741), Austrian composer known for his theoretical work on counterpoint, *Gradus ad Parnassum*, was born at Hirtenfeld in Styria. He became organist of the Schottenkirche in Vienna in 1696 and was appointed court composer to the emperor Leopold I in 1698. He remained at the imperial court for the rest of his life, holding, in addition, the post of *Kapellmeister* at St. Stephen's cathedral in Vienna from 1705 to 1715. He died at Vienna, Feb. 13, 1741.

Fux was a prolific composer of both vocal and instrumental music, composing no fewer than 18 operas. His celebrated *Missa Canonica* (1708) is written in canon throughout. His *Gradus ad Parnassum* (1725) was long the standard textbook on the subject of counterpoint, and was studied by the 18th-century composers, including Mozart and Haydn. It is published in English in an abridged form, *Steps to Parnassus*, translated and edited by A. Mann and J. St. Edmunds (1943).

See A. Liess, *J. J. Fux, ein steirischer Meister des Barock* (1948). (Cs. CH.)

FUZULI (d. 1556), Turkish poet, is the outstanding figure in the classical school of Turkish literature. Very little is known of his life. His real name was Mohammed ibn Suleyman and, probably born at Hilla, he never left Iraq. When in 1534 Suleiman the Magnificent conquered Baghdad, Fuzuli presented a *kaside* (congratulatory poem) to him. He received little favour, however, and he never seems to have achieved the status of the court poets of Istanbul. His famous *Shikeyetname* ("Complaint") sarcastically comments upon his failure to receive even the small pension granted to him. Victim of a plague, he is buried at Kerbela. Although born in an Azeri Turkish-speaking area and himself writing in this dialect, he studied also early Ottoman poets, particularly the great Chagatai poet Nevai, and achieved a synthesis of all these influences and the Persian classics, soon becoming recognized as the great poet of the Turkish world. There is a pervading strain of melancholy in his work. This is very evident in his romance of the unhappy love of *Leyla and Mecnun*, a story well known in Muslim literature, which is imbued with mystic passion and contains some of his best poetry. His *Divan* (book of collected poems) contains most of his other works. Fuzuli's intense sincerity overcomes the restrictive clichés of conventional literary forms and communicates to the reader the poet's own emotion.

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FYFFE, WILL (1885–1947), Scottish comedian and character actor, was a native of Dundee—though the most popular song he sang was called "I Belong to Glasgow." As a child he toured with his father, a provincial actor, and played Polonius at the age of 15. Though he devoted himself to the music hall his acting ability was considerable, and in the long series of character sketches that he built round each of his songs—the Glasgow drunk, the village idiot, the sailor, the centenarian, the railway guard and others—he proved his mastery of the art of comic and also truly pathetic impersonation. He appeared in England (at the London Pavilion) for the first time in 1921 and scored an immediate success. During the 1930s he took part in a number of films, notably as the Scottish shepherd in *Owd Bob*. He died at St. Andrews on Dec. 14, 1947. (A. H. D.)

FYN (FÜNEN), the second largest island of Denmark proper, lies between the Jutland peninsula and the island of Sjaelland, with Little Belt to the west and Great Belt to the east. Pop. (1960) 376,872. Area 1,149 sq.mi. Fyn has three major administrative subdivisions: Svendborg amt (county) and two *amtsraadskredse* (county council districts) of Assens and Odense. Rich arable and pastoral farming has developed on the fertile clay loams of the low, undulating morainic landscape. The large manufacturing town, port and cathedral city of Odense (*q.v.*) lies well inland up Odense fjord. Other chief ports are Svendborg, Assens (*qq.v.*), Middelfart, Nyborg and Faaborg. (HA. T.)

FYT, JAN (1611?–1661), Flemish painter of animals, was born at Antwerp. He was registered apprentice to Hans van den Berghe in 1621. At 20, young Fyt entered the gild of St. Luke as a master, and from that time until his death in 1661 he produced a vast number of pictures in which the bold facility of Snyders is united to the powerful effects of Rembrandt. There never was such a master of technical processes as Fyt in the rendering of animal life in its most varied forms. He was not clever at figures, and he sometimes trusted for these to the cooperation of Cornelius Schut or Willeborts, while his architectural backgrounds were sometimes executed by Quellyn. "Silenus Amongst Fruit and Flowers," "Diana and Her Nymphs With the Produce of the Chase," and "Dead Game and Fruit in Front of a Triumphal Arch" are specimens of the co-operation respectively of Schut, Willeborts and Quellyn. These pictures are also Fyt's masterpieces. The earliest dated work of the master is a cat grabbing at a piece of dead poultry near a hare and birds, and executed in 1644. The latest dated work of Fyt is a "Dead Snipe With Ducks," of 1660.

He died in Antwerp on Sept. 11, 1661.

FYZABAD (FAIZABAD), a city and headquarters of a district of the same name in Uttar Pradesh, India, lies in the mid-Ganges plain on the right bank of the Gogra river. Pop. (1961) 88,296. Roads radiate from the clock tower which is the city centre and around which is the main shopping area. There are four high schools, five intermediate colleges, a degree-granting college and a public library. Golab Bari is an old walled garden laid out by the nawabs, and the newly laid out Guptar park is close to the city. Bahu Begam-ka-Maqbera (memorial tomb) built in 1860 is the most important old building. Fyzabad is connected by railway west with Lucknow (80 mi.), south with Allahabad (98 mi.) and southeast with Varanasi (121 mi.) The national highway from Lucknow to Gorakhpur passes through the city.

Fyzabad was founded by Sa'adat Ali Khan in 1730 and developed and fortified by Nawab Shuja-ud-Daula. His son Nawab Asaf-ud-Daula made Lucknow his capital and left Fyzabad to be the residence of the begums of Oudh.

FYZABAD DISTRICT stretches along the right bank of the Gogra which forms its northern boundary, and to the south lies the Gumti river and the district of Sultanpur. The area is 1,705 sq.mi., and pop. (1961) 1,633,359. The land is a fertile alluvial plain sloping gently toward the southeast. The climate is of monsoon type and the average rainfall 40 in. The people are mostly engaged in agriculture. Main crops cultivated are rice, wheat, oilseeds, millets and sugar cane. The town of Tanda (pop. [1961] 32,687) is well known for the production of hand-loom cloth of excellent quality which is exported. Near Fyzabad is Motinagar sugar factory. The ancient town Ayodhya (*q.v.*), birthplace of Rama, is on the right bank of the Gogra near Fyzabad city. (M. N. K.)

THE history of this letter began with the Latin alphabet. The Greek alphabet from which, through Etruscan, the Latin was derived, represented the voiced velar stop by its third letter *gamma* Γ, ⟨ or C. This passed into Latin and was used in its rounded form C, to represent the same sound in early times, *e.g.*, in the word RECEI (probably an early dative form of *rex*, "king"), occurring in an early Latin inscription. The letter, however, came to represent the unvoiced velar stop, thus ousting K. This was probably due to Etruscan influence. To avoid confusion a new letter G was differentiated from C and used to represent the voiced velar, while C henceforward stood for the unvoiced velar only. The new letter was placed in the alphabet in the place of Greek Z (*zeta*) which was not required in the Latin alphabet. (*See* ALPHABET.)

The uncial form of the letter in the 6th and 7th centuries was Ꮆ or Ꮆ. The form with rounded head Ꮆ, from which our minuscule *g* is derived, appears first in Latin cursive writing about the beginning of the 7th century taking the place of such earlier forms as . It was standardized in Carolingian as ᵹ. The minuscule flat-headed form was adopted by Irish writing of the 6th and 7th centuries, *e.g.*, ȝ or ȝ. Such a form had been in use in Latin cursive, *e.g.*, ȝ (5th cent.), ȝ (late 7th cent.), ȝ (7th or 8th cent.). A form ȝ appears in Merovingian (pre-Carolingian French) writing in the 8th century, and a descendant of this was adopted into the Carolingian hand, not being entirely ousted by the round-headed form till the 11th century.

The flat-headed form was adopted by the early English hand from the Irish and remained the only form of the letter in use in England until introduction of Carolingian writing by Norman scribes in the 12th century. Meanwhile certain changes had taken place in the sound represented by the letter. The voiced velar had become palatalized before the front vowels *e* and *i*. Thus the flat-headed form of the letter, the only form in use in pre-Norman England, represented the velar before back vowels, the palatal before front vowels. It also stood for the sound now represented by *y* initially before front vowels. In Middle English the palatal stop developed into the sound now represented by *j*, a similar change having taken place in the development of the Latin velar on the continent. This sound was therefore introduced to English ears by the Normans, and in the Middle English period we find the two forms of the minuscule letter in use to represent different sounds. ᵹ represented the voiced velar (modern "hard" *g*) and the sound of *j*, ȝ represented the palatal stop (γ) and the sound of *y*. As the palatal stop (in such words as *might, high, enough*, etc.) disappeared from the language, the use of the flat-headed form was discontinued. It survived in remote parts, and by its similarity to the form of *z* produced confusion with the latter.

In modern English the letter represents two sounds: (1) the voiced velar; (2) the sound of *j* (dž) before the vowels *e, i* and *y* in words of Romance origin—*gesture, ginger, gymnastics* (contrast *give, gilt*). The combination *gh* often has the sound of *f* (as in *cough, rough, laugh*), yet not consistently, for in some words it is silent (*ought, though, through*). (B. F. C. A.; J. W. P.)

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	1200 B.C.	𐤂
CRETAN	1100-900	𐌂
THERAEAN	700-600	𐌂, 𐌂
ARCHAIC LATIN	700-500	(𐌂)
ATTIC	600	𐌂
CORINTHIAN	600	𐌂 𐌂
CHALCIDIAN	600	𐌂
IONIC	403	𐌂
ROMAN COLONIAL	PRECLASSICAL AND CLASSICAL TIMES	C G
URBAN ROMAN		G
FALISCAN		C
OSCAN		C
UMBRIAN		(K)
CLASSICAL LATIN AND ONWARD		G

THE DEVELOPMENT OF THE LETTER "G" FROM THE PHOENICIAN, THROUGH THE LATIN DOWN TO MODERN FORM

In music, G is the name of the seventh note of the musical alphabet or otherwise the fifth note of the scale of C. It gives its name also to the treble (or violin) clef, the distinguishing sign of which denotes the G line. The sign was originally nothing but a capital G which in the course of time has come to assume, as the result of various changes of shape, the conventionalized form with which we are now familiar.

GA-ADANGME. The Ga-speaking people of Ghana live on the southeast coast from the river Densu on the west to the Laloi lagoon about 40 mi. to the east. To the north of the Ga are the Akwapim; to the west the Fanti; and to the east are the Adangme who inhabit the territory as far east as Ada (bordering with the Anlo and the Ewe proper) and as far north as Bisa. The Adangme are of the same stock as the Ga. Their languages are not mutually intelligible, but they are both Sudanic, of the Kwa subfamily and have a considerable vocabulary in common.

The Ga are descendants of immigrants who came in successive parties down the Niger and across the Volta between the end of the 16th and the beginning of the 18th century. They settled in six "towns," Accra, Osu, Labadi, Teshi, Nungwa and Tema, each town being a confederation of houses or patrilineages which forms a distinct political unit. The original Ga immigrants engaged in

farming side by side with the aborigines, the Kpesi people; hunting, sea fishing and trading in imported goods are now the principal occupations. The trading is predominantly in the hands of the women. Inheritance and succession to public offices, both religious and secular, are determined mostly by patrilineal descent, but succession to offices held by women and inheritance of women's property are in the female line. Each patrilineage has its own set of personal names, divided into two subsets used in alternative generations. The traditional religion is polytheistic and ancestral. Of the public religious ceremonies, the two most important are the *Kpledzo*, the annual religious feast of the *Kple* gods, and the *Homowo* in which the oneness with one's living and dead kin is given ritual expression. Politically, Accra became the most prominent of the Ga towns, and is now the capital of Ghana. Until the mid-19th century it was a confederation of seven separate units, Asere, Abola, Gbese, Sempi, Otublohu, Alata and Akumadzei.

The Adangme-speaking people are said to have migrated from Lake Chad, through northern Yoruba (Western Nigeria) and Dahomey, and across the Volta. They include the Ada, Yilo Krobo, Manya Krobo, Shai, Ningo, Prampan, Kpone and Osudoku. The Adangme are organized in localized patrilineages; farming is the chief occupation and among the Manya Krobo this is based on the *huza* system, in which a tract of land, usually purchased from a neighbouring Akan tribe, is parceled out among the purchasers, who are often kinsmen. Many Adangme live in farming settlements of this kind and the markets of the *huza* farms supply food crops to Accra and other towns both along the coast and farther inland. As among the Ga, religion is based on polytheism and ancestor worship; and annual rites, like the *Nmayem* of the Krobo, concerned with planting and harvest, have great prominence in their religious observances. Inheritance and succession are determined by patrilineal descent, and the political organization is based on the patrilineage.

See also M. Manoukian, "Akan and Ga-Adangme Peoples of the Gold Coast," *Ethnographic Survey of Africa, Western Africa,* part i (1950). (K. A. Bu.)

GA'ALIN, the name applied in the Sudan to Arab immigrants who penetrated up the Nile, at first as individual traders and later as settlers and conquerors, from the 14th century onward. They eventually occupied both banks of the river from Abu Hamed to Khartoum and spread widely through the country during the 19th century, when they were prominent as slave raiders ("Bahhara"), especially under the famous Zubayr Pasha (*see* Zobeir Rahama). Their chief towns are Shendi and Metemma, on opposite banks of the Nile about 300 mi. N.E. of Khartoum. They suffered severely from Egyptian reprisals after the assassination of Ismail Pasha by their king Nimr in 1822 and for their resistance to the Mahdist Emir Mahmud on his march north to meet Kitchener on the Atbara river in 1898. Under the condominium regime (1898–1955) and the subsequent republic the Ga'alin have been prominent in public life and commerce and form a high percentage of the civil service. *See* also Sudan, Republic of the: *History; Population.* (K. D. D. H.)

GABAR (*cf.* Arabic *kafir*, "non-Muslim," "infidel," and Turkish *giaour*), a term of contempt (also transliterated *guèbre*), was formerly applied to Zoroastrians in Iran but not to their Parsee brethren in India (*see* Parsees; Zoroastrianism). The Zoroastrians who remained in Iran after the Arab Muslim conquest in the 7th century A.D. purchased some toleration for their faith by paying the *jizya* (poll tax), not abolished until 1882. The gabars were treated as an inferior race, had to wear distinctive garb (other than ritual dress) and were not allowed to ride horses or bear arms. They were concentrated in the remote cities of Yazd and Kerman, where temples with the sacred fire still exist. The community's sufferings have ceased with wider tolerance of religious minorities but have left their mark in the dignified bearing and peaceableness characteristic of this ancient, good-living and thrifty people. Many live also in Teheran, the total in Iran being approximately 18,000 to 20,000, mostly merchants, some of notable wealth. The eight *dakhmahs* or "towers of silence" for exposure of the dead are no longer used, conformity in burial having been adopted. Since the 19th century, ties with the Parsees in India and, latterly, in Pakistan have been extensive, and the Parsees of Gujrat organized a society for the amelioration of the conditions of Zoroastrians in Iran, providing, among other things, facilities for education. The word *gabar* is now obsolete, together with the degradation it once connoted. (P. W. A.)

GABARDINE, the term applied in the cloth trade originally to a particular type of waterproofed fabric employed for the manufacture of raincoats, but later as a general description of several varieties of worsted, cotton, silk and union or mixture fabrics, embodying certain features in common and chiefly made into suits and overcoats. It is a relatively strong and firm cloth somewhat resembling whipcord, but of lighter texture.

Covert coating fabrics are virtually gabardines of a lighter texture suitable for summer wear and for use in hot climates.

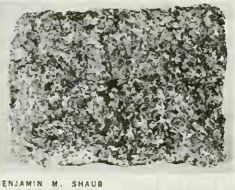
Because of the predominance of warp over weft threads in gabardine fabrics, the weft lies entirely at the back and is therefore not visible from the front, a circumstance which allows the use of weft of inferior quality without loss of durability, for only the warp surface is exposed to wear.

Although all varieties of gabardine fabrics have the same general textural appearance, they vary considerably in respect to the particular twill weave and in the character, quality and counts of material employed in their construction, as well as in the number of warp threads and picks of weft per inch in the fabric.

Some gabardine fabrics are produced entirely from cotton yarn. The better qualities of these are made from super-grades of combed twofold warp and weft, while those of coarser texture and inferior quality are made from single yarn both for warp and weft.

A so-called "voile gabardine" fabric of a more open and much lighter texture is produced entirely of silk. (H. N.; X.)

GABBRO, in petrology, is a group name for medium- or coarse-grained rocks consisting primarily of calcic plagioclase feldspar and pyroxene (*qq.v.*); essentially gabbro is the plutonic equivalent of basalt. The word is of Florentine origin but unknown etymology. Although basalt is often remarkably homogeneous in mineralogy and composition over vast areas, the gabbros are exceedingly variable. Gabbroic complexes may include sizable masses consisting almost entirely of plagioclase (anorthosite); of pyroxene and olivine (peridotite); of pyroxene alone (pyroxenite, hyperite); of pyroxene and plagioclase (norite). Banded or layered complexes in which these and other mono- or bimineral varieties (dunite, troctolite, etc.) are well developed have been described from Montana, the Bushveld in South Africa and the island of Skye. There are also gabbro complexes which, while locally streaky and inhomogenous, are not regularly layered. Among these may be cited the great Sudbury, Ont., basinlike intrusion or lopolith and some of the larger diabase sills, like those of Beaver Bay, Minn., the Palisades, N.J., and many of the Karoo diabases in South Africa. (For a brief description of lopoliths sills and other forms *see* the article Sills.)



BENJAMIN M. SHAUB

HORNBLENDE GABBRO FOUND NEAR SHELBY, N.C.

Prominent among the unlayered gabbro complexes are the so-called "massive" anorthosites, rocks consisting largely or entirely of plagioclase, exemplified by the famous Adirondack anorthosite, the Laramie, Wyo., complex and the anorthosites of eastern Quebec.

Gabbros and anorthosites are considerably less abundant than either basalt or granite, but the complexes in which they occur are nevertheless often of immense size. About 60,000 sq.mi. of eastern Canada is underlain by anorthosite, for instance, the Saguenay mass alone accounting for a tenth of this. The Morin anorthosite in the same area occupies 1,000 sq.mi. and the nearby Adirondack anorthosite is exposed over an area of about 1,500 sq.mi. The Bushveld complex underlies an area of about 20,000 sq.mi. and the Great Dyke of Rhodesia, another layered complex, has been traced for more than 300 mi.

Although these large masses are generally supposed to provide the best sample of the deep lithosphere, they often appear to be floored over most of their outcrop area; they are usually laccoliths, lopoliths or sills. The Canadian anorthosites are thought to be laccolithic, the Adirondack anorthosite a floored sheet. The thickness of the Sudbury lopolith is estimated at two miles, that of the Bushveld at three miles.

Gabbros are sometimes quarried for dimension stone (the "black granite" of commerce) and the San Marcos gabbro of southern California is used for gauge blocks, but the direct economic value of gabbro is slight. Far more important are the primary mineralizations of nickel, chromium and platinum, which occur almost exclusively in association with gabbroic or related ultrabasic rocks. Primary magnetite (iron) and ilmenite (titanium) mineralizations are often intimately associated with gabbroic complexes.

Origin and Composition.—In the layered gabbroic complexes it is rather generally assumed that segregation is attributable to some form of rhythmic or oscillatory crystal fractionation of basaltic magma under gravity control. Although there is much incidental laboratory support for the notion that any one of these varieties could crystallize from a magma of approximately basaltic composition, the notion that they in fact do so is substantially an *ad hoc* hypothesis, and the details of the process, particularly as regards the rhythmic or oscillatory nature of the fractionation, are vague. In the gabbro complexes that are not regularly layered, the passage between different members of a complex tends to be gradational rather than discontinuous, as in the layered variety. Interstitial micropegmatite, practically unknown in the sharply layered complexes, is common in these, in which it is not infrequently concentrated in rather irregularly bounded zones, seams or pods. Sometimes considered to be of hydrothermal origin, it is more often regarded as an end-stage derivative of crystal fractionation. At Pigeon point (Minn.), Beaver Bay, Sudbury and Duluth (Minn.) the micropegmatite occurs in masses large enough to collect and, sometimes, large enough to map. Field associations of this kind, together with much laboratory evidence based on phase equilibria, led to N. Bowen's hypothesis of the origin of granitic magma by crystal fractionation of basaltic magma. (*See* GEOCHEMISTRY: *Geochemistry of the Lithosphere: The Reaction Series*).

The plagioclase of the anorthosite members of layered complexes is ordinarily labradorite or bytownite but, in the absence of layering, plagioclase more basic than calcic andesine is uncommon. Anorthosite dikes are very rare, and effusive equivalents of anorthosite are unknown. The massive anorthosites, like the layered ones, are probably crystal accumulates, as suggested by Bowen, though the scale at which the process takes place must be staggering.

The Duluth lopolith is a notable exception to the rather arbitrary dichotomy between layered and unlayered gabbro complexes. The lower part of this mass has the average composition of an olivine gabbro but is strongly banded, individual bands varying in composition from anorthosite to peridotite. The upper portion is a comparatively homogeneous feldspathic gabbro, locally patchy and streaky but not sharply banded. Between the two major divisions, and again at the top of the feldspathic gabbro, is a zone of so-called "red rock," granophyre or micropegmatitic granite.

What is actually visible of most gabbro complexes is conveniently summarized by supposing that they are in general either of the sharply banded type, with ultrabasic derivatives, or of the unbanded type, with associated granitic or granophyric derivatives. The geology of the Duluth mass suggests that this distinction reflects observational limitations rather than any fundamental petrological distinction. (In this connection it may be noted that a granophyre facies occurs in the Bushveld complex, though there is much controversy about its relation to the gabbro.)

(F. Cs.)

GABELENTZ, HANS CONON VON DER (1807–1874), German linguist and ethnologist known for his studies of the Malayo-Polynesian and Mongolian languages, was born at Altenburg on Oct. 13, 1807. He studied at Leipzig and Göttingen and after 1830 held various public offices. He died at Lemnitz, in Saxe-Weimar, on Sept. 3, 1874.

Gabelentz is said to have learned no fewer than 80 languages, 30 of which he spoke fluently. Immediately after quitting the university he followed up his Chinese researches by a study of the Finno-Ugric languages, which resulted in the publication of his *Eléments de la grammaire mandchoue* in 1832. In 1837 he became one of the promoters and a joint editor of the *Zeitschrift für die Kunde des Morgenlandes*. His works include: *Grundzüge der syrjänischen Grammatik* (1841); a complete edition (with J. Löbe), with translation, glossary and grammar, of Ulfilas' Gothic version of the Bible (1843–46); articles on the languages of the Swahilis, the Samoyeds, the Hazaras, the Aimaks, the Formosans and other widely separated tribes in the *Zeitschrift der deutschen morgenländischen Gesellschaft; Beiträge zur Sprachenkunde* (1852), containing Dayak, Dakota and Cariri grammars; a *Grammatik und Wörterbuch der Kassiasprache* (1857); an edition of the Manchu translations of the Mongolian languages *See-schu, Schuking* and *Schi-king*, with a dictionary (1864); and *Die melanesischen Sprachen nach ihrem grammatischen Bau und ihrer Verwandschaft unter sich und mit den malaiisch-polynesischen Sprachen untersucht* (1860–73). The latter work deals with the languages of the Fiji islands, New Hebrides, Loyalty islands, New Caledonia, etc., and shows their strong affinity with the Polynesian class.

GABELLE, a form of tax in France before the Revolution; in particular, from the 15th century onward, the tax on salt. The ultimate origin of the name is uncertain, but in 1259 the name *caballa* is found applied in Provence to the salt tax. The monopoly over salt, under the name *salinaria*, had previously been a domanial right of local lords in Provence and on the coast of Languedoc. The word *gabelle* occurs in 14th-century French to denote any tax on the sale of consumer goods, but in the 15th century it begins to be applied without further specification to mean the salt tax.

The ordinance of Dec. 5, 1360, made it a permanent tax. From the beginning, however, it was not levied uniformly; regions that produced salt or provinces that were at that time under English rule were exempt. Elsewhere salt had to be bought from a *grenier* in the charge of a *grenetier* or from authorized *regratiers* or retailers. From 1370 the *sel du devoir* ("obligatory salt"), the minimum quantity estimated to be consumed by each family, was imposed annually on the countries of the *langue d'oïl*, a quota being assessed for every parish. Thus, the *gabelle*, in theory a tax on actual consumption, was turned into a distributory tax analogous to the *taille*. An ordinance of May 1680 finally settled the regional variations for the tax, the kingdom being divided between (1) *pays de gabelle*, including both *pays de grande gabelle*, in which the *sel du devoir* obtained, and *pays de petite gabelle*, where families were free to choose how much salt they took; (2) provinces where the tax was on production, not on purchase; and (3) *pays francs*, which were exempt. The clergy, nobility, members of the universities, royal officials (accordingly known as *francs-salés*) and charitable institutions were also exempt.

The high price and the unequal taxation provoked widespread contraband dealing in salt by smugglers known as *faux-sauniers*. Discontent over the *gabelle* was forcefully expressed in the lists of grievances drawn up for the estates-general of 1789, on the eve of the Revolution. The *gabelle* was abolished in March 1790.

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GABÈS, a town, port, oasis and governorate of eastern Tunisia, lies 143 km. (89 mi.) S. of Sfax by rail on the Gulf of Gabès. The gulf, known to the ancients as Syrtis minor, has extensive sandbanks uncovered at low water and, except for the Strait of Gibraltar and the Gulf of Venice, is the only part of the Mediterranean with a substantial tidal range (about eight feet at spring tides). The population of the town at the 1956 census was 24,420 (comm.), including 2,252 Jews and 1,664 Europeans—many of whom left in the late 1950s. The Gabès community lies chiefly

on the right (southern) bank of the Gabès wadi and consists of two adjacent villages, Djara and Menzel, extended toward the port by a modern quarter, and of eight villages in the oasis, of which Chenini (5 km., or 3 mi., S.W.) is the chief. The oasis to which Gabès owes its origin is irrigated by the Gabès and Bou Alloula wadies supplemented by artesian wells. Its dates (from about 200,000 date palms) are not of high quality by reason of the maritime climate, but it is noted for its orchards (apricots, peaches, pomegranates) and market gardens, yielding turnips, henna, onions, pimentos, tomatoes and tobacco.

Founded as the Roman Tacapae, Gabès prospered from the 9th to the 14th century, combining the profits of Saharan trade and of its weavers and fishermen with the resources of its oasis. Thereafter it declined, especially under Turkish rule, but during the French protectorate (1881–1955) it staged a modest revival, assisted by the construction of a metre-gauge railway, road network and port. The port is little used except by fishermen, owing to the competition of land routes.

GABÈS GOVERNORATE, with a population of 187,000 (1960 est.) and an area of 24,730 sq.mi., comprises the *délégations* (administrative districts) of Douz, El Hamma, Gabès, Kebili, Mareth, Matmata and Metouia. It embraces the oases of the Arad plain (including Oudref, Ghanouche, Zerkine-de-Kettana, Zareth) and the small, scattered oases of Nefzaova, partly inhabited by seminomads. In the hill district of Matmata, 45 km. (28 mi.) S. of Gabès are Berber cultivators of olives who live in remarkable underground dwellings. To the west the oasis of El-Hamma is the trading centre of the Beni Zid nomads. (J.-J. Ds.)

GABII, an ancient city of Latium 12 mi. E. of Rome on the Via Gabina (later the Via Praenestina). In early times it was sufficiently strong to resist the attack of Tarquinius Superbus (*q.v.*), who then made a separate treaty with it; this established isopolity (reciprocity of civic rights), and a copy survived in a temple at Rome until the time of Augustus.

By the 1st century B.C. Gabii had become insignificant, though its desolation is no doubt exaggerated by the poets. Its baths were well known, and Hadrian built a senate house and aqueduct. Its bishops are mentioned in ecclesiastical documents till the end of the 9th century. The ruins of the medieval fortress of Castiglione mark the primitive citadel, while the Roman town extended farther to the south; there is a ruined temple (250–200 B.C.); to the east lies the forum (excavated in 1792).

The Romans derived from Gabii a method of wearing the toga for certain ceremonies called *cinctus Gabinus*.

See T. Ashby, "Gabii and its Neighbourhood" in *Papers of the British School at Rome*, vol. i, pp. 180 ff. (1902); G. Pinza, "Gabii e i suoi monumenti," in *Bullettino della Commissione archeologica comunale di Roma*, xxxi, pp. 321 ff. (1903). (H. H. Sn.)

GABINIUS, AULUS (*d.* 47 B.C.), Roman politician and a supporter of Pompeius, attacked by Cicero in several of his speeches on both personal and political grounds. As tribune in 67 B.C. he proposed the *lex Gabinia* which conferred upon Pompeius immense powers for the conduct of the war against the Mediterranean pirates. Two other measures of Gabinius made loans of money to foreign ambassadors in Rome irrecoverable at law (as a check on senatorial corruption) and ordered the consuls to give audience to foreign envoys on certain fixed days (in February). Gabinius served as Pompeius' legate in the east (66–63), and as consul in 58 he helped Clodius to secure Cicero's exile. As proconsul of Syria (57–54) he reinstated Hyrcanus as high priest at Jerusalem, suppressed revolts, introduced administrative changes in Judaea and rebuilt several towns. He was sent by Pompeius to Egypt, without the consent of the senate, to restore Ptolemy XII Auletes to his kingdom. During his absence disturbances arose in Syria and Palestine, which he suppressed with some difficulty. He incurred the hostility of the *publicani* (tax-farmers), and on his return to Rome he had to face first a charge of *maiestas* (treason), on which he was acquitted, but he was then condemned for extortion and went into exile (54). Recalled by Caesar in 49, he fought for him in Illyricum (48–47) but died at Salonae (Split).

See E. M. Sanford, "The Career of Aulus Gabinius" in *Transactions of the American Philological Association*, vol. 70, pp. 64 ff. (1939); E. Badian, "The Early Career of A. Gabinius" in *Philologus*, Band 103, pp. 87 ff. (1959). (H. H. Sn.)

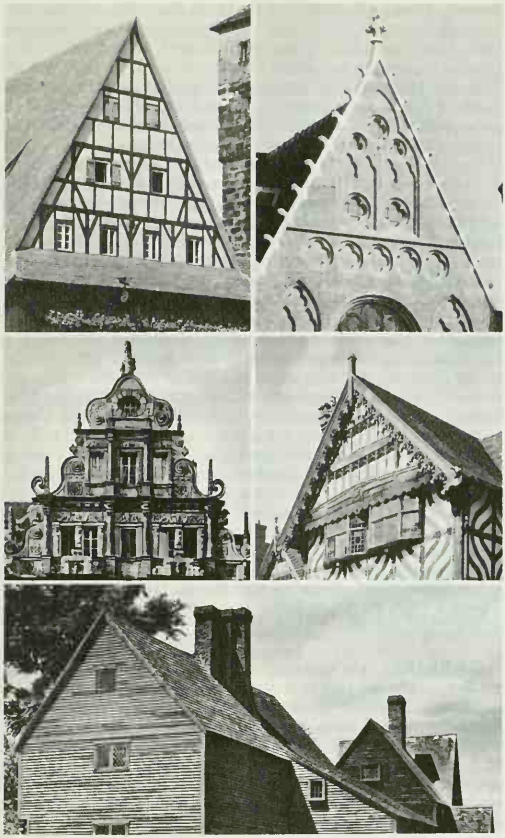
GABLE, (WILLIAM) CLARK (1901–1960), U.S. film star who reigned for almost a quarter of a century as the "king" among leading men. In a career that included more than 70 pictures (starting with bit parts in silent films as early as 1924), Gable rose to fame with his creation of a rough, no-nonsense, romantic hero—a role epitomized in his portrayal of Rhett Butler in *Gone With the Wind* (1939). Although he held no high opinion of himself as an actor, he won an Academy award for his performance in *It Happened One Night* (1934) and nominations for similar awards for his work in *Mutiny on the Bounty* (1935) and *Gone With the Wind*. His final role was as an aging cowboy in Arthur Miller's *The Misfits* (1960). He died of a heart attack in Hollywood on Nov. 16, 1960, less than two weeks after completing his last film.

Born in Cadiz, O., on Feb. 1, 1901, the only son of William H. Gable, an itinerant oil field worker, Gable worked at a variety of odd jobs as a youth and then joined the Ed Lilly stock company as callboy. He appeared on Broadway for the first time in 1928 in a leading role in *Machinal*. He was aided in this by his first wife, Josephine Dillon, a dramatic coach 17 years his senior whom he had married in 1924. With the introduction of sound films, Gable returned to Hollywood in 1930 and scored almost at once in a series of gangster roles. He remained under contract to Metro-Goldwyn-Mayer studios from 1931 to 1954, switching gradually to the light-hearted, adventurous parts for which he became most famous. After the death of his third wife, Carole Lombard, Gable enlisted in the U.S. army air corps during World War II; he won the Air Medal for "exceptionally meritorious achievement in five bomber missions" and achieved the rank of major. He was survived by his fifth wife, Kay Williams Spreckels, and a son born four months after his death. (A. Kt.)

GABLE, the upper part of the end walls of a building covered by a roof that slopes down from the centre to each side; hence the gable is always pointed in general form and usually triangular. In cases like the gambrel roof (*q.v.*), where the roof is in two slopes on each side, the gable becomes pentagonal. In classic work, where the slopes are low and where a cornice is continued across the end walls connecting the eaves, the gable is called a pediment (*q.v.*). The architectural treatment of the gable results from the effort to find a beautiful solution to the problem of keeping water out of the intersection of walls and roof. This was done either by carrying the roof out over the top of the end walls and finishing it with a molding, sloping cornices or a projecting, bracketed board known as a bargeboard (*q.v.*) or by carrying up the end walls above the roof level and capping them with a waterproof coping or cap. The former method is general in wooden buildings and in those of small size or little architectural formality; the latter is used in larger and more monumental masonry structures, particularly in the Gothic and early Renaissance styles.

In north and west areas of Europe, where roofs of steep pitch are general, gables are often richly decorated and finished at the top with a series of steps or fantastic breaks often curved, and in the Renaissance period further ornamented with obelisks, urns, statues and scrolls, as in the town hall of Bremen (1609), the Friedrichsbau at Heidelberg castle (*c.* 1590) or the town hall of Antwerp (1561). In England stepped and curved sided gables were common during the Elizabethan and Jacobean periods, as in many of the colleges of Oxford and Cambridge; more complicated forms, rich with scrolls and strap work, were used as decorations for wall coverings, as in Wollaton hall, Nottingham (last quarter of the 16th century). During the Gothic period gables were decorated with crockets (*q.v.*) and finials (*q.v.*) and sometimes, especially from the 14th century on, with tracery. Gables were also used purely as decoration, without roofs behind; the French flamboyant churches are unusually rich with examples of pierced and traceried gables, very similar to those of the porch of St. Maclou at Rouen (begun 1432).

Gables are important features in the architecture of China and Japan. In north China and Japan gables follow the roof slope and



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GABLED BUILDINGS: TOP LEFT: WEINSTADEL (WINE STORE), NÜRNBERG, GER., 1446–48; TOP RIGHT: KNIGHTS' HALL, THE HAGUE, NETH., 1280; CENTRE LEFT: RITTER HOTEL, HEIDELBERG, GER., RENAISSANCE PERIOD; CENTRE RIGHT: WHITWICK MANOR, STAFFORDSHIRE, ENG.; BOTTOM: IRONMASTER'S HOUSE, SAUGUS, MASS., 17TH CENTURY

are ornamented with rich projecting roof tiles, grotesque animals at the ridge and eaves and occasionally with surface patterns. In south China stepped gables are more common.

See also ROOF.

GABON REPUBLIC (RÉPUBLIQUE GABONAISE), since 1960 an independent state, formerly one of the four territories of French Equatorial Africa, lies athwart the equator fronting the Atlantic. Pop. (1961) 447,880, including about 4,000 Europeans or "assimilated persons." Area 103,317 sq.mi. About two-thirds of the country forms the basin of the Ogooué river and much of the rest is in the basins of the coastal rivers. Gabon is bounded north by Spanish Guinea (Río Muni) and the Republic of Cameroon, and east and south by the Republic of Congo.

Physical Geography.—The coastal plain, which in the south is narrow and is comprised of sandstone and alluvium, widens northward with outcrops of chalk, limestone and Cretaceous sandstones. South of Cape Lopez sand bars, caused by the Atlantic Benguela current which moves northward along the west African coast, form lagoons at the river mouths but north of the cape the current is no longer effective and the coast less regular, with the Gabon river forming a wide estuary. The interior relief is more complex though nowhere pronounced. In the north the Crystal mountains of crystalline rocks enclose basins with gentle hills flanking the valleys of the Woleu and N'Tem rivers and the Ivindo basin. Farther south the Ogooué flows through a great saddleback in which sandstone and schists outcrop to break into the plain through the granites at Lambaréné. In southern Gabon the coastal plain is dominated by granitic hills which are isolated by basins carved out of calcareous schists surmounted by sandstone, made use of by rivers such as the Nyanga and N'Gounié, an affluent of the Ogooué. Between the N'Gounié and the Ogooué the granites of the Chaillu massif, the country's main watershed, rise to more than 3,000 ft., Mt. Iboundji (5,165 ft.) being the highest point.

The climate of Gabon is equatorial with little distinction between seasons, abundant rain throughout the year and small variations in temperature. The cold Benguela current lowers the coastal temperatures and rainfall, which increase in the interior. Almost the whole country is covered by rain forest composed of more than 3,000 species, including the commercially valuable hardwood called okoume (Gabon mahogany, *Aucoumea klaineana*). Along the coast grow mangroves, pandanus and, in the lake region of the lower Ogooué, vast stands of papyrus. The varied fauna includes elephants, several varieties of monkeys, the giant anthropoid ape *Gorilla gorilla* discovered by Paul B. du Chaillu in 1856, antelopes, forest buffaloes and hippopotamuses.

The People.—A few thousand pygmies (Babinga) are dispersed in small groups in the forest, where they live by hunting and gathering food and in shelters of boughs and leaves. The most highly developed people, the Mpongwe on the coast, have been partly submerged by the Pahouin or Fang. In the northeast are tribes such as the Bakota related to groups in Cameroon. In the centre are the Kanda (Okande) but in the south some intermediate groups such as Bapunu are slowly declining. Animism is gradually yielding to Christianity spread by Protestant and Roman Catholic missionaries. In general land is collectively owned and managed by the chiefs; shifting cultivation is practised on plots cleared by burning.

The Fang language is spoken in the north and Bantu dialects are spoken elsewhere. French, adopted as the official language of the republic, is the medium of instruction in the schools. (J. D.)

History.—A number of small implements dating from the end of the Paleolithic and from the Neolithic periods have been discovered. The peoples of the Myéné language group (Mpongwe, Orungu, Galoa, Nkomi) at an early date occupied the lower Ogooué and the coast; the Mpongwe were already on the estuary by the 16th century. The Mitshogo-Okande group from the northeast occupied the centre. From the south came the Bapunu-Eshira, from the east the Mbédé-Aduma-Téké and from the north the Bakota. The Fang from the Cameroons migrated from the north in the 18th century and advanced to the middle Ogooué and the estuary in the 19th. The Bongom (Bakele), driven back from the Ivindo river, dispersed their groups of warriors and hunters throughout the country.

In about 1472 Portuguese navigators discovered the estuary which they named *gabão* ("hooded cloak") because of its shape. Soon afterward Lopo Gonçalves rounded Cape Lopez and in 1475 Ruy de Sequeira reached Cape St. Catherine, 100 mi. S. Portuguese from São Tomé often visited the coast for the trade in hardwood and ivory. In the 17th century the Dutch settled on Corisco Island from which they ravaged the Gabon estuary; the coast also attracted the English and French but the greater part of the trade remained Portuguese. The slave trade, nominally abolished in 1815, continued secretly until about 1880. Slaves from the interior were collected by Mpongwe, Orungu and Galoa traders and crowded into barracoons on the coast to await ships. In 1839 Capt. L. E. Bouet-Willaumez, charged with antislavery patrols, reached an agreement with "King" Denis, a local chief on the left bank of the Gabon estuary, and a few years later by a treaty with "King" Louis secured the right bank, where a fort was built in 1843. Christian missions were established 1842–44 and to a group of Mpongwe villages on the Gabon estuary was added a small settlement of refugee slaves; this town, together with the French fort, was in 1848 named Libreville. In 1855 Paul B. du Chaillu, an American of French origin, was commissioned to ex-

plore its delta and the Gabon estuary by the National Academy of Sciences, Philadelphia, Pa. His journeys, in the course of which he discovered the pygmies and gorillas, penetrated up the N'Gounié to the mountains that bear his name. The explorer A. M. A. Aymès (1867) and the British trader R. B. N. Walker (1873) attempted ascents of the Ogooué, whose confluence with the Ivindo was reached in 1874 by Alfred Marche and L. E. H. Dupont, marquis de Compiègne. Its source was reached in 1877 by Pierre Savorgnan de Brazza who in 1880 founded Franceville. In 1886 a French governor was appointed to Gabon, which was attached to French Congo (1889–1904) and then to French Equatorial Africa. Its frontiers with Cameroon were delimited in 1885 and those with Spanish Guinea in 1900. The pacification of the Fang, Bakota and Mitshogo lasted from 1904 until 1911.

In World War II Free French troops took over Gabon from the Vichy government in 1940. Gabon became in 1946 an overseas territory of France with its own territorial assembly, to which elections under universal suffrage were held in 1957. In 1958 the country became an autonomous republic within the French Community, and after concluding co-operation agreements with France declared its independence on Aug. 17, 1960. According to the constitution adopted Nov. 14, 1960, that replaced the constitution of Feb. 19, 1959, Gabon is a parliamentary democracy.

(Hu. De.)

Economy.—Most of the people live by subsistence agriculture (cassava, taro, bananas) or in the lagoon regions by fishing. Export crops include cocoa grown by the Fang in the Woleu-N'Tem region in the north and plantation rubber (*Hevea brasiliensis*) introduced at Lambaréné and Mayumba. The forests yield palm oil, ebony and coral wood as well as okoume, which is made into veneers and plywood in a factory at Port-Gentil. Rich mineral deposits include gold, mined since the 1930s, diamonds, rock salt, potash and petroleum from wells in the Cape Lopez district. There are important manganese deposits near Franceville, reached by a railway branching from the Congo-Océan line in Congo Republic. There are potential iron resources at Mékambo in the northeast and Tchibanga in the southwest, and uranium at Mounana near Franceville. The chief imports are foodstuffs, machinery and equipment and the chief exports timber, petroleum, palm oil and kernels, and cocoa. By the early 1960s petroleum exports had achieved a favourable balance of trade. Land communications are poor but Libreville and Port-Gentil are linked by air services with Paris and the main centres in western Africa, as well as with a number of Gabonese towns.

The capital is Libreville (*q.v.*); Port-Gentil is the chief port and industrial centre. Other towns are N'Djolé, the head of navigation on the Ogooué; Mouila in the south; Franceville on the upper Ogooué in the southeast; and Lambaréné, where in 1913 Albert Schweitzer (*q.v.*) founded his hospital. (J. D.)

See P. du Chaillu, *Explorations and Adventures in Equatorial Africa* (1861); R. W. Howe, *Theirs the Darkness* (1956); current history and statistics are summarized annually in the *Britannica Book of the Year*.

GABORIAU, ÉMILE (1832–1873), French novelist, founder of the *roman policier*, who has been described as the Edgar Allan Poe of France, was born at Saujon, Charente Inférieure, on Nov. 9, 1832. He wrote hastily, but with vivid imagination and realism, producing 21 lengthy novels (originally published in feuilleton form) in 13 years. He became secretary to Paul Féval (*q.v.*), and, after publishing several novels and miscellaneous writings, made his reputation with *L'Affaire Lerouge* (1866). His ensuing detective novels, many of them classics in their kind, included *Le Crime d'Orcival* (1867), *Monsieur Lecoq* (1869), *Les Esclaves de Paris* (1869), *La Vie Infernale* (1870) and *L'Argent des autres* (1874). Gaboriau died in Paris on Oct. 1, 1873.

See V. Williams, "Gaboriau: Father of the Detective Novel," *National Review*, lxxxii (1923); F. Fosca, *Histoire Technique du Roman Policier* (1937).

GABRIEL (Heb. "man of God"; Arabic Jabra'il or Jibril), in the Bible and the Koran, one of the archangels. Gabriel was the heavenly messenger sent to Daniel to explain the vision of the ram and the he-goat, and to communicate the prediction of the Seventy Weeks (Dan. vii, 15 ff.; ix, 21 ff.). He was also employed to announce the birth of John the Baptist to Zechariah, and that of our Lord to the Virgin Mary (Luke i, 18 ff., 26 ff.). It is because he stood in the divine presence (Luke i, 19; Rev. viii, 2; Tob. xii, 15) that both Jewish and Christian writers generally speak of him as an archangel. In the Books of Enoch "the four great archangels" are Michael, Uriel, Suriel (Raphael) and Gabriel, though elsewhere they are said to number seven. Gabriel's feast is kept on March 24, the day before the feast of the Annunciation. Both his name and his functions were taken over by Islam from Judaeo-Christian tradition. His name is mentioned in the Koran only three times, but various epithets are widely recognized as belonging to him (*e.g., al-ruh al-amin*, "the Faithful Spirit," in Sura xxvi, 192–195, who brings the revelation to Mohammed).

GABRIEL, JACQUES ANGE (or Ange Jacques) (1698–1782), French architect, creator of the Petit Trianon at Versailles, was born and died in Paris. Most celebrated of a family of accomplished architects, he was the son of Jacques V (1667–1742), whom he succeeded as premier architect to Louis XV and director of the Academy of Architecture in 1742. Among his royal commissions were the enlargements of Fontainebleau (1749) and the Louvre (1755), the châteaux at Compiègne (1751) and Choisy (1752), the grand project for Versailles (1763), and the École Militaire (1752). The magnificent Place Louis XV (now Place de la Concorde) in Paris (1755) shows him to have been an accomplished urban planner. His best-known work, believed to be one of the most beautiful buildings ever built, is the gracefully precise Petit Trianon (1762). The simple, highly refined architecture of Gabriel was esteemed for its elegance in an age that regarded elegance as commonplace.

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(H. Mn.)

GABRIELI, the name of two Italian composers, uncle and nephew, of the late 16th-century Venetian school.

Andrea (*c.* 1520–1586), born in Venice, studied with the Netherlands composer Adrian Willaert, at the time choirmaster at St. Mark's. Andrea is known to have traveled extensively in the Rhineland and Bohemia. He returned to Venice and in 1564 was appointed second organist at St. Mark's, where he remained, composing and teaching, until the death of Claudio Merulo, the first organist, to whose post he succeeded in Jan. 1585. He died in Venice in 1586.

The Venice into which Andrea Gabrieli was born was a city enriched by its trading with the east, with a superb architecture and colourful surroundings, and noted for the dignity and pomp of its public ceremonies and for the magnificence of the music of its religious services. It was in the Byzantine splendour of the church of St. Mark's that the greatest works of the Venetian school were created and where, in the second half of the 16th century, a new style of music was initiated; the Venetian style, which broke away from the traditions of the Renaissance, laid the foundations upon which the music of the baroque era was to develop. The use of double choirs, to which the architecture of St. Mark's was singularly well adapted, had been developed by Willaert and was brought to perfection by the Gabrielis, who also developed the *concertato*, or concerto, in which instruments, instead of merely doubling the vocal parts, were given an individual identity, being used both together with, and separately from, the voices.

During his lifetime Andrea was particularly famous for his madrigals. The first of these to be published was "Piangete, occhi miei" in V. Ruffo's collection of 1554; between 1566 and 1580 seven books of his madrigals were printed, several of them being reprinted more than once. His compositions were sought after by anthologists of the time. In *Gregesche e Giustiniane* (1571), to poems by his friend Antonio Molino, he developed a new comic style in vocal composition. In 1583 his *Psalmi poenitentiales a 6 voci* appeared and in the year of his death a collection called *Sonate a Cinque Instrumenti* was published, being compositions expressly designed for an instrumental ensemble. His organ compositions were no less important and paved the way for the organ

style of Girolamo Frescobaldi and J. P. Sweelinck. Among other works he also composed music for a performance of *Oedipus Tyrranus* of Sophocles, given in 1585, and a number of cantatas for the Venetian *signoria* to celebrate various political and military events such as the victory of Lepanto in 1571. It is in the great posthumously published collections such as *Concerti . . . per Voci et Stromenti* (1587), *Dialoghi musicali* (1592) and *Canzoni et Sonate* (1615), which also contain works by his nephew Giovanni, that Andrea's greatness is clearly shown.

GIOVANNI (1557–1612) studied music with his uncle Andrea in Venice and afterward probably spent some time under Orlando di Lasso at Munich. In 1585 he succeeded Andrea as second organist at St. Mark's, a post that he held until his death in Venice on Aug. 12, 1612. During his lifetime few collections of his works were published. Of these the most notable is the *Sacrae Symphoniae*, part 1 (1597), containing vocal and instrumental music in from 9 to 16 parts. His later works all appeared posthumously in 1615. Of these the most important are *Sacrae Symphoniae*, part II, *Canzoni et Sonate* (also containing works by Andrea) and *Reliquae Sacrorum Concentuum*, which also contains works by H. L. Hassler, his fellow pupil under Andrea. Giovanni's early works show a prodigious command of contrapuntal technique. With a sense of infinite variety he combines choruses of different registers and to the combination adds instrumental colour.

Giovanni's work before about 1600 is conceived within the general framework of Renaissance musical thought, and it was only in his later compositions that a new and revolutionary style showed itself in all branches of his work. An unprecedented use of dissonance and intensity of feeling for the setting of words, new rhythmic structures and, above all, his use of instruments in combination with voices separate him from the age of Palestrina. He uses such combinations as a six-part vocal choir with a second choir of six trombones in *Suscipe clementissime;* and in the *Sacrae Symphoniae*, part I, which contains 14 instrumental *canzoni* and two *sonatas*, groups or choirs of instruments are scored for; *e.g., Sonata pian'e forte* with one choir of one *violino* (viola) and three trombones and another of one *cornetto* and three trombones. A number of distinguished German and Italian musicians were among his pupils.

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GABRIELINO, an extinct Shoshonean group of California Indians that inhabited Santa Catalina island. Named from the Franciscan mission of San Gabriel, they numbered about 5,000. They shared their arts with the adjoining Chumash of Santa Barbara channel and had developed a religion with named gods. A form of this religion, referring to the supreme deity Chungichnish and making use of datura (a variety of nightshade) as a vision-producing narcotic, continued to spread to neighbouring tribes until after 1850.

GABRIEL Y GALÁN, JOSÉ MARÍA (1870–1905), Spanish poet who in his own works and by his researches encouraged the art of regional poetry. He was born at Frades de la Sierra, Salamanca, on June 28, 1870, and died at Guijo de Granadilla, Cáceres, on Jan. 6, 1905.

Chronologically he formed part of the famous "generation of 1898," though his spirit and preoccupation give him an independent role in opposing the poetry of *Modernismo* and in developing a style based on traditional, regional folk simplicity. He even wrote verse in the dialect of Spanish Extremadura, the most celebrated being *El Cristu Benditu* and *El Embargo*. Other works include *Castellanas* (1902); *Extremeñas* (1902); *Campesinas* (1904); and *Nuevas castellanas* (1905).

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GABRILOWITSCH, OSSIP (1878–1936), Russian-U.S. pianist and conductor, was born in St. Petersburg (Leningrad) on Feb. 7, 1878. He studied music at the imperial conservatory in that city under the personal supervision of Anton Rubinstein, winning the Rubinstein prize in 1894. Later he continued his studies under Theodor Leschetizsky in Vienna. At 18 he toured in Germany, Austria and England. In 1900 he first toured the United States, and this tour was followed by many others. He married Mark Twain's daughter, the singer Clara Clemens, in 1906. After having conducted in Munich and Vienna he settled in the United States in 1918 and became conductor of the Detroit symphony orchestra. Gabrilowitsch composed an *Ouverture Rhapsodie* for orchestra, an elegy for cello and piano pieces. He died in Detroit on Sept. 14, 1936.

GAD, one of the 12 tribes of Israel, claiming descent from Jacob and Zilpah, Leah's maid (Gen. xxx, 11). The territory of Gad lay to the east of the Jordan, and the more usual term for this district is Gilead (*q.v.*), a name that might be used for the tribe as well as for its territory. (*See* TWELVE TRIBES OF ISRAEL.)

The name is also that of a god of fortune, originally, perhaps, Aramaean, whose name occurs not infrequently in compound place names; and of a seer at the court of David, referred to especially in I Chron. xxi.

GADAG, a town in Dharwar district, Mysore state, India, lies 43 mi. E. of Dharwar town. Pop. (1961) 76,614. It is an important junction on the Southern railway with trade in cotton and silk, cotton stuffs and peanuts. There are factories for ginning and pressing, peanut-oil mills and a spinning and weaving mill. The suburb of Betigeri is noted for medium and coarse handloomed saris. There are two colleges affiliated to Dharwar's Karnatak university. Gadag's temples exhibit fine carving and inscriptions dating from the 10th century A.D. Its old name was Kratapura. It is a place of historic importance, containing many ancient monuments, including the Trikuteshwara temple and Saraswati shrine of the Chalukyan period. Kumara Vyasa, the 15th-century Kanarese epic poet and author of *Kannada Bharata,* resided at Gadag. (V. V. B.)

GADARA, an ancient city of Palestine, a member of the Decapolis (*q.v.*), now represented by the ruins of Umm Qays in Jordan, on the summit of a hill about 6 mi. S.E. of the Sea of Galilee. Gadara first appears in history as falling to Antiochus the Great (218 B.C.). Alexander Jannaeus took it after ten months' siege (*c.* 100 B.C.). Pompey restored it (64–63 B.C.) and Augustus gave it to Herod the Great (30 B.C.). Vespasian was voluntarily welcomed by its citizens. There are remains of three large theatres, a basilica, a temple and a colonnaded street. Hot springs in the Yarmuk valley added to the city's attractions. According to Strabo, several well-known littérateurs were Gadarenes: Philodemus, the Epicurean and epigrammatist; Meleager, the anthologist; Menippus, the satirist; Theodorus, the rhetorician. However, there may in some cases be a confusion with Gazara (Gezer, in western Israel). It is questionable whether the Gospel narrative of the Gadarene swine and the healing of the demoniac is associated with Gadara. (E. D. GR.)

GADDI, the name of a celebrated family of 14th-century Italian painters, active in Florence, 1318–96, comprising GADDO DI ZANOBI (documented 1318/19, still alive in 1327), by whom no works are known, his son TADDEO, and his grandsons AGNOLO and GIOVANNI. Two of these painters, Taddeo and Agnolo, were among the most important Florentine artists of their time.

TADDEO GADDI (*c.* 1300–1366), a pupil of Giotto, is sometimes assumed to have participated in Giotto's altarpiece of the Coronation of the Virgin in the Baroncelli chapel in Sta. Croce, and to have been responsible, while in close association with Giotto, for a panel of St. Stephen (Horne museum, Florence). His earliest authenticated work is a small triptych in the Kaiser Friedrich museum, Berlin, signed and dated 1334. In 1341–42 he seems to have been employed in S. Miniato al Monte outside Florence and in S. Francesco at Pisa. His most extensive works, the frescoed scenes from the life of the Virgin in the Baroncelli chapel in Sta. Croce, were probably completed in 1338. In these the figure style stems from Giotto, but is modified by a new concern with light. Between 1347 and 1353 Taddeo Gaddi painted a polyptych for S. Giovanni Fuorvicitas at Pistoia, while a "Virgin and Child" in the Uffizi gallery, Florence, from S. Lucchese at Poggibonsi, is

signed and dated 1355. The latter work maintains much of the dignity and weight of Giotto's figure style. Possibly about 1338, Taddeo Gaddi decorated the sacristy cupboards in Sta. Croce with panels representing scenes from the lives of Christ and of St. Francis; with one exception (in Berlin) these panels are in the Accademia in Florence. Enclosed in decorative frames, these are perhaps the most distinguished narrative panels of the generation after Giotto's. In 1363 Taddeo painted a fresco (lost) in the Mercanzia Vecchia and in 1366 is mentioned in documents for the last time. G. Villani and F. Sacchetti supply evidence of Taddeo Gaddi's considerable reputation, and his work is highly praised in the *Commentari* of the sculptor Lorenzo Ghiberti.

ALINARI

DETAIL FROM "VIRGIN AND CHILD" BY TADDEO GADDI. 1355: FROM S. LUCCHESE AT POGGIBONSI. IN THE UFFIZI GALLERY, FLORENCE, ITALY

AGNOLO GADDI (*c.* 1350–1396), son of Taddeo, was employed in Rome in 1369, as an assistant of his brother Giovanni (d. 1383) on frescoes for Pope Urban V. Between 1383 and 1386 he designed medallions of the Virtues for the Loggia dei Lanzi in Florence, which were carved by Jacopo di Piero Guidi, and between 1387 and 1395 his name appears as the designer or gilder of sculptures carved for the façade of the Duomo. His death in 1396 left unfinished the Altar of the Crucifixion in S. Miniato al Monte outside Florence. His most ambitious works are the frescoes in the choir of Sta. Croce in Florence, probably painted in the mid-1380s and certainly completed before 1395. They illustrate the Legend of the Cross, and in their figure style, their loose, flat compositions and their light palette are redolent of late Gothic mannerism. Between 1394 and 1396 Agnolo painted a cycle of scenes from the life of the Virgin and the legend of the Holy Girdle in the Cappella della Cintola in the cathedral at Prato, and subsequently (with G. Starnina) decorated the Castellani chapel in Sta. Croce in Florence. A facile and prolific painter, Agnolo Gaddi commanded neither the gravity of his father nor the decorative charm of his follower, Lorenzo Monaco.

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(J. W. P.-H.)

GADE, NIELS VILHELM (1817–1890), Danish conductor and composer inspired by folk music. Born at Copenhagen, Feb. 22, 1817, he studied the violin under F. T. Wexschall and composition under A. P. Berggreen who introduced him to Danish poetry and folk music. His overture, *Echoes from Ossian*, won the Copenhagen Musical society's prize in 1840. Both Mendelssohn and Schumann, who wrote of him in the *Neue Zeitschrift für Musik*, were attracted by the Scandinavian character of his music, and in 1843 Mendelssohn conducted his first symphony in Leipzig. In the following year and also in 1847 the Gewandhaus concerts in Leipzig were conducted by Gade. He was conductor of the Copenhagen Musical society in 1850, and in 1866 was appointed one of the directors of the Copenhagen conservatory. In 1876 he conducted his cantatas, *Zion* and *The Crusaders*, at the Birmingham festival for which he also wrote the cantata *Psyche* (1882). His works include eight symphonies, three ballets, a violin concerto and chamber works. He died at Copenhagen, Dec. 21, 1890. Gade's early works, spontaneously reflecting the spirit of Danish folk tunes, were among the first 19th-century examples of national music. Under the influence of Mendelssohn, his later works show greater technical command, but often at the expense of the ingenuous style which had made his earlier works attractive. His *Aufzeichnungen und Briefe* were edited by Dagmar Gade (1894).

See W. Behrend, *N. W. Gade* (1918) and *Minder om N. W. Gade* (1930).

GADIDAE, a family of fishes including the cod, whiting, hake and haddock (*qq.v.*) economically important fishes that inhabit the waters of the northern hemisphere. *See* also FISH.

GADIFER DE LA SALLE (*c.* 1340–*c.* 1422), French soldier and explorer, partner of Jean de Béthencourt in the conquest of the Canary Islands, came of a noble Spanish family that settled in Poitou *c.* 1330. He took part in the campaigns against Edward III of England during the Hundred Years' War, capturing the castle of Lusignan for the French in 1373. He was rewarded with the appointment of chamberlain to Jean de France, duc de Berry. Gadifer met Béthencourt while on crusade with Louis II of Bourbon against Tunis (1390) and afterward at the court of Orléans. Together they planned the expedition to the Canary Islands, which left La Rochelle on May 1, 1402. For its subsequent history, and for a description of the various manuscripts of *Le Canarien*, a contemporary account of the expedition, *see* BÉTHENCOURT, JEAN DE.

Gadifer, after his return to France in 1404, took part in Jean Boucicaut's expedition to Genoa and later became seneschal of Bigorre, which office he held until his death.

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GADOLINIUM is a silver white, moderately ductile metal of the rare earth group that is used for special electronic components, high-temperature refractories, magnetic cooling, many research purposes and as an alloying agent. It has the highest absorption cross section for thermal neutrons of any natural element (37,600 barns; 1 barn = 10^{-24} sq.cm.), and this property suggested its possible use in nuclear reactor control rods. The large cross section of gadolinium is attributed to the isotopes Gd^{155} and Gd^{157}, which are converted to Gd^{156} and Gd^{158} respectively by the absorption of thermal neutrons.

The symbol for gadolinium is Gd, its atomic number is 64 and its weight is 157.25. Naturally occurring stable isotopes of mass numbers 152, 154, 155, 156, 157, 158 and 160 are known. It reacts slowly with oxygen and with water. Below 18° C. the metal is ferromagnetic and at very low temperatures is super-conducting. Its melting point is 1312 ± 15° C.; the density of the hexagonal, close-packed structure is 7.868 g. per cc.

Credit for the discovery of gadolinium is shared by J. C. G. de Marignac and P. E. L. de Boisbaudran. In 1880 Marignac separated a new rare earth (oxide) from samarskite; in 1886 Boisbaudran obtained a fairly pure sample of the same earth, which, with Marignac's assent, he named gadolinia in honor of the Finnish chemist J. Gadolin. Gadolinium occurs in many minerals along with the other rare earths, but commercially it is obtained primarily from monazite. Bastnasite, gadolinite, xenotime and euxenite are other important ores; it also occurs in the products of atomic fission. Before World War II it was purified chiefly by fractional crystallization, but now ion exchange techniques are used for commercial production. The metal has been produced by thermoreduction of the anhydrous chloride by calcium.

Gadolinium is trivalent in all of its compounds and in solution and behaves as a typical rare earth. Its ionic radius is 0.938 Å. Its salts are white and its solutions are colourless. The Gd^{3+} ion has discrete, sharp absorption bands in the ultraviolet region of the spectrum that may be used for analysis. The ion is strongly paramagnetic because of the presence of unpaired electrons. Gadolinium salts were first used for magnetic cooling to produce temperatures below 1° K. (−272 C.). (LD. B. A.)

GADSDEN, JAMES (1788–1858), U.S. soldier, diplomat and railroad president, was born in Charleston, S.C., May 15, 1788. He graduated from Yale college in 1806 and engaged in business in his native city until 1812, when he was appointed a lieutenant of engineers in the U.S. army. In 1820 he was made responsible

for the establishment of military posts in Florida and supervised the removal of the Seminole Indians to southern Florida in 1823. Gadsden negotiated the treaty for the removal of the Seminoles to the west in 1832 and served in the war which followed the refusal of some Seminoles to leave Florida. (*See* also FLORIDA: *History.*) In 1840 he became president of a railroad in South Carolina.

Gadsden's most important public service followed his appointment as U.S. minister to Mexico in 1853. He was instructed to negotiate a treaty for the purchase of territory south of the Gila river through which ran the most desirable route for a railroad from the southern states to the Pacific. He succeeded in adjusting certain minor issues and in gaining a cession of territory in what is now southern New Mexico and Arizona. This added territory, which included the route of the proposed southern railroad, is generally known as the Gadsden Purchase (*q.v.*). Gadsden died at Charleston, Dec. 26, 1858. (H. W. BY.)

GADSDEN, a city of northeastern Alabama, U.S., the seat of Etowah county, is on the Coosa river, 65 mi. N.E. of Birmingham, in the foothills of the Appalachian mountain system. Pop. (1960) city, 58,088; standard metropolitan statistical area (Etowah county, including the town of Attalla), 96,980. (For comparative population figures *see* table in ALABAMA: *Population.*) Alabama City was annexed by Gadsden in 1932.

Gadsden is in the iron and coal region of Alabama and has abundant hydroelectric power from the Coosa river. Among its manufactured products are iron and steel, textiles, automobile tires and metal fabricated products. It is also in a rich agricultural region; the principal products are cotton, produce, grain and livestock.

The city was founded in 1840 and named for James Gadsden, southern railroad promoter who later (in 1853 while serving as minister to Mexico) negotiated the Gadsden Purchase. Emma Sansom, Confederate heroine, lived near Gadsden. In 1863 she guided Gen. Nathan Bedford Forrest across flood-swollen Black creek, enabling him to capture Col. Abel D. Streight and his command. Gadsden was incorporated as a city in 1871. (B. CR.)

GADSDEN PURCHASE. While it ended the bitter Mexican War, the treaty of Guadalupe Hidalgo (Feb. 1848) did not resolve all difficulties between the United States and the republic of Mexico. Article xi made the U.S. government responsible for preventing Indian raids into northern Mexico, but Apache depredations were heaviest in the years immediately following the treaty. The dominating problem, however, concerned the international boundary. The 1848 treaty established the natural boundary of the Rio Grande as the international line from El Paso eastward to the Gulf of Mexico, but it failed to provide a positive demarcation west of El Paso to the Pacific. Stipulating no longitude or latitude, the 1848 treaty merely declared that the boundary from El Paso westward should coincide with the line shown on Disturnell's map (1847).

When a joint Mexican-American survey party met in 1851 to locate landmarks on Disturnell's line, the map was found to be seriously inaccurate in that El Paso was placed 34 mi. N. of its actual site. This gave Mexico an unexpected advantage, which its commissioner, P. G. Condé, was determined to maintain. Condé's eventual compromise with the U.S. commissioner, J. R. Bartlett, was acceptable to the Whig administration of President Fillmore, but it was repudiated immediately by the Democratic expansionists who returned to office under Franklin Pierce in 1853. The Bartlett-Condé agreement was particularly noxious to the new secretary of war, Jefferson Davis of Mississippi, because it would mean the loss of about 3,000,000 ac. in the Mesilla valley, just west of El Paso. Davis strongly advocated a southern route in the construction of any transcontinental railroad; he argued, and with good reason, that the most practical route to California was across the Mesilla valley and then through the Gila river valley, which was altogether on the Mexican side of the 1848 line.

On the urgent recommendation of Davis, the South Carolinian railroad president James Gadsden (*q.v.*) was sent to Mexico as U.S. minister in May 1853. The major object of Gadsden's mission was to acquire all the territory needed for a transcontinental railway route—and as much additional land as President Santa Anna might be willing to sell. Gadsden was instructed to propose five alternative cessions to Santa Anna, the largest to include all of Lower California, and he was authorized to offer as much as $50,000,000. On Dec. 30, 1853, Gadsden concluded a treaty with Santa Anna, by which Mexico would relinquish the Mesilla valley and would cede 19,000,000 ac. south of the Gila river. Other adjustments were also incorporated: article xi of the 1848 treaty was abrogated; Mexico agreed to drop all claims for Indian depredations; and the United States assumed the Tehuantepec claims of the New York speculators P. A. Hargous and A. G. Sloo. The payment to Santa Anna's government was to be $15,000,000.

Gadsden had struck an admirable bargain, but his treaty became the subject of violent sectional debate when it reached the U.S. senate. Northern spokesmen, fearing as always the possible extension of slavery into the new lands of the southwest and still hoping to see a transcontinental railroad built elsewhere, argued that the territory was worthless. But protreaty lobbying by the New York speculators was vigorous, and southern senators finally achieved ratification by drastically amending the whole document.

The revised version was approved by a close vote on April 25, 1854, but not until the payment to Mexico had been cut to $10,000,000 and the total area of the cession reduced proportionately. Santa Anna placidly accepted these alterations, and the treaty was proclaimed on June 30, 1854. In Mexico the transaction was loudly denounced by Santa Anna's many rivals, and that veteran politician's career ended with banishment on a charge of high treason in 1855.

The Gadsden Purchase, as the cession came to be called, should be viewed as the final step in the Democratic program of "Manifest Destiny" that dominated the decade of the 1840s. As finally defined by the senate, the cession was bounded on the east by the Rio Grande, on the north by the Gila river and on the west by the Colorado river. Its area has often been given as 45,535 sq.mi., but this figure is much too large. In his *Report on the United States and Mexican Boundary Survey* (1857–59), Maj. William H. Emory set the total at 26,185 sq.mi. A more exact modern approximation is 29,640 sq.mi., of which 27,305 are within the present limits of the state of Arizona and comprise 24% of the area of that state.

BIBLIOGRAPHY.—The standard reference is Paul N. Garber, *The Gadsden Treaty* (1923), but *see* also the extended comments in Hunter Miller (ed.), *Treaties and Other International Acts of the United States,* vol. vi, pp. 293–437 (1942). Summaries are in J. Fred Rippy, *The United States and Mexico,* rev. ed. (1931) and James M. Callahan, *American Foreign Policy in Mexican Relations* (1932). A convenient review is Frank C. Lockwood's article, "The Gadsden Purchase," in *Arizona Quarterly,* vol. 2, pp. 5–16, (1946). (Jo. A. C.)

GADWALL, the common name of the fresh-water duck *Anas strepera,* also known as the gray duck or canvasbelly, which has long been esteemed for the table. Its habits and distribution are very similar to those of the common wild duck (*see* DUCK). It breeds in widely scattered locations, usually away from the seashore, across northern and eastern Europe, northern Asia and North America. It usually occurs in twos and threes or in mixed flocks with other ducks. The usual habitat is lakes, ponds, rivers and marshes; the nest, built among thick grass or underbush, is down-lined and contains 7–13 whitish eggs.

The gadwall's small head, flat back, elongated form and elevated stern render it easily recognizable. In coloration the two sexes are almost equally sombre, but the drake exhibits chestnut upperwing coverts. Both sexes resemble the female of the mallard in colour, but the white secondary quills form one of the most readily perceived characteristics of the species. (G. F. Ss.; X.)

GAEA (GE), the Greek personification of the earth as a goddess. Mother and wife of Uranus (heaven), from whom the Titan Cronus, her last-born child by him, separates her, she is mother also of the other Titans, of the Cyclops, the Giants and the Erinyes; hence literature and art sometimes make her the enemy of Zeus. Gaea, therefore, may have been originally a mother-goddess worshiped in Greece before the Hellenes introduced

the cult of Zeus. At Delphi she had preceded Apollo as oracle, and there and elsewhere she was associated or equated with her Titan daughter Themis (*q.v.*). Less worshiped in historic times, Gaea was described as the giver of dreams and the nourisher of plants and young children. (H. W. Pa.)

GAELIC LANGUAGE: *see* Celtic Languages.

GAELIC LITERATURE: *see* Irish Literature: *Gaelic Literature;* Scottish Literature: *Gaelic.*

GAETA, a town in Latina province, Lazio (Latium), Italy, a seaport and naval station and the seat of an archbishopric, lies 59 mi. (95 km.) N.W. of Naples, on the Via Flacca which links it with Rome and Naples. Pop. (1961) 21,441 (commune). Outside the walls the town has a modern appearance, but within them the character of a fortified square is preserved. The cathedral (1106, restored 1792) suffered considerable damage in World War II; it has a Romanesque-Moorish campanile (12th–13th centuries), and a banner of the victor of Lepanto and contains a museum. The castle, of Norman origin, the lower part of which dates from *c.* 1279, dominates the old town from the south. Monte d'Orlando (a public park) is supposedly the site of the grave of Caieta, the nurse of Aeneas, after whom the town was named. The tomb of the consul L. Munatius Plancus (d. after 22 B.C.), the founder of Lyons, is located there. West of this eminence, near the sanctuary of the Trinity, is the "cleft mountain," a vertical fissure running down to sea level. There is an oil refinery and a glassworks. Fishing, other maritime activities and agriculture are additional occupations. The principal import is raw petroleum; chief exports are petroleum products, bottles, fresh and preserved fish, vegetables, wine and fruit. Gaeta first came into contact with the Romans after the first Samnite War (*see* Roman History). A road was built *c.* 184 B.C. connecting the town with the port and the place became a holiday resort. After the fall of the western empire Gaeta remained loyal to Byzantium and preserved its freedom throughout the Gothic and Saracen invasions. In the 8th century it was a marine republic and after 915 an autonomous duchy. It capitulated to the Normans in 1140 and under them achieved importance. In the 15th century it was the centre of struggles for succession to the throne of Naples. The town was occupied by the Austrians from 1707–34. In 1806, after a heroic defense, it fell to the French (*see* Naples, Kingdom of).

The capitulation of Gaeta in 1861 marked the unification of Italy. (P. Co.)

GAETULIA, a district in the north of Africa, which in Roman writings comprised the wandering tribes of the southern slopes of Mount Aures and the Atlas as far as the Atlantic and the oases in the northern part of the Sahara. They were distinguished from the Negro tribes to the south and belonged to the Berber peoples who formed the population of Numidia (*q.v.*).

The modern tribes of this area are probably of the same stock and retain the same wandering habits. They were noted for the rearing of horses, were clad in skins, lived on flesh and milk, and the only manufacture connected with their name is that of purple dye.

GAFENCU, GRIGORE (1892–1957), Rumanian statesman, foreign minister at the outbreak of World War II, was born in Bucharest on Jan. 30, 1892. His grandfather was a Scot named Saunders; his father added Gafencu to his name, married a Rumanian woman and became a naturalized Rumanian subject. Their son took a law degree at Geneva (1912) and took up journalism after World War I, becoming publisher and editor of *Argus,* a leading Rumanian economic journal, in 1924. He joined the National Peasant party and in 1928 was elected to the chamber of deputies. He was undersecretary of state for foreign affairs in the first two cabinets of Iuliu Maniu (1928–30 and 1932–33) and minister of industry and trade in the short-lived third (1933). After Maniu's final quarrel with King Carol II, Gafencu went back to journalism and founded *Timpul,* which became the best Bucharest daily.

On Dec. 21, 1938, King Carol, by then dictator, appointed Gafencu minister of foreign affairs as a gesture to the western democracies, but on June 2, 1940, he dropped him as an act of appeasement toward Nazi Germany and Fascist Italy. Appointed minister to the U.S.S.R., Gafencu remained in Moscow until June 22, 1941, then returned to Rumania, which he soon left for Switzerland. His two books—*Préliminaires de la guerre à l'Est* (1944; Eng. trans., 1945) and *Derniers jours de l'Europe* (1946; Eng. trans. 1946)—are penetrating analyses of the events of 1939–41 and of Soviet-German relations in particular.

After World War II, Gafencu moved to Paris and took some part in Rumanian politics in exile. On Nov. 11, 1947, in Bucharest, he was sentenced *in absentia* to 20 years' imprisonment. Of great intelligence and charm, Gafencu was known as the handsomest man in Rumania. He died in Paris on Jan. 30, 1957. (B. Br.)

GAFSA, a town, oasis and headquarters of Gafsa governorate on the edge of the desert in western Tunisia, lies 127 mi. (204 km.) W.S.W. of Sfax by rail and 146 mi. (235 km.) by road. Pop. (1956) 24,345 (commune). The town stands on rising ground between the ruined 15th-century kasba (fort) and the oasis; to the southeast are the suburbs of El-Ksar (where the railway station is) and Lala. The oasis, irrigated by artesian wells drilled along a fault, contains about 200,000 olive trees as well as date palms and fruit trees (apricots, oranges, figs, lemons). Gafsa is descended with unbroken continuity from ancient Capsa, a Numidian and later a Roman town. Important traces of epi-paleolithic culture (Capsian) have been discovered in the region.

Gafsa Governorate (pop. [1961 est.] 279,100) includes the phosphate-mining concessions of Métlaoui, Redeyef, M'Dilla and Moularès, which extend as an almost desert tract westward to the Algerian frontier, the Djebelia villagers to the east and the great confederation of the Hamâma nomads. These remain shepherds and gatherers of alfa (esparto) grass, sow wheat, corn and barley in the flooded depressions, and some of them cultivate olives in the Sibi-bou-Zid district to the northeast. (J.-J. Ds.)

GAGARIN, YURI ALEKSEYEVICH (1934–), who made the first manned space flight, was born near Gzhatsk in the *oblast* of Smolensk, U.S.S.R., on March 9, 1934. The announcement of the flight revealed that Gagarin, a major in the Soviet air force, was launched at 9:07 A.M. Moscow time on April 12, 1961, in the 4¾-ton spaceship "Vostok." He circled the earth in 1 hr. 48 min. at a maximum speed of 18,000 m.p.h. and at a maximum height of 187 mi., landing at a predetermined spot in the Soviet Union without ill effects. During the flight he maintained radio contact with earth and was able to operate controls and make notes while in the state of weightlessness.

The son of a carpenter on a collective farm, Gagarin's early education was interrupted by World War II. In 1951 he graduated with distinction as a molder at a vocational school near Moscow. He later studied at the industrial college at Saratov and concurrently took a course in flying. On completing this course in 1955 he entered the military aviation school at Orenburg.

Gagarin, hailed throughout the world as "the Columbus of Interplanetary Space," was awarded the Order of Lenin, and given the titles of Hero of the Soviet Union and Pilot Cosmonaut of the Soviet Union. (W. J. Bp.)

GAGE, THOMAS (1721–1787), British general and colonial governor of Massachusetts. The second son of the first Viscount Gage, he entered the army in 1741 and saw service in Flanders and in the battle of Culloden. In 1754 he sailed with his regiment (the 44th) to America and took part in Gen. Edward Braddock's disastrous expedition. In 1758 he organized and became colonel of a regiment of light infantry (the 80th) and served in Jeffery Amherst's operations against Montreal. He was made governor of Montreal, promoted major general in 1761 and lieutenant general in 1770. In 1763 he succeeded Amherst as commander in chief of the British forces in North America, the most important and influential British post in the colonies, which he continued to hold until 1775. In 1774 he was appointed governor of Massachusetts and in that capacity was entrusted with carrying into effect the Boston Port act. The difficulties which surrounded him in the execution of his office at this time of the gravest unrest culminated in 1775, and the action of April 19 at Lexington initiated the American Revolution (*q.v.*). After the battle of Bunker Hill, Gage was

superseded as commander in chief by Howe and returned to England. He became general in 1782 and died on April 2, 1787.

See John R. Alden, *General Gage in America* (1948); Clarence E. Carter (ed.), *The Correspondence of General Thomas Gage*, 2 vol. (1931–33). (B. KN.)

GAGERN, a family prominent in German politics in the first half of the 19th century.

HANS CHRISTOPH, Freiherr von Gagern (1766–1852), was born on Jan. 25, 1766, at Klein Neidersheim, near Worms. Educated at Leipzig (1781–83) and at Göttingen (1783–84), he entered the Nassau-Weilburg administration in 1786 and was appointed chief minister by the prince, Frederick William, in 1788. He then proceeded to distinguish himself as a German patriot in the opening phases of the French Revolutionary Wars, making himself the leading exponent of plans for the arming of the whole German nation in 1793–94, through his pamphlet "Appeal of a German Nobleman to his Compatriots." He went to Paris as envoy for Nassau in 1801 and again in 1805–06, when he secured some accretions of territory for Nassau within the Confederation of the Rhine. He thus came into close contact with Talleyrand, and Gagern was at Napoleon's headquarters during the victorious campaign against Prussia in 1807. Leaving the Nassau service in 1811, he went to Vienna, where with Joseph von Hormayr and the archduke John he planned an insurrection in the Tirol (1812). Expelled from Austria in 1813, he went first to Switzerland, then to the Prussian headquarters. After several diplomatic missions, he was appointed administrator of the Orange principalities (1814) and then Netherlands envoy to the congress of Vienna (1815) and to the German *Bundestag* at Frankfurt (1816–18).

In the *Bundestag* he hoped to achieve too much, so that his role in the debates was unrealistic. Like other German patriots, he was disappointed when small states pursued their own interests instead of building up the *Reich* of which he had dreamed. In 1820 he became a member of the *Landtag* of Hesse-Darmstadt. His memoirs, *Mein Antheil an der Politik*, five volumes (1823–44), show his disillusionment. Gagern died at Hornau, near Höchst, on Oct. 22, 1852.

FRIEDRICH BALDUIN, Freiherr von Gagern (1794–1848), Hans Christoph's eldest son, was born at Weilburg on Oct. 24, 1794. Entering the Austrian army in 1812, he took part in Napoleon's Russian campaign and then in the war against Napoleon. Transferred to the Netherlands service in 1814, he fought at Waterloo as a captain. Seconded to his father at Frankfurt (1816), he completed his education at Heidelberg. In 1825 he was with the federal German military commission at Frankfurt. When the Belgians revolted against Dutch rule (1830–31), Gagern served as chief of staff to Prince Bernhard of Weimar against them. An open-minded man, in contact with many of his famous contemporaries, he visited Russia (1839) and undertook a mission to the East Indies (1844–46). He was appointed governor of The Hague in 1847, but the revolutionary events of 1848 called him back to Germany. As commander in chief of the Baden government's troops, he was shot by Friedrich Hecker's partisans on April 20, 1848, near Kandern, when he was trying by oral negotiations to restrain them.

HEINRICH WILHELM, Freiherr von Gagern (1799–1880), Hans Christoph's second son, was born in Bayreuth on Aug. 20, 1799. Wounded at Waterloo (1815), he then went as a student to Göttingen and to Jena, where he played an active part in the *Burschenschaft* (*q.v.*). Entering the Hesse-Darmstadt government service in 1821 and elected to the *Landtag* of 1832, he advocated a liberal policy. This led to his leaving the state service in 1833, and in subsequent meetings of the *Landtag* he was outspoken against the government. The troubles of 1848, however, resulted in his being appointed chief minister of Hesse-Darmstadt in March, but he soon devoted himself to the movement for German unity. Having exercised a decisive influence in the *Vorparlament* (*see* GERMANY: *History*), he was on May 19, 1848, elected president of the national assembly in Frankfurt, one day after its stormy opening. He secured the election of the Austrian archduke John as *Reichsverweser* or regent of the *Reich;* but when the Austrians left the ministry after the split between "Great" and "Little" Germans, Gagern himself became its head (Dec. 15). Three days later he presented to the assembly his project, the *Gagern'sches Program*, for the unification of Germany without Austria, which would remain connected with the *Reich* only in a loose form of union. After virulent contention, the assembly accepted the program, but on March 21, 1849, it rejected Gagern's proposal that Frederick William IV of Prussia should be elected hereditary emperor. Gagern thereupon resigned. He continued, however, to conduct the assembly's affairs and won a majority for his Prussian policy, but Frederick William finally refused the imperial title. Gagern left the assembly in May. In 1850 he went to serve with the army against Denmark. In 1862 he openly declared himself for Austria's "Great German" plan. Having been minister for Hesse-Darmstadt at Vienna from 1864 to 1872, he died at Darmstadt, a forgotten man, on May 22, 1880.

MAXIMILIAN, Freiherr von Gagern (1810–89), Hans Christoph's tenth and youngest son, was born at Weilburg on March 25, 1810. After experience in the Netherlands civil service and army (1829–33), he qualified as *Privatdozent* in history at Bonn in 1837. In the "Cologne Church controversy," however, he openly took the Roman Catholic side against Prussia; and the increasing bitterness of the dispute led him to give up teaching in 1840 and to enter the Nassau government service. He was himself converted to Roman Catholicism in 1843. Elected to the Frankfurt national assembly in 1848, he was in August appointed undersecretary of state for foreign affairs in the ministry of the *Reich*. In the spring of 1849 he undertook the celebrated "Gagern mission," touring the German courts in the hope of persuading them to offer the imperial dignity to Prussia. He was a deputy in the Erfurt Union parliament in 1850. Leaving the Nassau service in 1854, he was in 1855 appointed a ministerial councilor to the Austrian foreign office, on the recommendation of Leopold I, king of the Belgians. In 1881 he was made a member of the Austrian upper chamber (*Herrenhaus*). He died in Vienna on Oct. 17, 1889.

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GAGLIANO, MARCO DA (*c.* 1575–1642), Italian composer chiefly remembered for his operas. Born at Gagliano, near Florence, he worked in Florence, from about 1608 to 1625, as organist to Cosimo II de' Medici. In 1607 he visited Duke Ferdinando Gonzaga of Mantua, staging his opera *Dafne* at Mantua in 1608. *Il Medoro*, composed with Jacopo Peri in 1619, is lost; *La Flora* was produced in Florence in 1628. Gagliano kept to the simple pastoral idiom of the Florentine *camerata* (*see* OPERA), though his recitative is musically richer than Peri's or G. Caccini's, and he provides a greater variety of set numbers. His work seems pale, however, beside the dramatic and musical grasp of C. Monteverdi's *Orfeo* (Mantua, 1607). He also published sacred music and madrigals between 1594 and 1630. He died in Florence on Feb. 24, 1642.

See H. Goldschmidt, *Studien zur Geschichte der Italienischen Oper* (1901); D. J. Grout, *A Short History of Opera* (1947). (B. L. TR.)

GAG RULES, a series of resolutions passed in the U.S. house of representatives, between 1836 and 1840, providing that all petitions relating to the subject of slavery would be tabled without being printed, referred to committee or discussed. There was no similar action taken by the senate. These petitions flooded congress after the foundation of the American Anti-Slavery society (1833), reaching a total of 412,000 in 1838–39, signed by more than 2,000,000 persons. The first gag rule was the Pinckney resolution of 1836. It was followed by the Hawes and Patton resolutions (1837), the Atherton resolution (1838) and the Johnson resolution (1840), which was adopted as standing rule 21 on Jan. 28, 1840. Abolitionists were greatly disturbed by these infringements on the constitutional right of petition and gained increased support nationally. They supplied expert advisers, such as Theodore Dwight Weld, to a house group, led by former Pres. John Quincy Adams and Joshua R. Giddings, which attempted to get rule 21 repealed at the start of each session, finally succeeding on Dec. 2, 1844.

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GAILANI, AL-, name of an eminent religious family of Baghdad. Descent is traced from the founder of the Qadiri sect of the Sunni (traditionalist) branch of Islam, 'Abdul Qadir al-Dijli (or al-Gailani), who was born in the Gilan province of Iran, and spent a lifetime (1077–1166) of study, preaching, teaching and writing in Baghdad. He mingled elements of sufism (mysticism) with orthodoxy and attained a remarkable contemporary and posthumous position. This led to wealth in landed property and trusteeships, which survived some persecution under later caliphs, and under the Mongol destroyers of Baghdad (1258). The family, maintaining throughout the centuries a famous mosque and pilgrim guesthouse in Baghdad, acquired and retained both extensive foreign (especially Indian) connections and a position of high (mainly unofficial) authority in Iraq, with a close devotion to the Turkish sultan-caliph. The *Naqib al-Ashraf* ("head of the descendants of the Prophet") of Baghdad, with precedence in orthodox Islamic circles, was and is of the Gailani family. In modern Iraq, the first prime minister of the state (1920) and kingdom (1921) was 'Abdul Rahman al-Gailani who, new to politics and administration, rendered great services in state-building; a later Gailani prime minister, Rashid Ali, nominal leader of the abortive anti-British military insurgence of 1941, returned from exile to Baghdad in 1958 but rapidly lost the initial favour of the revolutionary government.

See article "'Abd al-Kadir al-Djilani" in *Encyclopaedia of Islam*, vol. i, 2nd ed. (1960); S. H. Longrigg, *Iraq 1900 to 1950* (1953). (S. H. Lo.)

GAILLARDIA, a genus of showy North American herbs of the family Compositae (*q.v.*), consisting of about 20 species, mostly from the far west and commonly known as gaillardia or blanketflower. All have yellow or yellow and red sterile ray flowers and fertile purple disk flowers. Two annual species, *G. amblyodon* and *G. pulchella*, are popular and widely grown in gardens and borders, and the perennial species, *G. aristata*, one of the last plants in the garden to die in autumn, for the large handsome heads. All are easily grown in most garden soils and preferably in full sun. (J. M. BL.)

GAINESVILLE, a city in north-central Florida, U.S., is situated approximately 60 mi. S.W. of Jacksonville and 120 mi. N. of Tampa. Founded in 1854 as the seat of Alachua county and named for Gen. Edmund Pendleton Gaines (1777–1849), U.S. army officer, it was incorporated as a town in 1869 and as a city in 1907. (For comparative population figures *see* table in FLORIDA: *Population.*)

During the 19th century, Gainesville was an agricultural trading centre, first for cotton farmers and later for citrus and vegetable producers. Freezes in the 1890s destroyed orange groves, and both citrus culture and truck gardening were moved to more southerly regions of the state. The East Florida State seminary, established in Ocala in 1853, was relocated in Gainesville in 1866 and was the cultural centre of the town, which contained fewer than 4,000 people at the turn of the century.

In the 20th century the city's growth paralleled that of the University of Florida. In 1905 Florida reduced the number of state-supported colleges from eight to three, and led by merchant William N. Wilson and Mayor William R. Thomas, Gainesville offered land, money and free water in perpetuity to win the University of Florida (so named in 1903) from Lake City, where it was located. The university and East Florida seminary were then consolidated as the new state university. The few hundred students of the first years in Gainesville increased in number to more than 13,000 in the second half of the 20th century. A medical centre, with a medical school and a teaching hospital, was added to the university in 1956; the hospital serves an area with a population of more than 1,000,000. The Florida State museum, with a large collection of Indian artifacts and wildlife specimens, and the Sunland Training centre for exceptional children who are unable to care for themselves are located in Gainesville.

Agriculture and industry also contributed to the city's growth. Watermelons, cucumbers, squash, tomatoes and other truck-garden crops are shipped from Gainesville in late spring and early summer. Electronics, wood products, meat packing, building materials, moss processing and other light industries provide employment.

Gainesville has a council-manager type of government, in effect since 1921. Broad avenues divide the city into quadrants, but within them are many narrow streets and few parks. Oak, pine, magnolia, dogwood, redbud, azaleas and camellias shade and beautify streets and yards. Near the city are Newnan's lake; the Devil's Millhopper, a picturesque sinkhole; and Payne's prairie, a wildlife preserve. The latter perpetuates the name of a Seminole Indian chief whose people once inhabited the area, and who in 1812 led his warriors in battle against the forces of Col. Daniel Newnan. (R. W. PA.)

GAINSBOROUGH, THOMAS (1727–1788), one of the foremost English painters of portraits and landscapes, was born on May 14, 1727, at Sudbury, in Suffolk, the youngest son of John Gainsborough, a maker of woolen goods. About 1740 he was sent to London to study and worked in the studio of Hubert Gravelot, the French painter and engraver. Gainsborough must have met Francis Hayman, who undoubtedly influenced his work, but there is no evidence that he was his pupil, as is suggested in most of the early biographies. In 1746 he married, in London, Margaret Burr, the illegitimate daughter of the duke of Beaufort. Soon after this he returned to Suffolk and about 1752 settled in Ipswich, where he made the acquaintance of his first biographer, Philip Thicknesse, and of Joshua Kirby, the first president of the Society of Artists. Gainsborough early acquired some reputation both as a portraitist and landscape painter and had no difficulty in making a living. In 1759 he moved to Bath, where his studio was soon thronged with visitors. He moved in musical and theatrical circles, and among his friends were members of the Linley family, whose portraits (now in the Dulwich gallery, London) he painted. It was also at Bath that he met David Garrick, who became a lifelong friend. His devotion to the work of Van Dyck was fostered by a visit to Wilton, where he made a free copy of the famous portrait of the Pembroke family. In spite of the demands for portraits, however, he continued to paint landscapes.

In 1761 he sent a portrait—the "Earl Nugent"—to the exhibition at the Society of Artists, and in the following year the first notice of his work appeared in the London press. Throughout the 1760s he exhibited regularly in London and in 1768 was elected a foundation member of the Royal Academy. In 1774 he moved to London and settled in part of Schomberg house in Pall Mall. In the early part of 1781 Gainsborough was commissioned to paint King George III and Queen Charlotte, whose portraits appeared in the Royal Academy exhibition of that year, and after this he was in constant demand at court. In 1784 he quarreled with the academy about the hanging of his portrait "Three Elder Princesses," and removed all the pictures intended for showing that year. He never again showed at the Royal Academy but held private exhibitions at Schomberg house. In the 1780s Gainsborough painted some of his best-known landscapes and a series of "fancy pictures," portraits of pretty country children. He died on Aug. 2, 1788, and was buried at Kew, Surrey.

Unlike most of his contemporaries Gainsborough did not go abroad to study, and was contemptuous of the fashion for history painting. He knew, however, that the language of his art must be learned somewhere and he turned his attention to the Dutch and Flemish painters. His early landscapes show the influence of J. Wynants and J. van Ruisdael in the detailed treatment of the foliage and plants and in the general design, notably the "Cornard Wood" (National gallery, London) finished in 1748. The "View of Dedham" (National gallery of Ireland) is more original in its feeling for the gray light of England, and in the background to "Mr. and Mrs. Andrews" (collection of G. W. Andrews) he approached the realism of Constable. But this soon gave place to a more generalized and poetic view of landscape, reflecting the French pastoral tradition and also the landscapes of Gaspard Poussin, then so popular in England. Gainsborough relied on memory rather

than direct study of nature and often worked from model landscapes set up in his studio. "The Harvest Wagon" (Barber institute, Birmingham) painted in the 1760s is one of his loveliest landscapes, a perfect blend of the ideal and the real. Among the best known of his later landscapes are "The Watering Place" (1775, Tate gallery, London) and "The Market Cart" (1786, National gallery, London). During the years in London he painted a number of pictures of idealized country scenes including "The Cottage Door" (Huntington collection, San Marino, Calif.). He also painted some sea pieces somewhat in the Dutch manner. Some of the "fancy pictures" of country children painted in these years, *e.g.*, the "Cottage Girl with a Pitcher," show a quasi-Wordsworthian approach to nature and are experimental not only in subject matter but also in technique, very thin oil paint being used almost as water colour.

Gainsborough was the only one of the great English portrait painters of the 18th century who also composed landscape drawings in great numbers and in a variety of techniques, including chalk, wash and water colours, some of them varnished. He made in addition a number of soft-ground etchings and constructed his own magic lantern with a number of glass slides painted by himself (now in the Victoria and Albert museum, London).

Gainsborough said landscapes were his real love but he was continually distracted by the demands of portrait painting. The portrait heads painted in Suffolk, if sometimes a little stiff, are penetrating character studies and are delicately penciled. Among the most distinguished are the "Self Portrait" (collection of Lady Cholmondeley) and "Mr. and Mrs. Kirby" (Fitzwilliam museum, Cambridge). While in Suffolk he painted a number of delightfully spontaneous portrait groups—small figures in landscapes, closely related to conversation pieces—that included "Mr. and Mrs. Brown" (collection of Lady Cholmondeley) and the more sophisticated "Heneage Lloyd and his Sister" (Fitzwilliam museum, Cambridge). The "Painter's Daughters Chasing a Butterfly" (National gallery), composed in the last years at Ipswich, is, in its easy naturalism and sympathetic understanding, one of the best of English portraits of children.

After he moved to Bath, Gainsborough had to satisfy a more worldly clientele, and although he tried to preserve the simple unconventional character of his early work, he had to combine it with a more formal and elegant style which he based on that of Van Dyck. "Miss Ford" (1760, Cincinnati Art museum) is an essay in the grand manner, but "Mrs. William Henry Portman" (*c.* 1768, collection of Viscount Portman) is a fine character study, full of humanity, and distinguished by rhythmical drawing and delicate gray tones. His best portraits of men date from this time, notably "Sir Benjamin Truman" (collection of Messrs. Truman, Hanbury and Co.).

BY COURTESY OF HENRY E. HUNTINGTON LIBRARY AND ART GALLERY

"THE BLUE BOY" BY THOMAS GAINSBOROUGH, 1779. IN THE HENRY E. HUNTINGTON LIBRARY AND ART GALLERY

When he went to live in London his portraits of women became more ethereal, and their flickering ribbons and laces seem to melt into the landscape background. "Mrs. Sheridan" (*c.* 1785, Washington, D.C., National gallery) and "Mrs. Robinson" (1781, Wallace collection, London) are insubstantial characters, but exquisitely painted. Unlike his great rival Sir Joshua Reynolds, he was less successful with men at this time, particularly public figures, but "Johann Christian Fischer" the hautboy player (1780, Buckingham palace, London) is one of his most inspired works of this period. "The Morning Walk" (1785, National gallery, London), a picture of Squire Hallet and his wife, sums up both the elegance and the informality of the 18th century. Gainsborough's many other works include "The Blue Boy" (Master Jonathan Buttall; Huntington collection, California) and "Mrs. Siddons" (National gallery, London).

Of all the English 18th-century painters, Gainsborough was the most versatile and original, always prepared to experiment with new ideas and techniques. He was not, like Reynolds, a master of formal composition, but was devoted to his craft and always sensible of the poetry of paint. His letters reveal a lively character with a pretty wit and a genius for friendship.

See PAINTING: *Great Britain;* PORTRAIT PAINTING: *Baroque and Rococo; see* also references under "Gainsborough, Thomas" in the Index volume.

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GAINSBOROUGH, a market town and urban district in the Parts of Lindsey, Lincolnshire, Eng., lies on the eastern bank of the Trent 18 mi. N.W. of Lincoln by road. Pop. (1961) 17,276. A tidal bore or eagre of the Trent reaches the town and achieves a height of several feet. Gainsborough's early importance as the headquarters of the local Saxon tribe of the Gainii was augmented in the 11th century by its adoption as a military base by Canute the Dane. It was spelled Gegnesburh in 1013 and probably became a borough by prescription, for mention is made of burghal tenure in 1280. The town assumed trading and marketing functions by virtue of its location on a navigable river and on the main road from London to the north. It developed the dual function of an inland port and district centre for the surrounding agricultural area. Markets are held on Tuesday (dating back to 1296) and Saturday. There is a weekly fatstock market, and there are two charter fairs or marts. Buildings of note include the parish church of All Saints, which is largely 18th-century but retains its Perpendicular tower, and the 15th-century Old Hall, a first-class example of a manor house preserved in almost original form. In 1589 Gainsborough grammar school was founded following the granting of a charter by Elizabeth I. The Congregational church (1897) commemorates John Robinson (*q.v.*), pastor of the Pilgrim Fathers at Leiden, Neth. The town's main industries are agricultural and general engineering, malting, milling and timber. Light industries concerned with the manufacture of corsetry, hosiery and underwear have been established. There is a good deal of barge traffic on the river and shipbuilding takes place on the Nottinghamshire side of the Trent. The town's central area, which suffered damage from air raids in 1942, was redeveloped after the war. Gainsborough is associated with St. Ogg's of George Eliot's *Mill on the Floss.* (J. E. BE.)

GAIRLOCH, a village and civil parish of Ross and Cromarty, Scot., on the sea Loch of Gairloch, lies 74 mi. W.N.W. of Inverness by road. Pop. (1951) 1,991. A holiday place with sandy beaches and splendid views of the coast and mountains (Beinn Alligin and Baosbheinn), Gairloch also has extensive herring, cod and salmon fisheries. The parish includes Loch Maree (12 mi. long by ¾–2½ mi. broad), with its cluster of islets. One of these, Isle Maree, contains a ruined chapel, some ancient graves and a well whose waters were believed to cure madness. According to tradition this island was the hermitage of St. Maree or Maelrubha, a 7th- to 8th-century Irish monk. The Beinn Eighe nature reserve and the Inverewe garden (owned by the Scottish National trust), with subtropical plants, are also in the parish. Of the islands round the coast, only Isle Ewe in Loch Ewe is still inhabited.

GAISERIC (GENSERIC), king (A.D. 428–477) of the Vandals and Alani (*qq.v.*), succeeded his brother Gunderic in 428 at a time when the Vandals were settled in Baetica (southern Spain). In May 429 he transported all his people, said to number 80,000, to Africa. It is reported that he was invited to Africa by Count Bonifacius (*q.v.*), who wished to use the military strength of the Vandals against the forces of the central Roman government, by whom he had been declared an enemy. Gaiseric caused great devastation as he moved eastward from the Strait of Gibraltar

across Africa. He turned on Bonifacius, defeated his army, and besieged him in Hippo Regius (Bône in northeastern Algeria) in the summer of 430. He raised the siege in July 431, and severely defeated the joint forces of the eastern and western empires which had been sent against him. Hippo fell into his hands soon afterward. In 435 Gaiseric concluded a treaty with the Romans by the terms of which the Vandals retained Mauretania and part of Numidia and became *foederati* ("allies under special treaty") of Rome. But on Oct. 19, 439, Gaiseric surprised Carthage, thus striking a devastating blow at Roman power. An invasion of Italy was feared, and in fact a Vandal attack was made on Sicily. In 441 a powerful east Roman force set sail to retake Carthage but had to be recalled because of Hun pressure on the Danubian frontier; and in 442 a treaty was arranged by the terms of which the Vandals were recognized as the masters of proconsular Africa, Byzacena, and part of Numidia, *i.e.* the north of modern Tunisia with northeastern Algeria (*see* AFRICA, ROMAN PROVINCE OF). At a later date Gaiseric's son Huneric was betrothed to Eudocia, the elder daughter of the western emperor Valentinian III. The Vandal fleet now controlled much of the western Mediterranean. Sardinia, Corsica, the Balearic Islands as well as Sicily were annexed. Gaiseric was even able to interfere in the eastern empire and to threaten the grain route from Egypt to Constantinople. His most famous exploit was, however, the capture of Rome in June 455. For a fortnight the Vandals occupied the city and plundered it systematically, carrying off many valuable works of art, including the treasures which the emperor Titus had taken from the Temple of Jerusalem in A.D. 70. Their prisoners included the empress Eudoxia and her two daughters. Gaiseric subsequently defeated two major efforts of the Romans to overthrow him, that of the emperor Majorian (*q.v.*) in 460 and that led by Basiliscus (*q.v.*) in 468. He died undefeated in 477.

See L. Schmidt, *Geschichte der Wandalen* (1942); C. Courtois, *Les Vandales et l'Afrique* (1955). (E. A. T.)

GAITÁN, JORGE ELIÉCER (1902–1948), Colombian statesman and penologist, was born in Bogotá on Jan. 26, 1902. He studied law at the National university, Bogotá, and continued his studies in Rome, where he was a student of Enrico Ferri and followed closely the early development of fascism.

In Colombia he became known as a champion of the people and founded a short-lived party called Union Nacional Izquierdista Revolucionaria or UNIR (Left Revolutionary National union). His maiden speech as a congressman was a polemic argument on the Santa Marta banana plantations owned by the United Fruit company (1928). He served as mayor of Bogotá (1936) and minister of education (1940).

In 1946, as the leader of the more radical factions of Liberals, he ran for the office of president in opposition to the official Liberal party candidate, Gabriel Turbay. As a result of this split in the ranks of the Liberals the victory went to the Conservative party candidate, Mariano Ospina Pérez. Gaitán's growing popularity seemed to indicate that his eventual election to the presidency was assured, but he was assassinated in Bogotá on April 9, 1948, while the ninth International Conference of American States was meeting. The infuriated populace rioted and set fire to the central part of the city. (G. As.)

GAITSKELL, HUGH TODD NAYLOR (1906–1963), British statesman, leader of the Labour party from 1955 to 1963, was born in London on April 9, 1906, of a family with a long record of public service. Gaitskell achieved distinction in three fields—education, administration and politics. From school at Winchester he went to New college, Oxford, where he gained a first-class honours degree in philosophy, politics and economics. On the outbreak of World War II in 1939 he was reader in political economy at London university. Hugh Dalton, a former colleague at the university, then persuaded him to leave his academic work and join the civil service; for most of the war he was Dalton's right-hand man at the ministry of economic warfare. It was also on Dalton's advice that he decided to leave the civil service and go into politics. The Labour landslide in 1945 brought him into parliament as member for Leeds South. Within six months he was a junior minister and in 1947 was appointed minister of fuel and power. He became minister of state for economic affairs after the election of 1950 and succeeded Sir Stafford Cripps as chancellor of the exchequer in October that year. He presented only one budget before the Labour government's defeat in 1951.

In opposition Gaitskell became a devastating critic of Conservative policies, and by his brilliance, energy and sheer integrity was chosen to succeed C. R. Attlee as leader of the opposition in Dec. 1955. Having established himself as leader, he had to face the disappointment of defeat in the 1959 general election. But the climax of his career came at the Labour party conference in Oct. 1960 when the party executive was defeated by supporters of unilateral nuclear disarmament. Gaitskell's struggle to reverse this decision and then to reunite the party called forth all his talents. His sudden death, in London on Jan. 18, 1963, came at a time when he was at the height of his influence. (D. H. E.)

GAIUS (CAIUS), **SAINT,** pope from about 283 to about 296, is said to have been a Dalmatian and even a relative of the emperor Diocletian. His epitaph was found in the cemetery of Calixtus. His feast day is April 22. (J. V. HN.)

GAIUS, a celebrated Roman jurist of the 2nd century A.D. Of his personal history very little is known. It is impossible to discover even his full name, Gaius or Caius being merely the personal name (praenomen) so common in Rome. His works were composed between the years 130 and 180, at the time when the Roman empire was most prosperous and its government the best. Most probably Gaius lived in some provincial town, and hence we find no contemporary notices of his life or works. After his death, however, his writings were recognized as authoritative; and the emperor Valentinian III named him, along with Papinian, Ulpian, Modestinus and Paulus, as one of the five jurists whose opinions were to be followed by judicial officers in deciding cases. The works of these jurists accordingly became most important sources of Roman law.

Besides the *Institutes,* which are a complete exposition of the elements of Roman law, Gaius was the author of a treatise on the *Edicts of the Magistrates,* of *Commentaries on the Twelve Tables,* of a treatise on the important *Lex Papia Poppaea* and of several other works. His interest in the antiquities of Roman law makes his work valuable to the historian of early institutions. In the disputes between the two schools of Roman jurists he generally attached himself to that of the Sabinians, who were said to be followers of Ateius Capito. Many quotations from the works of Gaius occur in the *Digest* of Justinian, and so acquired a permanent place in the system of Roman law; while a comparison of the *Institutes* of Justinian with those of Gaius shows that the whole method and arrangement of the later work were copied from that of the earlier, and numerous passages are word for word the same.

Unfortunately the work was lost to modern scholars until, in 1816, a manuscript, probably of the 5th century, was discovered by B. G. Niebuhr in the chapter library of Verona, in which certain of the works of St. Jerome were written over some earlier writings, which proved to be the lost work of Gaius. The greater part of the palimpsest was painstakingly deciphered, and comparison with other sources enabled some missing passages to be filled in. Two other important additions were made by the Oxyrhynchus papyri of about 250 and the important Antinoite or Egyptian fragments of the 4th or early 5th century.

The *Institutes* of Gaius are divided into four books—the first treating of persons and the differences of the status they may occupy in the eye of the law; the second of things and the modes in which rights over them may be acquired, including the law relating to wills; the third of intestate succession and of obligations; the fourth of actions and their forms.

For editions of the *Institutes,* see P. Krüger and W. Studemund, 7th ed. (1923); B. Kübler, 8th ed. (1939); and F. de Zulueta, 2 vol. (1946–53), which contains an English translation and full commentary.

See also ROMAN LAW. (J. F. LR.)

GAIUS CAESAR: *see* CALIGULA.

GAJO (GAVO). According to tradition the Gajo and Alas peoples of northern Sumatra came from Batak lands to the high-

lands neighbouring the Achinese (*q.v.*). There they lived in relative isolation, yet not without modifying contacts. Indian influence introduced the idea of a hereditary chieftain and a graded society. However, this did not result in a powerful court of elaborate ceremonial life. During a period of Menangkabau supremacy they accepted Islam but its precepts were not fully understood. Mosques were few in number and even in the 1960s only a minority performed the full religious rites. In the 17th century the Achinese imposed district rulers and strengthened the whole governmental structure. In later years these innovations tended to wane, and the *adat* or customary law became all-powerful.

A village consists of large community houses, each occupied by several families related in the male line. These structures are raised above the ground and consist of a men's gallery, a women's section and a common area which is divided into family compartments. A Gajo family consists of parents, children and married sons and their families. Theoretically all male members are related but adoption and other practices may modify this. A price is paid for the bride; then she and her offspring belong to the husband's clan. Polygyny is allowed but is rare.

In physical type the Gajo-Alas are proto-Malays but they show some intermixture with the Negrito and Malay. They probably do not exceed 100,000 in number. *See* also SUMATRA: *Population.*

See E. M. Loeb, *Sumatra* (1935); J. S. Mintz, *Indonesia* (1961).
(F.-C. Ce.)

GALAGO (BUSH BABY), the name of the long-tailed African lemurlike primates (*q.v.*), classed with the lorises and pottos in the family Lorisidae. They are extremely agile tree dwellers, characterized by the great elongation of the upper portion of the feet (tarsus) and the power of folding the large ears. They pass the day in sleep but are active at night, feeding on fruits, insects and small birds. When they descend to the ground they sit upright, and move about by jumping with their hind legs like jerboas. They are pretty little animals, varying from the size of a small cat to less than that of a rat, with large eyes and ears, soft woolly fur and long tails.

There are several species, of which *G. crassicaudatus* from central Africa is the largest.

GALÁPAGOS ISLANDS (ARCHIPIÉLAGO DE COLÓN), a group of 14 main islands and numerous smaller islands scattered over 23,000 sq.mi. of equatorial Pacific ocean, between 500 and 700 mi. W. of Ecuador. Total land area is 3,028 sq.mi., about half of which is contained in the largest and highest (5,600 ft.) island, Albemarle (Isla Isabela).

There has been much speculation concerning the origin of the islands in the absence of conclusive evidence. Geological and bathymetric data indicate that they probably were never connected with the American mainland. The islands are comprised largely of lava piles dotted with volcanoes, mostly extinct. One on Albemarle erupted in 1948, 1953 and 1957.

PHILIPPA SCOTT

(LEFT) TREELIKE CACTUS AT TORTUGA BAY, SANTA CRUZ; (RIGHT) FLIGHTLESS CORMORANT DRYING ITS WINGS, AND IGUANA IN THE BACKGROUND

The climate is characterized by such tropical anomalies as a markedly low rainfall along the coast (annual average 3–4 in.), low air temperatures (21°–29° C. [70°–85° F.]) and low ocean temperatures at the surface (17°–30° C. [63°–86° F.]). Largely responsible for this climatic regime are the chilling waters of the Humboldt or Peru current which upwells around Galápagos. Thundershowers may occur from January to April, and a mist (*garúa*) periodically blankets the area from May to December.

Treelike cactus, spiny shrubs and dwarf deciduous trees dominate the coastal regions. Native guava and unique sunflower trees flourish on the volcanic uplands.

However, the Galápagos are best known for their unusual animals, the most dramatic being the large spiny marine and land iguanas. The archipelago is named after the enormous land tortoises (*galápago*, old Spanish name for "tortoise"), considered among the oldest living creatures on earth, which may weigh 500 lb. or more. Other zoological curiosities include a four-eyed fish, distinct species of penguin, flightless cormorant and albatross, as well as a group of 13 species of very tame finches, one of which employs a stick as a tool to obtain food. Charles Darwin, who visited Galápagos in 1835 as naturalist of the "Beagle," was so impressed with the interisland variations in shape of the tortoise shells (some saddlelike, others domelike) and with the remarkable differentiation among the bills of the finches, later known as Darwin's finches (some had bills like a warbler, others like a grosbeak), that they inspired many of his views on natural selection.

The Galápagos Islands were discovered by Tomás de Berlanga, bishop of Panamá, while en route to Peru in 1535, and named Las Encantadas ("the bewitched"). Sites on several of the islands have yielded Inca pottery fragments providing evidence of pre-Spanish occupation. Numerous Spanish voyagers stopped at the islands during the 16th century, and in the late 17th century pirates used the islands as a hideout. About 1800 freebooting gave way to whaling. The buccaneers and whalers named many of the islands after English personalities of the period. At the beginning of the War of 1812, U.S. gunboats executed sea raids around Galápagos designed to harass British shipping. In 1841 the novelist Herman Melville visited the islands, which became the locale for his charming essay, *Las Encantadas.* Nineteenth-century sealers slaughtered untold thousands of fur seal and nearly exterminated this species. Since the earliest visits to the islands by man, domestic animals have escaped or have been put ashore, so that now cattle, horses, donkeys, goats, pigs, dogs and cats are running wild. The tortoises suffered the most from predation by pigs and dogs and from human exploitation for their meat and fat, and several forms have become extinct. The government of Ecuador made the Galápagos (in part) a wildlife sanctuary in 1935 and again in 1959.

The islands had been unclaimed for almost 300 years before colonization began on Charles Island (Isla Santa María) in 1832, when Ecuador took official possession of the archipelago and assigned Spanish names to the islands. Other colonies were started subsequently on Chatham Island or Isla San Cristóbal (the territorial capital), at Wreck bay (Bahía de Naufragio) and at Villamil on Albemarle Island. From about 1920 to 1940 a few European emigrants reached the islands, but most of them left because of food and water shortages. A few, however, settled on Indefatigable Island (Isla Santa Cruz) around Academy bay (Bahía de la Academia). In 1942 the United States constructed an air base (defunct since 1946) on South Seymour Island (Isla Baltra). Since then, Ecuadorians have been gradually settling on the arable islands. The population in 1960 was 1,900. Phenomenal yields of coffee, potatoes and lemons in the highlands and a plentiful supply of fish (tuna and groupers) along the coasts form the basis of the economy. There are small deposits of sulfur. The territory of Archipiélago de Colón is administered through Guayas province.

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GALASHIELS, a small burgh of Selkirkshire, Scot. Pop. (1961) 12,374. It is on Gala water within a short distance of its junction with the Tweed, 33 mi. S.S.E. of Edinburgh by road. The town stretches for more than 2 mi. along both banks of the river, the mills and factories occupying the valley by the stream. Woolen manufacture dates from the close of the 16th century, and the Scottish Woollen Technical college (1909) is the central institution for the industry which is now mainly confined to the weaving of tweeds and the making of knitwear. Galashiels was originally a village built for accommodation of pilgrims to Melrose abbey (4 mi. S.E.), and was created into a burgh of barony in 1599. The Catrail or Picts' Work ditch begins near the town and passes immediately to the west. Clovenfords, 3½ mi. W., is noted for the large Tweed vineries. Two miles farther southwest is Ashiestiel, where Sir Walter Scott resided from 1804 to 1812. Abbotsford (*q.v.*), his later house, lies to the south of the town, across the Tweed.

GALAŢI, formerly often GALATZ, an inland port and headquarters of the Galaţi *regiunea* (region) in southeast Rumania, occupies an eminence among the marshes along the left bank of the Danube between the confluences of the Siretul and Prut rivers and lies about 90 mi. from the Sulina mouth of the Danube and 120 mi. N.E. of Bucharest. Pop. (1956) 95,747, (1960 est.) 105,048. Galaţi became important as a trading centre for grain and cattle in the 17th century; the docks, begun in 1887, can accommodate vessels of about 3,000 tons but deep-draft vessels are excluded by the Sulina bar. It was formerly the headquarters of the European Danube commission (1856) and was the scene of the 1953 Danube conference. (*See* DANUBE.) One of the chief ports of entry for Rumanian imports and the leading port for timber exports, the town has shipyards and its industries include metalworking and the production of chemicals, textiles, building materials and foodstuffs. In the early 1960s an iron-and-steel plant with a potential annual output of 4,000,000 tons was under construction. Galaţi is a naval base, a rail junction and a cultural centre with a technical college, state theatre and symphony orchestra.

GALAŢI ADMINISTRATIVE AND ECONOMIC REGION, with a population (1960 est.) of 1,032,109 and an area of 4,985 sq.mi. (1961), is divided into seven *raions* (districts) about the lower Siretul and is chiefly riverine lowland with extensive shallow lakes, including Brateş (29 sq.mi.) and the saline Lacul Sărat and Amara with therapeutic properties. In the northwest the region rises to the Vrancei range of the Transylvanian Alps. The chief towns are Galaţi, Brăila, Focşani and Tecuci (pop. 25,772) in the northwestern foothills. Grain, oilseeds, flax and fruit trees are cultivated and nearly 20% of Rumania's vineyards are in the region. Cattle and sheep are bred and industrial products include lumber, cellulose, textiles, chemicals and foodstuffs.

GALATIA, in ancient geography, a district in central Asia Minor occupied by Celtic (Gallic) tribes in the early 3rd century B.C. (Galatai being the name used by 3rd-century Greek writers for Celts). It corresponds to the northern part of what was earlier known as Phrygia, and was bordered on the north by Bithynia and Paphlagonia, on the east by Pontus and Cappadocia, on the south by Lake Tatta (Tuz Golu) and Lycaonia, and on the west by the Attalid kingdom of Pergamum (*q.v.*). The district consists of barren uplands, apart from some small fertile areas in the north. There are two principal rivers: the Sangarius (Sakarya) in the west, the Halys (Kizil Irmak) in the east.

Three tribes, the Tolistoagii (or Tolistobogii), the Tectosages and the Trocmi, part of the Gallic horde then pressing into Macedonia and Greece, split off from the main body and crossed into Asia from Europe at the invitation of the Bithynian king Nicomedes I, who required their aid in a civil war which he was waging against his brother (278 B.C.). Soon they passed beyond Bithynia and began to plunder the lands of western Asia Minor in many directions. There was no check to their marauding until in 275 the Seleucid king Antiochus I engaged and defeated them in the so-called "elephant battle." It was perhaps at this point in time that they were settled (or settled themselves) in the region to which they gave their name. But there is no agreement among scholars as to whether this territory was actually assigned to them by any of the kings; nor whether the supposed grant was made by the kings of Bithynia and Pontus or by Antiochus. Since Phrygia seems to have been a Seleucid possession before the arrival of the Gauls the Seleucid kings may have looked upon Galatia as a vassal state of their empire after the Gauls had settled there. However that may be, the latter continued to raid Lydia, Ionia, Aeolis and the districts near the Hellespont during the following decades until decisive defeats at the hands of Attalus I of Pergamum about 230 brought a halt to their aggression. Earlier, Eumenes I of Pergamum had paid tribute to avert their incursions into his territory.

At the battle of Magnesia (winter 190–189) the Galatians fought alongside the Seleucid king Antiochus III against the forces of Rome and Pergamum. This brought down upon them a Roman punitive expedition led by the consul Gnaeus Manlius Vulso. He invaded their country, defeated them in two battles and took from them great quantities of booty, the fruits of their own raids in the past (189). From this setback they never recovered. Thereafter they submitted first to the authority of the kings of Pergamum, then (after 133) to that of the kings of Pontus. After the first Roman defeat of Mithradates VI of Pontus, Galatia became a Roman protectorate (85 B.C.). Until this time the Galatians had had a tribal organization, the three tribes being subdivided into four divisions or tetrarchies which were each governed by a tetrarch and a judge. After the death of Julius Caesar, however, one of their leaders, Deiotarus (*q.v.*), finally became king of all Galatia (44); and in 36 another Galatian leader called Amyntas was made king of the country by M. Antonius (Mark Antony). After the death of Amyntas in 25 B.C. Galatia, now enlarged by new acquisitions in Lycaonia, Pamphylia and Pisidia, became a Roman province. Later, further enlargement took place, particularly in A.D. 72 when Cappadocia and Armenia Minor were incorporated in the Galatian province (these last additions were detached again between 107 and 113). Under the reorganization of the emperor Diocletian, Galatia was divided (about A.D. 295) into two, the name being retained for the northern part, the original Galatia.

The population of Galatia was not entirely Gallic. Before the arrival of the Gauls, western Galatia up to the Halys river was inhabited by Phrygians, and eastern Galatia by Cappadocians and other native races. This native population remained, and constituted the majority of the inhabitants of the rural parts and almost the sole inhabitants of the towns. They were left in possession of two-thirds of the land on condition of paying part of the produce to their new lords, and agriculture and commerce with all the arts and crafts remained in their hands. The Gauls numbered 20,000 in all at the beginning. They formed a small military aristocracy, living not in the towns but in fortified villages, where the chiefs in their castles kept up a barbaric state, surrounded by their tribesmen. Losses in war and through emigration for mercenary service in the armies of the Hellenistic kings (to which many of them drifted) kept their numbers small. For centuries they retained their own language and customs. Not until the 2nd century A.D. did Galatia become really Hellenized, and only then did the city-life characteristic of Greek civilization flourish in the country.

See F. Stähelin, *Geschichte der kleinasiatischen Galater*, 2nd ed. (1907); D. Magie, *Roman Rule in Asia Minor* (1950). (R. H. ST.)

GALATIANS, EPISTLE TO THE, the fourth in the traditional collection of the Epistles of Paul in the New Testament. Its authenticity as one of the four main letters attributed to Paul was unquestioned by the literary criticism of the Tübingen school in the mid-19th century. Only those hypercritics who question the genuineness of all Paul's letters regard it as spurious. But though its Pauline authorship is undoubted, Galatians offers other

serious problems: its occasion, addressees and place and date of origin are all disputed.

Contents.—Paul begins with a defense of his position: he is an apostle not from men but from God, who has saved us from this evil age by Jesus Christ (i, 1–5). Paul does not include a defense like this within the salutation in his other Epistles, nor does he generally omit to give thanks to God for the faith of his correspondents and to pray for their spiritual well-being. In this book, however, after the salutation Paul plunges straight into a scornful condemnation of the Galatians for so quickly deserting Christ and turning to a different gospel that is really no gospel at all. Certain people are stirring up the congregation, and Paul lays a curse on anybody who preaches a gospel other than the one he had already preached (i, 6–9).

In order to prove that the gospel he preached did not derive from men but by revelation from Jesus Christ, Paul then gives a brief account of his life. He was an enthusiastic Jew who persecuted the church, but God revealed to him his Son in order that he should preach the gospel to the gentiles. After receiving this revelation he did not meet those who had been apostles before him until three years later, when he went to Jerusalem for a fortnight to see Peter, and also met James the "brother" of Jesus. He did not visit Jerusalem again until 14 years later, when his mission to the gentiles was admitted by the Jerusalem apostles to be divinely commissioned (i, 10–ii, 10).

Thus Paul proves that his calling is independent of the Jerusalem apostles, and he goes on to relate an incident at Antioch when he rebuked Peter for ceasing to eat with gentile Christians after the arrival there of some Jerusalem Christians (ii, 11–14). Paul concludes his defense with the argument that Jews too are justified only by faith in Christ and that he himself is crucified with Christ and lives by faith in the Son of God (ii, 15–21).

He then asks the "foolish Galatians" from what source they received the Spirit, whether it was from works done in accordance with the Law or from faith, and proves from the case of Abraham that faith alone can save (iii, 1–18). The Law was given later and played only a preparatory role until the time of salvation by faith in Christ (iii, 19–iv, 7). It is therefore folly to place themselves under the bondage of the Law, and Paul begs the Galatians to return to their former loyal allegiance to him (iv, 8–20).

He ends this personal appeal by an allegorical proof, drawn from the story of the two sons of Abraham in the Old Testament, that the Galatians are in fact free from the Law to which they are inclined to return (iv, 21–31).

It is clear from this polemic that the Galatians are being persuaded to accept the Law as their rule of life, and the concluding parenthetical part of the letter confirms this impression. Paul stresses that undergoing circumcision would be apostasy from Christ and that Christians are called to be free and live in freedom (v, 12–26). Some more concrete instructions about how to put brotherly love into practice (vi, 1–10) conclude the dictated part of the letter, but Paul adds in his own hand at the very end further warning against circumcision and a short blessing, without any personal greeting (vi, 11–18).

Occasion and Purpose.—Galatians is undoubtedly directed against some disturbance in the local churches that Paul finds is endangering their very existence ("O foolish Galatians! Who has bewitched you . . . ?" iii, 1). But who are the troublemakers, whence do they come and what is their teaching? The answers can be found only by careful interpretation of a few casual remarks in the letter itself. Clearly some persons are trying to induce the Galatian Christians to accept circumcision (vi, 12; v, 2–3) and obey the Law (iii, 2; iv, 21; v, 4). As the Galatians had not been Jews but pagans before they became Christians (iv, 8–9), Paul's opponents must be trying to make these Christians accept the Jewish Law as an indispensable addition to the Christian life. But at the same time Paul seems to be attacked personally, perhaps by the same persons, as an unacceptable apostle because he has received the gospel from the Jerusalem apostles (*cf.* i, 1, 11 ff.) and is still himself preaching circumcision (v, 11); that is, Paul seems here to be defending himself against the contention that he is still too much attached to Judaism and to the Jerusalem church. Further, Paul warns against the abuse of freedom as "an opportunity for the flesh" (v, 13) and in general against consideration for the flesh (v, 24; vi, 8); here he appears to be attacking moral laxity. Four main theories are advanced to account for the variety of positions taken up by Paul in this letter.

1. According to the commonest explanation, Paul's opponents were not themselves Galatians but came probably from the extreme legalistic wing of the early Christian community in Jerusalem. They were therefore "Judaizers," trying to persuade the Pauline converts that they could be saved only if they accepted the Law and assimilated themselves to the mother church in Jerusalem.

2. Some scholars, who find no direct indication that the agitators in the Galatian churches either came from Jerusalem or were connected to the mother church there, hold that these opponents of Paul were Christians of pagan origin, either local or Antiochene. These pagano-Christians, being convinced that circumcision was necessary, themselves underwent the rite and are now trying to induce the Galatian Christians to do the same. The weakness of this theory is that it does not explain why or by whom Christians from a pagan background not only were brought to be circumcised but also persuaded others to do the same.

3. Another theory supposes that there were two different groups of opponents to Paul in Galatia: the Judaizing pagano-Christians of the second theory and other Galatian Christians who from Paul's preaching of Christian freedom wrongly deduced a spiritual libertinism. In Galatians Paul is therefore attacking both these errors. But Gal. v, 13 ff. proves beyond doubt that the "libertine" ideas refuted by Paul are wrong consequences drawn by legalistic opponents from Paul's insistence on freedom from the Law.

4. Other scholars have therefore tried to show that the opponents in Galatia are Judaeo-Christian Gnostics who are defending not allegiance to the Law but spiritual freedom from the flesh and from worldly obligations and rules. But a firm obstacle to the truth of this theory lies in the fact that obedience to the Law is precisely what the agitators are demanding, and in this very connection they ask for circumcision (ii, 16; iii, 21; iv, 21). Further, Paul's proof of his independence from the Jerusalem apostles (i, 15 ff.) is a defense against the contention that he was dependent on these particular men, not only upon men in general.

Although a final solution to the problem cannot be reached, the most plausible answer is some form of the first theory stated above. Judaizing emissaries (perhaps from the Jerusalem church) had come to Galatia to persuade the Christians there to accept circumcision in obedience to the Law. At the same time they accused Paul of not being a true apostle and of encouraging moral laxity by his preaching of freedom from the Law. The epistle to the Galatians would then be Paul's reaction against the trouble caused by these emissaries in the churches he had founded.

Addressees and Date of Origin.—In the 3rd century B.C. some Celtic (Gallic) tribes had settled in central Asia Minor, and in 25 B.C. the kingdom of Galatia was included in the larger Roman province of the same name (*see* GALATIA). So in Paul's time "Galatia" could mean both Galatia proper (the central district of Asia Minor with the cities of Ancyra, Pessinus and Tavium) and the Roman province that included besides Galatia proper the districts to the north and south of it. So this Epistle addressed to "the churches of Galatia" may be intended for the churches of Iconium, Lystra and Derbe, which Paul had founded in southern Asia Minor on his first missionary journey (Acts xiii; xiv; xv, 40–41), as well as for the Christian congregations in central Asia Minor (Acts xvi, 6; xviii, 23).

It would be easier to decide on the identity of the addressees if the Epistle could be placed in its chronological position in the itinerary of Paul as given in the Acts of the Apostles. Paul himself seems to refer to two visits to Galatia ("You know it was because of an illness that I preached the gospel to you on my former visit," Gal. iv, 13), but as the last four words can also be translated "at first" (as in the Revised Standard Version), the possibility cannot be excluded that Paul had paid only one visit to Galatia when he wrote his Epistle. It is however more probable that he had been there twice; if, on this supposition, the churches

in the Roman province of Galatia are addressed, the Epistle could have been written soon after the beginning of Paul's second missionary journey (*i.e.*, after Acts xvi, 5). But in this case it is strange that Paul does not mention the fact that some of his addressees are living in the region of Syria and Cilicia, where he says he had gone after his first visit to Jerusalem (Gal. i, 21). Further, Paul's passing reference to his collection of money for the poor of Jerusalem in accordance with his promise at the Jerusalem conference would be more appropriate if the conference had not been a recent event, as it must have been had the Epistle been written near the beginning of the second missionary journey. (*See* ACTS OF THE APOSTLES for discussion of the identity of the Jerusalem conferences mentioned in Gal. ii, 1–10 and Acts xv.) But if, on the other hand, Paul is writing to the churches in Galatia proper, the epistle cannot be dated before Paul's arrival at Ephesus near the beginning of his third missionary journey (*i.e.*, after Acts xix, 1, where the second visit to Galatia proper is mentioned). If these arguments are combined with the fact that "O foolish Galatians" (Gal. iii, 1) is most suitably addressed to those who are Galatians by race, it seems more probable that the latter and not the churches of the Roman province are addressed in this epistle.

From this conclusion it follows that Paul would have written the Epistle in Ephesus, whither he had gone after his second visit to central Asia Minor. As some time must be presumed to have elapsed between his departure from the Galatians and the outbreak of the troubles there, it may be supposed that the Epistle was written in the middle or near the end of Paul's stay in Ephesus, which lasted from about 53 to 56. There is no evidence for a more precise dating.

Importance.—The Epistle is important for three reasons. First, it provides the only connected account from Paul's own hand of at least a part of his life (i, 13–ii, 14). This narrative provides a check on the information covering the same period in the Acts of the Apostles, which is less reliable as evidence on this point than the much earlier Epistle to the Galatians. Second, the doctrine of justification by faith in its polemical setting is here directed against the defenders of a Judaizing Christianity and shown to have arisen from the necessity of defending the gospel against legalistic misunderstanding. Finally, Galatians is, as a result of this polemic, the primary document of Christian freedom. The problem of the correct understanding of this Epistle has therefore been crucial not only in the early church but also at the Reformation and in modern times. *See* also BIBLE.

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(W. G. Kü.)

GALAX, an evergreen perennial herb of the Diapensiaceae family containing a single species, the beetleweed (*G. aphylla*), which has a thick matted tuft of creeping rhizomes beset with fibrous red roots, and sending up stiff, shiny, veiny heart-shaped or rounded leaves, 3–16 cm. across, and a slender spikelike flower stalk bearing small white flowers. It is native in open woods from West Virginia to Georgia and Alabama in the U.S., and is cultivated and escaped northward to Massachusetts. The leaves are collected in quantities in the mountains of North Carolina and Virginia, especially in autumn when they show a beautiful bronze colour, and are much used by florists in wreaths and other decorative pieces.

(J. M. Bl.)

GALAXY, the system of stars, appearing projected on the sky as the Milky Way (Greek, *galaxias kyklos*, the milky way), in which the solar system and all stars visible to the naked eye are located. The derived term "galaxies" refers to external systems similar to the Galaxy and is normally equivalent to extragalactic nebulae. The present article is limited to our own galaxy.

Nature of the Galaxy and Position of Solar System Within It.—Inspection of the Milky Way with a small telescope shows it to be resolved into myriads of faint stars. In fact, most classes of stars are concentrated to the Milky Way belt, the degree of concentration increasing as the stars studied become fainter, as was shown by the prolonged star counts (or gauges) carried out by Sir William Herschel at the end of the 18th century and extended to the southern hemisphere by his son, Sir John Herschel, in 1834–38. These counts were continued in selected areas, with the aid of photography and astrographic telescopes, by J. C. Kapteyn and his colleagues at Groningen in 1900–20. They found that the number of stars per unit volume of space decreased uniformly with distance in all directions in the Milky Way belt and concluded that our solar system is near the centre of a highly flattened discoidal system of stars with a radius of the order of 2,000 parsecs (1 parsec = 3.26 light years = 3.1×10^{13} km.). The conclusions as to the size of the system and our central position were quite mistaken because the obscuring effect of interstellar dust clouds (also concentrated in the Milky Way) was not realized at the time.

A more accurate picture was derived by Harlow Shapley from a study of the globular clusters, highly concentrated spheroidal systems, each with an average content of 1,000,000 stars. The 100 or so known globular clusters are equally numerous on either side of the galactic plane (the plane running centrally through the Milky Way belt) and undoubtedly describe orbits about the centre of the galaxy, but most of them are situated in or near the direction of Sagittarius while the rest are almost all in that half of the sky. The globular clusters are rich in variable stars, pulsating with periods of a few hours, known as RR Lyrae stars or cluster-type variables; by fitting the period-luminosity relation for Cepheid variables (first discovered from observations of Cepheids in the extragalactic Magellanic Clouds and calibrated by Shapley himself from observations of galactic Cepheids) to these RR Lyrae stars, Shapley estimated the distances of several globular clusters and concluded in 1918 that the centre of the system of globular clusters (and thus the centre of the galaxy) is situated in the Milky Way at a distance of 30,000 parsecs toward a point in Sagittarius.

This conclusion as to the solar system's peripheral position in the galaxy remains valid today, but the distance of the centre turns out to be only about 8,200 parsecs when the effect of interstellar absorption (which makes the cluster stars look fainter than they would in a transparent medium) is allowed for.

Fig. 1 (after J. H. Oort) gives an idealized picture of the galaxy as seen edge-on from an external point in the plane of the Milky Way. The brighter region, containing the hottest, brightest stars and clouds of interstellar gas and dust, forms a highly flattened disk with the solar system about halfway out from the centre. The

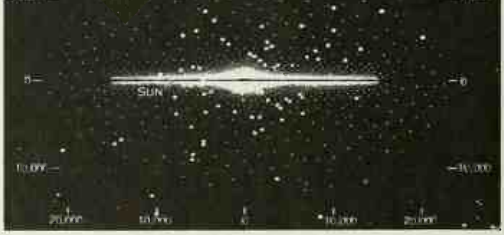

FIG. 1.—MODEL OF THE GALAXY
Numbers denote distances in parsecs

thickness of the disk is very small at the edges and perhaps about 5,000 parsecs in the central bulge. Surrounding this disk is a halo or corona of much lower mean density; the globular clusters (shown as large dots) are the most striking members of this nearly spherical subsystem. W. Baade's photographs of the Andromeda Nebula, which is probably very close to being a twin of our own galaxy, suggest that the spherical subsystem has a larger radius than the disk and may contain over 90% of the mass of the whole system.

Galactic Co-ordinates.—It is convenient to define a system of angular celestial co-ordinates based on the central plane of the Milky Way, also known as the galactic plane or galactic equator, which is inclined at about 63° to the celestial equator. Galactic latitude (b) is the angular distance from a point of the sky to the nearest point of the galactic equator, while galactic longitude (l) is the angular distance of this latter point (measured in the direction of increasing right ascension) from the intersection of the galactic and celestial equators in Aquila. The co-ordinates of the galactic centre are $b = -1°$; $l = 328°$, so that the sun is slightly north of the galactic plane. In 1959 a new system of galactic co-ordinates was adopted with $l = 0°$ in the direction of the galactic centre.

Rotation of the Galaxy.—Like other spiral nebulae, the galactic system rotates in its own plane. As might be expected from dynamics, the rotational speed is greatest in the highly flattened disk and least in the nearly spherical system of the globular clusters, which latter accordingly show a systematic drift velocity of about 250 km. per second toward Carina. B. Lindblad (1925) was the first to show how the phenomena of star streaming, and the drift velocities and spatial distributions of stars of various classes, could be understood in terms of a series of concentric spheroidal subsystems with the rotational speed and degree of flattening increasing from one subsystem to the next. In the inner portion of the galaxy, in which most of its mass is concentrated, it rotates more or less like a rigid body, but in the outer parts of the disk, containing the sun and majority of observable stars, the angular velocity diminishes outward from the centre as with planets in the solar system. Thus, if a group of stars surrounding the solar system is taken, those between us (the solar system) and the centre will be gaining on us and those farther away will be lagging behind. Hence stars nearer the centre and ahead of us, and stars farther away and behind us (*see* B and C in fig. 2) will both show a systematic velocity of recession when their velocity in the line of sight is measured; while those nearer the centre and behind us, or farther out and ahead of us (A and D) will show a systematic velocity of approach.

For distances up to about 2,500 parsecs, this effect of differential galactic rotation (first definitely established by Oort in 1927) increases uniformly with distance at a rate of about 18 km. per second per 1,000 parsecs in those directions where the effect is at its maximum (positive or recession $l = 13°$ and 193°, negative or approach $l = 103°$ and 283°), a result based on extensive measurements in the spectra of hot stars by J. S. Plaskett and J. A. Pearce (1934). The effect is thus most readily observed from the spectra of distant stars; for the nearer stars it is obscured by the presence of random velocities (such as the solar velocity of 20 km. per second toward Hercules) due to the fact that galactic orbits are not exactly circular.

A further effect of differential rotation appears in stellar proper motions, with a maximum effect in the directions toward and away from the galactic centre (*see* E and F in fig. 2). This is independent of distance and corresponds to a maximum proper motion of 0.15 sec. of arc per century, corresponding to a velocity of 8 km. per second per 1,000 parsecs. From the magnitudes of the effects in proper motion and radial velocity, it follows that the sun completes its orbit about the galactic centre in about 200,000,000 years; its velocity is less easy to estimate, since it depends on the distance of the galactic centre, but it is probably between 200 and 300 km. per second. From the speed of rotation it is possible to estimate the approximate mass of the galaxy, which is of the order of 3×10^{44} g. or 160,000,000,000 times that of the sun. From velocities perpendicular to the galactic plane, assuming that a condition of statistical equilibrium has been set up, it is possible to estimate the density of material in the solar neighbourhood. Oort (1930) found this to be 7×10^{-24} g. per cubic centimetre (or 0.1 of the mass of the sun per cubic parsec), slightly more than half of which is probably due to stars while the rest represents interstellar matter.

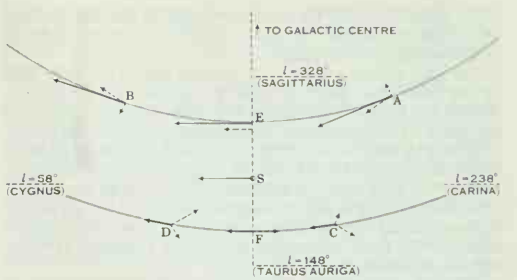

FIG. 2.—DIFFERENTIAL ROTATION OF THE GALAXY
S represents the solar system. A and B represent two stars closer to the galactic centre and thus traveling around faster than the sun; C and D are two stars farther away from the galactic centre and traveling more slowly. The arrows with full lines represent velocities relative to the galactic centre; arrows with broken lines represent velocities along and perpendicular to the line of sight

Relative to the "local standard of rest," a hypothetical point moving in a truly circular galactic orbit, the peculiar motions of most of the nearby stars (up to ±30 km. per second) tend to be toward or away from a vertex in the galactic plane about 22° away from the galactic centre. This phenomenon of star streaming was discovered by J. Kapteyn (1904) and reinterpreted by K. Schwarzschild in terms of spatial distribution of the peculiar velocities over the surface of an ellipsoid with its long axis pointing toward the vertex. H. H. Turner and Lindblad explained this effect as a consequence of slight eccentricities in galactic orbits; the deviation of the vertex (which in the simple theory should be toward the galactic centre) may be due either to the gravitational effect of local concentrations of stars and interstellar matter or to the significant influence of a few rich, moving clusters on the statistics.

High-Velocity Stars.—Many stars exist in the solar neighbourhood which do not share in this pattern of motion in and perpendicular to the galactic plane; they are known as high-velocity stars and belong either to the spherical population associated with the globular clusters or to an intermediate population with a lower degree of concentration toward the galactic plane than is possessed by the hot, bright stars and clouds of interstellar matter. Although the high-velocity stars have a much greater spread of velocities (±100 km. per second) than the low-velocity stars (±30 km. per second), corresponding to very elongated galactic orbits, their motions relative to the sun are all toward the half of the sky centred on $b = 0°$, $l = 238°$, *i.e.*, they are actually all lagging behind the solar system in galactic rotation. This is probably because stars overtaking the sun with a high enough speed to be identified as having high velocity would be moving so fast as to escape from the galaxy altogether.

Spiral Structure of the Galaxy.—Analogy with other galaxies having stellar populations similar to that in our own neighbourhood suggests that our own galaxy should be a spiral nebula. The spiral arms of external galaxies are rich in hot, bright stars and interstellar clouds of gas (mainly hydrogen) and dust; these same features serve as indicators of the spiral structure in our own system. The first evidence of spiral arms was obtained in 1951 by W. W. Morgan and various collaborators. From the spatial distribution of hot, bright stars (studied in collaboration with J. J. Nassau, A. E. Whitford and A. D. Code) and of regions of ionized hydrogen emitting the red H-α line (photographed in conjunction with S. Sharpless and D. E. Osterbrock), Morgan was able to identify portions of three spiral arms (*see* fig. 3): the Orion arm, stretching from Cygnus through Cepheus, Perseus, Orion and Monoceros and including the dust lane which causes the Great Rift

in the Milky Way; the Perseus arm, farther off and with its nearest portion in roughly the same direction; and the Sagittarius arm toward the galactic centre.

The solar system appears to be situated toward the inner edge of the Orion arm, which is about 400 parsecs wide, while the Perseus arm is about 2,000 parsecs away in the direction away from the centre. These conclusions were confirmed and extended shortly afterward by observations of the 21-cm., radio-frequency emission of neutral hydrogen by H. C. van de Hulst, C. A. Muller and Oort, and by F. J. Kerr and J. V. Hindman in the southern hemisphere. Using Oort's theory of galactic rotation, the distances of the neutral hydrogen clouds were obtained from their motions in the line of sight, derived from the Doppler shift in the frequency at which emission is a maximum.

The radio method penetrates to far greater distances than the optical methods and has led to the fairly extensive picture of spiral structure shown in fig. 3. G. Münch has shown that the interstellar absorption lines in the spectra of hot stars in the Perseus arm split into two groups with velocity shifts corresponding to the differential galactic rotation effects in the Orion and Perseus arms, respectively. Furthermore, the profiles of the interstellar lines closely resemble those of the 21-cm. line observed in the same direction.

The results of these and other investigations suggest that our galaxy is a spiral nebula of E. P. Hubble's type Sb, with both spiral arms and nucleus well developed, closely resembling the Andromeda Nebula.

Stellar Populations and Evolution of the Galaxy.—In 1941 Baade succeeded in resolving the nucleus of the Andromeda Nebula into stars by using red-sensitive plates, in contrast to the more usual blue-sensitive plates with which the brightest stars in the spiral arms had been picked out long before. His success resulted from recognition of the fundamental difference between the stellar population in the disk and especially the spiral arms (Population I) in which the brightest stars are hot and therefore blue, and that distributed spherically with a concentration toward the galactic nucleus (Population II) in which the brightest stars are cool red giants. Population I includes most stars in our neighbourhood, Cepheids, galactic open clusters and interstellar clouds, while Population II includes globular clusters, RR Lyrae stars, novae, planetary nebulae and some of the high-velocity stars. The physical differences between the two populations arise from the fact that Population I includes many young stars which have recently condensed from the interstellar medium, while star formation virtually ceased nearly 10,000,000,000 years ago in Population II; there the most massive stars, which run through their supplies of nuclear fuel the most rapidly, have become cool giants or have disappeared from view, *e.g.*, as white dwarfs.

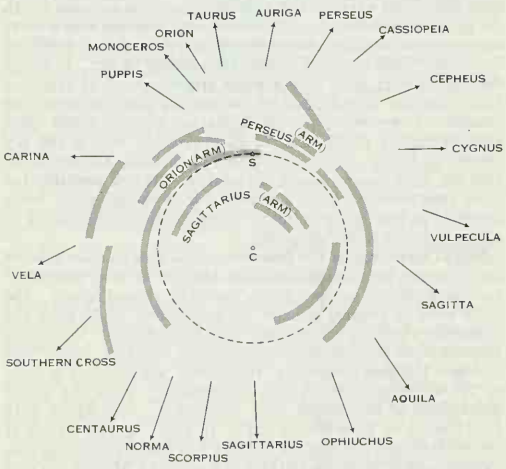

FIG. 3.—SPIRAL STRUCTURE OF THE GALAXY IN RELATION TO CONSTELLATIONS OF THE MILKY WAY FROM OPTICAL AND RADIO OBSERVATIONS

S represents the solar system and C the centre of the galaxy. The sense of galactic rotation is clockwise

Elliptical galaxies, which show no spiral arms and are free from interstellar dust clouds, consist entirely of Population II; in spirals, Population II probably accounts for most of the mass, but the hot, bright stars and ionized hydrogen clouds are the most conspicuous feature. Probably the Population II stars were the first to be formed from the contracting cloud of gas and dust from which the galaxy and its companions in the "local group" of galaxies are believed to have been formed; the remaining interstellar material could then have continued contracting and been spread out into a disk by the resulting increase in its speed of rotation.

Spiral structure might arise from the differential rotation of long filaments held together by an interstellar magnetic field. Population I stars have presumably been formed continuously in the spiral arms, but some older members have undoubtedly drifted into the inter-arm region since their formation. There is also evidence that the older Population I stars in our neighbourhood have galactic orbits of higher eccentricity than the young stars and clouds of interstellar matter. It has not been possible to say whether the heterogeneous structure of the galaxy, with numerous individual star clusters and larger groups showing common streaming motion, is a permanent feature or an initial stage which will ultimately be reduced to a more uniform distribution by stellar encounters, and by disruption through the tidal effect of galactic gravitation. However, it is to be expected that the interstellar material required for star formation will ultimately be used up, so that hot, bright stars and the associated spiral structure must ultimately disappear, leaving a stellar population in which the brightest stars are cool red giants as in the present Population II.

See STAR; NEBULA; INTERSTELLAR MATTER; RADIO ASTRONOMY; SPECTROSCOPY, ASTRONOMICAL; *see* also references under "Galaxy" in the Index volume.

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GALBA, SERVIUS SULPICIUS, Roman emperor A.D. 68–69, was born probably in 5 B.C., son of Gaius Sulpicius Galba (consul 5 B.C.) and Mummia Achaica. This ancient lineage was accompanied by great wealth; he also enjoyed favour from Augustus and Tiberius and began his senatorial career before the normal age. He was consul in 33, and in 39 received command of the Upper German army, where he served with distinction. A virtuous proconsulate in Africa about 45 seemed to have closed his active life, but in 60 Nero made him governor of Nearer Spain, and there he remained for eight years. In early 68 he accepted (perhaps even prompted) an invitation from Julius Vindex, the governor of Gallia Lugdunensis, to head a movement against Nero, whom he believed to be meditating his assassination (*see* NERO). He recruited a legion and other troops in Spain and built up a considerable party in many regions of the empire. After Vindex's defeat by the Rhine armies at Vesontio (Besançon) all seemed lost; yet when Nero killed himself the senate formally accepted Galba, who took the name *Caesar* and marched slowly to Rome, arriving about October. He had to execute numerous highly placed Romans, including Nymphidius Sabinus, the prefect of the praetorian guard who had been originally responsible for his proclamation. Then his policy of rewarding the Gallic states which had supported Vindex inevitably alienated the Rhine armies, and they proclaimed Vitellius emperor on Jan. 2, 69. Galba's more immediate difficulties, however, came from the praetorians, to whom he was unwilling to pay the donative which they claimed as reward for deserting Nero, and from the fact that he adopted L. Piso Licinianus as his successor rather than the ambitious Otho (*q.v.*). Otho engineered a mutiny, and Galba was murdered in the forum on Jan. 15, 69. Though his advisers were allegedly corrupt, his own government was upright to the point of pedantry:

this may account for the improvidence of his military measures. He drew from Tacitus the famous epigram *omnium consensu capax imperii nisi imperasset* ("generally agreed to be equal to supreme power if he had not held it").

See Tacitus, *Histories*, i, 1–49; Suetonius, *Galba;* Plutarch, *Galba*. (G. E. F. C.)

GALBANUM, a strongly aromatic gum resin produced by an umbelliferous plant (*Ferula galbaniflua*) related to the giant fennel and indigenous to Iran. The resin, excreted from the lower part of the stem, occurs usually in irregular, more or less translucent and shining lumps, or occasionally in separate tears, of a light-brown, yellowish or greenish-yellow colour, and has a bitter taste and musky odour. Galbanum is one of the oldest drugs. In Ex. xxx, 34 it is mentioned as a sweet spice. Hippocrates employed it in medicine, and Pliny ascribed to it extraordinary curative powers. Its use in medicine is now obsolete.

GALBULIDAE, a family (order Piciformes) of small to medium-sized tropical American birds comprising several species popularly called jacamar (*q.v.*).

GALE, ZONA (1874–1938), U.S. author whose *Miss Lulu Bett* established her as a promising novelist of the rising realistic school, was born at Portage, Wis., on Aug. 26, 1874. She graduated from the University of Wisconsin in 1895 and received her M.A. there in 1899. For two years she worked for various Milwaukee newspapers and then, in 1901, became a reporter for the *New York World*. After the publication of her first short story, in 1904, she gave her full time to writing.

Her books include *Romance Island* (1906); *The Loves of Pelleas and Etarre* (1907); *Friendship Village* (1908); *When I Was a Little Girl* (1913); *Heart's Kindred* (1915); *A Daughter of Tomorrow* (1917); *Birth* (1918); *Miss Lulu Bett* (1920); *Faint Perfume* (1923); and *Preface to a Life* (1926). Her early writings were in the sentimental, local colour tradition.

The dramatization of *Miss Lulu Bett* won her the Pulitzer prize in 1920. Other plays were *Mr. Pitt* (1924), a dramatization of *Birth,* and *Evening Clothes* (1932). She died in Chicago on Dec. 27, 1938.

See August Derleth, *Still Small Voice* (1940).

GALE. A wind of considerable force, specifically, in nautical and meteorological terminology, a wind classified on the Beaufort scale (*q.v.*) as force 8, 9 or 10 and, in some definitions, also force 7. This represents a range of wind speeds of from 32 to 63 m.p.h., or, including force 7, beginning at 25 m.p.h. The terms fresh gale, strong gale, etc., are used without standardization among the various countries, but a wind of force 10, or 55 to 63 m.p.h., is universally designated as a whole gale. (H. R. B.)

GALEN (*c.* A.D. 130-*c.* 200), Greek physician, founder of experimental physiology and, after Hippocrates, the most distinguished physician of antiquity, was born in Pergamum, the capital of Mysia in Asia Minor, a city renowned for its magnificent library, the creation of Attalid kings. Galen is sometimes wrongly spoken of as Claudius Galen, but the cognomen Claudius has no authenticity and is a result of a misunderstanding on the part of Renaissance scholars. From his earliest years Galen was familiar with the Platonic, Peripatetic, Stoic and Epicurean schools of thought. He began the study of medicine in 146, and two years later went to Smyrna to attend the lectures of Pelops, a celebrated physician. In search of knowledge he roamed through Greece, Cilicia, Phoenicia, Palestine, Crete, Cyprus and finally visited the famous medical school at Alexandria.

Settling at Rome in 164, Galen became acquainted with some of the highest officers of the state, among them the consul Boethius and the future emperor Lucius Septimius Severus. Many of these eminent persons attended his lectures and demonstrations. Galen used an unsparing pen against medical sects, the methodists, dogmatists, pneumatists and empirics then flourishing in Rome, and thus provoked the hostility of his professional brethren. He belonged to no particular school, though in philosophy he favoured Aristotelianism. Later he left Rome for Pergamum, but was recalled by the emperor Marcus Aurelius for service in the Germanic wars. This he managed to evade, returning to Rome to look after the health of the youthful Commodus, heir of Marcus Aurelius. Little is known of the rest of his life. Apparently he was in Rome during the fire of 191, when many of his works were burned, and he was still lecturing in the reign of Pertinax. He probably died in Sicily in A.D. 200.

Galen was the author of about 400 treatises, written in clear Attic Greek. In his *De Libris propiis* he mentions 124 purely philosophical treatises, which include commentaries on the *Categories* and *Analytics* of Aristotle, and on the *Timaeus* and *Philebus* of Plato. He wrote five treatises on ancient comedy which are lost. Only an insignificant fraction remains of his nonmedical works. Of the surviving medical works 98 are held to be genuine, 19 doubtful, 45 spurious and 19 are merely fragments.

Researches in Anatomy.—Galen's anatomical investigations were unrivaled in antiquity for their fullness and accuracy. He was an indefatigable dissector, describing mainly what he actually saw. He dissected apes and lower animals, though much that is relevant to the human body is incorporated in his works. As a specimen of his accuracy it may be mentioned that he recognized the lacteal vessels, and described the ducts of the lingual and submaxillary glands, though he was unaware of their function.

Many structures to which names of 16th- and 17th-century anatomists are attached were observed by Galen; *e.g.,* the aqueduct of Sylvius and the *foramen ovale* known as *le trou Botal.* Galen describes the mode of closure of the *foramen ovale* in language hardly since excelled.

Researches in Physiology.—Galen's physiological investigations were revolutionary. He knew of insensible perspiration, he ligatured the recurrent laryngeal nerve, he performed section of the spinal cord at various levels and observed the resulting sensory and motor disturbances and incontinence. He correctly interpreted the effect of cutting above the origin of the phrenic nerve. He described the heart with its three layers of fibres, which he hesitated to call muscle. The reasons for his reluctance are greatly to his credit: first, he noted that the cardiac substance presented characteristics different from those of ordinary muscle, as, for instance, in that its action was independent of volition; second, he recorded that section of its nerve supply was not followed by cessation of its activities. The valves of the heart are accurately described by him, and it is probable that he knew of the anastomosis of the vessels. One of his greatest contributions was the demonstration that the arteries contain blood and not air as the Alexandrian school had taught for over 400 years. He partially grasped the principle of the lesser circulation, as William Harvey (*q.v.*) pointed out.

Galen described aneurysm, differentiating the traumatic from the dilated variety, and he was also familiar with the use of the catheter. His facile teleology led him, however, to some strange errors. Among them was the elaborate hypothesis which he formulated concerning the *pneumata* or spirits, to the influence of which he attributes many vital processes. He is also the author, or at least the propagator, of the fateful theory that the septum of the heart was pierced by imperceptible foramina, through which some of the blood was supposed to exude from the right into the left ventricle.

Monotheistic Views.—Apart from his medical work, Galen occupies a position of considerable interest in the history of both religion and philosophy. He was a firm believer in a supreme creator of the universe in all its parts. He had set himself to prove that the bodily organs are in such perfect relation to the functions to which they minister that it is impossible to imagine any better arrangement. Thus, following the Aristotelian principle that nature makes naught in vain, he develops the problem of final causes along definite lines. These lines amount to determinism with God as determiner.

The peculiar feature of Galen's doctrine, however, is neither his determinism nor his monotheism (both of which were familiar to the thinkers of the day) but his extraordinary claim that God's purposes could be elicited in great detail from the examination of his works. This comes out most strikingly, perhaps, in his famous description of the hand, contained in his treatise *On the Uses of the Parts of the Body of Man.*

In several places in his works Galen mentions both Judaism and Christianity, though without much respect. In the great anatomi-

cal work under discussion he explains that in his belief God always works by law, and that it is just for this reason that natural law reveals him, and he adds that "in this matter our view . . . differs from that of Moses." It seems probable that he had read some books of the Bible. His position can thus be summed up as intermediate between Stoicism and Christianity. On the one hand he accepted the natural law of the Stoic philosophy but rejected its astrological corollary. On the other, he accepted the divine guide and architect of the universe which corresponded to the Christian scheme but rejected all idea of miracle.

Influence on Logic.—Galen is held to have had a certain influence on the development of logic. He was, however, simply purveying the ordinary Peripatetic doctrines of his day. Nevertheless he is of some importance as the carrier or transmitter of these doctrines by reason of the avidity with which his medical works were read during the middle ages. He is thus in some sense responsible for both scholastic methods and scholastic philosophy. His chief philosophical influence, however, is to be traced in the medieval doctrine of *pneuma* and the resulting conception of the nature of life. His monotheism no doubt contributed to his popularity in the ages that followed him.

Though nearly all writings were lost to western Europe after the break-up of the Roman empire, they were translated into Arabic and about the 11th century the *Methodus Medendi* and the *Ars Parva* or so-called *Microtegni* were recovered in Latin versions. The 15th and 16th centuries saw the effective completion of the Galenic canon in Greek by humanist scholars such as Thomas Linacre and Guinter von Andernach. Latin translations were studied in the medical schools until the 19th century.

Editions.—The standard edition of Galen is still that of C. G. Kühn in 20 (22) volumes (1821–33). A critical edition was produced in the *Corpus Medicorum Graecorum*. A French translation of the important anatomical and physiological writings is that of C. Daremberg, two volumes (1854). A section of the *De anatomicis administrandis*, of which the Greek original is lost, is edited with German translation by M. Simon in *Sieben Bücher der Anatomie des Galen*, two volumes (1906). *On the Natural Faculties* is available in English translation by A. Brock (1916).

See also references under "Galen" in the Index volume.

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GALEN, CLEMENS AUGUST, GRAF VON (1878–1946), German Roman Catholic prelate, the most effective opponent of Nazism among the German Catholic bishops, was born at Dinklage, Oldenburg, March 16, 1878. A descendant of one of the oldest noble families of Germany, he studied theology and philosophy and was ordained priest in 1904. He became bishop of Münster in 1933.

The Nazis were willing to accept him in view of his general conservative views; these, however, were the very reasons why he felt it necessary to oppose them.

Galen's fight against the Nazis began with his first pastoral letter, issued for Easter 1934, and continued relentlessly afterward, culminating in three major incidents: In Oct. 1934 he took under his protection a book severely criticizing Alfred Rosenberg's *Myth of the Twentieth Century*, which no one had dared publish, adding a vigorous preface; the Gestapo interfered but was unable to prevent 200,000 copies reaching the public. When in Nov. 1936 the Nazi administration of Oldenburg had all crucifixes removed from the schools, Galen protested so vigorously that a public demonstration, unparalleled under the Third Reich, occurred; the order was rescinded. Finally, in July and Aug. 1941 Galen, stung by the seizure of religious houses and the killing of "unproductive" sick and old people, preached three sermons which, in the strongest terms, scored these specific acts, as well as the general lawlessness of the Gestapo; as a result, the "mercy killings" were temporarily halted. Documents discovered later showed that the Nazis were close to a decision to hang him when Josef Göbbels interfered with the argument that such a step should be postponed until "after final victory." These incidents seem to confirm Galen's view that the risk of a more daring opposition to the Nazis than his fellow-bishops held possible was worth taking.

Galen was created a cardinal on Feb. 18, 1946, and died in the same year, at Münster on March 22.

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GALENA, a city of Illinois, U.S., seat of Jo Daviess county, is situated on the Galena river, 4 mi. from the Mississippi river in the far northwest corner of the state. The population is about 5,000. A quaint and picturesque town, Galena takes its name from the rich sulfite of lead deposits in the area.

Indians mined lead by 1700, and in the 1820s hopeful miners swarmed into the country. The town was laid out in 1826 and incorporated in 1835. For a time it prospered as a midpoint for Mississippi river traffic between Ft. Armstrong (Rock Island) and Ft. Snelling (St. Paul). As the mining industry and river commerce declined, so did the town. By the 1960s Galena had become a tourist centre. It also manufactures foundry products, mining machinery and dairy products. The restored home of Pres. Ulysses S. Grant, given to him by the people of Galena, is open to the public. (C. C. W.)

GALENA, lead sulfide (PbS), is the chief ore of lead. This mineral was mentioned by Pliny under the name black lead (*plumbum nigrum*) and it is sometimes known as lead glance (German *Bleiglanz*). It crystallizes in the cubic system; well-developed crystals are of common occurrence. The usual form of the crystals is that of the cube, cubo-octahedron or (less often) the octahedron. The mineral is most easily recognized by its perfect cubic cleavage and the brilliant metallic lustre of its freshly fractured surfaces. Galena also occurs in massive aggregates, sometimes with a fine or granular structure and occasionally fibrous or plumose. The colour of the mineral and of its streak is lead gray; it is opaque; the hardness is 2.5 and the specific gravity is 7.5.

Galena is one of the most widely distributed sulfide minerals and often occurs in metalliferous veins (Freiberg, Saxony; Broken Hill, Austr.; Coeur d'Alene, Ida.; Clausthal, Ger.; Cornwall, Eng.) associated with sphalerite, pyrite, marcasite, chalcopyrite, cerussite, anglesite, dolomite, calcite, quartz, barite and fluorite. Large deposits are also found as replacements of limestones or dolomites (Santa Eulalia, Mex.). In deposits of contact metamorphic origin galena is associated with lime silicates and fluorite (Darwin, Calif.). The mineral has occasionally been observed as a recent formation replacing organic matter such as wood, and it is sometimes found in beds of coal. In many occurrences galena contains small amounts of silver, rarely exceeding 0.1%, presumably due to included silver minerals such as argentite or tetrahedrite. Often the galena is mined as a source of silver as well as lead.

In the upper oxidized part of a deposit the galena alters to produce secondary lead minerals such as cerussite, anglesite, pyromorphite, mimetite, phosgenite and cotunnite. Banded nodules of anglesite and cerussite with galena cores are often found.

The electrical properties of galena have made it of considerable importance in the electronics industry. The point contact between a conducting metal and the cleavage surface of a crystal of galena is an efficient rectifier for small currents of radio frequency. This property made galena one of the most commonly used crystals in the early crystal radio sets. Its capability, when properly treated, of acting as either a P-(positive) type or N-(negative) type semiconductor (*see* TRANSISTOR) greatly enhances its use as an electronic circuit element. *See* also LEAD. (A. J. F.)

GALERIUS (GAIUS GALERIUS VALERIUS MAXIMIANUS), Roman emperor A.D. 305–311, was born near Serdica (now Sofia) in Thrace of humble parentage. After a distinguished military career he was nominated as *Caesar* on March 1, 293, by Diocletian (*q.v.*) to assist him in the government of the East. He spent much of his time on the Danube, but was summoned to command the Roman armies against a Persian invasion (297). In this

campaign after an initial defeat he won a decisive victory. As a result he gained increasing influence over Diocletian, and it was probably he who persuaded Diocletian to initiate the persecution of the Christians: he was and always remained a fanatical pagan. When Diocletian abdicated on May 1, 305, Galerius became *Augustus* of the East: he ruled the eastern Balkans (the dioceses of Moesia and Thrace) and Asia Minor (Asiana and Pontica), leaving Oriens (Syria and Egypt) to his *Caesar*, Maximinus. Technically he was junior to Constantius Chlorus, who simultaneously became *Augustus* of the West, but as he had secured the appointment of men of his own choice, Maximinus (his nephew) and Severus, to be *Caesares* not only in the East but in the West also, he was *de facto* supreme; and when Constantius died in 306, and his son Constantine was proclaimed *Augustus*, he insisted on Severus' becoming *Augustus* and Constantine his *Caesar*. His supremacy was, however, short-lived. In the same year Severus was overthrown and killed by Maximian's son Maxentius (*q.v.*), and when Galerius invaded Italy he was forced to beat a hasty retreat. In 308 he induced Diocletian and Maximian to meet him at Carnuntum on the Danube and to declare Maxentius a usurper, and on Nov. 11 proclaimed his friend Licinius *Augustus* of the West. Licinius, however, had effective control over Pannonia only.

Galerius was an able general, but a ruthless ruler. He imposed the poll tax on the urban population, which had been spared by Diocletian and was again released by his successors. Throughout his reign he maintained the persecution of the Christians, until in the winter of 310–311 he became the victim of a painful and disgusting disease. Fearing perhaps that this was the vengeance of the Christian god, he issued on April 30, 311, an edict in which he grudgingly granted toleration; shortly afterward he died. His death was hailed by the Christians as a signal act of divine justice, and his memory has perhaps been unduly blackened as a result.

(A. H. M. J.)

GALESBURG, a city of western Illinois, U.S., about 170 mi. W.S.W. of Chicago, the seat of Knox county. Rev. George Washington Gale (1789–1862) of Whitesboro, N.Y., a Presbyterian minister for whom the city was named, selected the site for a colonization society to establish a college-centred community. In 1836 the first settlers arrived, and in 1837 a charter was granted to the Knox Manual Labor college. The city was incorporated in 1857 and the institution was renamed Knox college. City and college played an important role in the abolition movement, and in 1858 one of the historic Lincoln-Douglas debates on the slavery issue was held on the Knox campus. Knox is now a private, nondenominational, coeducational, liberal arts college; in 1930 it absorbed Lombard college, founded by the Universalists in 1851.

Galesburg is the commercial centre of an agricultural and coal mining area. It is a division headquarters of the Burlington railroad which, with its freight yards, shops and tie plant, is one of the city's largest employers. Other industries produce a wide variety of goods ranging from refrigeration equipment to building supplies, from farm gates to outboard motors. A 30-mi. pipeline brings Mississippi river water to the city.

Galesburg is the birthplace of Carl Sandburg, the poet and Lincoln biographer. The Galesburg State Research hospital is a mental institution. Lake Storey, a beautiful artificial lake, once a railroad-owned water reservoir, has been transformed into a popular city-owned recreational park.

For comparative population figures *see* table in ILLINOIS: *Population.* (E. HG.)

GALGACUS (CALGACUS) (1st century A.D.), a prominent Caledonian chief, mentioned by the Roman historian Tacitus as present at the battle of Mons Graupius in A.D. 84. (*See* AGRICOLA, GNAEUS JULIUS; CALEDONIA). His name, cognate with *calgach*, "sword," means "swordsman." Tacitus puts into his mouth a fictitious battle address, in fact a brilliant rhetorical composition on the British view of Roman rule.

See Tacitus, *Agricola*, 29; W. J. Watson, *The History of the Celtic Place-Names of Scotland*, p. 7 (1926). (I. A. RO.)

GALIANI, FERDINANDO (1728–1787), Italian writer and economist was born at Chieti on Dec. 2, 1728, and was educated for the church. He went to Paris as secretary to the Neapolitan ambassador and remained from 1759 to 1769, lionized as a wit in the salons and befriended by the Encyclopaedists. Abbé Galiani enjoys a reputation in both French and Italian literature.

As an economist, he published a treatise on money, *Della moneta* (1750), and one on the grain trade, *Dialogues sur le commerce des blés* (1770), both remarkable for their clarity and methodical presentation. In the first, he evolves a theory of value based on utility and scarcity, which has been greatly praised for its originality but which follows scholastic tradition. In the second, Galiani stresses the necessity of regulation, opposing the Physiocrats who advocated complete freedom. After his return to Naples, he carried on a spirited correspondence with Madame d'Epinay and other Parisian friends. His letters are of interest for literary history and shed light on Galiani's debate with Abbé Morellet, the spokesman of the Physiocrats. Galiani died in Naples, Oct. 30, 1787.

See Fausto Nicolini, *Il pensiero dell'abate Galiani* (1909); Joseph Rossi, *The Abbé Galiani in France* (1930). (R. DE R.)

GALIB DEDE (SHEYH GALIB), pseudonyms of MEHMED ESAD (*c.* 1758–1798), was the last of the five great classical Turkish poets. Born in Istanbul, the son of a Mevlevi dervish, he became the sheik of the Galata monastery. He had as his patrons Sultan Selim III, himself a poet and musician, and many princesses who admired his work. The monastery became a centre for poetry and music in Istanbul where leading men of letters and musicians gathered. In his divan (collected poems) and his allegorical romance *Hüsn ü Ashk* ("Beauty and Love") he happily combines the mystic enthusiasm of Jalal-ud-din Rumi (*q.v.*), the complex imagery of the Persian "Indian school" and the warm, flowing language of Nedim (*q.v.*). Classical poetry's strict forms did not hamper his originality—his power of imagination, colourful similes and descriptions infused fresh breath into Turkish literature.

See E. Gibb, *A History of Ottoman Poetry*, iv (1905). (F. I.)

GALICIA, the name applied in the 19th century to a large province of the Austrian empire north of the Carpathian mountains, about 30,000 sq.mi. in area, with a population of about 8,000,000 in 1910; among these about 4,000,000 were Poles, more than 3,000,000 Ukrainians and more than 800,000 Jews. The Polish population prevailed in western Galicia (with its centre at Cracow); the Ukrainians were a majority in eastern Galicia with its centre at Lviv (Pol., Lwow; Ger., Lemberg). The Jews were an important part of the urban population throughout Galicia.

In the middle ages eastern Galicia, situated between Hungary, Poland and the western Russian principalities of Kiev and Volhynia, was coveted by all its neighbours, who vied for its fertile soil and important commercial connections. In 981 this land, then called "Chervena Rus" (Red Rus), was conquered by the Kievan grand prince Vladimir the Great and included in his vast realm. From 1087, under Rostislav's dynasty, eastern Galicia, between the San, Dniester and Zbruch rivers, with the capital city of Halicz, became an independent principality. Prince Roman Mstislavich of Volodymir in Volhynia, invited by Galician boyars, ascended the throne in Halicz in 1199 and united under his power both Volhynia (or "Lodomeria") and Galicia in 1200. In 1205 he was killed in a fight against the Poles, and his young widow with her two infant sons, Daniel and Vasilko, placed herself under the protection of the king of Hungary. But the boyars and the people of Galicia were unwilling to accept Hungarian occupation and feared that Roman Catholicism was to be introduced in place of Greek Orthodoxy; in 1219 Prince Mstislav Mstislavich the Daring of Novgorod, summoned by the Galicians, expelled the Hungarians and became prince of the troubled land. The difficult foreign relations of Galicia were aggravated by incessant internal struggles between the powerful and influential Galician boyars and the princes, who often were only nominal sovereigns of the land, while the real power belonged to the boyar class.

After Mstislav's death in 1228, the young prince Daniel (*q.v.*) Romanovich became prince of Galicia. Struggling against the opposition and intrigues of his own boyars, this outstanding statesman and military leader also defeated the Hungarians and the Poles. Crowned king of Galicia in 1253 by a papal legate, Daniel, however, was forced to recognize the sovereignty of the Mongol-Tatar

Golden Horde, who conquered all Russian lands in 1237–41.

When Roman's dynasty died out in Galicia in 1323, the boyars invited a Polish prince of the Piast dynasty, Boleslaw of Mazovia, to the throne. He accepted the Greek Orthodox faith and the Orthodox name of Yuri (George); on his seal he was designated as *Georgius rex Russiae, dux Ladomeriae.* After his death in 1340, the Polish king Casimir the Great invaded Galicia and, in 1349, formally annexed it to the kingdom of Poland, in which it remained until the first partition of Poland in 1772. The Polish sovereigns tried to polonize Galicia as much as possible; they invited Polish settlers there, granting them special concessions and privileges; Polish legal and social institutions were introduced during the 15th century. The immigrant Polish gentry, having acquired large estates and occupied administrative positions, soon became a socially dominant class; the majority of the local Galician boyars adopted the Polish language, Polish customs and Roman Catholicism.

The peasantry became serfs of the Polish and polonized nobility and lived in misery and oppression. The town population tried to resist polonization and Roman Catholicism. Orthodox associations (*bratstva*), concerned with welfare and mutual aid, established schools and printing houses for the support of the West Russian language and of the Greek Orthodox faith, but, after the high clergy in 1596 had accepted a religious union with the Roman Catholic Church, the lower clergy followed suit. By the beginning of the 18th century the Uniate (or Greek Catholic) Church entirely dominated eastern Galicia.

At the first partition of Poland (1772) Galicia was annexed by Austria. The congress of Vienna in 1815 confirmed Austria's possession. The city of Cracow with its adjacent region was proclaimed an independent republic under the protection of Austria, Prussia and Russia. In 1846, the revolutionary movement in the Cracow republic and a peasant uprising in Galicia against the landlords gave the Austrian government a pretext to annex the Cracow region and to incorporate its territory with the rest of Galicia. In 1848–49 serfdom in Galicia was abolished by the Austrian government.

The first half of the 19th century was a period of centralized bureaucratic rule in Galicia, but in 1861 provincial diets were established in all Austrian lands. In 1867 Galicia was granted a large degree of autonomy. The dominant position, however, in the provincial diet, in the administration and in cultural life belonged to the Poles. This engendered opposition from the other ethnic group, called Ruthenians by the Austrians and the Poles and Ukrainians by their own leaders. The latter demanded administrative autonomy for eastern Galicia and fostered the development of the Ukrainian language and culture. The Enlightenment society (*Prosvita*, founded in 1868) and the Shevchenko Scientific society (founded in 1873) were strongholds of Ukrainian nationalism. The historian Myhaylo Hrushevski and the writer Ivan Franko were its outstanding leaders. National rebirth in Galicia was complicated by the struggle between two factions, the anti-Russian Ukrainian nationalists and the pro-Russians, who emphasized the close affinity between the Ukrainians and the Russians.

Galicia became a battlefield in World War I and its eastern part was held by Russian troops for about a year in 1914–15. When the Austrian empire disintegrated in the autumn of 1918, the Ukrainians in eastern Galicia proclaimed a short-lived independent government under Evhen Petrushevych in Lviv, but the re-established Polish state claimed and took over all of Galicia for itself. The Allied powers recognized eastern Galicia as a part of Poland in 1919 and 1923. The Ukrainian nationalists in Galicia opposed Polish domination; the Polish government suppressed opposition and enforced the "pacification" of the country. Finally the leading Ukrainian political party, the Ukrainian National Democratic union, adopted a moderate attitude toward Poland and concluded, in 1935, an agreement on Polish-Ukrainian cooperation.

On Sept. 17, 1939, when German troops were crushing the Polish army, the Soviet government proclaimed that "the Polish state and its government have, in fact, ceased to exist" and that Soviet troops were ordered "to cross the frontier and to take under their protection the life and property of the population of western Ukraine and western Belorussia." The supreme soviet of the U.S.S.R., in its session of Nov. 1, 1939, decided to incorporate eastern Galicia into the U.S.S.R. and to unite it with the Ukrainian Soviet Socialist Republic.

After the German attack on the U.S.S.R., German units reached Lviv on June 30, 1941. On the same day the Ukrainian nationalists under Stefan Bandera and Yaroslav Stetsko proclaimed a Ukrainian state, but the German authorities refused to recognize it and dispersed the Ukrainian "government." Only the formation of some police units and, later, of a Galician SS. division, was authorized by Hitler. In 1944 the Soviet army reconquered eastern Galicia; western Galicia remained a part of Poland. *See* also POLAND; UKRAINE.

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(S. G. PU.)

GALICIA, in the middle ages one of the constituent kingdoms of the crown of Castile, and subsequently a Spanish province, occupies the northwestern corner of the Iberian peninsula. It consists of the modern provinces of La Coruña, Pontevedra, Lugo and Orense. Its name is derived from the Gallaeci, who lived there when the region was conquered by the Roman legions *c.* 137 B.C. The Gallaeci were probably not Iberians. Some historians consider the region was heavily settled by Celts, but this has been disputed. In Roman and Visigothic times Galicia stretched south to the Douro and eastward to beyond the city of León, and formed part of the archdiocese of Bracara (Braga). From *c.* 410 it was an independent kingdom under the Suebi until 585 when the latter were finally destroyed by Leovigild. After 711 its population was greatly increased by an influx of Visigothic refugee settlers who were able to establish themselves in its river basins. The language of Galicia is closely related to Portuguese, and the existence of a separate Galician-Portuguese language can be discerned by the early 11th century. By the 13th century there was a flourishing tradition of lyric poetry in Galicia and, as a result, Galician-Portuguese became the language even of Castilian lyric poets until late in the 14th century.

Despite its clear ethnic, linguistic and geographical differences from the rest of Spain, and its remoteness from the centre, Galicia, though regarded as a separate kingdom in the later middle ages, rarely enjoyed, or appears to have sought, political independence. As a result of Alfonso III's division of his kingdom it was ruled by Ordoño II as king (910–914), by Sancho I as a refugee (926–929) and by García, son of Ferdinand I, as king (1065–71). After 1369 it was unwilling to accept the usurpation of Henry II of Trastámara and, for a time, seemed disposed to accept Ferdinand of Portugal as king. Subsequently it favoured the claims of John of Gaunt, duke of Lancaster, to the Castilian throne. This, however, seems partly to have been due to the presence of an influential Jewish population in some of the Galician towns, rather than to any separatist leanings. Probably the possession of the national shrine of St. James of Compostela (Santiago de Compostela) from the 9th century attached the Galicians, for religious and economic reasons, firmly to the central kingdoms. In modern times there has been a revival of interest in the Galician language and culture. *See* also SPAIN.
(P. E. R.)

GALILEE, the northern region of Palestine, bounded on the south by Samaria and Mt. Carmel, on the west by Phoenicia, on the north by the Leontes (Litani) river and on the east by the Jordan river. Its exact limits varied, but its maximum extent was about 60 mi. long and 30 mi. broad. On the west Phoenicia blocked the way to the sea; to the north lay the Lebanon mountains; and to the east a rather barren region. Under such conditions Galilee inevitably faced mainly toward the south. Its limestone hills, later extensively overlaid with a lava that has added fertility to the soil, are a southern extension of the Lebanon mountain range. It has two clearly marked parts—Upper Galilee, more mountainous, with a maximum elevation of about 4,000 ft., and Lower Galilee, with fertile plains and lower hills, none rising over 1,850 ft. On

the south the hills slope down to the fertile Plain of Esdraelon, which separates Galilee from Samaria. The boundary line between Galilee and Samaria is hard to draw; it varied from time to time, but at least part of the Plain of Esdraelon was usually included in Galilee. The Jordan valley, which dips below sea level just south of Lake Huleh or Semechonitis and is almost 700 ft. below sea level by the time it reaches the Sea of Galilee, clearly divides Galilee from the plateau to the east. Since the high plateau east of the Sea of Galilee stands over 2,000 ft. above that lake, while the lake was easily accessible from the west, the entire Sea of Galilee, including the shore on the north and east sides, was a part of Galilee.

Compared with the dry and barren hills of Judaea, and even with the somewhat open and fertile hill country of Samaria, Galilee, blessed with abundant water, was still more fertile in producing good crops of grain, olives, etc., especially in Lower Galilee and the Plain of Esdraelon. According to Josephus (*Wars*, III, 10, 7–8), the Plain of Gennesaret, on the northwest shore of the Sea of Galilee, was unusually fertile and produced crops the year round. The Sea of Galilee teemed with fish, and pickled fish were exported to many countries; the centre of this industry was Tarichaea, perhaps identical with Magdala (Mejdel), on the western shore of the lake.

A network of important roads linked Galilee with surrounding regions to the east, south and west. From Damascus on the northeast and from the Plateau of Hauran on the east, roads crossed the Jordan both below and above the Sea of Galilee and ran west through Galilee to Tyre and Accho or Ptolemais (Akka) on the Mediterranean coast or south across the Plain of Esdraelon to Samaria and the Plain of Sharon (the latter was reached through the pass at Megiddo). The "way of the sea" in Isa. ix, 1 came from Damascus and other points to the east, crossed the Jordan between Lake Huleh and the Sea of Galilee, ran past the northwest shore of that sea, and then either went on west to the Mediterranean or ran south to southern Palestine and Egypt. Nazareth, the boyhood home of Jesus, was near several east-west and north-south roads, which could be seen from the hills above it. This ease of access to Galilee meant freedom of trade, acquaintance with people of various regions and races, and exposure to effective attack in war. In such a situation, the reputation of the Galileans for fierce defense of their rights had special point (Josephus, *Wars*, III, 3, 2).

Galilee has had a long history, and important remains of prehistoric man have been found there. When the tribes of Israel began to invade the region, the Canaanites were strongly entrenched, and Jabin, king of Hazor (Tall al Qedah) and leader of the Canaanites (Josh. xi, 1; Judg. iv, 2, 17, 24), barred the way. Although Josh. xi and xix suggest that the Israelites quickly seized the entire region, Judg. i, 30–33 shows that many cities and the Plain of Esdraelon remained in the hands of the Canaanites. Under the combined leadership of Deborah of Ephraim and Barak of Kedesh (Tall Qades) the northern Israelite tribes defeated the Canaanites (Judg. iv and v) and gave the northern tribes (traditionally Asher, Zebulun, Naphtali and Issachar) a much firmer hold on the Galilean and Esdraelon region. Galilee was included in the united kingdom of Israel; Solomon could give Hiram of Tyre 20 cities of (presumably northwest) Galilee in return for help that Hiram gave him (I Kings ix, 11). In later years rulers of neighbouring empires (Ben-hadad, in I Kings xv, 20; Tiglath-pileser, II Kings xv, 29) overran and ravaged the country. The weakness of Judaism in Galilee at the time of the Maccabaean struggle is clear; Simon rescued the loyal Jews of Galilee, then called "Galilee of the Gentiles" (I Macc. v, 15); he took them to Judaea (about 163 B.C.), leaving Galilee to those who accepted Syrian rule. But by the end of the 2nd century B.C. Galilee was once more strongly Jewish, and in the 1st century A.D. it was predominantly though by no means exclusively Jewish in population and religious life. (*See* also JEWS: *Earliest Times to A.D. 135.*)

The ministry of "Jesus the Galilean" (Matt. xxvi, 69) was largely spent in Galilee. He was born when Herod the Great was the puppet king of all Palestine (40–4 B.C.). He spent his boyhood and most of his ministry under Herod Antipas, tetrarch of Galilee and Perea (4 B.C.–A.D. 39), whose capital city was at first Sepphoris (Saffuriyeh) and later Tiberias (Tabariyeh), which Herod built about A.D. 20–22. All Galilean cities named in the Gospels were in Lower Galilee and most of them cluster about the Sea of Galilee: mentioned are Nazareth, Cana (Khirbet Qana), Capernaum (Tall Hum), Chorazin (Khirbet Kerazeh), Bethsaida (east end of al 'Araj), Gerasa (Kursi?), Tiberias (mentioned only in John vi, 1, 23; xxi, 1, with no suggestion that Jesus had been there) and Nain (Nein, probably included in Galilee at that time).

The Jews of 1st-century Galilee considered themselves good Jews; evidently every town had at least one synagogue, and it was common for Galilean Jews to go to feast celebrations at Jerusalem (John iv, 45), a practice that Jesus followed, especially at the Passover season. But it was possible to distinguish Galileans by their speech (Matt. xvi, 73), and the Jewish leaders in Jerusalem looked on Galilean Judaism with condescension.

Yet in both Christianity and Judaism Galilee played a notable role. Even when the early church rallied at Jerusalem and began its preaching there, the Jerusalem nucleus of the church was Galilean: "Are not all these who are speaking Galileans?" (Acts ii, 7). The church had moved its centre from Galilee, where Jesus centred his ministry, to Jerusalem, but the apostles (except the traitor Judas) were Galileans. Following the fall of Jerusalem, Judaism centred for a time in Jabneh (Jamnia, Yebna), but later the centre of its rabbinical leadership moved to Galilee, first at Sepphoris and then at Tiberias, where, it seems, the Mishnah was given its classical written form and the Jerusalem Talmud was produced. (*See* TALMUD.) The noteworthy number of Galilean synagogue ruins from this period, and the ruins, including catacomb burials, from such places as Beth-shearim (Sheikh Abreiq), indicate the strength of Judaism in Galilee in the early Christian centuries. The Christian interest in the biblical sites of Galilee explains the attempts of the crusaders to wrest Galilee from Muslim hands, and though these attempts finally proved unsuccessful, the numerous ruins of crusader castles recall that period of Galilean history. *See* also ISRAEL; JUDAEA; PALESTINE; SAMARIA.

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(F. V. F.)

GALILEE, SEA OF (LAKE TIBERIAS), the lake in Israel through which the Jordan river flows. It is 13 mi. long, 7½ mi. across at its widest point, and has a surface area of 64 sq.mi. (165 sq.km.). Its surface is, on the average, 696 ft. below the Mediterranean sea. The water level varies as much as 12 ft. in the course of a year, being highest in late spring and lowest in late summer. The lake bottom slopes gently from all sides save the east, where there is a sharp drop to the maximum depth of 157 ft.

The Sea of Galilee has important biblical associations. Its Old Testament name, Sea of Kinneret or Chinnereth, comes from its harplike shape. Other names are: Gennosar (Books of Maccabees and Josephus), Lake of Gennesaret (Gospel of St. Luke), Sea of Tiberias (Gospel of St. John), Bahr Tabariyeh (Arab) and Lake Tiberias (modern usage).

The upheavals that formed the Jordan rift (*see* JORDAN RIVER) were followed by fracturing and by extensive volcanism during Pliocene and Pleistocene epochs. Basalt flowed across the valley floor from the lava-covered Hauran to the east and the southern Galilee hills to the west. During the Pluvial period, Lake Jordan filled most of the rift, but with the Recent epoch's drier climate, this Pleistocene lake shrank, leaving the Dead sea. To the north, the waters of the Jordan river were dammed by two basalt sills, thus forming the Sea of Galilee and Lake Huleh. The southernmost of these sills outcrops at Gesher, 6 mi. below the Sea of Galilee. There, in 1932, a diversionary channel was cut. A hydroelectric plant and a reservoir were built at the confluence of the Jordan and Yarmuk rivers, using the 90-ft. drop. The plant was destroyed in May 1948 during the Arab-Israeli war.

Black basalt hills rise from the lake's eastern and western shores.

Underlying Pleistocene-Pliocene fossiliferous limestones and sandstones, and Eocene marls and limestones outcrop in places. The lake shore is wide enough for roads, but plains border the water in only three places. To the northwest lies the depositional Plain of Gennesaret (Al Ghuweir). Historically abundant in grapes, figs and olives, Gennesaret was bordered by Tabgna and Capernaum on the north, and Magdalena on the south. To the northeast lies Al Buteiha, composed of the Jordan's delta and deposits of other streams and wadies. This marshy area is poorly drained and is the site of two small Syrian villages. Where the Jordan exits in the south is the Valley of Kinneret, composed of fertile gypseous clays, marls and recent alluvials that are widely used for agriculture. Overlooking the lake on the heights west of Tiberias is the Plain of Arbel, a fertile tableland of weathered lava, connected to the lake by the canyon of Arbel. Hot springs containing chlorides and sulfides dot the shore at Hammat, Fuliya and Tabgha on the west, and Al Hamma on the east. The Tiberias baths are among Israel's most important winter resort attractions.

Most of the Sea of Galilee's inflow (74%) comes from the Jordan river; the rest comes from springs, wadies, underwater seepage and rainfall. Draining of the Huleh marsh and channelizing of the Jordan river have increased the Jordan's inflow. The lake's waters are warm. Mean February temperatures range from 12.5° C. (55° F.) to 15° C. (59° F.); August temperatures average 30° C. (86° F.). Between December and February, intense mixing aerates the water at all depths. This is true especially in the northeast, where the Jordan enters, and in the west, where warm, saline waters from ground and underwater springs mix with cool, surface waters. During these months planktonic plants and animals are most abundant, and fishing is at its peak. Summer is a period of stagnation when oxygen values are very low.

In New Testament times, fishing was a major industry on the Sea of Galilee. Modern Israel has revived this activity. One thousand tons of fish are caught annually with modern nets cast from motorboats and trawlers. Winter is the main season for sardines and tilapia but these and larger fish are caught all year round. Friction with Syria is of major concern to Israeli fishermen because the international boundary on the northeast comes within ten yards of the lake.

The Sea of Galilee's economic revival has been accompanied by irrigated agriculture. About two dozen farm settlements surround the lake, the majority in Kinneret valley. Most are collectives, like Degania at the southern tip, which was Palestine's first collective settlement (established 1909). They yield vegetables, bananas, grapefruit, poultry and dairy products. The Israeli government's master water plan calls for use of the lake waters for supplementary irrigation in Beisan valley, and use of the lake as the main holdover storage basin for the Jordan river-Negev irrigation system.

The climate of the region is mild, permitting crops to grow the year round. Average minimum January temperatures at Tiberias are 7.4° C. (45.3° F.). Strong, dry east winds (Sharkiya) descend upon the lake in winter, warming the area but also occasionally causing destruction. Rain falls in winter and is heavier on the west (Tiberias, 17.5 in.) than on the east (Ein Gev, 14.3 in.). Summers are hot and continental, with average daily temperatures reaching 38° C. (100° F.). Although the summer is rainless and the humidity is low, the high temperatures make the air feel oppressive. The August mean maximum temperature for Tiberias, for example, is 30.8° C. (87.4° F.). Strong, hot summer westerlies sometimes cause sudden squalls.

The Jewish historian Josephus wrote of nine cities situated on the Sea of Galilee in ancient times but all except Tiberias have disappeared. After Israel gained its independence in 1948 Tiberias doubled in size and became a thriving commercial centre as well as Israel's major winter resort. Its tourist attractions include ancient fortifications, houses of worship and tombs of Jewish sages.

Archaeology.—Principal archaeological sites in the lake area are listed in counterclockwise sequence from the northern end:

1. Karraza (Chorazin), whose ruins include a black basalt synagogue from Roman times.
2. Kefar Nahum (Capernaum), with remains of the synagogue where, according to tradition, Jesus healed the centurion's servant.
3. Tel Kinrot (Tell 'Ureima), with excavations from the Bronze and Iron Ages and the Roman period.
4. Tabgha, with a Byzantine church and mosaics.
5. Khan Minya, with Arab period ruins.
6. Wadi el 'Amud, in which the skull of Neolithic "Galilee Man" was found. It empties into the northern part of Gennesaret.
7. Canyon of Arbel, with caves dating from the Roman period, and a nearby synagogue.
8. Tel Rakat (Qunoitira), with Canaanite Age relics.
9. Tiberias, with its Roman acropolis and medieval seashore tower.
10. Beth Yerah ("City of the Moon"), at the southern tip of the lake. There the most extensive diggings have taken place, revealing Early Bronze Age walls, walls and relics from the Hellenistic period and later synagogues and churches.
11. Tel 'Eli, on the western side of the Jordan river crossing. This strategic site was occupied from Early Neolithic times.
12. Shaar HaGolan, between the Yarmuk river and the lake, with its Neolithic agricultural village that revealed for the first time Yarmukian culture.
13. Susita (Hippos), on the hill overlooking Ein Gev. Remains include a water conduit dating from the Second Temple, a Hellenistic theatre and a Byzantine church.
14. El Fiq (the ancient Aphek), whose spring supported Susita's water system.
15. El Koursi, the Gerasa of the 4th century.
16. Kal 'at el Husn, the Gamala of Josephus' time.

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GALILEO GALILEI (1564–1642), Italian mathematician, astronomer and physicist, who made three significant contributions to the founding of modern scientific thought. (1) As the first man to use the telescope to study the skies, Galileo amassed evidence that proved the earth revolves around the sun and is not the centre of the universe as had been believed. His system was such a radical departure from accepted thought that Galileo was tried by the Inquisition in Rome, ordered to recant and forced to spend the last eight years of his life under house arrest. (2) Galileo informally stated the principles later embodied in Newton's first two laws. Because of his pioneer work in gravitation and motion and in the combining of mathematical analysis with experimentation, Galileo often is referred to as the father of modern mechanics and experimental physics. (3) Perhaps the most far-reaching of Galileo's achievements was his re-establishment of mathematical rationalism against Aristotle's logico-verbal approach, and his insistence that the "Book of Nature is written in mathematical characters." Through this he was able to found the modern experimental method. (*See* RATIONALISM: *Epistemological Rationalism.*)

Legend of the Lamp.—Galileo was born at Pisa on Feb. 15, 1564, the son of Vincenzio Galilei, a musician. He received his early education at the monastery of Vallombrosa near Florence, where his family had moved in 1574, and in 1581 entered the University of Pisa to study medicine. While in the Pisa cathedral during his first year at the university, Galileo supposedly observed a lamp swinging and found that the lamp always required the same amount of time to complete an oscillation, no matter how large the range of the swing. Later in life Galileo verified this observation experimentally and suggested that the principle of the pendulum might be applied to the regulation of clocks.

Until he supposedly observed the swinging lamp in the cathedral, Galileo had received no instruction in mathematics. Then a geometry lesson he overheard by chance awakened his interest, and he began to study mathematics and science with Ostilio Ricci. But in 1585, before he had received a degree, he was withdrawn from the university because of lack of funds. He returned to Florence, lectured at the Florentine academy and in 1586 published an essay describing the hydrostatic balance, the invention of which made his name known throughout Italy. In 1589 a treatise on the centre of gravity in solids won for Galileo the honourable but not lucrative post of mathematics lecturer at the University of Pisa.

Galileo then began his research into the theory of motion, first

disproving the Aristotelian contention that bodies of different weights fall at different speeds. Because of financial difficulties, Galileo, in 1592, applied for and was awarded the chair of mathematics at Padua, where he was to remain for 18 years and perform the bulk of his most outstanding work. At Padua he continued his research on motion and proved theoretically (about 1604) that falling bodies obey what came to be known as the law of uniformly accelerated motion. He also gave the law of parabolic fall with its inertial component. The legend of his dropping weights from the leaning tower of Pisa apparently has no basis in fact.

Research With the Telescope.—Galileo became convinced early in life of the truth of the Copernican theory but was deterred from avowing his opinions—as shown in his letter of April 4, 1597, to Kepler—because of fear of ridicule. While in Venice in the spring of 1609, Galileo learned of the recent invention of the telescope. After returning to Padua he built a telescope of threefold magnifying power and quickly improved it to a power of 32. Because of the method Galileo devised for checking the curvature of the lenses, his telescopes were the first that could be used for astronomical observation, and they soon were in demand in all parts of Europe.

As the first person to apply the telescope to a study of the skies, Galileo in late 1609 and early 1610 announced a series of astronomical discoveries. He found the surface of the moon was irregular and not smooth as had been supposed; he observed that the Milky Way was composed of a collection of distant stars; he discovered the satellites of Jupiter and named them Sidera Medicea in honour of his former pupil and future employer, Cosimo II, grand duke of Tuscany. Galileo also observed spots on the sun, the phases of Venus and what appeared to him as the three forms of Saturn. His first decisive astronomical observations were published in 1610 in *Sidereus Nuncius* (*see* TELESCOPE: *Early History*).

Although the Venetian senate had granted Galileo a lifetime appointment as professor at Padua because of his findings with the telescope, he left in the summer of 1610 to become "first philosopher and mathematician" to the grand duke of Tuscany, an appointment that enabled him to devote more time to research.

Conflict With Rome.—In 1611 Galileo visited Rome and demonstrated his telescope to the most eminent personages at the pontifical court. Encouraged by the flattering reception accorded to him, he ventured in his *Letters on the Sunspots,* printed at Rome in 1613, to take up a more definite position on the Copernican theory. Movement of the spots across the face of the sun, Galileo maintained, proved Copernicus was right and Ptolemy wrong.

The great expository gifts of Galileo and his choice of Italian, in which he was an acknowledged master of style, made his thoughts popular beyond the confines of the universities and created a powerful movement of opinion. The Aristotelian professors, seeing their vested interests threatened, united against him. They strove to cast suspicion upon him in the eyes of ecclesiastical authorities because of contradictions between the Copernican theory and the Scriptures. They obtained the cooperation of the Dominican preachers, who fulminated from the pulpit against the new impiety of "mathematicians" and secretly denounced Galileo to the Inquisition for blasphemous utterances which had been freely invented. Galileo, gravely alarmed, agreed with one of his pupils, B. Castelli, a Benedictine monk, that something should be done to forestall a crisis. He accordingly wrote letters meant for the grand duke and for the Roman authorities (letters to Castelli, to the grand duchess dowager, to Monsignor Dini) in which he pointed out the danger, reminding the church of its standing practice of interpreting scripture allegorically whenever it came into conflict with scientific truth, quoting patristic authorities and warning that it would be "a terrible detriment for the souls if people found themselves convinced by proof of something that it was made then a sin to believe." He even went to Rome in person to beg the authorities to leave the way open for a change. A number of ecclesiastical experts were on his side. Unfortunately, Cardinal Bellarmine, the chief theologian of the church, was unable to appreciate the importance of the new theories. He clung to the time-honoured belief that "mathematical hypotheses" have nothing to do with physical reality. He only saw the danger of a "scandal" which might undermine Catholicity in its fight with Protestantism. He accordingly decided that the best thing would be to check the whole issue by having Copernicanism declared "false and erroneous" and the book of Copernicus suspended by the congregation of the Index. The decree came out on March 5, 1616. On the previous Feb. 26, however, as an act of personal consideration, Cardinal Bellarmine had granted an audience to Galileo and informed him of the forthcoming decree, warning him that he must henceforth neither "hold nor defend" the doctrine, although it could still be discussed as a mere "mathematical supposition."

For the next seven years Galileo led a life of studious retirement in his house in Bellosguardo near Florence. At the end of that time (1623), he replied to a pamphlet by Orazio Grassi, S.J., about the nature of comets; the pamphlet clearly had been aimed at Galileo. The reply, titled *Saggiatore* . . . ("Assayer . . ."), was a brilliant polemic on physical reality and an exposition of the new scientific method. Galileo distinguished in it between the primary (*i.e.,* mathematical) properties of matter and the others, and wrote the famous pronouncement that the "Book of Nature is written in mathematical characters." The book was dedicated to the new pope, Urban VIII, who as Maffeo Barberini had been a longtime friend and protector of Galileo. Pope Urban received the dedication enthusiastically.

In 1624, Galileo again went to Rome, hoping to obtain a revocation of the decree of 1616. This he did not get, but he obtained permission from the pope to write about "the systems of the world" both Ptolemaic and Copernican, so long as he discussed them noncommittally and came to the conclusion dictated to him in advance by the pontiff, that is, that we cannot presume to know how the world is really made because God could have brought about the same effects in ways unimagined by us, and we must not restrict His omnipotence. These instructions were confirmed in writing by the head censor, Monsignor Riccardi.

Galileo returned to Florence and spent the next several years working on his great *Dialogo dei Massimi Sistemi* "Dialogue of the Two Chief World Systems"). As soon as it came out in 1632, with the full imprimatur of the censors, it was greeted with a tumult of applause from every part of Europe as a literary and philosophical masterpiece.

On the crisis which followed we have only inferences. It was pointed out to the pope that despite its noncommittal title, the work was a compelling and unabashed plea for the Copernican system. The strength of the argument made the prescribed conclusion at the end look anticlimactic and pointless. The Jesuits insisted that it could have worse consequences on the established system of teaching "than Luther and Calvin put together." The pope in anger ordered a prosecution. The author being covered by licence, the only legal measures would be to disavow the licencers and prohibit the book. But at that point a document was "discovered" in the file, to the effect that during his audience with Bellarmine on Feb. 26, 1616, Galileo had been specifically enjoined from "teaching or discussing Copernicanism in any way," under the penalties of the Holy Office. His licence, it was concluded, had therefore been "extorted" under false pretences. (The consensus of historians, based on evidence made available when the file was published in 1877, has been that the document was a plant and that Galileo was never so enjoined.) The church authorities, on the strength of the "new" document, were able to prosecute him for "vehement suspicion of heresy." Notwithstanding his pleas of illness and old age, Galileo was compelled to journey to Rome in Feb. 1633 and stand trial. He was treated with special indulgence and not jailed. In a rigorous interrogation on April 12, he steadfastly denied any memory of the 1616 injunction. The commissary general of the Inquisition, obviously sympathizing with him, discreetly outlined for the authorities a way in which he might be let off with a reprimand, but on June 16 the congregation decreed that he must be sentenced. The sentence was read to him on June 21: he was guilty of having "held and taught" the Copernican doctrine and was ordered to recant.

Galileo recited a formula in which he "abjured, cursed and detested" his past errors. The sentence carried imprisonment but this portion of the penalty was immediately commuted by the pope into house arrest and seclusion on his little estate at Arcetri near Florence, where he returned in Dec. 1633. The house arrest remained in effect throughout the last eight years of his life.

Although confined to his estate, Galileo's prodigious mental activity continued undiminished to the last. In 1634 he completed his *Discorsi e Dimostrazioni Matematiche intorno a due nuove scienze* . . . ("Dialogue on Two New Sciences . . ."), in which he recapitulated the results of his early experiments and his mature meditations on the principles of mechanics. This, in many respects his most valuable work, was printed by the Elzevirs at Leiden in 1638. His last telescopic discovery—that of the moon's diurnal and monthly librations—was made in 1637, only a few months before he became blind. But the fire of his genius was not even yet extinct. He continued his scientific correspondence with unbroken interest and undiminished acumen; he thought out the application of the pendulum to the regulation of clockwork, which Christiaan Huygens put into practice in 1656; he was engaged in dictating to his disciples, Viviani and Torricelli, his latest ideas on the theory of impact when he was seized with the slow fever which resulted in his death at Arcetri on Jan. 8, 1642.

Value of His Work.—The direct services of permanent value which Galileo rendered to astronomy are virtually summed up in his telescopic discoveries. A puzzling circumstance is his neglect of Kepler's laws, which were discovered during his lifetime. But then he believed strongly that orbits should be circular in order to keep the fabric of the cosmos in its perfect order. This preconception prevented him from giving the full formulation of the inertial law, which he himself discovered although it usually is attributed to Descartes. Galileo believed that the inertial path of a body around the earth must be circular. Lacking Newtonian gravitation, he hoped this would allow him to explain the path of the planets as circular inertial orbits around the sun. His name is nevertheless justly associated with a vast extension of the bounds of the visible universe, and his telescopic observations are a standing monument to his ability. Within two years after their discovery, he had constructed approximately accurate tables of the revolutions of Jupiter's satellites, and he proposed their frequent eclipses as a means of determining longitudes on land and at sea. The idea, though ingenious, has been found of little use at sea. His observations on sunspots are noteworthy for their accuracy and for the deductions he drew from them with regard to the rotation of sun and the revolution of the earth.

The idea of a universal force of gravitation seems to have hovered on the borders of this great man's mind, but he refused to entertain it because, like Descartes, he considered it an "occult" quality. More valid instances of the anticipation of modern discoveries may be found in his prevision that a small annual parallax would eventually be found for some of the fixed stars, and that extra-Saturnian planets would at some future time be ascertained to exist, and in his conviction that light travels with a measurable although extremely great velocity. Although Galileo discovered, in 1610, a means of adapting his telescope to the examination of minute objects, he did not become acquainted with the compound microscope until 1624, when he saw one of Cornelis Drebbel's instruments in Rome and, with characteristic ingenuity, immediately introduced several improvements into its construction.

A most substantial part of his work consisted undoubtedly of his contributions toward the establishment of mechanics as a science. Some valuable but isolated facts and theorems had previously been discovered and proved, but it was Galileo who first clearly grasped the idea of force as a mechanical agent. Although he did not formulate the interdependence of motion and force into laws, his writings on dynamics are everywhere suggestive of those laws, and his solutions of dynamical problems involve their recognition. In this branch of science he paved the way for Newton. The extraordinary advances made by him were due to his happy method of applying mathematical analysis to physical problems.

Galileo was the first man who perceived that mathematics and physics, previously kept in separate compartments, were going to join forces. He was thus able to unify celestial and terrestrial phenomena into one theory, destroying the traditional division between the world above and the world below the moon. The method which was peculiarly his consisted in the combination of experiment with calculation—in the transformation of the concrete into the abstract and the assiduous comparison of results. He created the modern idea of experiment, which he called *cimento* or "ordeal." This method was applied to check theoretical deductions in the investigation of the laws of falling bodies, of equilibrium and motion on an inclined plane and of the motion of a projectile. The latter, together with his definition of momentum and other parts of his work, implied a knowledge of the laws of motion as later stated by Newton. In his *Discorso intorno alle cose che stanno in su l'acqua* ("Discourse on Things That Float"), published in 1612, he used the principle of virtual velocities to demonstrate the more elementary theorems of hydrostatics, deducing from it the equilibrium of fluid in a siphon, and worked out the conditions for the flotation of solid bodies in a liquid. He also constructed in 1607 an elementary form of air thermometer.

See ASTRONOMY: *The Founding of Modern Astronomy;* CAUSALITY (CAUSATION): *Historical Development;* GRAVITATION; MOTION, PRINCIPLES AND LAWS OF; *see* also references under "Galileo Galilei" in the Index volume.

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GALINTHIAS, sometimes called Galanthis, a servant of Alcmene who was mother by Zeus of Heracles. Zeus's wife, Hera, goddess of childbirth, was clasping her hands, thus by sympathetic magic preventing delivery, when Galinthias falsely announced Heracles' birth, so causing Hera to relax. As punishment Galinthias was turned into a weasel, an animal which in popular belief conceived and was delivered through the mouth. Her name is pre-Hellenic, and the legend is evidently based on folk mythology. (H. W. PA.)

GALIUM, a genus of perennial plants, commonly called bedstraw (*q.v.*), of the madder family (Rubiaceae), comprising about 300 species of world-wide distribution, mostly slender herbs. *See* also CLEAVERS; RUBIACEAE.

GALL, SAINT (fl. *c.* 600), Irish monk from Bangor, County Down, accompanied St. Columban (*q.v.*) to France and Burgundy. When Columban proceeded to Italy, Gall stayed behind among the Alamanni. He lived as a hermit on the banks of the Steinach river, preaching to the people of the district, which was still semipagan, and died there at an unknown date during the 7th century. His feast day is Oct. 16.

Little is known about Gall from authentic sources. The biographer of Columban, Jonas of Bobbio, who knew Gall personally, relates merely that he once disobeyed Columban in a trifling matter.

The earliest life of St. Gall, of which only a fragment survives, dates from the 8th century; most popular during the middle ages was the life by Walafrid Strabo of Reichenau, written about 833. Some incidents in these and other lives of Gall might be substantially historical.

The abbey of St. Gall, founded about 720 on the site of Gall's hermitage, had close links with Ireland especially during the 9th century and acted then as a channel for Irish influences on the continent, but there is no evidence of a continuous Irish tradition from the death of Gall to the abbey's golden age.

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GALL, FRANZ JOSEPH (1758–1828), anatomist, physiologist and founder of phrenology, was born at Tiefenbronn, Baden, Ger., on March 9, 1758, and studied at Baden, Strasbourg and Vienna. Gall gradually reached the conviction that the talents and dispositions of men are dependent upon the functions of the brain, and that they may be inferred with precision from the external appearances of the skull. His phrenological lectures in Vienna met with increasing success until in 1802 they were interdicted by the government as dangerous to religion. Gall left Vienna in 1805 and eventually settled in Paris, where he practised medicine, lectured and wrote a number of books setting forth his theories. He died in Paris on Aug. 22, 1828.

GALL, a digestive fluid secreted by the liver and known also as bile. The term is sometimes used also for the gall bladder, the pear-shaped diverticulum of the bile duct that forms a reservoir for the bile. From the extreme bitterness of the secretion, "gall," like the Latin *fel*, is used for anything extremely bitter, whether actually or metaphorically. (*See* DIGESTION; GALL BLADDER; LIVER.)

Gall, meaning a sore or painful swelling, especially on a horse, may be derived from an early use of the word as meaning poison. But in Romance languages, the French *galle*, Spanish *agalla*, a wind gall or puffy distention of the synovial bursa on the fetlock joint of a horse, is derived from the Latin *galla*, "oak apple," from which comes the English gall, meaning an excrescence on plants. *See* GALL, PLANT.

GALL, PLANT, may be defined as any abnormal enlargement or hypertrophy of plant parts or organs, of which many morphologically distinct types are found. All these overgrowths result from some physical or chemical insult, inflicted either naturally, by such agencies as parasites and radiation, or experimentally, by man. Natural plant galls may be classified with reference to the type of parasite that is concerned in their origin and development —specific bacteria, viruses, slime molds, fungi, roundworms or nematodes, mites and insects.

By far the majority of galls arise not solely because of the physical presence of a parasite in the plant tissues but also because of specific chemical irritants that are produced by the parasite and that stimulate plant cells to excessive growth. Some of these irritants or metabolites appear to be quite similar in their physiological action to the growth-regulating hormones normally found in plants. A parasite may model a gall characteristic of its species by introducing such chemical substances into plant cells in an orderly fashion, spatially, temporally and quantitatively; at other times the chemical stimulus produced by a parasite appears to be quite different from any thus far recognized in the normal plant and, being different, tends to divert the normal growth pattern of a plant into new and sometimes very unusual directions. The metabolite elaborated by a parasite may not itself be a hormone-like substance that directly influences the growth pattern of a plant; it may instead affect specifically the regulatory mechanisms of a host cell by either temporarily or permanently causing the affected host cell to produce excessive amounts of growth-promoting substances.

Thus the morphology of the resulting galls may be determined by the chemical nature of the inciting stimulus, by the manner in which a gall-forming parasite introduces the chemical and by the way in which plant cells respond to such a stimulus. Plant galls may, therefore, also be classified with reference to the degree and manner in which the typical organization of a plant is affected into self-limiting and non-self-limiting galls.

SELF-LIMITING GALLS

There exist in plants a vast array of growth abnormalities that are of a self-limiting nature. Such galls, in contrast to the non-self-limiting tumours (*see* below), are characterized by the fact that their continued growth is dependent upon the continued presence of a substance elaborated by the invading parasite. These galls commonly have a characteristic size and structure, although in a number of instances the ultimate size of the gall is determined by the number of parasites present in the diseased tissue.

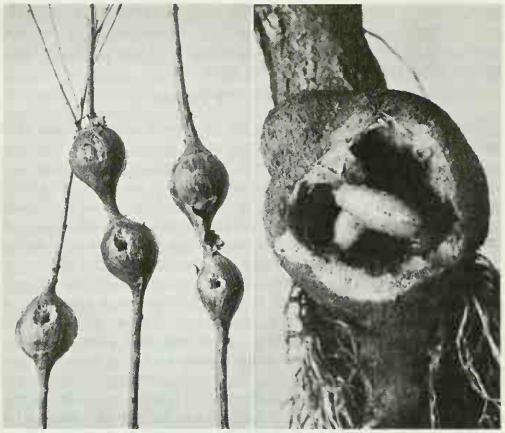
Injury Inflicted.—These localized overgrowths are almost never fatal to a plant, though they may represent a considerable burden when present in large numbers on leaves or roots. An exception is the clubroot disease of cabbage and other crucifers, which is caused by the slime mold *Plasmodiophora brassicae* and is a highly destructive disease. The typical overgrowth produced on the roots of cabbage by this organism is spindle- or club-shaped. Such a club is a morphological unit and is usually the result of a single primary infection. Sometimes the swellings resulting from two or more primary infections fuse to form a compound club, which is more irregular in outline than those resulting from a single primary infection. As a result of the presence of such overgrowths, the roots fail to absorb adequate amounts of nutrients and water from the soil, a functional failure that brings about starvation and, ultimately, the severe stunting of the plants. Heavily infected seedlings are usually killed before they reach maturity. Similarly, the root-knot disease, which is caused by species of nematodes belonging to the genus *Meloidogyne*, is very destructive to many cultivated and wild plants.

Importance in Disease.—Certain plant galls are of considerable practical importance because of their role as disseminators of disease. The common cedar-apple rust, which is caused by the fungus *Gymnosporangium juniperi-virginianae*, infects the leaves of the red cedar and stimulates the host cells to develop into small brown galls known as cedar "apples." These galls do not mature for at least a year. In the following spring they increase in size and extrude long, thin, bright orange gelatinous horns from slight depressions that are present on all sides of the gall. The horns consist in large part of many two-celled fungal spores (teliospores), which germinate within the horns to produce four other spores (sporidia) on the filament (promycelium) that arises from each of the original two cells. The sporidia are discharged forcibly into the air and may eventually fall on apple leaves or fruits, where, if environmental conditions are favourable, they may establish infection and cause a serious disease of the apple. When the supply of teliospores is exhausted, the cedar galls dry up and drop from the cedar leaves. (*See* also FUNGI: *Classification: Rusts.*)

JOHN H. GERARD

CEDAR-APPLE GALLS PRODUCED BY A RUST FUNGUS

Mite and Insect Galls.—Among the most interesting of the self-limiting galls are those that arise from the activities of mites and insects. The gall-making habit is found in the following orders of insects: Coleoptera (beetles), Lepidoptera (butterflies and moths), Hemiptera (aphids, scale insects, etc.), Thysanoptera (thrips), Diptera (flies) and Hymenoptera (wasps, sawflies, etc.). Only one family



(LEFT) JOHN H. GERARD; (RIGHT) A SHELL PHOTOGRAPH

(LEFT) GOLDENROD WASP GALLS; (RIGHT) BEETLE GRUB IN GALL ON CABBAGE STEM

of mites produces galls: Eriophyidae, the gall mites. By far the most important gall makers are the gall wasps (family Cynipidae), gall midges (family Cecidomyiidae) and other flies, certain aphids and their allies and gall mites. More than one-half of all plant families are subject to attack by gall makers. The oaks are attacked by the greatest variety of these forms, especially by gall wasps. Willows, maples, birches, beeches and roses are hosts chiefly for gall mites but also for some gall wasps and other hymenopterans. Gall midges prefer willows, oaks, roses, legumes and composites (goldenrod, aster, etc.). Some gall wasps also attack roses and composites.

These galls, which serve as temporary dwellings for the immature mites and insects, may assume forms that are extraordinarily varied in external appearance and internal structure. In the insect galls the typical organization of the plant undergoes orderly qualitative changes which, in their most interesting form, reveal growth and developmental potentialities quite different from any realized during normal growth and development.

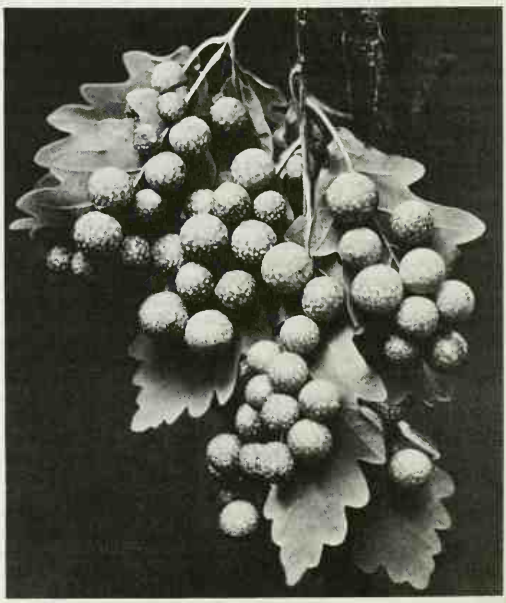
For convenience of description galls of this type may be divided into: (1) simple galls in which a single animal or a colony of animals is confined to a single plant organ, and (2) compound galls, which arise when several organs (usually vegetative or floral buds) are involved in the production of the overgrowth. The simple galls may, in turn, be subdivided on the basis of structure into: (1) felt galls, (2) mantle galls and (3) solid galls.

Felt Galls.—Many felt galls are produced by gall mites. They appear as cottony growths in rather sharply defined areas on the lower surface of green leaves and on stems. In the formation of the felt galls the epidermal cells of the plant, which are normally tabular, elongate enormously under the stimulus of the gall mite and become transformed into bent and twisted club-shaped tubes. These cells, which appear as short hairs to the naked eye, stand side by side in large numbers and give the covering a felted appearance. The mites then deposit their eggs in the elongated cells; when the eggs hatch, the larvae live on material contained within those cells. Felt galls caused by mites are common on leaves of lime (linden), alder and horse chestnut.

Mantle Galls.—A large number of simple galls are grouped together under the name of mantle galls. The parasites, especially gall mites, aphids and scale insects, that give rise to them live on the surface of the leaves and attach their eggs to the epidermis. Growth of certain leaf cells is excited by a substance secreted by these animals, and the new growth ultimately surrounds the colony like a mantle. This may be accomplished in a variety of ways. In some instances the surface of a leaf, which is normally flat, grows more profusely on one side than on the other, with the result that the leaf lamina is rolled up lengthwise in the form of a scroll in which the larvae are hidden. Examples of scroll galls are often seen on alpine rose, cranes-bill and orach. In other instances the protective mantle may assume the form of a pocket or hollow protuberance whose excavated cavity serves as a dwelling place for the parasites; such protuberances produced by different species of mites and insects present a great variety of forms and shapes, examples of which are the wrinkled galls of elm and red currant, caused by aphids. In still other instances the mantle completely covers the insects and such overgrowths are known as covering galls; the cavities of these galls do not arise from an excavation, as in the case of the pocket galls, but from an overarching of tissue in which the new growth rises up in the form of a fleshy wall and continues to grow until the animals are wholly enclosed. Gall midges cause simple covering galls on ash leaves, and on leaves of stinging nettle and alder.

Solid Galls.—The third type of simple gall is the solid gall, which is produced by insects that pierce the plant tissues and lay their eggs in the wound; common examples are the oak "apples" and marble galls of oaks (produced by gall wasps) and stem galls of composites (produced by gall midges and a few gall wasps). The solid galls are commonly well-organized structures that are composed of two or three distinct types of cell layers. In the centre of a typical solid gall is the cavity or larval chamber, which is lined with a layer of juicy, thin-walled cells known as the medulla or pith of the gall. The gall pith furnishes the larva with food and, as the cells are eaten, they are rapidly replaced for as long as the larva requires food. Surrounding the gall pith is usually but not always a second layer of very hard cells that serves to protect the larva. An outer layer of cells covers the inner layer (or layers) like a skin or bark.

In the solid galls the larva is completely enclosed, and if it is to emerge and complete its life cycle, it must make an exit passage from the gall. In the case of the gall wasps this is done simply by the insect biting a hole through the wall of the gall. In other instances the escape mechanisms may be very complex and quite remarkable. This is true in the capsule gall that is produced by the South American moth *Cecidoses eremita* on the green cortical



F. LOCK

SOLID GALLS PRODUCED ON OAK LEAVES BY A GALL WASP

tissue of the pepper tree (*Schinus longifolia*). This gall is spherical and very hard. When the time draws near for the enclosed larva to escape, a circular plug with a projecting rim develops on the side of the gall farthest from its point of attachment to the plant. When the plug is pushed out a circular hole which looks as if it had been cut with a knife is left.

The morphology and particularly the surface structure of solid galls produced by different insect species is very different. Some are smooth, others are warted or rugged, while still others are covered with finely dissected woolly or velvety hair, or with spines or claws. Some are spherical, others star-shaped, while still others have the appearance of a cone, bullet or trumpet.

Specificity of Self-Limited Galls.—There is no question that the morphological form that a gall assumes depends upon the species of insect that produces it. The morphological structure of a gall produced by a given insect species is, in fact, so specific that it is considered by some to be a more reliable criterion for distinguishing between closely related species of insects than are the morphological characteristics of the adult insects themselves.

All this seems to indicate that highly specific morphogenetic stimuli of a chemical nature are elaborated by certain insect species and that these substances are capable of initiating, stimulating and directing most precisely the development of plant cells in new and unusual directions. Unfortunately little experimental evidence is as yet available to establish the validity of this view.

To reiterate, the distinguishing feature of the insect galls in general, and the more highly developed cynipid galls in particular, is the determinate or limited growth of these structures. They are of constant form and size and possess their own polarity and symmetry. It has been suggested that they are almost comparable in their determinate growth to a leaf or a fruit.

NON-SELF-LIMITING GALLS (PLANT TUMOURS)

A number of plant galls are non-self-limiting growths that have no characteristic size or structure; these are true tumorous growths. In at least one instance, *e.g.* the crown-gall disease, the inciting bacterium (*Agrobacterium tumefaciens*) elaborates a tumourigenic principle that converts normal plant cells to tumour cells in relatively short periods of time (*see* also PLANT DISEASES: *Bacteria*). Such tumour cells acquire, as a result of their transformation, a capacity for continued abnormal and essentially unregulated growth even in the absence of the inciting bacterium. This leads to the development of massive tumourous growths that, in extreme instances, may weigh as much as 100 lb. Such tumours are potentially malignant, and they seriously damage or kill the plants in which they develop.

Relation to Animal Tumours.—Because plant tumours of this type possess many of the characteristics of malignant animal tumours, they have become recognized as objects of fundamental value for research dealing with the tumour problem generally. In comparing plant and animal tumours it must be remembered, however, that there are certain developmental and functional characteristics commonly used in the diagnosis of animal cancers that are more or less restricted to animals and cannot, because of structural differences in the two types of organisms, be applied to plants. The most essential characteristic, namely the capacity of a tumour cell to grow in an unregulated and autonomous manner, upon which all other diagnostic characters ultimately depend and without which there would be no tumours, is, however, equally capable of expression in all higher organisms, since it is a characteristic of the cell itself. Plant tumours have been widely used as experimental test objects in the field of experimental oncology (the study of tumours), because it is felt by some scientific investigators that when those changes in cellular metabolism that lead to autonomous growth are fully understood, they will show common features in members of the two kingdoms.

Action of Tumourigenic Agents.—Plant tumours, like animal tumours, may be initiated by some of the most diverse agencies known to biologists. Among these are radiant energy, irritation, tumourigenic chemicals, microorganisms and viruses. The effectiveness of these various agencies in eliciting the alteration of a normal cell to a tumour cell appears to be a function of the hereditary constitution of the host. Nevertheless the physiological basis for the continued abnormal and autonomous growth of the tumour cells appears to be very similar regardless of the initiating cause. Experimental studies have demonstrated that the transition from a normal plant cell to a tumour cell in all instances involves the excessive production by the tumour cell of two intracellular hormones that are concerned specifically with the processes of cell enlargement and cell division. (Certain other metabolites essential for growth are also synthesized by tumour cells in greater than normal amounts.) The precise mechanism by which any one of several tumour-inducing agencies disturbs the normal enzymatic machinery of the cell, thereby causing it to produce excessive amounts of growth-promoting substances, is not yet clear. It is associated in some way with the greater ability of tumour cells to take up specific ions from the environment. (Ion uptake is far less efficient in normal cells of the type from which the tumour cells were derived.)

BY COURTESY OF THE ILLINOIS NATURAL HISTORY SURVEY; PHOTOGRAPH BY WILMER O. ZEHR

CROWN-GALL TUMOUR ON A ROSE PLANT PRODUCED BY A BACTERIUM

GALLS USEFUL TO MAN

The deleterious effects of plant galls in general overshadow the beneficial effects of a few specific kinds of galls. Certain galls produce chemical substances reputed to have medicinal qualities, some provide dyestuffs and others serve as food for birds, squirrels, mice and other animals.

The gall nuts of commerce, also called Aleppo, Mecca, Chinese or Turkey galls, are produced on various species of oak and other trees by certain Eurasian cynipid wasps. Among the best grades, containing more than 50% tannic acid, are those harvested in Iran, Syria and Turkey. These galls, long used in parts of Asia and Africa to make dyes and medicines, are now processed for use in the tanning, ink and pharmaceutical industries. The chief active principles are the astringent tannic and gallic acids. (*See* also TANNIN; GALLIC ACID.)

A considerable series of galls produce a sweet, sticky fluid called honeydew. These galls, caused chiefly by cynipid wasps, attract bees and other insects that feed upon the secretion.

Foremost among the useful galls are the root nodules found to arise on many species of leguminous plants as a result of infection by bacteria of the genus *Rhizobium*. These root growths are highly beneficial to the host plants and to mankind because of their role in symbiotic nitrogen fixation. It has been estimated that as a result of this process 5,500,000 tons of atmospheric nitrogen is returned to the soil annually to be used by higher plants in their growth and development. *See* NITROGEN, FIXATION OF; BACTERIOLOGY: *Some Activities of Bacteria;* SOIL: *Soil Microbiology.*

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GALLA (who call themselves OROMO, plur. OROMOTA), a Hamitic people who occupy much of western and southeastern Ethiopia, stretching across into northern Kenya, with a detached group in

the Tana area of eastern Kenya. They were formerly divided into Baraytuma (eastern) and Borana (western), those of northern Kenya still using the latter name. The Galla are composed of more than 200 tribes, numbering about 2,500,000 people, grouped as: (1) Wallaga, in western Ethiopia, about 8 major tribes; (2) Macha, south of the Blue Nile in Ethiopia, about 50 tribes; (3) Tulama, in east central Ethiopia, about 35 tribes; (4) Wallo, north of the Tulama, about 24 tribes; (5) eastern, in the Harar uplands, about 50 tribes; (6) Arsi or Arusi, in southeastern Ethiopia, about 16 tribes; (7) the Tanaland Galla in eastern Kenya. The Galla came from southern Arabia and settled in the Horn of Africa, from which they were gradually expelled by the Somali. Some found their way south to Tanaland, some settled on the eastern edge of Ethiopia in the Harar region, but by 1590 the majority had penetrated into Ethiopia as far north as Lake Ashangi and westward as far as Wallaga, the greater part of Ethiopia south of latitude 12° N. (except for the southwest corner) being occupied by them.

They are basically a pastoral people, owning large herds of cattle, together with donkeys, sheep, goats, civet cats (in some areas) and horses, which are highly valued. As agriculturists, they use a plow, which was probably adopted after their invasion of Ethiopia.

Though there are large Muslim and Christian elements among the Galla, many are pagans, acknowledging a supreme being, *Waqa* the creator, together with various spiritual beings, some with distinctive names, others known collectively as *ayana,* guardian spirits. There are also two lesser deities, *Oglie,* who may have been a fertility god, and *Atete,* worshiped especially by women, a fertility goddess who was equated by the Christian Galla with the Virgin Mary. The Galla have a strong reverence for nature. Formerly, a member of every third generation in each family used to make a pilgrimage to the Abba Muda, "father of anointing," who lived near Wolabo about 60 mi. east of Lake Abaya and, as the personification of Galla law and tradition, was a ritual focus for the whole nation.

The political structure was based on an organization of age sets (*q.v.*), or *gada,* working within a framework of age grades, also called *gada,* although by the 1960s this seemed to have broken down. The men of every tribe were grouped in ten *gada* sets which ran in two hemicycles of five *gada* each; the sons of men of the first hemicycle belonged to the second. These sets, the names of which were recurrent and borne throughout life by each member, passed through five *gada* grades, remaining in each grade for eight years. While in the fourth grade, the men formed the tribal government, led by an elected leader called *Abba Boku* "father of the staff," or Hayu. At the close of the final or Yuba period, the men retired and took no further part in public affairs. *See* also Ethiopia: *The People; History;* Hamite.

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GALLAIT, LOUIS (1810–1887), Belgian painter of historical scenes, was born at Tournay, Hainaut, on May 9, 1810. He studied at Tournay under Hennequin, and at Antwerp under Van Brée. He then settled in Paris, sending from there to the Belgian salons a series of important historical pictures. He was then urged to return to Brussels, where the latter half of his life was spent, and where he died on Nov. 20, 1887.

Among his most famous works are: "The Abdication of Charles V" (1841), "The Last Honours Paid to Counts Egmont and Horn by the Corporations of the Town of Brussels" and "The Death of Egmont." His art was that of a skilled painter, but superficial. As an artist employed by the state, he exercised considerable influence and was a leader of public taste in Brussels.

GALLAND, ANTOINE (1646–1715), French orientalist, archaeologist and numismatist whose translation of the *Arabian Nights* introduced the tales to Europe and remains the standard French translation, was born at Rollot (Somme), April 4, 1646. After walking to Paris at 14 to learn Greek and Hebrew, he studied at the Collège de France and accompanied the French ambassador to Constantinople (1670), returning twice to the Levant for further studies. He was admitted to the Académie des Inscriptions (1710), was made "antiquary to the King" and was offered the chair of Arabic at the Collège de France (1709). He died in Paris, Feb. 17, 1715.

In addition to *Les Mille et une nuits,* 12 vol. (1704–17), Galland's works include *Paroles remarquables, bons mots et maximes des orientaux* (1694; Eng. trans. 1795); *De l'Origine et du progrès du café* (1699); and many archaeological and numismatic treatises. A translation of the Koran and a history of the Turkish sultans remain unpublished. *Contes et fables indiennes de Bidpaï et de Lokman* were published posthumously in 1724. His *Journal pendant son séjour à Constantinople, 1672–73,* was edited by C. Schefer (1881); the *Journal parisien, 1708–1715,* with his *Autobiographie, 1646–1715,* was edited by H. Omont (1919). *See* also the article Thousand and One Nights.

GALLARATE, a town in Varese province, Lombardy, Italy, lies 40 km. (25 mi.) N.W. of Milan by road. Pop. (1957 est.) 32,187 (commune). The town is of medieval origin and has the Romanesque church of S. Pietro (11th–12th century). It is on the railway from Milan to Domodossola and Switzerland and 5 km. (3 mi.) W. is the airport of Malpensa. Gallarate is known for its textile industry. Nearly one-tenth of all Italian looms are to be found in and around the town, which is also a centre of the machine embroidery trade.

GALLAS, MATTHIAS, Graf (1584–1647), Austrian general in the Thirty Years' War, was born in Trento on Sept. 16, 1584, and learned the military profession in Spanish services in the Netherlands and in upper Italy. He fought with distinction in the army of the Catholic league against Christian of Brunswick and in the imperial army in the War of the Mantuan Succession (1628–31). Albrecht von Wallenstein thought highly of him and entrusted him with important commands against Gustavus Adolphus and Bernhard of Saxe-Weimar (1631–33), but Gallas, together with Ottavio Piccolomini, was instrumental in the overthrow of Wallenstein, after whose murder he obtained the supreme command of the imperial army and Wallenstein's estate of Friedland (Frydlant). His victory in the first of the battles of Nördlingen (*q.v.*) in 1634 marked the acme of his successes. Thereafter carelessness and drunkenness marred his conduct of war, and he became known as the "destroyer of armies," especially after his disastrous campaigns of 1637, 1638 and 1644, each of which resulted in the complete annihilation of his troops. He had eventually to resign his command and died in Vienna on April 25, 1647.

(S. H. S.)

GALLATIN, (ABRAHAM ALFONSE) ALBERT (1761–1849), U.S. secretary of the treasury and diplomat, was born in Geneva, Switz., on Jan. 29, 1761, of an old and noble family. His father died in 1765, his mother five years later, and he was cared for by his grandparents and by a Mlle Catherine Pictet, an intimate friend of his mother's. In 1779 he graduated with honour from the academy in Geneva, and, giving up fortune and social position, slipped away from home and embarked for America despite the wishes of his relatives. In July 1780 Gallatin and his friend Henri Serre (d. 1784) landed in Massachusetts and entered business; but, conditions in the country being unsettled, they failed. For a time Gallatin taught French at Harvard college, then moved to the backwoods of Pennsylvania, where he engaged in land speculation and took an interest in state politics. He was elected to represent Pennsylvania in the U.S. senate in 1793 but was deprived of his seat because he had not been a U.S. citizen for the required nine years.

Elected to the house of representatives, Gallatin took his seat in 1795 and immediately made himself a conspicuous figure. He became the financier of his party and succeeded in inaugurating the house committee on finance, which later came to be called the ways and means committee, and fought for simplicity and economy in government. In debate (1796) over the Jay treaty he defended the constitutional right of the house of representatives to consider treaties. He conceded that the president and senate had the sole right to make treaties, but maintained that the house could refuse to approve the appropriations to carry them out. When in May

1797 President Adams asked for appropriations for war because of France's refusal to receive American ambassadors, Gallatin struggled successfully to keep down appropriations and to prevent the three United States frigates from being equipped for sea. He continued his opposition to a strong navy and in the following year helped to defeat a resolution for the preparation of 16 armed vessels and a declaration of war against France. He even went so far as to maintain that all political intercourse with other nations should be gradually given up, and that commercial intercourse should be protected merely by the consular system.

The greatest period of Gallatin's career in congress was in 1798, when, after the publication of the famous XYZ dispatches (*see* XYZ CORRESPONDENCE) had inflamed the people against France and given the Federalists control of the government, he was attacked as a French agent, and Jefferson believed that the Sedition bill was intended to drive Gallatin from office. However, the extreme measures adopted by the Federalists shocked the country with the result that the Republicans carried the elections of 1800, and Jefferson became president.

Jefferson appointed Gallatin as secretary of the treasury. Gallatin made few changes in the policies of his predecessor, Alexander Hamilton, but he did seek for simplicity of government and the extinction of the public debt. He preferred to bribe the Barbary pirates rather than spend money to subdue them and wished to avoid commercial warfare at all costs. Despite the fact that he could not reduce naval expenditures as he wished, and despite the Louisiana Purchase (1803), he managed to reduce the public debt by $14,260,000 within six years. However, relations with Europe became strained and in Dec. 1807 Jefferson put into execution the embargo. Gallatin, recognizing the consequences, declared, "I prefer war to a permanent embargo," and reported that a continuous embargo would necessitate a loan while war would not. The embargo proved futile and, after causing a deficiency in the treasury, was repealed (1809) in favour of the Non-Intercourse act. When Jefferson completed his second term in 1809 he was succeeded by Madison. Madison had regarded Gallatin as his successor as secretary of state; but a cabal in the senate opposed him and Gallatin was left as secretary of the treasury.

In June 1812 war was declared against England. This shattered Gallatin's cherished schemes, for he believed war was fatal to prosperity and progress. He therefore put the nation's finances in the best order he could, and set himself to attain an early peace. With this end in view he grasped at the proffered mediation of Russia, and with Madison's permission sailed with James A. Bayard for Europe in May 1813 without resigning as secretary of the treasury. Great Britain refused to negotiate through Russia, and in addition Gallatin heard that the senate had refused to confirm his appointment because he was still secretary of the treasury. He resigned from the treasury and remained in Europe, working unofficially until his second appointment as peace commissioner was confirmed. In the meantime Great Britain had expressed its willingness to proceed with direct negotiations and the English and U.S. commissioners finally met at Ghent, Belg. Gallatin, Bayard and John Quincy Adams (who was minister to Russia) were supplemented by Jonathan Russell and Henry Clay. In the tedious discussions that followed, Gallatin played the leading part, preserving peace among his colleagues and establishing a reputation as a diplomat. He refused to push the U.S. claim to Florida, but stood firmly on other points with his colleagues. Peace rewarded them; the treaty was signed on Dec. 24, 1814.

While still in Europe he had been asked by Madison to become minister to France; this appointment he accepted in Jan. 1816, and adhered to his acceptance in spite of his being asked in April 1816 to serve once more as secretary of the treasury. He remained in France for the next seven years, and in 1818 assisted Richard Rush, then United States minister in London, in negotiating a commercial convention.

In June 1823 he returned to the United States, where he found a bitter struggle in progress for the presidency. His favourite candidate was his personal friend, William H. Crawford, with whom he consented in May 1824 to run for the vice-presidency. The contest was full of intrigue. Martin Van Buren, then in the Crawford interest, came to the conclusion that Gallatin, by his foreign origin, weakened the ticket, and in October Gallatin retired from the contest. As no candidate received a majority of the electoral votes the election was thrown into the house of representatives and resulted in the choice of John Quincy Adams. Gallatin then retired to his western Pennsylvania home, "Friendship Hill," but in 1826 President Adams persuaded him to serve as minister to England. In Nov. 1827 he once more returned to the United States and bade farewell to public life.

Taking up his residence in New York city, he was in 1832–39 president of the National Bank (afterward the Gallatin bank) of New York. By writing his *Synopsis of the Indian Tribes Within the United States East of the Rocky Mountains and in the British and Russian Possessions in North America* (1836), and by founding the American Ethnological society of New York in 1842, he earned the title of "father of American ethnology." He died in Astoria, L.I., on Aug. 12, 1849.

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GALLAUDET, THOMAS HOPKINS (1787–1851), U.S. educator of the deaf-mute, was born in Philadelphia, Pa., of French Huguenot ancestry, on Dec. 10, 1787. He graduated at Yale in 1805 and studied theology at Andover. Eventually he determined to devote his life to the education of deaf-mutes. He visited Europe and studied the methods of the abbé Sicard in Paris, and of Thomas Braidwood and his successor Joseph Watson in Great Britain. Returning to the United States in 1816, he established at Hartford, Conn., a school for deaf-mutes, in support of which congress made a land grant. Gallaudet presided over the school with great success until ill-health compelled him to retire in 1830. He died at Hartford on Sept. 10, 1851. *See* also DEAF AND HARD OF HEARING, TRAINING AND WELFARE OF.

GALL BLADDER. The gall bladder in man is a pear-shaped, hollow organ situated on the undersurface of the liver; it acts as a storage place for bile, the digestive fluid secreted by the liver. The base of the gall bladder is called the fundus; the main portion, the body; and the narrow end, the neck. The latter terminates in the cystic duct, which joins the common bile duct. The wall of the gall bladder consists of three layers: (1) an inner mucous layer of surface epithelium, (2) a middle fibromuscular layer consisting of smooth muscle and connective tissue and (3) a serosa that covers that portion of the organ not in contact with the liver. The walls of the gall bladder are distensible, and its capacity varies considerably. The gall bladder receives its blood supply from the cystic artery, a branch of the hepatic artery, and from vessels reaching it from the liver. The veins of the gall bladder empty into the portal vein. It has a dual nerve supply, sympathetic and parasympathetic. It is generously supplied with lymphatics.

Although a gall bladder is present in most of the higher species of animals, there are several that do not possess it. It can be removed surgically without causing untoward effects. The liver secretes bile continuously, but bile is not required during the interdigestion periods. When there is no food in the intestine, a sphincteric mechanism closes the terminal end of the common bile duct and the bile passes into the gall bladder. Water is absorbed from the bile by the wall of the gall bladder until the bile is concentrated eight to ten times. In this manner it is possible for a relatively small organ to function as an important reservoir. This organ is emptied by contraction of the smooth muscle contained in its walls. The gall bladder may be caused to empty by ingestion of a meal of fat, such as egg yolk and cream, and specifically by a hormone, cholecystokinin, which is found in the mucosa of the upper portion of the intestine. The gall bladder is subject to many diseases such as inflammation and formation of calculi (gall stones) within it (*see* CALCULUS [IN MEDICINE]: *Biliary Calculi or Gallstones;* GALL BLADDER, BILIARY TRACT AND LIVER, DISEASES OF).

See also DIGESTION; GALL BLADDER, BILIARY TRACT AND LIVER, SURGERY OF; LIVER.

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GALL BLADDER, BILIARY TRACT AND LIVER, DISEASES OF, include a large number of disorders of the liver, the gall bladder and the bile ducts that link them with each other and with the small intestine. The anatomy and function of these organs are described in the articles Gall Bladder and Liver.

LIVER

The liver is the largest and functionally the most complex organ in the body. Its many vital activities concern the removal of bilirubin (bile pigment) from the blood, excretion of bile into the intestine, metabolism of proteins, carbohydrates and fats, utilization of vitamins, storage of materials essential to the formation of blood and protection against infections and poisons. The symptoms and consequences of liver disease depend upon the degree to which these functions are disturbed. Fortunately, the reserve capacity of the liver is tremendous, and it may function adequately until approximately 90% of its substance is destroyed.

Infectious Hepatitis.—This disease (also called catarrhal jaundice) is an inflammation of the liver cells caused by a virus. It exists in sporadic or endemic form throughout the world, but increases in frequency under conditions of crowding and poor sanitation. Persons of all races and all ages are susceptible. The infection is transmitted usually from person to person and by water or food contaminated with infected fecal material; ordinary methods of purifying the water supply do not eradicate the resistant virus. Fifteen to thirty days usually elapse between exposure and the appearance of symptoms.

The illness is characterized by loss of appetite, nausea, a curious distaste for tobacco, weakness, headache, fever, chills, respiratory complaints, diarrhea and discomfort or pain in the upper abdomen. Jaundice (*q.v.*) develops gradually and increases in intensity; it may be absent in mild forms of hepatitis. The liver is large and tender; the spleen may increase in size. Laboratory tests show impaired liver function. The disease ordinarily is self-limited, with complete recovery in four to six weeks; however, it may persist for several months. In a small percentage of cases, because of poor nutrition, insufficient rest, intercurrent infection or the use of alcohol, infectious hepatitis becomes chronic. The mortality rate is low. Treatment includes a substantial intake of carbohydrate and protein and a moderate amount of fat in the diet, vitamins and adequate rest; glucose solutions intravenously may be required. The return to full activity should be very gradual. Administration of immune serum globulin intramuscularly to persons in close contact with the patient generally is recommended as a prophylactic measure.

Homologous Serum Jaundice.—This is a similar viral infection, transmitted by the injection of human blood or its products; by plasma convalescent serum or vaccines; and by any type of hypodermic injection with a poorly sterilized syringe. The incubation period extends from 40 to 190 days. One attack probably confers substantial but not absolute immunity against reinfection. There is no cross-immunity between the two types of hepatitis. The mortality rate varies, perhaps approximating 35%. Treatment is the same as for infectious hepatitis. The control of serum jaundice is aided by the detection of carriers among prospective blood donors and upon the use of plasma stored at room temperature instead of under refrigeration.

In severe viral hepatitis, with extensive destruction of the liver, there may be temporary obstruction to the flow of bile from the small bile ducts to the small intestine, so-called medical obstructive jaundice. A similar situation may complicate bacterial inflammation of the liver, excessive accumulations of fat in the liver cells (as in severe malnutrition) and certain defects in enzyme systems within liver cells; the latter category includes deficiency of the enzyme glucuronyl transferase. In the Dubin-Johnson syndrome, the liver cells, though seemingly normal, apparently are unable to excrete properly the normally formed bilirubin-glucuronide.

Toxic Hepatitis.—Toxic hepatitis is an acute disease caused by a variety of poisons: commercial solvents containing carbon tetrachloride or chloroform, phosphorus, mercury, gold, snake venom and poisonous mushrooms. The disease also may follow certain infections. The central portions of the liver lobules usually are destroyed; other changes include large accumulations of fat and shrinkage of the liver. The extent of liver injury and the outcome depend upon the injurious agent, the quantity of the toxic dose, the duration and frequency of contact and the nutritional state of the liver. Symptoms resemble those of infectious hepatitis but are more severe; the mortality rate is high. Treatment is limited to rest, diet, vitamins and glucose intravenously. British antilewisite (BAL) may be effective when arsenic or mercury is the cause.

The liver also may be injured occasionally by medicinally prescribed drugs, including chlorpromazine, methyltestosterone, marsilid, thiouracil, methimazole, arsenicals, phenylbutazone, para-amino sulfonic acid, sulfanilamide, trinitrotoluene and cinchophen, among many others. The microscopic changes in the liver include bile stasis, inflammation around the portal tracts, mild degeneration of cells and proliferation of bile ducts. Symptoms may develop within four days to five weeks of the onset of the treatment, and include nausea, vomiting, anorexia, malaise, jaundice, itching and abdominal pain. The symptoms and laboratory findings suggest interference with the normal flow of bile. The liver and spleen may increase in size. Since this problem occurs only in a small percentage of patients receiving medication, hypersensitivity to the drug and individual susceptibility have been suggested as causative factors. Treatment consists in discontinuance of the medication, the general measures for liver disease and, occasionally, ACTH and the adrenal steroids. Recovery usually is complete; in a small number of cases, the illness may terminate fatally.

Primary Cholangiolitic Hepatitis.—This uncommon inflammatory disease of the liver occurs predominantly in young women. The cause is not known; the metabolism of lipids in the liver appears to be disturbed. The symptoms include, in addition to jaundice, itching and variable abdominal distress. There may be increased pigmentation of the skin and deposition of lipid around the eyes, the creases of the palms and on the elbows, producing striking lesions (xanthomata). The liver is enlarged, and the spleen may be normal or large. The urine is dark in colour. The laboratory findings are compatible with an obstruction to the flow of bile; namely, an increase in the serum bilirubin, cholesterol, alkaline phosphatase and bile acids; the pattern of the plasma proteins also is normal. Gallstones (cholelithiasis) develop occasionally. There is no completely satisfactory treatment. Therapy includes the usual measures for liver disease; adrenal steroids may provide symptomatic improvement, though the underlying disease is not improved. Linoleic acid, as ethyl linoleate, and as a modified milk in which all the butter fat is replaced by safflower oil, has been recommended.

Portal Cirrhosis.—Portal cirrhosis is the result of chronic diffuse liver injury, characterized by destruction of cells, deposition of fat, excessive scarring and distortion of the liver. The flow of blood within the liver is disturbed, causing enlargement of the spleen and the development of accessory venous channels (varices), especially around the esophagus. The liver becomes large, hard and irregular. Chronic alcoholism and malnutrition are the most important causes; however, cirrhosis may develop after any injury to the liver cells associated with cell destruction and the accumulation of fat. Symptoms may be absent, but loss of appetite, nausea, jaundice and fever are common. Spiderlike dilatations of small blood vessels may appear on the face and upper portion of the body. Bleeding may occur into the skin or after the rupture of varices. Fluid may accumulate within the abdomen (ascites, or dropsy) or in the tissues (edema). The accumulation of fluid within the abdominal cavity is attributable to several factors: interference with the outflow of blood from the liver; increased communications between the major blood vessels of the liver; excessive production of hormones, such as aldosterone, from the adrenal gland; retention of salt in the body; decreased protein in the circulating blood; increased output of antidiuretic hormone; and excessive production of lymph from the liver.

Treatment is directed to restoration of normal nutrition and the control of complications. It includes the avoidance of alcohol, a diet rich in carbohydrate and protein, and vitamins, especially the B complex. Ascites and edema are treated by a low-salt diet, drugs facilitating the elimination of salt and the replenishment of body proteins with diet, blood transfusions and albumin; drainage of the excess fluid may be necessary. Various "shunting" operations, redirecting the flow of blood, may be required for recurrent bleeding. The liver cells may be so diseased as to result in serious metabolic and chemical disturbances.

Hepatic Coma.—Patients with severe liver disease may pass into a coma, continuing for days to weeks and often ending fatally. The onset is very gradual and is characterized by vague, almost imperceptible changes in emotion, including untidiness, inappropriate behaviour and nocturnal wakefulness. These symptoms are followed by mental confusion, a characteristic flapping tremor of the outstretched hands and fingers, and then by coma, accompanied by typical changes in the brain wave pattern of the electroencephalogram. The cause of this complication often is not apparent. Precipitating factors may include gastrointestinal bleeding from esophageal varices or peptic ulcer, removal of fluid from the abdominal cavity, excessive intakes of protein, infection, administration of drugs containing ammonium, diuretics, opiates, sedatives and other drugs. The laboratory findings frequently indicate severely impaired liver function and its associated metabolic disturbances, and often but not invariably an increased amount of ammonia in the blood. Important factors in the development of liver coma include abnormal bacterial action upon the proteins within the bowel, inability of the diseased liver to remove adequately the excessive ammonia from the portal blood stream draining the digestive tract, and rapid transfer of the excessive ammonia and other toxic substances into the general circulation. Other disturbances in protein metabolism and defective carbohydrate and vitamin metabolism also may be implicated.

The management of liver coma is difficult. Avoidance of those factors known to precipitate the complication is important. Treatment usually requires skilled nursing care; adequate fluids; glucose and vitamins intravenously; limitation of the protein intake, at least temporarily; saline enemas to eliminate excessive protein from the alimentary tract; antibiotics such as neomycin, chlortetracycline or oxytetracycline to decrease the bacterial content of the bowel and thereby reduce the production of ammonia and other toxic materials. Glutamic acid and L-arginine or arginine glutamate have been administered to decrease the ammonia content of the blood and the brain. In the most severely ill patients, corticotrophin (ACTH) and adrenal steroids have been administered in very large quantities, with occasionally spectacular, though usually temporary, improvement. The outlook for patients with liver coma, though not necessarily hopeless, is grave, since the complication denotes very serious, often irreversible disease.

Biliary Cirrhosis.—This is characterized by excessive scar tissue formation, an increase in the number of small bile ducts within the liver, and inflammation of the bile channels (cholangitis). In the primary (cholangiolitic) type, the larger bile passages and the gall bladder are normal, and the process is confined to the smaller bile ducts within the liver. The cause is not known, although infectious hepatitis may be implicated. Biliary cirrhosis often is the result of persistent, incomplete obstruction of the common bile duct by impacted gallstones, adhesions or scar tissue developing after operations on the gall bladder, or by new growths.

Symptoms include jaundice, itching of the skin and attacks of chills, fever, sweats and abdominal pain. The urine is dark and the stools are light in colour. The liver and the spleen are large. The inadequate flow of bile into the intestine interferes with the metabolism of fats and with the absorption of fat-soluble vitamins. Treatment consists in removal of the obstruction, whenever possible, rest, diet, vitamins and control of infection with sulfonamides and antibiotics.

Abscess of the Liver.—Liver abscess most often is of the pyogenic type, with many small abscesses caused by bacteria brought to the liver via the blood stream from infected areas (as the appendix) within the abdomen. The characteristic symptoms are intermittent fever, chills, sweats, jaundice and toxemia. The liver becomes large and tender. Treatment consists of sulfonamides, penicillin or other antibiotics, and drainage of the abscess. "Tropical" abscess of the liver usually is single and large and almost always the result of infection with *Endamoeba histolytica* (the cause of amoebic dysentery). The administration of antiamoebic drugs and aspiration of the abscess usually are effective. Other less frequent causes of liver abscess are injury, the penetration of a foreign body or infection of an echinococcus cyst.

Weil's Disease.—This is an acute infection of the liver caused by the spirochete *Leptospira icterohaemorrhagiae*. It is transmitted via food or water contaminated with the urine of infected rats. The organisms may enter the body through the skin, eyes, mouth or intestine. Men coming in contact with rats—miners, fishermen, farmers and workers in sewers, railroad yards and rice or sugar-cane fields—often are affected. The illness begins suddenly with fever, aching in the muscles and joints, headache, prostration and jaundice. The liver and spleen become enlarged, hemorrhages occur in the skin, and the kidneys and central nervous system become involved. There is no specific treatment; penicillin and other antibiotics appear to be of value.

Syphilis of the Liver.—This is no longer common. The left lobe is especially involved, either by diffuse scarring or large masses called gummata. The liver is large, hard and very nodular. Treatment consists in the administration of antisyphilitic drugs (*see* VENEREAL DISEASES).

Hemochromatosis.—Hemochromatosis of the liver is a metabolic disorder of unknown cause, characterized by the deposition of two pigments, hemosiderin (an iron-containing pigment) and hemofuscin, in the liver and pancreas and sometimes in the skin. The disease affects chiefly men during the ages of 50 or 60; it occurs in conjunction with chronic malnutrition and pellagra among the Bantu of South Africa. The symptoms are related to those of diabetes and cirrhosis. The skin occasionally assumes a rusty or bronze pigmentation, and there may be loss of body hair and atrophy of the testes. Treatment is directed to the diabetes, utilizing proper diet and insulin, if necessary. The management of the cirrhosis is similar to that outlined above.

Malignant Disease.—Primary cancer (*q.v.*) of the liver generally is uncommon, though the incidence is high in the far east and South Africa, where parasitic infestations and malnutrition are common. The tumour may arise in the liver cells or the bile ducts, in association with cirrhosis. Secondary involvement of the liver by cancer occurs in approximately 50% of patients with tumours originating elsewhere in the body, especially the stomach, colon, pancreas, lungs and breast. Symptoms include pain in the upper abdomen, loss of appetite and weight, fever and weakness. Treatment is limited to the relief of pain.

GALL BLADDER

The gall bladder is a thin, pear-shaped structure, with the capacity of one to two ounces, situated on the undersurface of the right lobe of the liver. Its principal activities are to store the bile excreted by the liver for digestive purposes, and to regulate the pressure in the biliary system, preventing back-pressure on the liver in its continuous production of bile. The gall bladder is not an essential organ, and its removal by operation does not deprive the body of any vital function; nor does removal of the gall bladder decrease the quantity of bile entering the digestive tract. Bile is of value in aiding the digestion of fat, and as a means of excreting certain toxins and poisons removed from the body by the liver.

Acute Cholecystitis.—This is an inflammation of the gall bladder caused usually by the following sequence of events: obstruction of the cystic duct (leading from the gall bladder to the common bile duct) by gallstones, stasis of bile and chemical inflammation, induced by constituents of bile. Bacterial infection may or may not be present.

There is a sudden onset of pain in the right upper quadrant of the abdomen, often radiating to the back or shoulder, fever, nausea, vomiting and occasionally jaundice. Symptoms may continue for several hours to several weeks, depending upon the severity of the attack. The disease may be complicated by softening or gangrene

of the gall bladder, with rupture and peritonitis, or by inflammation of adjacent portions of the liver. Treatment comprises bed rest, relief of pain, avoidance of liquid and food by mouth, glucose and salt solutions intravenously, and the use of sulfonamides and antibiotics. In cholecystitis without jaundice, the flow of bile into the intestine is unimpeded; hence there is no need for bile salts or laxatives. Surgical removal of the gall bladder may be performed promptly or deferred until the inflammation subsides.

Cholelithiasis.—This term designates stones in the gall bladder; *i.e.*, gallstones (*see* CALCULUS [IN MEDICINE]). Several factors are involved: stasis of bile with concentration and precipitation of cholesterol (as in the latter months of pregnancy); infection of the gall bladder (typhoid fever); precipitation of calcium carbonate in obstruction of the cystic duct; and increased concentration of bilirubin, as in hemolytic anemia with destruction of red blood cells and excessive formation of bilirubin. Gallstones may develop at all ages and in both sexes, but they occur more often in obese women, after pregnancy. They may be present for a lifetime without producing symptoms. The complaints of belching, flatulence and intolerance for fatty or fried foods, commonly attributed to gall bladder disease, frequently develop in the presence of a normal gall bladder and are related to gastrointestinal irritability. The passage of stones into the cystic or common bile channels causes stretching and spasm of these ducts and sudden, severe, cramping pain in the right upper abdomen, radiating to the back and right shoulder. Chills and fever reflect an accompanying cholecystitis; jaundice indicates an obstruction to the flow of bile. Biliary colic often occurs during the night, several hours after a heavy meal, and the attack usually subsides within several hours. There may be an associated inflammation of the pancreas (acute pancreatitis), diagnosis of which is facilitated by measurement of one of the enzymes produced by the pancreas (serum amylase). X-rays may reveal calcium-containing gallstones; or the gall bladder may fail to visualize, indicating nonfunction. Opiates often are required to relieve the pain. Gallstones cannot be dissolved, nor can stones be evacuated from the gall bladder via the intestine. Surgical removal of the gall bladder is the only curative procedure. Recurrent or continuing symptoms after surgery may be caused by a remnant of the cystic duct overlooked at the time of operation. A more serious problem is that of injury to the main bile duct at surgery, producing partial or complete interference with the normal flow of bile into the intestine; infection of the bile ducts within the liver and extensive disease of the liver usually ensue.

New Growths.—Tumours and cancer of the gall bladder are uncommon, benign tumours being found in approximately 5% of gall bladders removed surgically. These conditions include papilloma, adenoma, fibroma and lipoma. Cholesterol stones imbedded in the wall of the gall bladder may simulate benign tumours. The diagnosis is made only at X-ray examination or operation. Cancer of the gall bladder usually occurs in association with gallstones. Symptoms are caused by the stones or by an accompanying cholecystitis. The principal physical findings are jaundice and a hard, irregular mass in the region of the gall bladder. Cancer of the bile ducts also is rare. Symptoms consist of progressively increasing jaundice, itching of the skin, fever, loss of appetite and weight, and bleeding. These diseases usually are fatal; early surgical removal offers the only hope of cure.

See also GALL BLADDER, BILIARY TRACT AND LIVER, SURGERY OF; JAUNDICE.

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GALL BLADDER, BILIARY TRACT AND LIVER, SURGERY OF. This article is concerned with surgery that is performed on these organs. For information about their anatomy and diseases *see* GALL BLADDER; GALL BLADDER, BILIARY TRACT AND LIVER, DISEASES OF; LIVER.

The gall bladder, although it is absent in many lower species, is rarely lacking in man. Congenital abnormalities of the gall bladder, such as double gall bladder and bilobed gall bladder, also are rare. Anomalies of the bile duct, however, are fairly common and may be of considerable technical importance to the surgeon in the performance of operations on the biliary tract. Other serious congenital anomalies, which may be corrected by surgery, are congenital obliteration of the bile duct and congenital cystic dilatation. By far the commonest operations performed on the gall bladder are complete removal (cholecystectomy) and drainage of the gall bladder (cholecystostomy); the latter may be done as a temporary expedient. These operations are usually performed for inflammatory disease associated with gallstones. In case of obstruction to the common bile duct produced by tumour, the gall bladder may be joined to the duodenum or small bowel to relieve the pressure in the biliary tract. The common indication for exploration of the common bile duct is the presence of obstructing gallstones. After the stones are removed from the bile ducts, a drainage tube is frequently left in place for a time. Occasionally, obstruction to the outflow of bile from the liver follows damage to the bile ducts during an operation. Operations for correction of these postoperative strictures of the common bile duct are serious procedures but usually are successful. Cancer is found in about 1% of all gall bladders removed at operation and is usually associated with gallstones. The outlook for patients with cancer of the common bile duct is poor. An exception is the cancer that occurs in the terminal portion of the common bile duct, or ampulla of Vater, which may produce symptoms early enough for a radical operation to be curative.

The vast blood supply of the liver and the relatively inaccessible position of the hepatic veins make extensive operations on the liver technically difficult. Laceration of the liver often results from severe injury to the abdomen; the right lobe is approximately six times more likely to be injured than the left. Successful repair of extensive liver injuries has been accomplished on many occasions. Small pieces of liver may be removed for diagnostic purposes, either by inserting a biopsy needle through the skin into the liver or by direct operation. Either lobe of the liver may be removed because of tumours but the right lobe is more difficult to remove than the left. Both primary tumours (*i.e.*, those that originate in the liver) and secondary tumours (*i.e.*, those that metastasize to the liver) have been removed by these methods; the outlook for cure in removal for secondary tumour is poor. Abscesses occur occasionally in the liver. These may be of parasitic origin, such as amoebic abscesses, or they may result from the spread of pus-producing organisms from other sites of repair. In both instances, large solitary abscesses may be drained successfully by operation. Nonparasitic cysts of the liver are rare, although in sheep-raising areas parasitic hydatid cysts are seen occasionally. These cysts may be removed by operation. (A. P. TH.)

GALLÉ, ÉMILE (1846–1904), French glass and furniture maker, a leading designer of *art nouveau* (*q.v.*), was born on May 8, 1846, at Nancy, the son of a successful potter. He studied philosophy and botany, and, at Meisenthal, learned the crafts of glass. After the Franco-German war he joined his father's factory. By the late 1870s he was known as a spirited glass designer working in the revival styles then current. Over the next decade he became internationally famous and imitated as his glass assumed the free, asymmetric naturalism and symbolistic overtones of *art nouveau*. He employed wheel cutting, acid etching and casing with rare virtuosity, calling his effects "*marqueterie de verre*." His equally successful furniture designs in fact featured wood marquetry, delicate and unconventional, while their structural forms were generally borrowed from the rococo. Gallé led the revival of craftsmanship, and its dissemination via mass production, that

then flourished in Nancy; and he collaborated with many fellow citizens. His works are often inscribed and are signed, sometimes most imaginatively. Gallé died in Nancy on Sept. 23, 1904. His glass enterprise continued until 1913; on works made after his death the signatures are accompanied by a star. A vogue for collecting Gallé glass, etc., was revived in the 1950s.

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GALLE (formerly POINT DE GALLE), a port and principal town of Galle district and Southern province on the southwestern coast of Ceylon, lies 71 mi. S. of Colombo, with which it is connected by road and rail. Galle town (pop. [1953] 55,848 [mun.]) is hardly noticed in the Sinhalese chronicles before 1267, and Ibn Batutah (*q.v.*), writing in the middle of the 14th century, distinctly states that Kali (Galle, "a rock") was a small town. It was not until the Portuguese occupation period that it rose to importance. The Dutch further developed it, and their fortifications and some of their buildings may still be seen. The opening of the Suez canal in 1869 and the development of planting districts more accessible from Colombo led to the transfer of most commercial shipping to the capital and seriously diminished the prosperity of Galle. By mid-20th century, however, there was a tendency to divert shipping from Colombo to Galle because of congestion and other difficulties in the former. The town is administered by a municipal council.

GALLE DISTRICT (pop. [1953] 524,369) forms a narrow strip along the coast. The climate is hot and humid and population density is high, the majority being engaged in the cultivation of rice, tea and rubber. (B. H. F.)

GALLEGOS, RÓMULO (1884–), eminent Spanish-American novelist, educator and former president of Venezuela, was born Aug. 2, 1884, in Caracas. He began his literary career in 1909 as coeditor of *La alborada*, a periodical in which he published his first works, political and social essays.

His first short stories were published in *El cojo ilustrado* in 1910. After a brief attempt at the drama in 1915, Gallegos continued writing short stories until 1920, when his first novel, *El último Solar*, appeared. In 1925, a second novel, *La trepadora*, prepared the way for *Doña Bárbara* in 1929 (Eng. trans. by Robert Malloy; 1931, 1948). With *Doña Bárbara* he became an internationally known literary figure and one of the leading novelists of Spanish America. Two more major novels, *Cantaclaro* (1934) and *Canaima* (1935), followed. In 1936 Gallegos began an active political career that led to the ministry of education and finally to the presidency in 1947. His government was overthrown by a military coup in Nov. 1948, and he was sent into exile in December.

A historical novel, *Pobre negro* (1937), was followed by three other novels: *El forastero* (1942), *Sobre la misma tierra* (1943) and *La brizna de paja en el viento* (1952).

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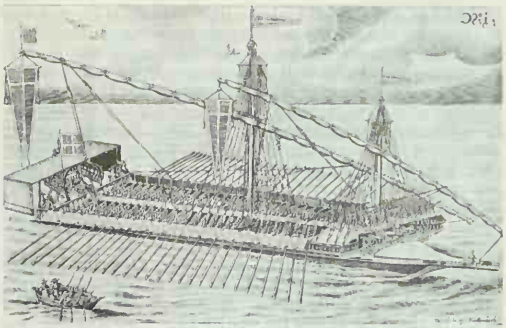
GALLEN-KALLELA, AKSELI VALDEMAR (1865–1931), Finnish painter, was born on April 26, 1865, at Pori. He established himself in 1884 in Paris. He is best known for his symbolic scenes from the *Kalevala* epic, for his landscapes, especially snow scenes, and for some admirable portraits, notably one of Maxim Gorki. He also executed work in black and white. His illustrations for *Seitsemän Veljestä*, by Aleksis Kivi (1906–07), are well composed and imaginative. He died at Stockholm, March 7, 1931.

GALLEY, a long single or half-decked vessel of war, with low freeboard, propelled primarily by oars or sweeps, but also having masts for sails. The word is used generally to refer to the ancient war vessels of Greece and Rome of various types, whose chief propelling power was the oar or sweep, but its more specific application is to the medieval war vessel which survived in the navies of the Mediterranean sea powers after the general adoption of the larger many-decked ship of war, propelled solely by sail power. Lepanto (1571) was the last great naval battle in



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

DRAWING OF AN EARLY 17TH-CENTURY GALLEY OF THE LARGEST SIZE, WITH FIVE MEN ON EACH OAR, ROWING TO THE BEAT OF A DRUM IN THE STERN; THE CENTRE GANGWAY WAS PATROLLED BY OVERSEERS

which the galley played the principal part. It became the custom among the Mediterranean powers to sentence condemned criminals to row in the war galleys of the state. Traces of this in France can be found as early as 1532, but the first legislative enactment is in the *Ordonnance d'Orléans* of 1561. In 1564 Charles IX forbade the sentencing of prisoners to the galleys for less than ten years. The galley slaves were branded with the letters GAL. At the end of the reign of Louis XIV the use of the galley for war purposes had practically ceased, but the corps of the galleys was not incorporated with the navy until 1748. The name *galérien* was still given to all convicts, though the galleys had been abandoned, and it was not till the French Revolution that the name was changed to *forçat*. In modern nautical use, the galley is a ship's kitchen.

See also references under "Galley" in the Index volume.

GALLEY HILL FOSSILS: *see* MAN, EVOLUTION OF: *Antiquity of Homo Sapiens*.

GALLFLY, a name applied to a number of different kinds of insects that cause the production of galls in plants. They include gall midges (*see* GALL MIDGE) and certain fruit flies (*see* FRUIT FLY), among the true flies or Diptera; gall wasps, among the Hymenoptera (*q.v.*); and certain aphids (*see* APHID), among the Homoptera. The galls are usually diagnostic for the species making them.

See also GALL, PLANT.

GALLIARD (Fr. *Gaillard*, meaning "lively"; It. *Gagliarda*) is a gay dance of the 15th century. Coupled with the pavane, it became the earliest of court dances. Although the music was in $\frac{3}{4}$ time, the dance was performed, often without holding hands, to counts of six (2 measures), with various kicking and jumping steps (*petit saut*) on 1, 2, 3, 4, a *saut majeur* ("high jump") or *saut moyen* ("medium jump") on 5, with a cadence posture on 6. Hence it acquired the name of *cinque-pas* (the English cinquepace). Musicians usually wrote pavanes and galliards in pairs, the galliard tune becoming a rhythmic adaptation of that of the pavane which it followed. It retained its vogue as a court dance from *c.* 1530 to 1620. (L. HT.)

GALLIC ACID occurs in many plants either in the free state or combined as gallotannin (*see* TANNIN). It is present to the extent of 40%–60% combined as gallotannic acid in tara and in Aleppo or Chinese galls (*see* GALL, PLANT), from which it is obtained commercially by the action of acids or alkalies.

Gallic acid is 3,4,5-trihydroxybenzoic acid and has the formula $(HO)_3C_6H_2.CO_2H$. When heated to 200°–250° C. it splits into carbon dioxide and pyrogallol (pyrogallic acid), the photographic developer. With iron salts it gives a deep blue-black colour, the basis of writing ink (*see* INK). It is used in the manufacture of a few dyes and as bismuth subgallate it has been employed in medicine as a mild skin antiseptic and astringent. Esters of gallic acid, principally propyl gallate, are important antioxidants for the prevention of rancidity in edible oil and fats. (V. H. W.)

GALLICAN CHANT, the music of the ancient liturgies used in France for about 400 years from the beginning of the 5th century. The problem of tracing its origin and development down to its eventual suppression under Charlemagne at the end of the 8th century can only be solved in connection with that of the origin of the Gallican liturgy. Scholars tend to assume that a virtually uniform liturgical chant existed in the west up to the end of the 5th century and that only in the 6th and 7th centuries did the Gallican Church develop its peculiar rite by introducing a number of feasts and customs from the east together with their melodies. One of the main differences between the celebration of the Mass in the Roman and the Gallican rites was the Gallican adoption of the *Trishagion* of the Greek Orthodox Church in place of the Gloria in the Roman Mass. Gallican chant differs from the so-called Gregorian chant in that it is richly ornamented and contains traits that are common in eastern chant. When Pepin III came to power in 751 he aimed at unifying the western rites, a tendency that was pursued even more vigorously by his son Charlemagne. Their intenion of making the Roman rite the only legal one was widely opposed by the clergy and was hampered by the small number of books of Roman chant available. In fact, the opposite happened of what was intended: the richness and beauty of some of the Gallican customs and their music impressed the liturgists of Rome so much that a number of Gallican chants were introduced into the Roman repertory. Thus from the 9th century onward the chant of the Roman Church became a mixture of Roman and Gallican elements and has descended in that form.

See J. B. Thibaut, *L'Ancienne Liturgie gallicane* (1929); E. Wellesz, *Eastern Elements in Western Chant* (1947). (E. J. Wz.)

GALLICANISM was an ecclesiastical doctrine—not, in its purely ecclesiastical aspects, peculiar to France but as a theological and legal position totally French—that advocated restriction of papal power. It was opposed to Ultramontanism. Though "Gallicanism" as a word comes from the 19th-century dispute within the Roman Catholic Church between these two opposing positions, the doctrine itself had its roots in early French nationalism, especially in the organizing action of Charlemagne in the 8th and 9th centuries, and came to conscious flower in the 14th century.

French Gallicanism.—During the pontificate of Boniface VIII (1294–1303) occurred the struggle between the pope and Philip IV the Fair of France over the nature of and relationship between the royal and papal powers (*see* BONIFACE; PHILIP IV). Philip, a nationalist and a builder of the French monarchy, wanted political independence from the pope. Boniface appealed to the unwritten constitution of Christendom—*i.e.*, the *res publica Christiana* of western Europe—as a united political society under the headship of the pope and bishops. In this debate theology and constitutional law were badly confused, and in the long history of the Gallican controversy the confusion was never properly clarified. In Italy the pope's position was defended by theologians and jurists; Philip had the support of the University of Paris.

On the French side the most significant theologian was the Dominican Jean Quidort (d. 1306), whose theory on the papal powers —that in matters spiritual the pope had final power but that in matters secular he could intervene only if the secular matter was indirectly connected with the moral or theological order—was a valuable contribution to theology. The Sorbonne also aided the emperor Louis IV the Bavarian in his 14th-century quarrel with Pope John XXII. In 1324 Marsilius of Padua and John of Jandun, both of the university, both far to the left of the true Gallican position, published the *Defensor Pacis,* which gave no jurisdiction whatsoever to the pope and made the king supreme even in matters spiritual (for a detailed discussion of this work, *see* MARSILIUS). John condemned it in 1327.

The cause of Gallicanism was advanced in the next century and a half by the development of the conciliar theory, in the formation of which two Sorbonne theologians, Jean de Gerson and Pierre d'Ailly (*qq.v.*), were conspicuous. According to this theory, issued as the decree *Sacrosancta* by the Council of Constance (1414–18), a general council drew its powers directly from Christ, and even the pope was subject to its decisions. The decree *Sacrosancta* was renewed by the Council of Basel (1431–37), but it was rejected by Eugenius IV, who refused to include it among the conciliar decrees. (*See* also COUNCIL: *Council of Constance* and *Council of Basel;* BASEL, COUNCIL OF.) The French king Charles VII, however, took advantage of it. In the assembly of the clergy of France at Bourges in 1438, a declaration of 23 articles—modified Basel pronouncements affirming that the pope was subject to a general council and that his jurisdiction was conditioned by royal will—was drawn up, signed by the king as a pragmatic sanction and became basic law for the French courts. The popes, though from then on they constantly urged revocation of the Pragmatic Sanction of Bourges, did not succeed in this effort until 1516, when it was replaced by a concordat conceding the French king's right to nominate bishops. The French bishops who took part in the Council of Trent (1545–63) were instructed by the crown to defend the Gallican doctrine of restricted papal power; as a result, the question could not be definitively treated by that council.

In France the doctrine of restricted papal power was implicit in the action of the courts, and as a result much literature came forth on the matter.

By this time, two kinds of Gallicanism, political and theological, could be distinguished; and political Gallicanism could be further divided into parliamentary (*i.e.*, judicial) and royal. "Royal Gallicanism" thus designates the traditional policy of the French kings in matters ecclesiastical, and "parliamentary Gallicanism" indicates the juridical postulates of the French courts and legislature in dealing with church affairs.

The chief champions of parliamentary Gallicanism were able men. The first of them was the jurist Pierre Pithou, a convert to Catholicism from Calvinism, who published his great work, *Les Libertés de l'Église gallicane,* in 1594. According to his own statement, Pithou's political Gallicanism could be reduced to two principles: first, in matters secular the pope has no jurisdiction whatsoever; second, even in matters spiritual the pope's power in France is limited by the traditions and privileges that are part of the immemorial life of the French church. *Les Libertés* had great influence in France, especially with Pierre Dupuy's supplementary collection of historical proofs (1639) and commentary (1652). Not unexpectedly, the books were condemned at Rome. Pierre de Marca, later archbishop of Toulouse, published in 1641 his *De concordia sacerdotii et imperii,* which was irenic in intention but accepted the basic principles of Pithou. It too was condemned.

A work that influenced both political and theological Gallicanism was the *De ecclesiastica et politica potestate* (1611) of Edmond Richer, a priest and syndic of the University of Paris. Though Richer's conclusions were not substantially different from those of Pithou, his work contained some theological arguments as well. The best expression of theological Gallicanism, however, was found in the Four Articles of the assembly of the clergy of France (7 archbishops, 26 bishops and 38 theologians) in 1682, which gave Gallicanism its final form: (1) the power of the popes is purely spiritual and has no secular dimension; (2) in spiritual matters papal power is plenipotentiary subject to conciliar authority, according to the restrictions made at the Council of Constance; (3) papal power must recognize the validity of previous canons of the total church and the immemorial customs of the churches; (4) the pope is infallible in his teaching, provided this teaching is approved by the total church. Bishop Jacques Bossuet redacted and defended the Four Articles in a published apology for the doctrine in 1682. Though they were condemned at Rome by Alexander VIII in 1690 and revoked in France by Louis XIV in 1693, they remained the typical expression of Gallicanism.

Not all of the French clergy was Gallican; the French Jesuits, in particular, were fervently Ultramontane. The 18th century, with its rationalist attack on the very foundations of Catholicism, weakened the French concern for Gallicanism, and the Revolution took the life out of it. Napoleon, though he favoured the clerical Gallican party, had no strong interest. The first Vatican council, by defining the Ultramontane position in the decree *Pastor Aeternus* (papal infallibility), destroyed it altogether.

Febronianism.—Febronianism, the German form of Gallicanism, derives its name from Justinus Febronius, the nom de plume of Johann Nikolaus von Hontheim (*q.v.*), auxiliary bishop of Trier,

who in 1763 published *De statu ecclesiae et legitima potestate Romani Pontificis*. Hontheim's doctrine, as set forth in this work, was not only Gallican but extremely so. His motive was to attract German Protestants to the Catholic Church by removing Protestant fears of the papacy. The work was condemned and placed on the Index of forbidden books in 1764.

Hontheim's doctrine may be summarized as follows: (1) jurisdiction in the church belongs to the total church, which chooses the pope to exercise it; (2) the pope always remains subject to the total church, which can judge him and depose him; (3) although the pope exercises vigilance over the total church, this means only that he sees to it that the ancient canons are observed; he is not superior to the other bishops but only the first among equals; (4) the pope has no power over bishops in their own dioceses, and he is always subject to a general council of bishops; (5) sovereigns of states are not subject to the pope, and both sovereigns and bishops must resist the Roman tendency to encroach on their powers.

The French Revolution and lack of support from German bishops led to the collapse of Febronianism by the end of the 18th century.

Josephinism.—Josephinism is not so much a doctrine as the application of Febronianism in the Holy Roman empire by the emperor Joseph II. Joseph's reforms were aimed at removing Roman jurisdiction over ecclesiastical affairs in the empire, and they included an edict of toleration (1781), suppression of some religious orders and requirement of consent by the state before publication of any papal document. His policy was extended beyond the frontiers of the empire by his brother Leopold, archduke and later king of Tuscany. Through Leopold, the bishop of Pistoia and Prato, Scipione de' Ricci, in 1786 convoked a diocesan synod in Pistoia at which Leopold's plan of church reform, patterned on the lines instituted by Joseph, was codified and proclaimed. Josephinism ended when the emperor died in 1790. Ricci was deposed in that year, and the Febronian and Jansenist reform of Pistoia was condemned by Pius VI in 1794.

Gallicanism in History.—The disappearance of Gallicanism in the 19th century, after its wide spread in the three preceding centuries, provides an indication of its true nature. Neither Gallicans nor Febronians, it must be emphasized, were democrats; on the contrary, they were stoutly aristocratic in their position. Although Gallicans always spoke of the liberties of the French church, they were really defending the freedom of the crown, and the Febronians' position was similar. While appearing to be a defense of the church against Roman arrogation of authority, Gallicanism was in fact the practical policy of strong kings and a theory constructed by their supporters. When the monarchs lost their power in Catholic lands, Gallicanism melted away. As a result, the first Vatican council, without great episcopal opposition, could do what the Council of Trent could not do because it had to contend with the opposition of kings. The Vatican council defined the fullness of papal jurisdiction over the whole church and all parts of it in 1870.

Sixteenth-century Gallicanism in France, it may be noted, was guided in no small part by the example of the Anglican establishment in England. There were moments in the evolution of Gallicanism when it seemed probable that the French church would separate itself from Rome, and only the close connection of Rome and France during long centuries prevented the separation that had taken place in England. *See* also COUNCIL; INFALLIBILITY; ULTRAMONTANISM.

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GALLI-CURCI, AMELITA (1889–1963), Italian-U.S. operatic soprano, was born at Milan on Nov. 18, 1889, of Italian and Spanish parentage. After a general education she studied piano and composition at Milan royal conservatory; as a singer she was self-taught. Her operatic debut, as Gilda in Verdi's *Rigoletto*, was at Trani in southern Italy, and her first important appearance was at Rome on April 20, 1908, in Bizet's *Don Procopio*. Tours with opera companies in Egypt, South America, Spain and Russia established local reputations for Galli-Curci, but she was almost unknown in the U.S. when, on Nov. 18, 1916, she appeared, again as Gilda, in Chicago; she made her New York debut as Meyerbeer's Dinorah 14 months later. In 1921 she joined the Metropolitan Opera company and sang regularly there until 1930. Foreign concert tours followed, and in 1936 she made her final stage appearance in Puccini's *La Bohème*. Galli-Curci's voice was exceptionally fluent, warm and smooth, unusually dark in quality for one whose speciality was florid, high soprano music. Her repertory included 28 operatic roles ranging from Rossini's Rosina to Strauss's Sophie and Puccini's Butterfly. On her second marriage, to her accompanist, Howard Samuels, she became a U.S. citizen. She died in La Jolla, Calif., on Nov. 26, 1963.

(WI. S. M.)

GALLIÉNI, JOSEPH SIMON (1849–1916), French army officer, the conqueror of the western Sudan and of Madagascar and the defender of Paris in 1914, was born at St. Béat (Haute-Garonne) on April 24, 1849. He left the military academy of St. Cyr in 1870, fought in the Franco-German War, was wounded and made prisoner. Posted to Réunion after the war, he was transferred to Senegal in 1876. Thoughtful and unsociable, Galliéni was more like a scholar or a scientist than a typical officer. In Senegal he relieved his boredom by reading history and philosophy and by keeping a diary in macaronic sentences of German, English and Italian. He soon won the affection of the Africans, however, which he happily reciprocated.

Captained in 1879, Galliéni was ordered in 1880 to undertake a military expedition in the basin of the upper Niger, then controlled by Ahmadou (*q.v.*). In May 1880 he was made prisoner by the Africans, but in March 1881 he obtained from Ahmadou a treaty giving the French exclusive rights of commerce on the upper Niger. Appointed major, he was married in Paris and then served for three years in Martinique. Governor of the French Sudan in 1886, he had to fight against the Sudanese leader Samory, whom he forced to accept a treaty abandoning the left bank of the Niger. In May 1888 Galliéni returned to Paris to study at the École de Guerre. In Sept. 1892, as a colonel, he was sent to Tongking, where he remained till Jan. 1896, suppressing piracy and gradually spreading French influence by peaceful penetration. Promoted general in August, he was appointed commander in chief of the French forces in Madagascar, where the Merina were in revolt against the French; in April 1897 he was made resident general. Galliéni suppressed the rebellion forcefully. He abolished the monarchy, exiled the queen, Ranavalona III, and had two ministers shot. Afterward he soon pacified the whole island. His administration thenceforward was flexible, efficient and fair to all the tribes; he encouraged secular education without hindering the missionaries; and he did much to develop the island economically, building the Tamatave-Antananarive railway and many roads. When he left the island in 1905 he was well liked by the Malagasy peoples. He was then appointed to the command of the XIV army corps in Lyons.

Galliéni could have been appointed commander in chief of the French forces in 1911, but because of his age and poor health he suggested that his friend Gen. J. J. Joffre be appointed instead. He reached the age of retirement in April 1914 and left the service to live at St. Raphaël, but on Aug. 1, on the eve of World War I, shortly after his wife's death, he was recalled to active service and appointed commander of the Paris fortified area. While the French armies were retreating and the government left Paris for Bordeaux, Galliéni informed the Parisians that he would defend the capital. Seeing his role as one not merely of passive defense, he awaited the opportunity for a counterstroke. From information received on Sept. 3 he concluded that the right wing of the German forces marching on Paris had inclined to the southeast, thus offering him an exposed flank. In agreement with Joffre, he

launched Gen. M. J. Maunoury's 6th army against the German flank, using Paris taxis as means of transport. Joffre showed no haste to satisfy Galliéni's desire for the command of an army group; but on Oct. 29, 1915, Aristide Briand appointed Galliéni minister of war. Once more he revealed himself an excellent administrator; his courtesy and his matter-of-fact speeches pleased the parliament, but he had to resign for reasons of ill health on March 16, 1916. He died at Versailles on May 27, 1916, and was buried at St. Raphaël. On April 21, 1921, the dignity of marshal of France was conferred on him posthumously.

See P. Gourou, *Galliéni* (1946); H. Deschamps, *Galliéni pacificateur* (1949). (L. G.)

GALLIENUS, PUBLIUS LICINIUS EGNATIUS, Roman emperor A.D. 253–268, was proclaimed emperor with his father Valerian (*q.v.*) in 253 and placed in command of the west while his father took charge of the eastern frontiers. After a series of campaigns on the Rhine, Gallienus was summoned to the Danube, probably in 258, to deal with the successive revolts of Ingenuus and Regalianus. In June 260 Valerian was taken prisoner and the Persians overran the east, supplementing the previous devastations of the Germans on the Rhine and the Goths on the Danube. Independent rulers were acclaimed in Gaul and in the east, and Gallienus was left in control only of Italy and the devastated Balkans, whence he effectively chased the invaders. In view of the repeated revolts of senatorial army commanders in the last 15 years, Gallienus transferred the command of the Roman armies from senators to professional equestrian officers, thereby breaking a tradition some seven centuries old. At the same time, since the old linear defense of the frontiers was no longer adequate, he organized a mobile cavalry reserve, which became the nucleus of the field army of the later empire.

In the five relatively peaceful years 262–267, Gallienus at Rome sponsored a vigorous intellectual renaissance, clearly discernible in the surviving art of the period and in contemporary literature, notably that of the Neoplatonist philosophers such as Plotinus. He thereby earned the bitter condemnation of the Latin writers, offset by the warm sympathy of Greek and Christian tradition. Toward the end of his reign, Gothic attacks were renewed: Gallienus' defensive measures were interrupted by the revolt of his cavalry commander, Aureolus, whom he successfully blockaded in Milan, but during the siege he was himself murdered, and his new cavalry commander, Claudius (*see* CLAUDIUS II), succeeded him. (JN. R. M.)

GALLIFFET, GASTON ALEXANDRE AUGUSTE, MARQUIS DE, Prince de Martignes (1830–1909), French army officer, was born at Paris on Jan. 23, 1830. He entered the army in 1848, and served with distinction at the siege of Sevastopol in 1855. Under Napoleon III he served in several campaigns in Algeria, Italy and Mexico, and by 1867 became colonel of the 3rd Chasseurs d'Afrique. He commanded this regiment in the Franco-German War of 1870 and on Aug. 30 became general of brigade. At the battle of Sedan he led his brigade in the heroic charge of Gen. J. A. Margueritte's cavalry division (*see* SEDAN). He was taken prisoner at the capitulation, but returned to France and in the suppression of the Commune his severity earned him the bitter enmity of the left. His military career continued until 1895; he suppressed an Algerian rebellion in 1872, was promoted general of division in 1875, and became a member of the Conseil Supérieur de la Guerre in 1885. In later life he became a politically controversial figure, being sponsored by L. Gambetta, who respected his military talents, and in 1899 became minister of war in the René Waldeck-Rousseau cabinet after the turmoil of the Dreyfus case. Although regarded by the moderates as a good republican, he remained the object of great animosity on the left. He died on July 8, 1909.

See L. Thomas, *Le Général de Gallifet,* new ed. (1941). (D. TN.)

GALLIFORMES, an order of birds, comprising the game birds. *See* CURASSOW; FOWL; FRANCOLIN; GAME BIRDS; GROUSE; MEGAPODE; ORNITHOLOGY (for classification); PHEASANT; PTARMIGAN; QUAIL; TURKEY.

GALLINULE, the name for several species of fresh-water birds of the family Rallidae, about the size of a hantam hen but compressed like the rails and the coots (*qq.v.*). The common European gallinule (*Gallinula chloropus*), blackish with a scarlet forehead plate, is known as moor hen (*q.v.*), its North American race (*G. c. cachinnans*) as the Florida gallinule. They are noisy birds. They lay 7 to 11 brown-spotted creamy eggs in a bulky nest of rushes on or near the ground.

DADE THORNTON FROM NATIONAL AUDUBON

AMERICAN PURPLE GALLINULE (PORPHYRULA MARTINICA)

The larger purple gallinule or swamp hen of Mediterranean shores is *Porphyrio porphyrio,* with related species over Africa, Madagascar, southern Asia to Australia, the Philippines and southwest Pacific islands. The purple gallinule, water hen or sultana of America is *Porphyrula martinica,* with bright olive-green and purplish-blue plumage, light-blue forehead plate, red and yellow bill, yellow legs and feet. It is found from South Carolina and Texas to northern Argentina; an allied species, *P. parva,* occurs from central Brazil and Paraguay to the Guianas, and *P. alleni* is seen over Africa and Madagascar.

Many peculiar flightless island forms are found throughout South America, Africa, southern Asia, Australia and islands of western and southwestern Pacific: among those extinct or nearly so are the island hen of Tristan da Cunha (*Porphyriornis nesiotis*); the mountain cock of Gough Island (*P. comeri*); the white swamp hen of Lord Howe Island (*Porphyrio albus*); the huge moho of New Zealand (*Notornis mantelli*); and *Pareudiastes pacificus* of Samoa. (G. F. Ss.; X.)

GALLIO, JUNIUS (originally LUCIUS ANNAEUS NOVATUS) (d. A.D. 65), the elder brother of L. Annaeus Seneca (*q.v.*), was born at Corduba (Córdoba) about the beginning of the Christian era. At Rome he was adopted by Junius Gallio. It is probable that he was banished to Corsica with his brother and that both returned to Rome when Agrippina selected Seneca to be tutor to Nero. In A.D. 51 or 52, while proconsul of Achaea, he dismissed the charge brought by the Jews against the apostle Paul (Acts xviii, 12–17). After the fall of his brother Seneca he committed suicide.

GALLIPOLI (GELIBOLU, anc. CALLIPOLIS), a seaport and city of the *il* (province) of Canakkale in European Turkey, is situated at the northeastern extremity of the Dardanelles (*q.v.*) at the western entrance of the Sea of Marmara. It lies on a narrow peninsula (which extends 50 mi. to the southwest) and is 132 mi. W.S.W. of Istanbul and 90 mi. S. of Edirne. Pop. (1960) 12,956. Beside several mosques, the city has Roman and Byzantine remains, a magazine of the emperor Justinian I (483–565), a square castle and tower attributed to Bayazid I (1354–1403) and some tumuli known as the tombs of the Thracian kings. Gallipoli is connected by shipping service with Istanbul and by main road with Edirne and Istanbul. It is an important fishing and canning centre.

Gallipoli has always been a strategic point in the defense of Istanbul; it was largely destroyed in the fighting during World War I. For an account of the Gallipoli campaign in that war *see* DARDANELLES CAMPAIGN. (N. TU.; E. TU.; S. ER.)

GALLIPOLIS, a city of southern Ohio, U.S., on the Ohio river, about 90 mi. S.E. of Columbus, the seat of Gallia county. It was founded in 1790 by the Ohio company as a town of 80 cabins for stranded French immigrants who had been beguiled by agents of the Scioto company to purchase land certificates which were worthless (*see* OHIO COMPANY); the name Gallipolis means "city of the Gauls." It was incorporated as a village in 1842 and as a city in 1865. Its municipal government is by the council-manager plan in effect since 1918.

The city has a small number of manufacturing industries and is the shipping centre for a farming and coal mining region. Rio Grande college, a private college founded in 1876, is 12 mi. dis-

tant. The Gallipolis State institute for epileptics and mentally defective children was established in 1890. Hospital and medical services are provided by the Holzer Hospital foundation, consisting of a clinic, a hospital and a school of nursing, and the Gallipolis clinic.

Gallipolis, the third settlement on the Ohio river within the limits of the state of Ohio, has several points of historical interest. Our House, built as a tavern in 1819, is now a museum of the Ohio Historical society.

For comparative population figures *see* table in OHIO: *Population.* (G. J. BL.)

GALLITZIN, DEMETRIUS AUGUSTINE (1770–1840), U.S. Roman Catholic priest, known as the "Apostle of the Alleghenies," was born at The Hague, Neth., on Dec. 22, 1770, during the tour of duty there of his father, Prince Dmitri Alekseevich Golitsyn, as Russian ambassador to Holland. Both his parents were filled with the spirit of the Enlightenment, but at the age of 17 Demetrius joined the Roman Catholic Church. Traveling to America, he began studying for the priesthood and was ordained in Baltimore, Md., in 1795. Bishop John Carroll (*q.v.*) sent him to Cambria county, Pa., where immigrant Catholics were settling in the foothills of the Alleghenies. He was one of the first priest missionaries during the colourful immigrant period of American history, and was soon, like so many of his 19th-century counterparts, deeply engrossed in land and colony projects to attract Catholic immigrants into the west and onto the land. Known as "Mr. Smith" in the United States, Gallitzin was a benevolent and eccentric despot who at the same time exercised a great power for good among his parishioners. At the time of his death, on May 6, 1840, there were around 10,000 Roman Catholics living in his district, where 40 years earlier he had found a scant 12.

Gallitzin wrote controversial religious tracts and pamphlets in defense of the Catholic religion against attacks by frontier Protestant sects. Most typical of these polemics is his *A Defense of Catholic Principles* (1816). A collection of his letters was published in 1940.

BIBLIOGRAPHY.—A contemporary biography in German by his assistant, Peter H. Lemcke, *Life and Work of Prince Demetrius Augustine Gallitzin,* tr. by Joseph Plumpe (1940); several popular biographies typical of which is Daniel Sargent's *Mitri* (1945). (C. J. BY.)

GALLIUM, a chemical element that is a bluish-white metallic solid, which becomes a liquid at slightly above room temperature. Gallium is a member of Group III of the periodic table and is generally associated with aluminum and boron in the main group, but in some forms of the table gallium, indium and thallium are placed in the subgroup. The symbol for Gallium is Ga; the atomic number is 31 and the atomic weight is 69.72.

Gallium was discovered in 1875 by Paul Émile Lecoq de Boisbaudran, who observed its principal spectral lines (λ 4172.2 Å and 4033.2 Å) while examining material isolated from zinc blende of Pierrefitte, Hautes-Pyrénées, France. He recovered a sample of the metal and studied its properties. A few years previously D. I. Mendeleyev had predicted the existence of a number of elements, not yet discovered, each corresponding to a blank space in his periodic table. He gave the provisional name eka-aluminum to the missing element lying between aluminum and indium and predicted its principal physical and chemical properties. His predictions relative to eka-aluminum were verified by the discovery of gallium, whose properties were found to coincide almost exactly with those predicted.

Applications.—Gallium has not been extensively used, although its unique properties indicate some interesting possibilities. Because of its low vapour pressure and long liquid range, it would be a suitable material, enclosed in clear quartz, for a high-temperature thermometer. Its use as a coating for optical mirrors, as a liquid seal in strongly heated apparatus and as a substitute for mercury in ultraviolet lamps has been suggested. Gallium has been considered as a possible heat-exchange medium in nuclear reactors, although it has a high neutron cross section. Gallium attacks a great many metals such as titanium, iron, nickel and copper, forming compounds or solid solutions; it must therefore be enclosed in a resistant material. Radioactive Ga^{72} shows some promise in the study of bone cancer; a compound of this isotope is absorbed by the cancerous portion of the bone, which may thus be more accurately identified.

Gallium may be quantitatively separated by extraction from an acid solution with a chloroform solution of 8-hydroxyquinoline and determined by the use of the spectrophotometer. It is also determined by spectrographic methods.

Occurrence and Production.—It has been estimated that gallium constitutes about 0.0015% of the earth's crust, although it is widely distributed and has not been found in concentrated deposits. It is a constituent of many coals and some of the ores of zinc, aluminum, iron, copper, germanium and chromium. The zinc blendes of the Missouri-Oklahoma-Kansas district contain up to 0.02% of gallium; aluminum-bearing minerals, particularly bauxite, contain up to 0.01%; germanite, a complex sulfide mineral found in the lead copper ores of the Tsumeb district of South-West Africa, contains up to 0.8%.

Gallium is extracted as a by-product from zinc and aluminum ores or from flue dust by processes which involve the separation of small quantities of its compounds from those of other metals and a subsequent electrolytic reduction. In an older method for the recovery of zinc the roasted ore is smelted in retorts and the gallium accumulates in the retort residues when the zinc is distilled. The metals in the residue are converted to chlorides and the more volatile gallium trichloride is separated by distillation. The more recent process involves leaching of the roasted zinc ore with sulfuric acid and neutralization of the excess acid to precipitate such impurities as gallium, aluminum and iron. The precipitate is treated with sodium hydroxide, which dissolves the aluminum and gallium compounds, and these are reprecipitated by neutralizing the solution with acid. The precipitate is then dehydrated to make insoluble any silicon dioxide which may be present, and treated with hydrochloric acid. The gallium trichloride is extracted from the concentrated acid solution by ether, the aluminum salt and some of the other impurities remaining in the hydrochloric acid solution. Gallium metal is obtained by the electrolysis of a sodium hydroxide solution of the gallium salt. The metal is purified by washing alternately with water, hydrochloric acid and nitric acid and by successive crystallizations from the supercooled liquid.

Gallium is recovered from the alkaline solutions of bauxite, which are prepared by treating the aluminum ore with hot sodium hydroxide. The concentrated solution, containing mostly sodium aluminate, is seeded with aluminum hydroxide and cooled. The hydrated aluminum oxide crystallizes and is separated from the waste liquor, which contains the gallium and considerable aluminum hydroxide. More of the aluminum compound is removed and the gallium compound is precipitated, redissolved in sodium hydroxide and electrolyzed.

In England gallium is commercially recovered from flue dusts which contain also iron and germanium. The dust is smelted with sodium carbonate, lime, carbon and copper oxide. A button or mass of metal containing most of the germanium and gallium thus formed beneath the slag is treated with chlorine under ferric chloride solution. The germanium tetrachloride is removed from the solution by distillation. The residue liquid containing the gallium is further purified by precipitation of the copper salts and other precipitable metals while the iron is reduced to the ferrous state. The gallium chloride is then extracted by ether. After removal of the ether by distillation, the gallium chloride is treated with sodium hydroxide and the gallium metal recovered by electrolysis.

Properties.—Gallium is a bluish-white metal with an unusually low melting point (29.78° C.). It expands upon solidification and supercools readily, remaining in the liquid phase at temperatures as low as 0° C. Gallium remains in the liquid phase over a temperature range of more than 2,000° C. with a very low vapour pressure up to about 1,500° C., the longest useful liquid range of any element. It has a hardness of 2–3 on Mohs' scale and at fairly low temperatures is brittle. Two stable isotopes with mass numbers 69 (60.1%) and 71 (39.9%) are known, and a number of radioactive isotopes have been prepared. The crystal structure of the metal is orthorhombic, with each atom surrounded by seven

others, one at 2.44, two each at 2.70, 2.73 and 2.79 Å. The structure probably contains Ga_2 molecules. Gallium is diamagnetic. Additional physical and atomic properties are listed in the table.

Numerical Properties of Gallium

Outer electron configuration	$4s^2,4p^1$	Melting point, ° C.	29.780
Mass number and half life, radioactive isotopes		Boiling point, ° C.	2,070
	64 (2.5 min.)	Vapour pressure (mm. Hg)	
	65 (15 min.)	1,315° C.	1.0
	66 (9.4 hr.)	1,726° C.	100
	67 (78 hr.)	Ionization potential, volts	
	68 (68 min.)	1st electron	6.00
	70 (21 min.)	2nd electron	20.43
	72 (14.1 hr.)	3rd electron	30.6
	73 (5 hr.)	Potential for $Ga \rightleftarrows Ga^{3+}$ + 3e at 25° C., volts	0.52
	74 (~8 min.)	Specific heat 20°–127° C., cal. per g.	0.0977
Density at 20° C., g. per c.c.	5.907	Covalent radius, Å	1.245
29.65° C. (solid)	5.9037	Ionic radius of Ga^{3+}, Å	0.62
29.8° C. (liquid)	6.0948		
Atomic volume of solid c.c.	11.76		

The chemical properties of gallium resemble in some respects those of aluminum. It oxidizes slowly in moist air to form a thin surface film of oxide, but the oxidation does not proceed much further even under more favourable conditions. The wetting of glass and similar surfaces by the metal is attributed to the presence of traces of the oxides. Gallium does not react with water at temperatures up to 100° C. but reacts slowly with hydrochloric and other mineral acids. The action of nitric acid is slow at room temperatures for, like aluminum, gallium becomes passive. The passivity is probably attributable to the formation of a protective film of the oxide, which on the liquid metal is tenacious and somewhat elastic. Hot nitric acid and aqua regia react on the metal more rapidly. Gallium is amphoteric and reacts with sodium or potassium hydroxide solutions, forming a gallate and liberating hydrogen. The halogen elements attack vigorously.

Compounds.—In most of its compounds gallium is trivalent; a few divalent salts, in particular the halogens, are known. There is no evidence of a monovalent gallium except in the sulfide, Ga_2S, and possibly the selenide, Ga_2Se.

All four of the trihalides of gallium are known. The hydrated fluoride, $GaF_3.3H_2O$, is prepared from gallic hydroxide and hydrofluoric acid; the anhydrous gallic fluoride is made by heating the complex salt, ammonium fluorogallate, $(NH_4)_3GaF_6$, in a stream of fluorine. The chloride, $GaCl_3$, the bromide, $GaBr_3$, and the iodide, GaI_3, are prepared by treatment of the metal with the respective halogen elements. The latter three gallic halides volatilize at relatively low temperatures and may be purified by distillation *in vacuo*. They dissolve in water but are extensively hydrolyzed. In the vapour phase the chloride, the bromide and to a lesser degree the iodide are dimeric and probably have bridge structures. Gallic chloride has been found to be more effective than aluminum chloride as an acid catalyst in the Friedel-Crafts synthesis of benzophenone and similar reactions. The anhydrous gallic fluoride, GaF_3, sublimes at temperatures above 800° C. and is only slightly soluble in water. The trihalide molecules are electron pair acceptors and thus classified as Lewis acids.

Gallium hydroxide, $Ga(OH)_3$, is amphoteric but slightly more acid than its aluminum analogue and when heated decomposes to the oxide, Ga_2O_3. Other trivalent gallium salts are: the sulfate, $Ga_2(SO_4)_3$, which forms alums with the sulfates of ammonium or the alkali metals; the nitrate, $Ga(NO_3)_3$; the perchlorate, $Ga(ClO_4)_3$; the sulfide, Ga_2S_3; and the nitride, GaN.

On the basis of electronic configuration, the existence of divalent gallium compounds seems improbable, yet several halides, the sulfide and probably the oxide have been prepared. Gallous chloride, $GaCl_2$, originally prepared by Lecoq de Boisbaudran, decomposes into the trichloride and the metal when heated above 200° C. Vapour density studies indicate the presence of a considerable number of molecules of $GaCl_2$ with some polymers. Since the solid dichloride is diamagnetic, it is inferred that the polymers have Ga-Ga linkages. The fused salt is a conductor of electricity, dissolves in benzene but reacts with water, liberating hydrogen. Gallium dibromide and diiodide have also been prepared.

A hydride, Ga_2H_6, a methyl hydride, $Ga_2(CH_3)_4H_2$, and a methyl borohydride, $(CH_3)_2GaBH_4$, of gallium have been reported. Gallium forms a number of compounds with organic groups; *e.g.*, gallium trimethyl, $Ga(CH_3)_3$; triethyl, $Ga(C_2H_5)_3$; triphenyl, $Ga(C_6H_5)_3$; gallium acetylacetonate, $Ga(C_7H_5O_2)_3$; and a number of chelated oxy-compounds.

See also references under "Gallium" in the Index volume.

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GALL MIDGE, any of the minute, delicate flies constituting the family Cecidomyiidae (or Itonididae) of the order Diptera; the larvae of a great many species are injurious to crops and ornamentals by producing abnormal growths called galls (*see* GALL, PLANT). The flies are characterized by having beaded, somewhat hairy antennae and few veins in the very short-haired wings. The larvae are frequently orange in colour and live in flowers, axils of leaves and in the leaves themselves, usually causing the formation of galls, some of which are inconspicuous. A few live in galls produced by other dipterans. Pupation takes place in the gall or in the soil; the winter is passed in the immature stages.

The Hessian fly (*q.v.*) is the most serious pest. The chrysanthemum midge, *Diarthronomyia hypogaea*, attacks these plants in Europe and North America, making small galls in the leaves; in northern latitudes they occur chiefly in greenhouses. Nicotine spray is used to control them. The rose midge, *Dasyneura rhodophaga*, infests the young buds and shoots of roses in greenhouses and is a serious pest, occurring but rarely outside. Some other serious pests are the wheat midge, sorghum midge, rice midge, clover midge and pear midge. Tobacco fumigation and use of dust on soil controls them. The pine cone gall on willow results from the bunching of the terminal growth.

The few beneficial species are predaceous on aphids, mites, scale insects and bark beetle larvae. The most interesting species, scientifically, belong to the genus *Miastor*, which exhibit an unusual method of reproduction called paedogenesis; the female, at times, produces one or several large eggs that develop into large larvae, each of which contains many smaller larvae that consume the host.

See FLY. (C. H. Cn.)

GALLOWAY, JOSEPH (*c.* 1731–1803), American colonial statesman and loyalist who introduced "A plan of a proposed Union between Great Britain and the Colonies" at the first continental congress in Philadelphia, Pa., in 1774, was born at West River, Anne Arundel county, Md. Galloway studied law in Philadelphia. Beginning practice in 1747, he distinguished himself by pleading cases before the supreme court of Pennsylvania before he was 20 years of age. He married Grace Growdon, daughter of a wealthy provincial councilor, in 1753. In his practice Galloway became an authority on disputed land claims which often involved questions of provincial administration. His prominence was recognized by his election to the Pennsylvania assembly in 1756 where he occupied the powerful post of speaker from 1766 to 1775. His writings exhibit a lawyer's concern for precedent and property rights. Galloway's plan of 1774 provided for a president general to be appointed by the king, and a colonial legislature known as the grand council, which was to have "like Rights, Liberties and privileges as are held and exercised by and in the House of Commons." Members of the legislature were to be selected for three-year terms by the colonial assemblies, and bills could be initiated either in parliament or in the colonial legislature but had to have the assent of both to become law. Galloway's plan was rejected by only one vote after a day's debate and was later expunged from the record. The radicals opposed him because he believed differences between the American colonies and Britain could be solved by a written constitution for the empire rather than by rebellion. Because he thought the Revolution unreasonable and unjust he left Philadelphia and joined Gen. William Howe's army. He returned to the city as a civil administrator during the British occupation, but with the re-entry of the patriots in 1778 he fled to England where he remained until his death on Aug. 29, 1803.

Although Galloway was a Tory, he was liberal in his views. He has been unjustly criticized by historians who attributed to him a conservative plan of union which was probably written in 1785 by Jonathan Sewell, the New England loyalist. Galloway drew up

several plans of union after the Declaration of Independence with the hope that they might be used when the rebels were defeated. Galloway was, perhaps, the greatest of the colonial loyalists, a man who was exiled from his wife, his estates and the country of his birth because of his convictions.

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GALLOWAY, a district in southwest Scotland comprising the counties of Kirkcudbrightshire (East Galloway) and Wigtownshire (West Galloway). It is bounded by Ayrshire, Dumfries, the Solway Firth and the North channel, the latter providing the shortest sea passage (from Stranraer) to Ireland. The Rhinns of Galloway, a hammer-shaped peninsula forming the southwestern extremity of Wigtownshire, projects southward to the Mull of Galloway, a promontory 210 ft. above sea level with a 60-ft.-high lighthouse marking the most southerly point in Scotland. The district's name is derived from the Gallgaidhel or Gallwyddel, who were the Celtic Gauls of this region and the Noventae of the Romans. The last "king" of Galloway died in 1234, and during the 14th century the Baliols and Comyns were the chief families, succeeded about 1369 by the Douglases (until 1458) and in 1623 by the Stewarts. The Covenanters (*q.v.*) found much support throughout the district. Dairy farming is the main industry, and the polled black Galloway cattle are indigenous.

The Galloway River scheme, under which the power stations of Kendoon, Garsfad, Earlston, Glenlee and Tongland were erected and the waters of the Dee and Ken harnessed for the generation of electric power, was completed in 1936.

New Galloway (pop. [1961] 327) is a royal (charter 1629) and small burgh and a noted angling centre in Kirkcudbrightshire on the river Ken, 19 mi. N. of Kirkcudbright by road.

GALLOWS: *see* Capital Punishment; Hanging.

GALLUP, a city of northwest New Mexico, U.S., at an altitude of 6,514 ft., on the Puerco river, about 20 mi. from the Arizona line and 140 mi. W.N.W. of Albuquerque; the seat of McKinley county. The city was established in 1882 and named for David L. Gallup, paymaster for the Atlantic and Pacific railroad. Prior to that time it served as a Westward Overland stagecoach stop. It was incorporated in 1891.

Gallup's economy is primarily mercantile; it serves as a trading centre for the Navaho and Zuñi Indians in a trade area exceeding 15,000 sq.mi. The city's leadership in the field of Indian arts and crafts and its proximity to Indian reservations and national parks and monuments have also established it as a tourist centre. At the Intertribal Indian ceremonials, held each year in August, southwestern Indians from as many as 40 different tribes present their ceremonial dances and display their native arts and crafts. For comparative population figures *see* table in New Mexico: *Population*. (J. G. O'C.)

GALLUS, GAIUS CORNELIUS (*c.* 70–26 B.C.), Roman soldier and poet, is famous for his four books of poems to his mistress "Lycoris" (the actress Volumnia; stage name, Cytheris). He also translated works of the Greek poet Euphorion. Born at Forum Julii (Fréjus, on the French Riviera coast), he was a friend of Augustus and Virgil and, having distinguished himself in the war against Mark Antony, was made governor of Egypt. There, however, his imprudent conduct led to his disgrace and suicide. The loss of his works is regrettable, for Quintilian ranks him with Tibullus, Propertius and Ovid as one of the great Roman elegists. Virgil celebrated him in the tenth *Eclogue*, which contains many echoes of his poetry, and Parthenius dedicated to Gallus his book on unhappy love affairs. (E. J. Ky.)

GALLUS, GAIUS VIBIUS TREBONIANUS, Roman emperor A.D. 251–253, came of an ancient family of Perusia (Perugia) whose ancestry went back to the pre-Roman Etruscan aristocracy. He, his son Volusian, and his wife Afinia Gemina Baebiana bore the names of ancestors distinguished among the foremost Roman nobility under Trajan, Nero, perhaps under Augustus and even earlier, but his father had remained an equestrian (*see* Equites). Gallus served Decius (*q.v.*) with loyalty and distinction as legate of Moesia and was proclaimed emperor after Decius' defeat and death at the hands of the Goths. He concluded a treaty with the victorious enemy, but when they renewed their attacks early in 253, the Danube armies proclaimed their commander Aemilian (*q.v.*) emperor: Gallus summoned Valerian (*q.v.*) and the Rhineland armies to his aid but was killed by his own troops before they arrived. (Jn. R. M.)

GALLUS CAESAR (officially known as Flavius Claudius Constantius) (325/6–354), reigned as *Caesar* in Antioch from 351 to 354 (for an explanation of the title *Caesar* see Emperor). He was born in Etruria in 325 or 326, the second son of Julius Constantius, half brother of Constantine the Great. Gallus was the elder half brother of Julian the Apostate and the cousin of Constantius II (*q.v.*). Like Julian, with whom he grew up, he was given a strongly Christian education. Constantius proclaimed him as *Caesar* at Sirmium on March 15, 351, and at the same time married him to his sister Constantia. Gallus' severe and isolated upbringing left him with a harsh and tactless character, and his reign at Antioch is described as tyrannical and even murderous. He instituted a widespread system of espionage among his subjects, and several people were put to death by him. Not all of them were innocent of the crimes with which they were charged. He suppressed revolts in Palestine and in Isauria and held the Persians at bay. His subordinates sent unfavourable and sometimes misleading reports about him to Constantius, who recalled him to court, stripped him of his powers, and executed him on an island near Pola late in 354. His wife had died shortly beforehand. (E. A. T.)

GALOIS, ÉVARISTE (1811–1832), French mathematician famous for his contributions to higher algebra, gave his name to the Galois theory of groups. He was born Oct. 25, 1811, at Bourg-la-Reine, where his father was mayor, and entered the Lycée Louis-le-Grand in Paris in 1823. Despite his genius for mathematics he was evidently a difficult student. He failed twice in the entrance examinations to the École Polytechnique; he was accepted at the École Normale in 1830 but expelled the same year for a newspaper letter about the actions of the director during the July Revolution. In 1831 he was arrested for a threatening speech against King Louis Philippe but was acquitted; then shortly afterward he was sentenced to six months in jail for illegally wearing a uniform and carrying weapons. He died May 31, 1832, when only 20 years old, from wounds received in a duel, possibly with an *agent provocateur* of the police.

Galois published only a few small papers; three larger works on the theory of equations were refused by the French Academy. Knowledge of his mathematical achievements stems mainly from a letter to his friend Auguste Chevalier written on the eve of his fatal duel and from posthumous manuscripts. Nevertheless, the Galois theory of groups has become one of the most penetrating concepts of modern mathematics. In the letter to Chevalier, published in the *Revue Encyclopédique*, Sept. 1832, Galois outlines the content of three mathematical treatises. One concerns elliptic integrals and the integrals of algebraic functions. The other two, one of which was completed ("Mémoire sur les conditions de résolubilité des equations par radicaux"), deal with the theory of equations. Galois emphasizes the use of domains of rationality to which all roots of the given equation have been adjoined, now called Galois fields. Next he introduces the fundamental concept of the (Galois) group of an equation, consisting of all the permutations of the roots which may be applied to any existing rational relations between them. In modern form this leads to the one-to-one correspondence between the subfields of the Galois field and the subgroups of the Galois group. Galois applies the theory to express a general condition for the solvability of equations by radical expressions. Among other concepts associated with Galois's name are the Galois imaginaries, now usually considered as the elements of finite fields.

See also Fields; Groups; Equations, Theory of.

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GALOP, a lively social dance in 2/4 time, of German origin, popular in England and France during the 19th century. Its spirited rhythm occurs in the finale of Ponchielli's *Dance of the Hours* and in many ballets. Its basic step (slide, close and slide) is considerably elaborated for theatrical usage. (LN. ME.)

GALSWORTHY, JOHN (1867–1933), English novelist and playwright, winner of the Nobel prize for literature in 1932, was born at Kingston Hill, Surrey, on Aug. 14, 1867. His family, of Devonshire farming stock traceable to the 16th century, had made a comfortable fortune in property in the 19th century. His father was a solicitor. Educated at Harrow and New college, Oxford, Galsworthy was called to the bar in 1890. With a view to specializing in marine law, he took a voyage around the world, during which he encountered Joseph Conrad, then mate of a merchant ship. They became lifelong friends. Galsworthy found law uncongenial and took to writing. For his first works, *From the Four Winds* (1897), a collection of short stories, and the novel, *Jocelyn* (1898), both published at his own expense, he used the pseudonym "John Sinjohn," *The Island Pharisees* (1904) being the first book to appear under his own name. *The Man of Property* (1906) began the novel sequence to be known as *The Forsyte Saga* (1922), the long chronicle novel by which Galsworthy is chiefly remembered; others in the same series are "Indian Summer of a Forsyte" (1918, in *Five Tales*), *In Chancery* (1920), *Awakening* (1920) and *To Let* (1921). The story of the Forsyte family after World War I was continued in *The White Monkey* (1924), *The Silver Spoon* (1926) and *Swan Song* (1928), collected in *A Modern Comedy* (1929). Several later volumes were also more or less connected with the Forsytes. Galsworthy's other novels include *The Country House* (1907), *The Patrician* (1911) and *The Freelands* (1915).

Galsworthy was also a successful dramatist, his plays, written in a naturalistic style, being usually based on an examination of some controversial ethical or social problem. They include *The Silver Box* (1906), which, like many of his other works, has a legal theme and depicts a bitter contrast of the law's treatment of the rich and the poor; *Strife* (1909), a study of industrial relations; *Justice* (1910), a realistic portrayal of prison life which roused so much feeling that it led to reform; and *Loyalties* (1922), the best of his later plays, more personal in theme, but showing the same power to create effective, if not always convincing, dramatic situations, and to rouse compassion. He also wrote verse.

In 1905 Galsworthy married Ada Pearson, the divorced wife of his first cousin, A. J. Galsworthy. Galsworthy had, in secret, been closely associated with his future wife for about ten years before their marriage. "Irene" in *The Forsyte Saga* is to some extent a portrait of Ada Galsworthy, although her first husband was wholly unlike Soames Forsyte. Galsworthy was awarded the Order of Merit in 1929. He had no children, and died at Grove lodge, Hampstead, on Jan. 31, 1933.

Galsworthy's reputation stands or falls by *The Forsyte Saga,* the history of a large family, similar to the author's own, recently risen to wealth and success in the professional and business world. The Forsytes are tenaciously clannish and anxious to increase their possessions. Although Galsworthy himself denied that he wrote "with a purpose," the novel reiterates, at least by implication, that this desire for property is morally wrong. Its style has been likened to "a blend of Marx and Meredith"; diatribes against wealth being interspersed with lively passages describing character and background. The author attacks the Forsytes chiefly in the character of Soames Forsyte, a solicitor. Soames' wife, Irene, whom he is represented as considering a mere form of property, finds her husband physically unattractive, and falls in love with a young architect. However Galsworthy may hate the Forsyte world, he also loves it, remaining always, as it were, a Forsyte novelist. A passionate partisan of liberal humanitarianism, he had little sympathy with the modern movement in the arts taking place around him. The pictures of the Forsyte uncles are written with irony and perception, as are also some of the passages describing Forsyte daily life. At the same time, unlikely situations are often to be found in a narrative that makes a claim to scrupulous naturalism of circumstance. This straining of belief is also to be found in Galsworthy's plays. He had, in short, no profound understanding of human nature, only a keen emotional feeling for the society in which he had himself been brought up; and a sentimental esteem for "the underdog."

In the United States and on the continent of Europe, his works, by their abstention from complicated psychology and their greatly simplified social viewpoint, became accepted as a pattern of English life. Certain aspects of Victorian and Edwardian upper middle-class life no doubt resembled Galsworthy's picture, but with the exception of Soames Forsyte—for whom in the end the author himself seems to feel a certain sympathy, even self-identification—no character comes completely to life. His acceptance of surface values becomes sometimes laughably inept when postwar society which he knew less well is described in the later novels. He will be remembered, however, for his evocation of a vanished, if somewhat unreal, world, and as the creator, in Soames, of a dislikable character who yet compels sympathy.

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(A. D. Po.)

GALT, SIR ALEXANDER TILLOCH (1817–1893), Canadian statesman, one of the fathers of confederation, was born in Chelsea, London, Eng., on Sept. 6, 1817, the youngest son of the novelist John Galt (*q.v.*). In 1835, upon entering the service of the British American Land company as a clerk at Sherbrooke, in Canada, he began a long association with the eastern townships and the English-speaking minority of Lower Canada (now the province of Quebec), which was to have a predominant influence on his career. From 1844 to 1855 he served as the company's chief commissioner and took an active interest in the promotion of the St. Lawrence and Atlantic and the Grand Trunk railways. In 1849 Galt entered politics as member of parliament for the county of Sherbrooke. Shortly after his election he voted against the contentious Rebellion Losses bill and supported the movement for annexation to the United States. In both instances he was reflecting the views of his constituents, but in endorsing the annexation movement he stressed the economic advantages rather than the anti-French animosity that had contributed to the growth of annexation sentiment after the Rebellion Losses bill was passed. In 1850 he resigned from parliament, but he was re-elected in 1853 for the town of Sherbrooke and continued to represent that constituency, as the leader of the English-speaking minority in Lower Canada, until 1872.

In 1858 Galt joined the Cartier-Macdonald administration as minister of finance, on condition that the federation of British North America should be adopted as an objective of the government. During his first term of office his name was associated with that of his predecessor in the introduction of the Cayley-Galt tariffs (1858–59), the first Canadian protective tariff. Although he was unsuccessful in his efforts to obtain confederation in 1858, Galt played a major role in the Charlottetown and Quebec conferences of 1864, and in recognition of his contribution to confederation (which came into being in 1867) he was created a knight commander of St. Michael and St. George in 1869 and a knight grand cross of St. Michael and St. George in 1878.

He was appointed the first minister of finance of the new dominion in 1867, but within four months he resigned; he never again held cabinet office, although he was offered the portfolio of finance in 1869. After his resignation he gave intermittent support to the government until he retired from parliament in 1872, but at the same time he began to advocate Canadian independence as the ultimate goal. A firm belief in national autonomy, if not outright independence, was reflected in many aspects of his political career.

After his retirement from active politics Galt served Canada in a diplomatic capacity on the Anglo-U.S. fishery commission at Halifax in 1875 and as the first Canadian high commissioner in London, 1880–83. From 1883 until his death, on Sept. 19, 1893, he lived in retirement, devoting his attention to his interests in the Canadian northwest.

Galt was the author of several pamphlets: *Canada, 1849–1859*

(1860); *The Political Situation* (1875); *Church and State* (1876); *Civil Liberty in Lower Canada* (1876); *The Relation of the Colonies to the Empire* (1881); and *Future of the Dominion of Canada* (1881).

See O. D. Skelton, *The Life and Times of Sir A. T. Galt* (1920). (W. G. O.)

GALT, JOHN (1779–1839), Scottish novelist admired for his studies of country life, was born on May 2, 1779, at Irvine, Ayrshire, and educated in his native town and at Greenock. In 1804 he settled in London. Commissioned by a merchant firm to find methods of evading the Berlin and Milan decrees (*see* CONTINENTAL SYSTEM), he was traveling in the Mediterranean when he met Byron and J. C. Hobhouse at Gibraltar. He traveled with Byron to Malta, met him again at Athens and in 1830 published a biography of him. In 1814 he visited France and the Netherlands on similar business for a Glasgow firm. In 1826 he went to America as secretary of the Canada Land company. Galt opened up a road between Lakes Huron and Erie through the forest country and founded the city of Guelph in Upper Canada (now Ontario) on St. George's day (April 23), 1827. The town of Galt was named after him. But, though his work was successful, he had enemies who discredited him with the company and returned home practically a ruined man. All his life he had been a voluminous writer, and he now devoted himself entirely to literature. The last years of his life were spent at Greenock, where he died on April 11, 1839.

His masterpieces are *The Ayrshire Legatees* (1820), *The Annals of the Parish* (1821), *Sir Andrew Wylie* (1822), *The Provost* (1822), *The Entail* (1823) and *Lawrie Todd* (1830). *The Ayrshire Legatees* gives, in the form of letters, the adventures of the Rev. Pringle and his family in London. These letters to their friends in Scotland are made the excuse for endless tea parties and meetings of kirk session in the rural parish of Garnock. *The Annals of the Parish* are told by the Rev. Micah Balwhidder, Galt's finest character. This work (which existed in manuscript before Scott's *Waverley* was published in 1814) is a humorous and truthful picture of the old-fashioned Scottish pastor and the life of a country parish. In *Lawrie Todd* the life of a Canadian settler is depicted with imaginative power.

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GALT, a city of Waterloo county, Ont., Can., 22 mi. N.W. of Hamilton. Of its 100 diversified industries, the most important are those producing forgings, castings, machinery and machine tools; shoe, plastics and textile industries are also important. The original settlement, about 1816, at a power site on the Grand river, was known as Shade's Mills, after the builder Absalom Shade. In 1827 the village was renamed after the novelist and Canadian colonizer John Galt (*q.v.*), was incorporated as a town in 1857 and as a city in 1915. Pop. (1961) 27,830. (G. FN.)

GALTON, SIR FRANCIS (1822–1911), English scientist, explorer and anthropometrist, best known as the initiator of the study of eugenics, was born of Quaker ancestry on Feb. 16, 1822, near Sparkbrook, Birmingham. A cousin of Charles Darwin, he was educated at Birmingham General hospital; King's college, London; Trinity college, Cambridge; and St. George's hospital, London. After traveling in the Balkans, Egypt, the Sudan and the Levant, he undertook a 1,700-mi. journey in southwest Africa (1850–51), later visiting Spain. He received the Royal Geographical society's annual gold medal for his African explorations in 1853 and was elected a fellow of the Royal society in 1856. The following year he settled in London to devote himself to science, the latter part of his life being chiefly concerned with eugenics (*q.v.*), or improving the biological make-up of the human species by selective parenthood. In his analysis of men of famous families, given in his classic *Hereditary Genius* (1869), he tended to underestimate the role of social environment in the development of the individual.

In 1863 Galton indicated the significance in meteorology of anticyclones, a term coined by him. He was a pioneer in the development of composite photographs and in the use of fingerprints for personal identification. To interpret his numerous "family records" and the data obtained for more than 9,000 subjects examined in the anthropometric laboratory that he established at the International Health exhibition in London, 1884–85, he devised new statistical methods, culminating in the correlational calculus, perhaps his greatest scientific achievement. The family records provided him with material for the quantitative assessment of heredity through correlating the physical and mental attributes of kinsmen, and his recognition that two characters measured on an organism are not independent but associated arose from his interest in anthropometry. His investigations of identical twins and of sterility arising from marriage with heiresses (who as sole issue of unprolific parents might tend themselves to be infertile) are of particular importance. He was knighted in 1909. He died at Haslemere on Jan. 17, 1911, leaving an endowment for a chair in eugenics at the University of London.

Galton's other principal works are *English Men of Science* (1874); *Inquiries Into Human Faculty* (1883); *Noteworthy Families* (1906); *Essays in Eugenics* (1909).

See also references under "Galton, Sir Francis" in the Index volume.

See his *Memories of My Life* (1908); Karl Pearson's *Life of Francis Galton*, 4 vol. (1914–30); C. P. Blacker's *Eugenics: Galton and After* (1952). (J. C. TR.)

GALUPPI, BALDASSARE (1706–1785), Italian composer, chiefly known for his comic operas, was born on Oct. 18, 1706, on the island of Burano, near Venice—hence his nickname, Il Buranello. His father, a barber and a violinist at the local theatre, was his first teacher, and later he studied at Venice under A. Lotti. After producing two operas in collaboration with G. B. Pescetti (1728–29), Galuppi began to compose operas for the Venetian theatres, writing sometimes as many as five a year. In 1741 he visited London and arranged a *pasticcio, Alexander in Persia*, for the Haymarket theatre; several of his own operas were produced in England, including *Enrico* (1743), and Charles Burney considered his influence on English composers to have been very powerful. In 1748 he was appointed *maestro di cappella* at St. Mark's in Venice, and in 1762 director of the Conservatorio degli Incurabili. Catherine II invited him to Russia, where in 1768 he composed the *opera seria, Ifigenia in Tauride*. He returned to Venice later in that year and died there on Jan. 3, 1785.

Galuppi's best works are his comic operas, of which *Il Filosofo di Campagna* (Venice, 1754) was the most popular. His melodies are vivacious and attractive and his harmonic and orchestral technique often superior to that of his contemporaries. Besides operas he wrote religious works and some instrumental pieces, especially sonatas for harpsichord and concertante quartets for strings.

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GALVANI, LUIGI (ALOISIO) (1737–1798), Italian physiologist, an early experimenter in electricity, was born at Bologna on Sept. 9, 1737. He was appointed lecturer in anatomy at Bologna in 1762 and gained repute as a comparative anatomist from researches on the organs of hearing and the genitourinary tract of birds. He enunciated his theory of animal electricity in 1791. In the course of some experiments on frogs he had noticed what appeared to be a correlation between muscle twitching and simultaneous contact with both iron and copper. He proceeded to construct a device of two different metals; one metal he placed in contact with a frog's nerve, the other with a muscle; contraction of the muscle occurred. In Galvani's view the contraction was the result of the union, by means of the metallic "arc," of the arc's (exterior) negative electrical charge with positive electricity traveling along the nerve from the inner nerve substance (a process named galvanism). He had, of course, produced an electric current. Galvani died at Bologna on Dec. 4, 1798.

GALVANIZED IRON AND STEEL. A zinc coating applied to iron or steel protects it against rusting by sealing it from the atmosphere and is commonly known as galvanizing.

When porosity develops in the coating with age, if discontinuities of the coating occur, galvanic (electrolytic) action ensues and then

protection of the steel is by sacrificial corrosion action, the zinc being the anode and the steel the cathode. (*See* ZINC: *Applications.*) When a galvanized coating has been properly applied protection from atmospheric corrosion may last for 15 to 30 years or more.

Zinc is applied by two general methods: hot dipping and electrolytic deposition, the former representing the bulk of the application. This article deals with the industrial processes used in galvanizing.

For production and uses of galvanized iron and steel *see* IRON AND STEEL INDUSTRY: *Mills for Semifinished Materials;* WIRE.

HOT-DIP PROCESSES

There are three general hot-dip processes: (1) hand dip for small steel articles; (2) mechanized operations for continuous sheet coating; (3) continuous-wire galvanizing. Other specific methods are sherardizing and metal spraying.

Before galvanizing, the object must be cleaned to remove oil or grease lubricants by immersion in weak alkali solutions or by vapour degreasing. After cleaning, the object is descaled (pickled) and then passed into the molten zinc.

Pickling.—Sulfuric acid solution (60° C.) is generally used at a concentration of 5% to 20%. This acid acts galvanically and to some extent chemically, and mechanically causes dislodgment of the scale, which after its separation is insoluble.

Hydrochloric acid (5% to 10%) acts chemically on both the scale and the underlying metal. Hence a greater loss of steel is sustained when this acid is used.

Inhibitors are used to avoid excessive acid attack of the steel without unduly restricting descaling. These compounds may be

FIG. 1.—DRAWING OF ZINC-IRON ALLOY LAYERS SHOWING (A) SERRATED BOUNDARY BETWEEN ALLOY LAYERS AND OUTER ZINC AND (B) SMOOTH BOUNDARY OBTAINED BY CLEANING

inorganic, such as arsenic, or organic, such as oils, molasses, bran, etc.

Fundamentals.—The cross section of a hot-dip coating (fig. 1) shows the alloy-layer structure between the steel and the zinc, brittle when thick and causing the coating to crack when the sheet is bent. The portion of this multiple layer next to the steel is usually termed $FeZn_3$ or low-zinc alloy. It is frequently invisible or extremely thin. Next is the iron-zinc alloy, $FeZn_7$, high in zinc and forming an irregular boundary with the outer zinc layer which approximates the composition of the zinc bath.

The relation of the iron in the structure to the ductility of the coating lies largely in the smoothness of the boundary between this alloy layer and the outer zinc coating. The smoother and cleaner the steel surface the less rapidly and less irregularly the alloy grows.

If a clean descaled steel sheet is passed through a strong solution of zinc chloride (25%) or zinc ammonium chloride before entering the zinc bath, a thinner alloy layer and more ductile coating is obtained. When the steel surface is not cleaned from sulfates, chlorides or pickling products, the salts are reduced to sponge iron by the action of the molten zinc (a prime source of iron for dross in the zinc bath) and cover the steel surface with irregular jagged points of alloy.

Spangles.—Hot-dip coatings have characteristic crystalline surface patterns known as spangles. The size and shape of these metal crystals are influenced by several factors, principally the surface condition of the steel, the kind and amount of impurities present in the bath, metal additions to the bath and the rate of cooling (*see* fig. 2). Large spangles may be produced by the addition of metals such as tin and by slow-cooling of the freshly coated sheet.

Effect of Metal Impurities and Additions.—Metals commonly present in the zinc bath, other than iron, are cadmium

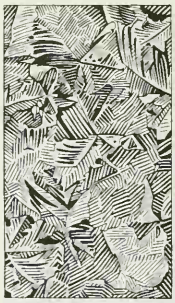

FIG. 2.—SPANGLES ON SURFACE OF GALVANIZED SHEET STEEL

and lead in small fractions of 1%; these impurities come from the ore used in the production of the zinc. Metals commonly added to the bath for specific effect are tin and aluminum and sometimes antimony.

Tin promotes fluidity of the bath and imparts brightness to the coated sheet. Aluminum also promotes fluidity. The formation of thick viscous zinc oxide on the surface of the bath is retarded by a thin layer of aluminum oxide. Aluminum has a further beneficial effect in retarding the reaction between iron and zinc, thereby reducing the thickness of the iron-zinc alloy layer and making the coating more ductile.

Galvanizing Practice.—For actual galvanizing, a welded steel kettle is used to hold the molten zinc and is kept at approximately 850° F. by applying heat to the sides (*see* fig. 3). The cleaned sheet is passed through a box containing a mixture (or compound) of zinc-ammonium chloride flux having a variable composition. This flux, floating in a confined area on the molten zinc bath, serves to evaporate the surface water on the sheet prior to its entrance into the zinc, and also to remove residual oxides. A system of multiple rolls receives and guides the sheet and partly controls the thickness of the zinc deposit. The amount of zinc taken up on the surface of the sheet may vary from one-half to two ounces per superficial square foot, depending upon the kind of process used, the quality of operation and the service intended.

The Effect of Steel Composition.—Great difficulty is experienced in securing a ductile heavy zinc coat on pure iron wire and steel of low carbon content when conventional practice is followed. A continuous process for galvanizing iron and low-carbon steel has been developed and is known as the Sendzimir Zincgrip process ("Armco," American Rolling Mill Co., Middletown, O.). Its aim is to obtain a surface, prior to galvanizing, which is absolutely free from oxides. This is accomplished by forming a thin layer of iron oxide integral with the steel, reducing it in an atmosphere of hydrogen at 1,100° F. and passing the hot strip, in the absence of air, into a relatively small kettle of molten zinc, the temperature of which is maintained by the aforesaid strip (*see* fig. 4).

Wire Galvanizing.—Wire galvanizing is also a continuous process. The wire is drawn through successive pickling, annealing and washing operations. It is frequently dried before passing into the galvanizing pan and is drawn out through wipers of charcoal, saturated carbon, coke, sand or asbestos. A 20% hydrochloric acid solution at 135° to 155° F. is used for pickling, which must be rapid because of the high speed of the wire.

Low-Temperature Processes.—*Sherardizing Process.*—This is a process of forming intermetallic compounds of iron and zinc on

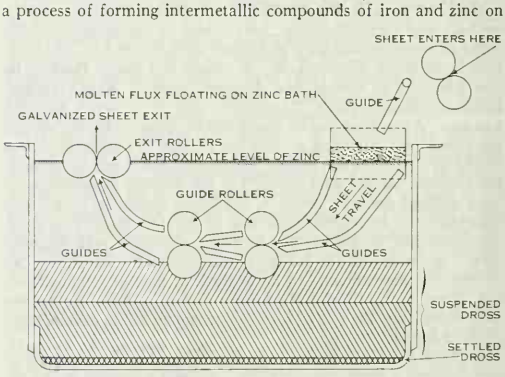

FIG. 3.—SCHEMATIC DRAWING OF SHEET GALVANIZING BATH, HOT-DIP PROCESS

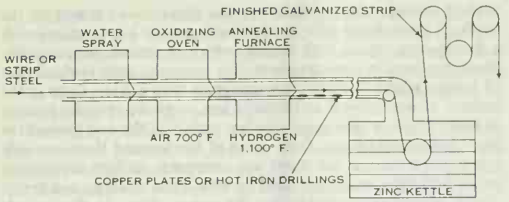

FIG. 4.—SCHEMATIC DRAWING OF ZINCGRIP PROCESS

the surface of a steel article by heating it in the presence of finely divided zinc below the melting point of the zinc.

Metallic Spraying (Schoop Process).—This is a process which consists of applying a fine spray of molten zinc to the surface of steel which has been cleaned, roughened, as by sandblasting, and warmed. In this process the zinc, in the form of a wire, strip or powder, is fed at a uniform rate through an oxygen-hydrogen or other flame or through an electric arc, and then projected onto the surface to be coated. There are no chemical reactions to form compounds, the zinc adhering directly to the surface.

ELECTROGALVANIZING PROCESSES

The cold or electrogalvanizing process is used for certain classes of work. Its advantages over hot-galvanizing are: (1) greater economy in the use of zinc and somewhat healthier conditions; (2) complete control over thickness of coating; (3) deposition of a coat of pure zinc (no alloy of iron-zinc as found in the hot-dip process); (4) suitability for articles that would be adversely affected by the temperature of molten zinc if coated by the hot-dip process; and (5) no distortion of the coating of flat surfaces as with the hot process.

Its disadvantages are that greater care is required and greater difficulties are encountered in obtaining a correct coat than with hot-galvanizing; for articles that have to be made watertight the electrolytic process does not have the same "soldering" effect as the hot process.

There are two general processes of electrogalvanizing or electroplating (*q.v.*) with zinc, distinguished by (1) soluble anodes in zinc sulfate solution of low acid content; (2) insoluble anodes in zinc sulfate solution of high acid content.

In the soluble anode process the wire or strip is generally annealed by passing it through molten lead; tight scale is generally removed by pickling in hydrochloric acid solution. The coating, being free from the brittle alloy layer, possesses great ductility, uniformity and adherence; the latter is a mechanical bond.

In the insoluble anode process, roasted zinc ore is leached with dilute sulfuric acid, the solution purified and the soluble zinc electroplated on wire (or strip) at high current density. The cathodic deposit from this solution using a lead-silver alloy anode (1% silver) is exceptionally pure (99.99% zinc) and ductile; the galvanized wire can be wound around its own perimeter without cracking.

For annealing, wires enter near the bottom of a pan of molten lead at 1,000° F. and pass upward in an inclined position. As they leave the lead they enter a molten caustic soda bath (700° F.) and are cleaned by cathodic electrolysis. The wires are then washed and pass into the electrolytic zinc cell in which a current of 700 to 1,500 amp. per square foot is applied. The coated wires are washed in water and then highly polished by a rotary mechanism using hard abrasive. Adherence of the zinc coating is greater than by the hot-dip process. (Hr. R. H.)

GALVANOMETER, an instrument for measuring an electric (galvanic) current. *See* Instruments, Electrical Measuring.

GALVESTON, a city of Texas, U.S., the seat of Galveston county, a major port and resort area on the Gulf of Mexico, is about 50 mi. S.E. of Houston on the northeast end of Galveston Island, which extends northeast and southwest off the Texas coast for about 32 mi. The island is connected to the mainland by causeways, and a superhighway gives rapid access to Houston and other communities. Access from the northeast is by ferry from Bolivar peninsula across Galveston harbour. Pop. (1960) city, 67,175; Galveston-Texas City standard metropolitan statistical area (Galveston county), 140,364. (For comparative population figures *see* table in Texas: *Population.*)

Shipping and its allied industries, insurance, banking and resort business are the city's major economic assets. The county's economy was enriched after 1945 by expansion of the petrochemical industries centred at Texas City on Galveston bay. Galveston's port is publicly owned and tax exempt. Chief exports are cotton, grain and sulfur; imports are sugar, tea and bananas.

Early 18th-century maps of the Gulf of Mexico show an island recognizable as Galveston. Later maps name it San Luis. In July 1785 the bay was named Galveston (Galveztown) by Don José de Evía, a Spanish pilot who surveyed the Gulf coast by order of Don Bernardo de Gálvez, governor of Louisiana and, later, viceroy of Mexico. From 1817 to 1821 the privateer Jean Laffite made Galveston his headquarters. In 1836 the Republic of Texas granted Michel Branamour Menard land on the east end of the island. Menard platted a town site whose lots were first sold in 1838 by the Galveston City company. The city was incorporated in Jan. 1839.

Galveston grew steadily until the American Civil War, but expansion after the war was greater. By 1885 the city had great commercial power. Two factors dislodged it from its leading position: the rise of competitive Texas ports, notably Houston, whose ship channel is entered from Galveston bay, and a destructive hurricane on Sept. 8, 1900, in which over 5,000 lives were lost and much of the city was destroyed. After the storm a 17-ft.-high protective sea wall was built and the city's grade raised proportionately to the wall's height. The wall is about 8 mi. long and is paralleled by a wide boulevard overlooked by the leading resort hotels. In Sept. 1961 the most powerful hurricane ever recorded in the area hit Galveston. Despite extensive flooding and wind damage, the wall broke the force of the heavy waves and this, combined with the evacuation of much of the population, was responsible for keeping the death toll under 50.

Galveston's educational facilities include schools of medicine and nursing of the University of Texas. A major cultural asset is Rosenberg library, which serves the county. There is a civic symphony orchestra and a little theatre. The climate is humid but rarely brings extremes of temperature. (T. G. R.)

GÁLVEZ, JOSÉ, Marqués de la Sonora (1720–1786), Spanish colonial administrator particularly noted for his work as inspector general (*visitador general*) in New Spain (Mexico), 1765–71, was born in Vélez-Málaga, Spain. Among his important accomplishments were the reorganization of the tax system, the formation of a government tobacco monopoly, the reorganization of the defenses of the northern frontier of the viceroyalty and the Spanish occupation of Upper California. Upon completion of his inspection he recommended further administrative and fiscal reforms, the most important of which, the intendancy system, was introduced in 1786. Subsequently he was named minister of the Indies (1775) and was granted the title of marquis of Sonora (1785). (L. N. McA.)

GÁLVEZ, MANUEL (1882–), Argentinian novelist and biographer, was born in Paraná on July 18, 1882. Leaving the provincial milieu of his boyhood, he went to Buenos Aires to attend the university, and made that city his permanent residence. The founding of the literary magazine *Ideas,* residence in Europe and an appointment as inspector of secondary schools further enlarged the scope of his observation. Although he used many literary forms, he is most noted for his realistic novels on Argentinian life, especially his early ones: *La maestra normal* (1914), usually judged his best novel, based on customs in the provincial city of La Rioja; *El mal metafísico* (1916), on the materialism of Buenos Aires; *La sombra del convento* (1917), laid in Córdoba; and *Nacha Regules* (1919), dealing with social injustice in Buenos Aires. With a trilogy, "Scenes From the Paraguayan War" (1928–29), Gálvez began a series of historical novels which, together with novelized biographies of Argentinian figures, constituted his main output after 1938. The chief features of

Gálvez' novels are conscientious documentation of a remarkably wide range of national scenes; concentration on social situations rather than individual psychology; and the injection of ideas into the fictional framework. (A. Cn.)

GALWAY, HENRI DE MASSUE, Marquis de Ruvigny and Earl of (1648–1720), French soldier, who became a loyal and disinterested servant of the English king William III, was born in Paris on April 9, 1648. His father, the 1st marquis of Ruvigny, was titular leader of the Huguenots and related by marriage to the Russells, earls of Bedford; he served as ambassador to England 1667–77. The son was aide-de-camp to Marshal Turenne from 1672 to 1675, and went on a diplomatic mission to England in 1678. He succeeded his father as deputy general of the Protestant churches in 1679, but on the revocation of the Edict of Nantes (1685) he refused Louis XIV's offer of preferential treatment. He, his father and his brother settled in England in 1688. In 1690 he forfeited his French estates by entering the English army as major general of horse; he fought with distinction in the Irish campaign and was created Viscount Galway in 1692. He was one of the few men in whom William III reposed absolute trust. After displaying great courage and skill at the battle of Landen (1693), he was appointed to command the allied armies in Savoy (1694), but withdrew the English contingent to Flanders when the duke of Savoy changed sides. In 1697 he was granted an earldom and sent as lord justice to Ireland, but, knowing himself to be unfitted for politics, he was glad to retire in 1701.

However, being one of the very few disinterested public men available in an era of violent faction which embraced the armed forces as well as parliament, Galway was destined to be called out of retirement. In 1704 he was appointed commander of the allied forces in Portugal. After a successful campaign in 1706, he was decisively defeated at Almanza (April 25, 1707) by James II's son, the duke of Berwick. After another five years in retirement he was finally required to act as lord justice in Ireland during the difficult and dangerous years 1715–17. He died unmarried on Sept. 3, 1720, in Hampshire. (J. P. K.)

GALWAY (Contae Na Gaillimhe), a county in the west of Ireland in the province of Connaught. Pop. (1961) 149,800. Area 2,293 sq.mi.

Physical Features.—It is a region of richly varied scenery, roughly divisible by a line drawn northward through the city of Galway then immediately west of Loughs Corrib and Mask. To the east of this line the county belongs to the Irish central lowland and has varied conditions for agriculture, depending on the local nature of the rock, chiefly limestone, and the soils developed on it. To the west of this line there is Connemara, primarily a lowland with peat bogs, thousands of lakes, stretches of heath and some fine mountains, such as the Twelve Bens (misnamed Pins) and the Maamturk mountains, with numerous summits exceeding 2,000 ft. Between Connemara and Lough Mask is Joyce's Country, a district named after a Welsh family settled there in the 13th century. The Aran Islands, three in number, are all inhabited; they face the open Atlantic between Clare and west Connemara and consist of bare waterless limestones on which fields have been made with sand, seaweed and relics of glacial deposits.

In Connemara the living conditions are among the hardest in Ireland. Most of the population live on small farms, generally of ten acres or less, in a coastal belt about one mile wide. The fields are made from sand, seaweed and manure on the bare rock or the natural peat cover; vast numbers of stones are piled up into walls or heaps.

The eastern boundary of the county is Lough Derg and the river Shannon to its junction with the Suck, its largest tributary. From Lough Derg, Galway's southern boundary passes through the Slieve Aughty, hills from 1,200 ft. high, and thence across the lowland to the southern shores of Galway bay. More than two-thirds of the county lie within the central lowland of Ireland, which has a thin or nonexistent cover of glacial drift over much of its surface, particularly in the west near Galway bay. There are, however, some patches of drift and a number of eskers, which are long sinuous ridges of gravels normally not very fertile. Areas of cultivable soil are used for crops or the rich pastures that may develop in this area of considerable rainfall, but the limestones outcrop in the fields, in some places with good natural pasture but in others with a hazel scrub mixed with thorns, which is almost impenetrable. Sheep are kept in large numbers, this being the only lowland part of Ireland where they are more numerous than cattle. Gaps in the pattern of agricultural settlements are rough woodlands, patches of rocky heath or peat bogs—the last mainly in the east toward the Suck and the Shannon. Over much of the lowland there are only a few short streams but there are numerous shallow depressions called turloughs, which are filled up with water at times and dry at others, according to the level of the water table. In dry periods the turloughs provide good pastures. (T. W. Fr.)

History.—Roderic (*q.v.*; Rory O'Connor), the last high king of Ireland, died in 1198 after his daughter had married Hugh de Lacy, the Anglo-Norman earl of Meath. The conquest of Connaught (*q.v.*), in force, did not come, however, until the 1230s and was led by Richard de Burgh who took for himself the best land between Corrib and Shannon. The descendants of his followers later became known as the "tribes of Galway." The county was given its shire boundaries in the reign of Elizabeth I. After Galway city surrendered to the parliamentary forces in 1651 the Cromwellian land settlement established a new class of landed proprietors and the old "tribes of Galway" were ruined. (Hu. S.)

Population and Administration.—Though the Gaelic speech is in decline, Galway had the largest Gaelic-speaking element of any Irish county in 1946, with 35,386 Gaelic speakers in its *fior Ghaeltacht* or purely Irish-speaking districts, and 25,086 in its *breac* or speckled *Ghaeltacht*. At the Irish college at Spiddal there are special facilities for those desiring to learn Gaelic as a spoken language.

Only about 30% of the county's people live in towns and villages. Apart from Galway city (21,989) the towns are small, with less than 5,000 inhabitants. They include Ballinasloe; Tuam; Loughrea; Athenry; and Gort. There is a county council and county manager, with offices in Galway city. Galway city is a borough with mayor and corporation since 1937. Ballinasloe is an urban district. Loughrea and Tuam are administered by town commissioners. The three constituencies of Galway North, Galway South and Galway West each return three members to *dail eireann*. The Aran Islands (*q.v.*) belong administratively to County Galway.

Industries.—Galway produces a black marble composed of carboniferous limestone and Connemara marble, a green-streaked dappled marble of great beauty. In the Irish-speaking areas of Connemara there is a government greenhouse plan for growing tomatoes and many farms have greenhouses. Electricity is available and some new schools have been built. Galway's industries include bootmaking at Ballinasloe, cotton spinning at Loughrea and sugar refining at Tuam.

See M. J. D. O'Sullivan, *Old Galway: the History of a Norman Colony in Ireland* (1942); R. Hayward, *The Corrib County* (1943), *This Is Ireland: Connacht and the City of Galway* (1952).

(T. W. Fr.; Hu. S.)

GALWAY (Gaillimh), a seaport and the county town of County Galway, Rep. of Ire., on the northern shore of Galway bay and 133 mi. W. of Dublin by road. Pop. of urban district (1961) 21,989. After the building of its walls by Anglo-Norman settlers (about 1270) it developed as a commercial centre, and in later centuries traded considerably with Spain—as is evidenced by a few remaining traces of Spanish influence in local architecture. Richard II's charter of incorporation, confirmed by Henry IV, was extended in 1545 to give the port jurisdiction over the Aran Islands about 28 mi. W.S.W., and to permit exportation of all goods other than linens and woolens. A charter from James I established the town and the land within a radius of 2 mi. as a county. In the Civil War the town surrendered to the parliamentary forces, the inhabitants were dispersed and their property given to adventurers and soldiers. During the campaigns of William III the town was again captured.

Lynch's mansion is Spanish in style, with a square central court. St. Nicholas church, a cruciform building founded in 1320, was collegiate from 1484 until 1840, and Edward VI created the Royal

College of Galway in connection with it. There are remains of a Franciscan friary founded in 1296, and the town is the seat of a Roman Catholic diocese. University college was founded in 1849 as Queen's college under an act of 1845, and its name was changed when it received a new charter in 1908 as a constituent college of the National University of Ireland.

Claddagh, which was the Irish part of the town in Norman times, is now a suburb engaged in sea and salmon fisheries. The harbour is connected with Lough Corrib by the Eglington canal, but the canal trustees abandoned navigation on the canal and three of the swing bridges were replaced by fixed bridges. The chief exports are wool, agricultural produce, locally polished marble and china. The main industries are represented by corn mills, an iron foundry, a hat and furniture factories. The famous Galway races are held at the end of July or the beginning of August. A shipping service connects Galway with the Aran Islands.

GAMA, VASCO DA (*c.* 1460–1524), Portuguese navigator and discoverer of the sea route to India, was born *c.* 1460 at Sines, Alentejo, Port. Little is known of Da Gama's early training, but in 1492 he was employed to seize certain French vessels lying in Setúbal and the Algarve. Later John II chose him to complete the work of Bartolomeu Dias (*q.v.*) in opening the sea route to India. Da Gama sailed from Lisbon on July 8, 1497. His fleet comprised four vessels: the flagship "S. Gabriel," which he commanded himself, the "S. Rafael," the "Berrio" and a storeship. Like Dias and Diogo Cam (*q.v.*), he carried *padrões* (stone pillars) which he set up as marks of discovery and overlordship. The expedition passed the Canaries on July 15 and reached the Cape Verde Islands on the 26th; it remained at São Tiago until Aug. 3. Then, in order to avoid the currents of the Gulf of Guinea, Da Gama took a circular course through the South Atlantic to the Cape and reached St. Helena bay (32° 40′ S.) on Nov. 7. The expedition weighed anchor again on Nov. 16 but, because of unfavourable winds, did not round the Cape of Good Hope until the 22nd. Three days later Da Gama anchored in Mossel bay, erected a *padrão* on an island and ordered the storeship to be broken up. The fleet sailed again on Dec. 8 and reached the coast of Natal on Christmas day. On Jan. 11, 1498, the fleet anchored for five days near the mouth of the Copper river. Rio de Bon Signaes (where another *padrão* was placed) was reached on Jan. 25.

After 32 days the expedition continued to Mozambique (arriving March 2), where the inhabitants believed the Portuguese to be Muslims like themselves. Da Gama learned that they traded with Arab merchants and that four Arab vessels, laden with gold, jewels, silver and spices, were then in port and that Prester John, the long-sought Christian ruler, lived in the interior but held many of the coastal cities. The sultan of Mozambique supplied Da Gama with two pilots, one of whom deserted on finding that the Portuguese were Christians. The expedition reached Mombasa on April 7. Anchor was dropped at Malindi on April 14 and a pilot who knew the route to Calicut was taken aboard. After a 23-day run across the Indian ocean the Ghats were sighted and Calicut was reached on May 20. There Da Gama erected a *padrão* as proof of his having reached India. He was welcomed by the zamorin or Hindu ruler of Calicut (then the most important trading centre in southern India), but he failed to conclude a treaty because of the hostility of certain Muslim merchants.

Da Gama left Calicut at the end of August, taking with him five or six Hindus in order that King Manuel might learn about their customs. He visited Angediva Island before sailing again for Malindi where he erected a *padrão*. Because of unfavourable winds, the expedition took nearly three months to cross the Arabian sea and many of the crew died of scurvy. At Malindi, because of greatly reduced numbers, Da Gama ordered the "S. Rafael" to be fired. Mozambique (where he set up his last *padrão*) was reached on Feb. 1. On March 20 the "S. Gabriel" and the "Berrio" rounded the Cape together, but a month later were parted by a storm, the "Berrio" reaching the Tagus on July 10. Da Gama continued to Terceira Island in the Azores, from where he is said to have dispatched his flagship to Lisbon. He himself reached Lisbon on Sept. 9 and made his triumphal entry into the city nine days later, spending the interval in mourning his brother Paul, who had died on Terceira. Manuel I granted Vasco the title of "dom," an annual pension of 1,000 cruzados and lands.

To further Da Gama's achievement, Manuel I dispatched P. A. Cabral, who left Portugal on March 9, 1500, and succeeded in establishing a factory at Calicut; but the Portuguese whom he left behind were murdered by the Hindus at the instigation of Muslim traders. Da Gama was recalled to India and ordered to avenge this outrage. Shortly before he sailed in 1502, he received the title of admiral of the Indian seas and was granted other favours including the right to import merchandise to the value of 200 cruzados with every royal fleet from India, so that he became one of the richest men in Portugal. On reaching Calicut he bombarded the city and destroyed a fleet sent against him. He then proceeded to Cochin where he concluded a favourable trade treaty. He returned to Lisbon in Sept. 1503. Soon after he retired to Évora but continued to advise Manuel I on Indian and maritime matters until 1505. He was created count of Vidigueira in 1519 and was nominated viceroy of India in 1524. He died at Cochin on Dec. 24, 1524. *See* also references under "Gama, Vasco da" in the Index volume.

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(E. M. J. C.)

GAMALIEL. This name, which in Old Testament times figures only as that of a prince of the tribe of Manasseh, was hereditary among the descendants of Hillel (*q.v.*). Six persons bearing the name are known.

GAMALIEL I, a grandson of Hillel, and like him designated "the elder," by which is apparently indicated that he was a member of the Sanhedrin. According to tradition Gamaliel succeeded his grandfather and his father as nasi, or president of the Sanhedrin. Though this tradition does not correspond with historic fact, and merely reflects later conditions after A.D. 70, it is at any rate certain that Gamaliel took a leading position in the Sanhedrin and enjoyed the highest repute as teacher of the Law. He was the first to whose name was prefixed the title *rabban* ("master," "teacher"). It is related in Acts (v, 34 ff.) that he intervened in the Sanhedrin in favour of the disciples of Jesus, and in this connection he is referred to as a Pharisee of wide repute. In the Mishnah (*Gittin* iv, 1–3) he is spoken of as the author of certain legal ordinances affecting the welfare of the community. His function as a teacher is proved by the fact that the apostle Paul boasts of having sat at the feet of Gamaliel (Acts xxii, 3). Of his teaching, beyond the saying preserved in *Aboth* i, 16, which enjoins the duty of study and of scrupulousness in the observance of religious ordinances, little is preserved. His renown in later days is summed up in the words (Mishnah, end of *Sotah*): "When Rabban Gamaliel the Elder died, regard for the Torah (the study of the Law) ceased, and purity and piety died."

GAMALIEL II, grandson of Gamaliel I. To distinguish him from the latter he is also called Gamaliel of Jabneh. In Jabneh (Jamnia), where during the siege of Jerusalem the scribes of the school of Hillel had taken refuge by permission of Vespasian, a new centre of Judaism arose under the leadership of the aged Johanan ben Zakkai (*q.v.*), a school whose members inherited the authority of the Sanhedrin of Jerusalem. Gamaliel II became Johanan ben Zakkai's successor, and rendered immense service in the strengthening and reintegration of Judaism, which had been deprived of its former basis by the destruction of the Temple and by the entire loss of its political autonomy. He put an end to the division which had arisen between the spiritual leaders of Palestinian Judaism by the separation of the scribes into the two schools called respectively after Hillel and Shammai. Gamaliel was recognized by the Roman government as patriarch. He devoted special attention to the regulation of the rite of prayer, which after the cessation of sacrificial worship had become all important. He gave the principal prayer, consisting of 18 benedictions, its final revision, and

declared it every Israelite's duty to recite it three times daily. He died before the insurrections under Trajan. His son, Simon, long after his father's death and after the persecutions under Hadrian, inherited his office, which thenceforward his descendants handed on from father to son.

GAMALIEL III, son of Judah ha-Nasi, the redactor of the Mishnah (*see* TALMUD), and his successor as patriarch. The redaction of the Mishnah was completed under him, and some of his sayings are incorporated therein (*Aboth* ii, 2–4). Gamaliel III lived during the first half of the 3rd century A.D.

GAMALIEL IV, grandson of the above, patriarch in the latter half of the 3rd century; about him very little is known.

GAMALIEL V, son and successor of the patriarch Hillel II. Beyond his name nothing is known of him. He lived in the latter half of the 4th century.

GAMALIEL VI, grandson of the above, the last of the patriarchs, died in 425. (W. BA.; G. H. B.)

GAMBETTA, LÉON (1838–1882), French statesman, one of the founders of the democracy of the third republic, was born at Cahors on April 2, 1838, the son of Joseph Gambetta, a grocer of Genoese-Jewish origin, and of Orasie Massabie. He was educated at the Catholic school of Montfaucon and at the *lycée* in Cahors before going to Paris to study and practice law. From 1860 onward opposition to the policies of Napoleon III and his ministers became more open and energetic, and nowhere more than in Paris. Gambetta was increasingly drawn into political journalism and republican politics. Exuberant in spirit, boisterous in temperament, he won repute as an audacious writer and advocate. He campaigned for the republican cause in the elections of 1863.

Along with other brilliant young lawyers, Gambetta found a safe platform for political speeches as counsel for the defense of republican agitators brought to trial for their activities against the government. This political tactic reached its climax in the *affaire Baudin* of 1868. Jean Baptiste Baudin, a deputy who had been killed resisting the *coup d'état* of Dec. 1851, had become a republican martyr, and in 1868 eight journalists were prosecuted for promoting the erection of a monument to his memory. Leading opposition lawyers undertook the defense of the accused; Gambetta handled that of the veteran Jacobin Louis Charles Delescluze. Press reports of Gambetta's brief, incisive speech, packed with political invective, made his political fortune. In the election of 1869 he stood both in Paris against Hippolyte Carnot and in Marseilles against Adolphe Thiers and was triumphant in both.

Though he chose Marseilles as his constituency, Gambetta's electoral campaign in the Parisian working-class district of Belleville established a contact that he cherished for the rest of his life. The radical program with which he won there became a basis for subsequent radical manifestoes. It was, indeed, a statement of democratic principles more extreme than what he himself held to be immediately practicable and began that combination of dogmatic Jacobinism with moderation of actual measures that characterized the French Radical party of modern times.

As one of 90 republican deputies, Gambetta entered the legislative assembly at the crisis of the second empire. Ill health incapacitated him in the summer of 1869, but he took his seat in Jan. 1870 and assumed the leadership of those who were irreconcilable with the empire, even with the "liberal empire" headed by Émile Ollivier. He opposed the measures that led to the outbreak of the Franco-German War in July 1870 but urged its vigorous prosecution once it had begun. On Sept. 4, when news of the great disaster at Sedan and of the emperor's capitulation reached Paris, Gambetta strove to preserve the authority of the *corps législatif* and read from the tribune a formula of deposition that was loudly cheered. At the Hôtel de Ville the leading republican deputies set up a provisional government of national defense. In it Gambetta was named minister of the interior. It was the product of Paris and the Paris mob and included every Parisian deputy except Thiers.

Gambetta's immediate aim, as the inspirer of total national effort led by the government of national defense, was to rouse the provinces for the defense of the capital, to recruit and equip fresh armies from the areas beyond reach of the invading German troops. A delegation was set up at Tours for this purpose, as the capital was surrounded and besieged by the Germans. On Oct. 7 Gambetta left Paris in a balloon, floating over the German lines to Amiens. Armed with virtually plenary powers, he reached Tours on Oct. 9 and began the most heroic period of his career. He assumed the direction of the government of unoccupied France and prepared to wage "a people's war" to the last ditch. Despite prodigious efforts, an armistice had to be signed on Jan. 28, 1871. Elections were held for a new national assembly to meet in Bordeaux in February and to ratify the terms of peace. Victory, as Gambetta ruefully admitted, could not be improvised.

Returned for nine constituencies, Gambetta opted for the Lower Rhine and sat with the deputies from threatened Alsace. When the terms of peace were voted on March 1 by the predominantly monarchist assembly, he joined in the Alsatian deputies' moving protest against the German annexation of Alsace-Lorraine. Implementation of the terms deprived him of membership of the assembly, and he spent the spring at San Sebastian in Spain. Meanwhile the Paris Commune broke out and was crushed. In by-elections in July Gambetta was returned for the *département* of Seine. He emerged as the leading republican critic of Thiers, now serving as chief of the executive power in the provisional regime.

To establishment of the third republic Gambetta made three distinctive contributions. By his personal speeches and tours throughout France and by persuasive articles in his paper, *La République Française*, founded in Nov. 1871, he won many converts to the ideals of moderate democratic republicanism. By his prestige and political influence, exercised partly through the Paris salon of Mme Juliette Adam, partly through his parliamentary group, he laid the basis for an effective political party, the Republican union. By backing Thiers against both royalists and Bonapartists, he helped to mold the new regime into a conservative but anticlerical parliamentary republic.

Gambetta's contributions to the defense of republican institutions once they had been set up were no less important. In May 1873 Thiers was replaced by Marshal MacMahon, candidate of the diehard right, which regarded his tenure of the presidency as the prelude to restoration of the monarchy. Gambetta, at the head of the Republican union, was a leading antagonist of all schemes to undermine the republic. When the elections of 1876 produced a republican majority in the chamber, MacMahon was obliged to accept a republican government under Jules Simon. But on May 16, 1877, he abruptly dismissed Simon and held new elections on Oct. 14. Gambetta's party ensured a republican majority in the new chamber, and in Jan. 1879, when the republicans also won a majority in the senate, MacMahon was compelled to resign.

In the "republic of the republicans" that now came into being, with Jules Grévy as president, Gambetta became (Jan. 31, 1879) president of the chamber of deputies. It was Nov. 14, 1881, before opportunity arose for him to form a ministry. It was a pale shadow of the kind of government that he might have formed earlier and it excluded some of his most eminent colleagues such as Jules Ferry and Léon Say. It became excessively preoccupied with proposals for constitutional revision. It was overthrown on Jan. 26, 1882, with its ambitious program of reforms unfulfilled. Gambetta died on Dec. 31, 1882, at Ville-d'Avray, near Paris, and was buried in Nice. Léonie Léon, to whom he became passionately attached after 1872, lived with him as his wife during his last years and survived him until 1906.

Gambetta achieved less during his two periods of power than during his long years in opposition. His faith in the wisdom of universal suffrage and the sanity of the people was matched by a fervent patriotism. Rating national unity above party doctrine, he yielded to domestic opponents for the sake of republican unity and gained a reputation for opportunism. If the fruit of his effort was the consolidation of parliamentary democracy in France, the result of his failures was a fragile party system that weakened democratic government.

There are editions of his speeches by J. Reinach, 11 vol. (1881–85), and of his letters for the period 1868–82, by D. Halévy and E. Pillias (1938).

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GAMBIA, a country in West Africa and a member of the Commonwealth of Nations, previously a British colony and protectorate, forms an enclave in the Republic of Senegal. It consists of a narrow strip of land along both banks of the Gambia River extending inland for about 300 mi. (480 km.) between latitudes 13° and 14° N. Area (excluding the river) 4,003 sq.mi. (10,368 sq.km.). The distance by river from Bathurst (*q.v.*), the capital, which stands on St. Mary's Island at the mouth of the Gambia, to Koina, the easternmost village in the country, is 292 mi. (470 km.). Such unity as this oddly shaped territory possesses is conferred by the Gambia River, one of the finest waterways in West Africa, which is navigable as far as Kuntaur (150 mi. [240 km.] upstream) by seagoing ships drawing up to 17 ft. and as far as Koina by smaller vessels. Unfortunately, political severance from Senegal greatly limits the value of the river, while the French-built (1923) Niger Railway between Dakar and Kayes runs about 25 mi. (40 km.) N of the northern boundary of the country.

Physical Geography.—The river valley forms an elongated gash in the Senegambian Tertiary sandstone plain; the edges are irregular because of constant weathering. There are three main physical elements in the country: (1) the valley floor, built up of alluvium and with areas known as *banto faros* liable to flooding during the rains; (2) the dissected plateau edge, consisting of sandy, often precipitous hills alternating with broad sandy valleys; and (3) the sandstone plateau, parts of which extend across the border from Senegal. The sandstone soils are lateritic and infertile, those of the *banto faros* heavier and more productive.

The climate is a fairly dry tropical one, with alternating dry and wet seasons. Average annual rainfall is about 40 in. (1,016 mm.) but decreases inland, and year-to-year variations are large, extremes of 24 in. (610 mm.) and 66 in. (1,676 mm.) being recorded. The rainy season, usually June to October, with August the wettest month, has its arrival and departure marked by line squalls. Cooler weather follows the rains, and the dry season (usually November to May) is dominated by the dry and often dusty harmattan wind from the Sahara. Near the coast dry-season temperatures vary between about 18°–32° C (65°–90° F), but upriver the range is greater (10°–40° C [50°–105° F]). The vegetation is savanna, with gallery forest along watercourses. Much of the region near Bathurst is thickly covered with stands of oil palm. (H. R. Ja.)

Animal Life.—The narrow riverain forest strip shelters birds characteristic of the West African forest, but the large fauna is found either in the river itself or in the dry savanna woodlands. The Nile crocodile extends throughout the river system and coastal lagoons, but the hippopotamus and manatee exist only in scattered places. Cultivation in the savanna has driven out most of the larger game, which are the typical West African antelopes and gazelles, but monkeys (mostly red patas and baboons) can do serious damage to farms. A few Derby elands still exist. (G. S. Ce.)

Population.—The principal tribes are: (1) the Mandinka (or Mandingo) numbering about 130,000, who have made great progress in clearing mangrove swamps for rice growing; (2) the Wolof, often very dark in colour, who number more than 41,000 and whose women are renowned for their elaborate makeup, hair styles, and dresses, and whose men are farmers or (in Bathurst) traders; (3) the Jola, more than 22,000, who live in scattered hamlets as cultivators, many of them having turned from paganism to Islam; (4) the Serahuli, more than 21,000, Muslims who are skilled traders or industrious farmers, living mainly in large compact villages in the eastern part of the country, away from the main river but near tributaries; (5) the Fulbe or Fula, who number about 42,000, are a light-skinned, cattle-keeping people similar to the Nigerian Fulani. Their several subgroups include the more primitive Rorobe (Lorobo), whose ancestors came from Bondu; the Torobe (Toranko), a Muslim group also from Senegal; the Firdu Fulbe on the south bank, darker in colour and including both Muslims and pagans; and the Jombonkabe, often light skinned and fine featured, who include pagans, Muslims, and Christians and form a long-established element whose ancestors came from Ké-Macina on the Niger River. (D. P. Ga.)

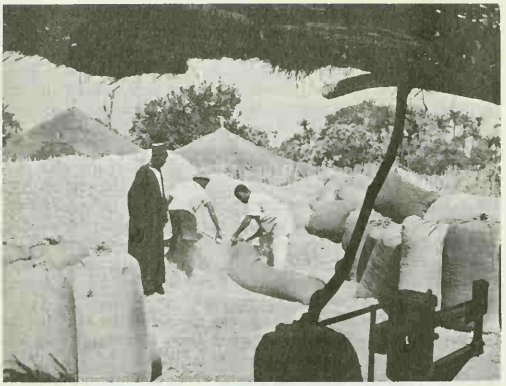
The population increased during the first half of the 20th century (1963, 315,486), but in the absence of reliable figures it is not possible to say by how many. Below Kaur (about 100 mi. [160 km.] upstream) most villages are on the sandstone plateau, avoiding the insect-ridden and unhealthy *banto faros*, but above Kaur the swamps are not saline and have more settlements, as they are valuable for rice growing in the middle river district around Georgetown and above that for peanuts. (H. R. Ja.)

History.—The Gambia River was discovered in 1455 by the Portuguese, whose main object apart from obtaining slaves was the "river of gold" supposed to be not far distant; in fact, quantities of gold reached the lower Gambia from the interior. In 1588 the Portuguese sold to some English merchants exclusive trading rights in the river, but the venture led to no permanent settlement. In 1618 James I granted a charter to a company formed for trading with Gambia and the Gold Coast (modern Ghana), but its first agent, George Thompson, was murdered by natives after his ship had been seized by the Portuguese. His successor, Richard Jobson, is reputed in 1620 to have reached the Barrakunda Rapids. In about 1660 James, duke of Courland (godson of James I of England), acquired from a local chief an island, later known as Fort James Island, about 17 mi. (27 km.) upriver, where he erected a fort. In 1661 Charles II granted a new patent to a body of adventurers who in 1663 sent an expedition to the Gambia River under Commodore Robert Holmes. He found the Courland garrison reduced to seven Europeans and took possession of the fort. In about 1681 the French from their base at Gorée established an enclave at Albreda on the north bank of the Gambia River opposite Fort James Island. In the wars following the English Revolution of 1688 the French captured the fort on four occasions, but at the Treaty of Utrecht (1713) they recognized the English claim to Fort James Island and were themselves allowed to retain Albreda. In 1779 the French captured and later destroyed the fort, but the Treaty of Versailles (1783) reserved the Gambia River to Great Britain while recognizing the French enclave of Albreda.

When at the close of the Napoleonic Wars Gorée was restored to France, the British decided to establish a base at the mouth of the Gambia River for checking the slave trade. On April 23, 1816, the chief of Kombo ceded Banjul (later renamed St. Mary's) Island, and a settlement was established and named Bathurst after the then colonial secretary. British traders from Gorée followed the garrison to this new settlement. In 1821 Bathurst was subordinated to the Sierra Leone colony and in 1843 became a separate colony, but in 1866 it was made part of the "West African settlements" governed from Freetown, reverting to separate status in 1888. Albreda was transferred to Britain by an exchange arrangement with France in 1857.

Following various cessions and purchases of territory in the years 1823–53, negotiations in the 1870s for the exchange of Gambia with some French West African territory were twice broken off because of opposition from the natives of Gambia, as well as from British politicians and merchants. Nevertheless, the French continued to expand in Senegal, and when in 1889 the boundaries were defined by international agreement, Great Britain was able to secure on the Gambia only a narrow strip of land on either bank as far as the Barrakunda Rapids. Though these strips were somewhat wider in the lower reaches, for most of their length they were no more than 7 mi. (11 km.) wide. The British protectorate was established in 1894.

Except for some trouble with slave-raiding chiefs, Gambia enjoyed peace after its separation from Sierra Leone. In 1906 an ordinance was passed abolishing slavery throughout the protectorate. During World War II Gambia contributed fighting men



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BAGGING PEANUTS, GAMBIA'S MAIN CASH CROP AND PRINCIPAL EXPORT, AT A FARMERS' COOPERATIVE PRODUCE MARKETING CENTRE

for the Burmese campaign and was used as an air staging post on the routes to the Middle and Far East.

Revised constitutions in 1954, 1959, and 1961 advanced the autonomy of the territory, which in February 1965 achieved full independence. (X.)

Administration and Social Conditions.—Gambia is an independent constitutional monarchy and a member of the Commonwealth of Nations, acknowledging the British sovereign as head of state. Under the constitution, as amended in 1964, the British sovereign is represented in Gambia by a governor-general, who acts on the advice of his ministers, except where the constitution specifies otherwise. The House of Representatives (Parliament) consists of 39 members, comprising 32 elected by constituencies, 4 elected by chiefs from among themselves, and 3 nonvoting members. The governor-general appoints as prime minister the elected member of the House of Representatives most likely to command the support of the other elected members. Other ministers are appointed by the governor-general on the prime minister's advice. Both ordinary and specially entrenched provisions are contained in the constitution. The former may be amended by a two-thirds majority of elected members of Parliament; the latter, which cover such matters as fundamental human rights, the establishment and procedures of Parliament, and the judicial system, must, in addition, be submitted to a national referendum.

In the early 1960s there were about 13,000 pupils attending 70 primary schools and 12 secondary schools and schools with postprimary classes. There were also about 150 students enrolled at a teacher-training college at Yundum. Other Gambians were pursuing higher educational and vocational courses at universities in Britain, Sierra Leone, and the United States. Gambia had two general hospitals, with more than 300 beds, and a number of health centres and dispensaries. Health services also included special mosquito-control units and a leprosy-control clinic.

The Economy.—Only crops suited to the drier tropics will flourish in Gambia. Subsistence crops include millet, maize (corn), and rice; the chief export crop (upon which the whole economy depends) is the peanut, which is grown especially in the upper and middle river districts. The African growers are helped by "strange farmers," seasonal migrants from Senegal seeking a cash wage. More than 90% by value of Gambia's exports are peanuts, the export duty on which provides most of the government revenue. When prices are more favourable in Senegal, there is serious loss from illegal exports across the border. All peanuts and other oilseeds are bought by the Gambia Oilseeds Marketing Board, which fixes the season's price in advance and sells overseas; its profits go to a "farmers' fund" applied to improving rural water supplies and wharves, pest control, and research. Other exports are palm kernels, hides, and beeswax.

The chief port is Bathurst on the eastern tip of St. Mary's Island. Ports for peanuts are Kuntaur, where vessels moor against the riverbank for loading; Balingho; and Kaur; other river ports are Georgetown on MacCarthy Island, Basse (242 mi. [389 km.] upstream), and Fatoto (288 mi. [463 km.] upstream).

There is some fishing in coastal waters and in the lower river. In 1948 the Colonial Development Corporation launched an unsuccessful project for supplying the British market from poultry farms at Yundum; this was abandoned in 1951 with a loss of about £800,000. Coastal sands south of Bathurst were exploited for ilmenite from 1956 to 1959, when operations ceased. There is no large-scale industry, but some cotton spinning and weaving are carried on.

The airport at Yundum provides direct links with London and Lisbon and the main West African centres. Shipping companies provide regular services to Bathurst for passengers and cargo, and government vessels maintain a weekly service between Bathurst and Basse. Outside the towns, only a small proportion of the country's roads are of all-weather standard, and the Trans-Gambia Road, built by the French government, linking Senegal and the Casamance River via Balingho and Yellitenda, was opened in 1958. (H. R. Ja.)

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GAMBIA RIVER, of West Africa, provides one of the finest waterways in the African continent and forms the main transportation artery of Gambia. Ocean-going vessels regularly penetrate 150 mi. (240 km.) upriver to Kuntaur, the leading port for the export of peanuts, and occasionally to Georgetown, 200 mi. (320 km.) from the Atlantic. River steamers maintain a service between Bathurst, at the mouth of the river, and Basse, 242 mi. (389 km.) upstream.

The Gambia rises in the Republic of Guinea as the Gambie on the Fouta Djallon plateau, only 150 mi. from the sea, though it follows a course of about 700 mi. (1,100 km.) to reach the Atlantic. It flows first northeast, but near its confluence with the Nericho it turns westward. The Grey river, its chief tributary, flows northward from the Tenda hills to join it about 25 mi. (40 km.) before it enters Gambia territory. At the border it spills over the Barrakunda Rapids, 175 yd. (160 m.) broad. Downstream from these rapids the Gambia is tidal and has a range of about 2 ft., but this is far less important than the seasonal range of nearly 30 ft. (9 m.) which occurs near Fatoto. Flooding occurs chiefly between June and November when the riverine lands become swamps known locally as *banto faros*. This seasonal rise diminishes downstream as the river broadens; at Georgetown it is nearly 20 ft. (6 m.) and at Kuntaur about 2 ft., for above Georgetown the channel is gorge-like, but below there it sweeps round in an extensive arc fringed with low-lying swamps.

Further changes become noticeable below Elephant Island (93 mi. [150 km.] upstream) where the Gambia again turns westward: the water is generally saline, though during the rains the salinity limit is pushed downstream to Balingho, 80 mi. (130 km.) from the mouth (at its maximum extent salinity extends almost to Kuntaur), the banks are fringed with an almost unbroken growth of towering mangroves; and the waterway broadens appreciably. Even at Elephant Island it is 1 mi. across, and this is reckoned as the head of the estuary. Just above Bathurst it is 7 mi. (11 km.) across, though the protrusion of St. Mary's Island (upon which Bathurst stands) from the south bank and of Barra point opposite narrows the mouth to $2\frac{1}{2}$ mi.

In the lower estuary a channel roughly $\frac{3}{4}$ mi. broad is safe for shipping, though it twice turns sharply between Bathurst and the open sea; a bar across the mouth gives a minimum clearance of 26 ft. (8 m.). Vessels drawing 17 ft. of water can reach Kuntaur, though the minimum depth falls to 13 ft. (4 m.) at Georgetown

(MacCarthy Island) and to 6 ft. near the eastern tip of Gambia protectorate. During the flood season small boats can even pass the Barrakunda Rapids and proceed another 160 mi. (260 km.).

The Gambia was known to Ptolemy and the Arabian geographers. It was possibly visited by Genoese navigators in 1291 and was certainly discovered by the Portuguese but it was first explored for any distance (1455) by the Venetian Alvise Ca Da Mosto.

Later Gambia became a starting place for explorers of the interior, among them Mungo Park, who began both his journeys (1795 and 1805) from this river. It was not until 1818 that the sources of the Gambia were discovered by the Frenchman Gaspard Mollien. The middle course of the river was explored in 1851 by R. G. MacDonnell, then governor of the colony, and again in 1881 by V. S. Gouldsbury. (H. R. Ja.)

GAMBIER, JAMES GAMBIER, Baron (1756–1833), British naval officer, remembered especially for the dispute with Lord Cochrane which ended in Gambier's court-martial and acquittal, was born in the Bahamas on Oct. 13, 1756, the son of John Gambier, the lieutenant governor there. John was the brother of Capt. (afterward Vice-Adm.) James Gambier; of Samuel Gambier, first commissioner of the navy; and of Margaret, who married Charles Middleton (afterward Adm. Lord Barham), comptroller of the navy, 1778–90), and a relative of Henry Dundas (later earl of Melville), secretary of state and treasurer of the navy. John Gambier's daughter Margaret married William Morton Pitt, a distant relative of the prime minister. James Gambier was therefore extremely well-connected for advancement in the navy. He began his service by entry in the books of the guardship that his uncle commanded (1767) and reached post rank in America in 1778 when his uncle was rear admiral at New York under Lord Howe. His interest was overwhelming but he chose to remain ashore between 1783 and 1793, gaining a reputation chiefly for piety. His ship the "Defence" was badly damaged in breaking the French line at the battle of the Glorious First of June, 1794. He then became a naval member of the board of admiralty, remaining there until 1801, by which date he was vice-admiral. He served for short periods at sea but was back at the admiralty again in 1804–06.

Gambier was appointed commander in chief in the Baltic in 1807 and directed the second bombardment of Copenhagen, after which he shared £300,000 prize money with Lord Cathcart and returned to the admiralty with a peerage. He was commander in chief of the Channel fleet in 1809 when Lord Cochrane (*see* Dundonald, Thomas Cochrane, 10th Earl of) came with orders to make a fireship attack on a French squadron in the Basque Roads. Gambier disliked and disapproved of Cochrane and his methods and gave only halfhearted support to the attack. Cochrane's subsequent remarks induced Gambier to ask for a court-martial, by which he was acquitted, remaining with the Channel fleet until 1811.

He was made admiral of the fleet in 1830. He died in Buckinghamshire on April 19, 1833, and his title became extinct. For an officer of such high rank he had exceptionally little sea experience; but the accounts most readily available of the Basque Roads episode came mainly from Lord Cochrane, and Gambier was not the only flag officer to think Cochrane an intolerable nuisance. (C. N. P.)

GAMBLING is the betting or staking of something of value, with consciousness of risk and hope of gain, on the outcome of a game, a contest, or an uncertain event whose result may be determined by chance or accident or which may have an unexpected result by reason of the bettor's miscalculation. All elements of the definition are essential. The person who buys a lottery ticket and hopes to win the prize is gambling; the person who is given a lottery ticket is not gambling, for he risks nothing; the person who buys a raffle ticket to aid a charitable cause is not gambling, for his incentive is not gain. A person who buys a house for himself and his family is not gambling, though a fall in real-estate values may cause him to lose money, for he has no consciousness of risk. There is a subjective qualification: A bet of a small coin might represent the staking of "something of value" to a charwoman, hence gambling; but not to a millionaire, hence not gambling. Legally (as detailed below), a game of mere skill cannot be gambling; but the superior player who bets that he will win in a game, such as chess or tennis, is gambling, because he may have miscalculated the skill of his opponent, or on this occasion he may play less well than usual.

Gambling as here defined is a pejorative term. The operator of a casino and the insurance underwriter rely similarly on mathematical expectancies, and their respective enterprises tend to be similarly profitable; but the occupation of the former is not conventionally respectable and often is not lawful, while that of the latter is in all civilized societies both lawful and respectable. The character of the hoped-for gain is significant. A mountain climber is said to be "gambling with his life," but, since he has no more than glory to gain, his enterprise is socially admirable. The expert player who seeks to win money at his game is at best tolerated.

DERIVATIONS

Gambling has existed in every known society from the most primitive to the most complex. In surviving or recorded Stone Age cultures, among the Bushmen of South Africa, the Australian aborigines, and the American Indians, there are dice games and sometimes guessing games—rude intellectual contests. H. R. Schoolcraft reported itinerant professional gamblers among American Indians. Evidence of gambling also survives from all the advanced cultures of antiquity: dice in an Egyptian tomb of 3000 B.C.; a gaming board cut into a step to the Acropolis at Athens; innumerable evidences from the decadent centuries of the Roman Empire.

Gambling in primitive societies is by scholars commonly connected with religion in those societies. The Hebrews cast lots before the Lord (Josh. 18:10), and the Lord decided (Prov. 16: 33; *see* also Urim and Thummim). In other cultures priests have used divinatory devices, such as casting stones or directing arrows toward occult patterns (*see* Divination), and onlookers bet among themselves on the result. S. Culin convincingly related the designs of early dice and playing cards to contemporary divinatory tableaus in Korea and China (*see* Cards, Playing). The betting of the early Germans, reported by Tacitus, was probably on the results of their trials by ordeal. Great emotional response, as of religious fervour or superstitious fear, often marked the behaviour of participants in primitive people's games. Tacitus remarked that the Germans ("and without the excuse of liquor") gambled away their wives and children and ultimately themselves into slavery; so did many members of African tribes; and there are cited instances in which a Chinese gambler staked a hand and, losing, cut it off.

There is nevertheless no convincing evidence that belief in supernatural agency had a causative effect on the emergence of the gambling spirit. In no society has the rise of rationalism brought about a decrease in the incidence or volume of gambling. Though in higher cultures the emotional response has not been so marked, the impulse to risk has been no less. In Tacitus' own time, wealthy Romans bet so heavily on chariot races that many lost their fortunes and their respectability; Europeans and Americans suffer equivalent losses from betting on horse racing in the 20th century. In either case the forfeit is subjectively as great as the liberty that the ancient Germans and the Africans gambled away.

Some observers have considered a gambling spirit to be instinctive in man, but this view is not widely held. Psychologists tend to consider gambling a morbid symptom (theoretically curable) but to treat it as a concomitant of man's basic cultural patterns. The wish to be, or to have been, right is inseparable from the emulative spirit. The hope of gain is similarly natural, but it does not necessarily apply to gambling. A child enjoys competition but does not willingly accept risk.

No animal except man gambles as the term is defined here. This fact probably (though not necessarily) places gambling among those abstract notions of which only the human mind is known to be capable. The criterion is not the capability of accepting risk or coveting gain but the social compulsion to pay when one loses. European gentry made gambling losses "debts of honour" from

the 17th century into the 20th, and under the Prussian officers' code suicide was recommended for a loser who could not pay.

MORAL AND JURIDICAL SANCTIONS

History.—Philosophers generally have opposed gambling as nonproductive, though similarly nonproductive recreational activities, such as the dance, have seldom been condemned, and in ancient Greece athletic games were quasi-religious observances. There is no direct biblical injunction against gambling, but the Semitic religions have almost uniformly opposed it, though for varying reasons. Talmudic law holds the acceptance of gambling winnings to be thievery, but as usually read this merely forbids a Jew to win from another Jew. The Koran denies Muslims all games except chess (perhaps the only popular game of pure skill when the Koran was written). In Christianity, St. Cyprian held that gambling violates the First Commandment and charged Lucifer with inspiring dice; the English clergy have generally adhered to the view of Jeremy Taylor, who defended the playing of games for pleasure but called gambling immoral; the Puritans considered gaming implements themselves to be blasphemous, in that playing cards were in violation of the prohibition against graven images, while reliance on chance was in violation of that against taking the name of the Lord in vain. Protestant churches generally adhered to the Puritan dictum until the 20th century, since when most of them have withdrawn their opposition to games played for amusement. Roman Catholic churches have frequently obtained funds for parish uses by conducting lotteries and games (euchre, whist, bingo) for prizes.

In the Oriental religions, the opposition to gambling has been no less, though seldom on the ground that it offends a deity. Aristotle and Confucius denounced gamblers, but apparently they had in mind the predatory gamblers, who by superior skill or chicanery victimized their less cognizant opponents.

Law.—Nearly all laws relating to gambling have been antagonistic. The long record of Western legislation against gambling, though perhaps partly inspired by the church, seems to have been based more on political and economic expediency. Ancient Egyptian and Roman laws inhibited gambling as effeminating, and the earliest English (1388) and French (1397) laws had a similar purpose: to divert the common man to archery, in which developed skill would be of military value to the state. Later laws, of the 15th to 17th centuries, were intended to prevent unproductive diversion of the workingman's time, and the chief purpose of 18th-century antigambling laws, as of the sumptuary laws of ancient Rome, was to discourage the moneyed classes from dissipating their assets and falling to a lower estate, or to direct their energies to ends more useful to the nation. Antigambling laws of the 19th and 20th centuries, in western Europe and America, have had more of a moral base, because the majority of legislators have considered gambling "wrong." In almost all cases the laws have applied minor penalties, if any, to the person who gambles unprofessionally and heavy penalties to the common gambler—that is, the person who derives a living from gambling with anyone who approaches him for that purpose, such as a bookmaker or the proprietor of a casino.

Antigambling legislation in the United States follows the pattern that prevailed in England until 1960 (*see* below). In the United States, regulation is complicated by the fact that the instant power is reserved to the states and there are 50 different sets of state laws and, in addition, countless local ordinances, which vary in severity according to the pressures brought on legislators.

Even the term gambling, essential to most of the pertinent statutes and ordinances but almost never fully defined in them, is so often differently interpreted that one cannot rely on the legal record, which is a mass of reversals and contradictions. Most but not all courts in the United States follow the English common law, under which (27 Corpus Juris p. 969) a game played for stakes is lawful if skill predominates, unlawful if chance predominates. The decision as to the status of a particular game is within the judgment of the court. California courts have held draw poker to be a game of skill, stud poker not. One justice of the New York Supreme Court held duplicate bridge to be a game of chance; all others have held it to be a game of skill. In 1965 the solicitor's office of the U.S. Post Office Department held gin rummy to be a game of chance; a federal court ruled it a game of skill.

Legalization of Gambling.—There has been controversy for at least 300 years over licensing and state control of gambling. Proponents of legalized gambling argue that antigambling legislation is ineffective because law-enforcement officers are reluctant or unable to prevent minor gambling, while the profits of major gambling are so great that professional gamblers purchase immunity from prosecution with bribes; that legal gambling would provide huge tax revenue and so reduce other taxes; that corruption of police and politicians would be reduced with the bribery incentive removed; that the public, which cannot be prevented from gambling anyway, would be protected against the exorbitant profits exacted by illegal gamblers (partly because they must pay protection money) and against dishonesty and other abuses.

Opponents of legalized gambling are most often clergymen and others who base their opposition on moral grounds, but they cite also practical reasons: that licensed gambling eliminates no abuses and merely aggravates the betting habit; that wherever gambling has been made legal (as in Nevada, to some extent in New York and other states, and in the West Indies and Puerto Rico) members of the criminal underworld have almost immediately acquired control of gambling enterprises; that legalization of gambling opens the way for many members of the lowest-income classes to lose money, which they least of all can afford; that only a limited portion of personal income is available for recreation, and if more money is diverted to gambling there will be less for intellectual, artistic, and athletic pursuits.

Several German princes maintained gambling as a state monopoly in the 18th and 19th centuries. From the late 1860s into the 1880s, pamphlets were circulated throughout Europe, in several languages, including English, purporting to prove statistically that state-licensed gambling is deleterious to the state economy. Though it later became known that the pamphlets were inspired and paid for by the Blanc brothers to discourage competition for their casino at Monte Carlo, this does not necessarily make the statistics less valid, and the pamphlets probably had some effect. For whatever reason, public casinos were prohibited in Germany soon after the formation of the German Empire in 1871, and most European casinos, including those at Monte Carlo, are open only to temporary visitors.

Nevertheless, the need for tax revenue from indirect—hence not unpopular—sources has persuaded nearly every sovereign entity, including more than 30 states of the United States, to license some form of gambling, especially since the 1940s; many nations and states had done so before that time. In nearly every case the licensed gambling has been a lottery, or horse racing, or a casino at some resort attended only by the moneyed classes, but there have been exceptions, as in Nevada. Permissive gambling legislation, though tax revenue may have been its motive, has usually been justified or rationalized on the ground that it is a violation of civil rights to prohibit gambling by an adult. Horse-racing associations originally cited "improvement of the breed" as their purpose.

The British Betting and Gaming Acts of 1960–63.—The betting and gaming laws adopted by Parliament in 1960 and amended in 1963 were perhaps the most significant in the history of gambling legislation. They were not adopted cynically, to produce revenue, but realistically, to meet current conditions and satisfy public desires. Because of the prestige of British legislation, the new laws were bound to establish a pattern for other countries; members of Parliament knew this and in most cases governed their decisions accordingly.

English law on gambling, prior to 1960, was a maze of inconsistencies almost as great as the federal United States could produce with its many states and municipalities. Parliament had tried vainly in the 18th century to outlaw specific games and in the 19th century to discourage gambling by making gambling debts uncollectible by law, but none of many acts had the intended effect. In 1926 Parliament acknowledged and licensed bookmakers and by a uniquely enlightened provision permitted them to accept bets

only on credit, not in cash, thus protecting the poor who could not establish credit. As in most countries, pari-mutuel betting at racecourses was permitted, as well as football pools that were equivalent in effect to a national lottery. At the same time the police could and often did arrest and prosecute groups that played a card game, such as poker, in their homes or clubs.

Under the laws of 1960 and 1963, licensed betting offices might be maintained to accommodate persons who wished to bet on horse races or other events without attending the racecourse or other place of occurrence; games of chance were permitted in clubs (if the players had been members for at least 24 hours) or in homes, provided no proprietor or member had a regulated advantage over any other participant in the game and provided no entertainment (such as a cabaret, television, the service of refreshments, etc.) was offered as an inducement to attend. Mechanical gambling devices, such as are called slot machines, fruit machines, or one-armed bandits, were permitted if the promoters (except charitable beneficiaries) did not receive more than their expenses and fair recompense for their services.

Taxes on Gambling.—Wherever gambling is lawful, it is taxed. In the United States professional gamblers are subject to federal taxation, as an inhibitory measure, even where gambling is unlawful according to local law. Where betting on a contest is permitted, the tax is almost always a percentage of the gross amount bet and may range as high as 10% on horse or dog racing and even higher on lotteries. The 1963 British laws required a licensed bookmaker to pay £100 for a permit, but subsidiary and renewal rights were taxed only nominally: £5 for a betting agency permit, £1 for a betting office licence, and in every case only £1 per year renewal fee.

In 1950–51 a committee of the U.S. Senate, with Estes Kefauver as chairman, conducted a series of hearings that led to the conclusion that gambling in the United States is almost invariably connected with organized crime. As a result of the Kefauver Committee's findings, Congress in 1951 assessed a tax of $250 per year on each "coin-operated game device" (gambling slot machine), while bookmakers were required to register, pay a $50 registration fee, and pay a tax of 10% on all bets handled (accepted). In the 1960s compliance was considered to be general with respect to slot machines but to be at most 5% with respect to bookmakers and other common gamblers, since nearly all operate contrary to local laws and to register would be to expose themselves to local prosecution. Arrests for violation of this federal statute were infrequent; in 1963 there were only 327, as compared with an estimated 80,000 or more violations.

THE GAMBLER

A gambler is not merely one who engages in gambling as defined here. There are various types, some professionals and some amateurs. For professional gamblers the designation seems a contradiction in terms, because within their profession they seek to avoid risk. A convenient subclassification is: among professionals, the banker or bookmaker, the percentage gambler, and the cheater; among amateurs, the casual and the compulsive gamblers.

The Banker and Bookmaker.—The banker operates a casino, called also a gambling house, or euphemistically a club; the bookmaker accepts bets on the outcome of sporting events, political elections, and some other contingencies. Each exploits capital to induce betting by persons who wish to risk relatively small amounts in the hope of winning relatively large amounts. Each relies on a greater mathematical expectancy of winning than of losing; if the computations are correct and the capital adequate, the expectation is always realized.

In most cases the motive of the banker or bookmaker differs little from that of a merchant or other businessman, but his social attitude must be different because in no case is his occupation conventionally respectable even when it is legal. Often the casino operator begins as a restaurateur, essays a cabaret, and then—since the cabaret is a precarious business venture—adds gambling as an adjunct. Nearly all American cabarets outside the largest cities provide gambling in some form, if only a row of illegal slot machines. The proprietor need not be unscrupulous, but usually he must bribe law-enforcement officers, thus committing at least a misdemeanour, and he must associate with and condone persons who pursue illegal vocations. Almost inevitably he is drawn into the criminal underworld.

The Percentage Gambler.—The percentage gambler seeks to exploit his superior skill at some game played for stakes by winning from inferior players. The game may be athletic, as golf and tennis; coordinative, as billiards; intellectual, as bridge or chess. If it is a fashionable game, such as bridge or golf, the percentage gambler may become a social lion, even a celebrity. Except in rare cases, he does not cheat. Almost invariably the percentage gambler has a special aptitude for probabilities and will not accept a bet unfavourable to him; in games of chance, such as craps, his only advantage is this superior grasp of probabilities. Like the businessman gambler, the percentage gambler usually makes a living, often a very good one. When he fails to do so, it is because he has overestimated the degree of his superiority over his opponents.

A person may become a percentage gambler because he is obsessed with the challenge of a game too profound to master completely, such as chess and bridge, and his preoccupation may lead him to abandon regular employment and devote all his time to the game. Or he may have the predatory approach typical of the underworld and prefer to seek his livelihood by victimizing others.

The Cheater.—Like the percentage gambler, the cheater seeks always to have an advantage over his opponent, but to gain it he manipulates cards, dice, or other gaming implements; uses dishonest equipment of which his opponent is not aware; or enters into collusion with another player to victimize a third. In nearly all societies cheating is considered dishonourable, and the penalty for one who is caught is ostracism, but this does not prevent cheating. Some cheaters have no other occupation than gambling, but the majority are employed persons who cheat in social games to augment their incomes. During World War II the U.S. Army and Navy found about three cheaters in each thousand men drafted. (*See* also *Cheating Devices*, below.)

The Compulsive Gambler.—This is a person who cannot or does not set a limit on his risk. He is characterized by irrational hope of winning and mystical reliance on chance, sometimes based on superstition. Many instances of defalcation, misappropriation of funds, violation of trust, and other larcenous practices are traceable to compulsive gambling, yet nearly all compulsive gamblers are honest while gambling. More damaging socially is the compulsive gambler's tendency to gamble away money needed for his own and his family's subsistence. It was this fact that led in 1948 to the formation (in Louisville, Ky.) of an organization called Gamblers Anonymous, chapters of which have since been formed in many U.S. cities and in some other countries.

Habitual compulsive gamblers are relatively rare; except for the very rich, only those who have the aptitude for becoming percentage gamblers or cheaters can afford to yield to the compulsion habitually. The occasional compulsive gambler is common. A businessman attends a convention, is drawn into a game probably organized by a percentage gambler or cheater, loses heavily, is remorseful, "swears off," and may not suffer a relapse until the next convention. Nevertheless, the seed of the compulsion is in him, and he is the person most likely to take to gambling to provide the means of satisfying some addiction, such as an expensive mistress or social ambition.

The emotion of the compulsive gambler has often been interpreted in fiction, most notably in F. Dostoevski's autobiographical short novel *The Gambler* (1866).

Nearly all professional gamblers are potential compulsive gamblers, as are nearly all members of the underworld. E. H. Sutherland remarked (*The Professional Thief*, University of Chicago Press, 1937) that "the patrons of gambling houses are confined almost entirely to the underworld, bootleggers, pimps, whores, and thieves." While this is no longer true—respectable society supplies so many gamblers that the underworld could hardly outnumber them—there are few members of unrespectable society who do not gamble.

The Casual Gambler.—The casual gambler seldom risks money essential to the necessities of his life, though he occasionally risks more than he can afford; if he loses, he retrenches, unlike the compulsive gambler, by forswearing gambling until he can afford it again. There are so many casual gamblers that their contributions, individually small, constitute perhaps 90% of all the money lost in gambling throughout the world: in the purchase of low-priced lottery tickets; attendance at games such as bingo, which cost little more than a theatre ticket; small coins dropped in gambling slot machines; the lowest-priced pari-mutuel tickets at racecourses; larger sums, but only somewhat larger, staked at casinos during holidays once or twice a year. Objectively, the sum of such bets can be deplored; subjectively, it is not seriously damaging, for the casual gambler seldom risks even so much as 5% of his annual income, and, of course, he sometimes wins.

Psychology of the Gambler.—Psychologists have treated almost exclusively the compulsive gambler, and even about compulsive gamblers there is no agreement. The compulsive gambler is commonly considered to be impelled by motives of self-destruction or of rebellion against a past or present, real or imagined, authority. The percentage gambler psychologically substitutes the mock struggle for a real one. The banker or bookmaker may be equated with any unscrupulous businessman; he risks or deliberately forfeits respectability in the belief that it is already lost or is unattainable, or because his superego is underdeveloped or he has overcome it. The casual gambler is motivated only by hope of gain, and his approach is not generally considered abnormal. He does not consider that he is gambling if the amount risked and the possible reward are subjectively incommensurate—that is, the risk of ten cents to win $100 or more. A bet of $2 on a horse race to win $5 or $10 is gambling because these are commensurate quantities. But the casual gambler never considers as gambling the risk of a small amount that he can afford without deprivation—for example, a $2 bet on a horse when he is at the racetrack and in a holiday mood.

Women are as likely as men—perhaps more so—to be either casual or compulsive gamblers, but they tend to risk much smaller amounts. Children seldom gamble before adolescence, but thereafter boys follow the adult pattern while girls take up gambling later, usually after they have become housewives with free time. Nearly all laws that permit gambling in the U.K. and in the U.S. states forbid participation by persons under 18 years of age.

Extent of Gambling.—It has been estimated that during the 1960s the total amount bet on gambling games in the United States alone approximated $50,000,000,000 each year; that in England 48% of the adult population risked some money by gambling, a larger percentage than in the U.S., though the money risked did not approach the same proportion of national income; and that throughout the world the amounts risked annually approached 6.66% of personal income. These figures do not represent net expenditure by the gambling public, since perhaps 75% of the amount risked is returned in the form of winnings or prizes, but the worldwide loss through gambling, which goes to the profits of common or professional gamblers and the shares or salaries of their employees, apparently reached or exceeded $25,000,000,000. About 2,000,000 persons, almost all of them entrepreneurs or employees in the gambling business, derived all or most of their livelihood from this fund.

MEANS OF GAMBLING

Nearly all gambling consists in betting on the outcome of a contest, and the majority of contests are games requiring some paraphernalia. The earliest games and gaming implements, often developed independently in different ethnic groups or in different parts of the world, were notably similar in form, and many of them have endured without essential change. This is not strange, since they were designed to reproduce in play, or to simulate, basic human activities. Games may incorporate any of three themes:

1. The race to a goal, as in the footrace or horse race. The ancient games of backgammon and pachisi, and athletic games, such as baseball (thematically identical with them), are elaborations on this theme. Related games were traditional in the Orient, among the Aztecs, among African tribes before the advent of Europeans, and among many other peoples both primitive and relatively advanced.

2. Capture or conquest, basically physical strife in direct encounter or vicariously in such diversions as cockfighting. Chess and draughts or checkers are pure games of capture, and the theme of conquest is encountered in many ancient guessing and counting games that determine intellectual ascendancy.

3. Comparison with some established pattern, physically exemplified by such sports as target shooting. Typical are the casting of dice; lottery; card games such as faro, baccarat, and blackjack; and divinatory practices. This is generally assumed to be the earliest gambling theme known to man.

Games that have been developed in civilized countries often combine two or all three of these themes; for example, pinochle (comparison and capture), fan-tan (comparison and the race), and rummy (in some forms, as canasta, all three).

Horse Racing.—Betting on the result of a horse race is apparently the principal form of gambling in the English-speaking countries and in France; because it is universally taxed, it is the only form on which audited statistics are always available. (Statistics are available also for dog racing in the U.K. and some states of the U.S. where it flourishes and is taxed.)

In the early 1960s, betting through pari-mutuel devices (*see* HORSE RACING AND BREEDING: *Totalizator*) passed an annual volume of $4,000,000,000 in the U.S. and £300,000,000 in the U.K. More money was bet through bookmakers than at the track. In the U.S., where bookmaking is legal only in Nevada, betting through bookmakers is variously estimated at two to four times the amount bet through pari-mutuel machines—that is, from $8,000,000,000 to $15,000,000,000. In the U.K., where bookmaking is licensed, the amount is about twice that bet at racecourses. Large bettors place most of their bets through bookmakers because betting through the pari-mutuel machines reduces the odds.

In France and Australia bookmakers are licensed. Through both bookmakers and pari-mutuel devices, about 2,000,000,000 new francs in France and about A£225,000,000 in Australia were bet annually on horse races. The greatest betting volume per capita is in Australia.

In the U.S. the state of New York accounted for nearly one-third of the total bet through pari-mutuel machines; also New York was the only state in which harness races produced almost as great revenue as "flat" or running races. Florida and Massachusetts were the principal dog-racing states.

In all countries there has been a steady growth in the amount of money bet on horse racing, attributable to population increase, monetary inflation, and, in many cases, improved economic conditions. Horse racing was maintained in all belligerent countries, including the U.S.S.R., during World War II; occasionally there was some degree of curtailment, as in the U.S. during 1944–45, to reduce absenteeism at factories producing war materials. Wherever horse racing is popular, it has become a major business, with its own newspapers and other periodicals; extensive statistical services; self-styled experts who sell advice on how to bet; networks of telephone and telegraph wires that furnish information to betting centres; bookmakers and their employees; and workers incidental to the care and breeding of horses. The same is true, to a smaller extent, of dog racing. It was estimated that 420,000 persons were employed in these activities in the U.S. in 1963. Interstate and, in some cases, intrastate use of the telephone and telegraph for betting is illegal in the U.S. but usually has proved difficult to detect.

Lottery.—Of all advanced nations in the world, only the U.S. and Canada in the 1960s did not conduct or license some form of national lottery, and in both these countries illegal lotteries flourished. In the U.S. one state (New Hampshire) sanctioned a legal lottery beginning in 1963, the first time a U.S. state had done so since 1893, when the Louisiana lottery was discontinued. Other U.S. states permitted forms of lottery, such as raffles and bingo, for charitable purposes; but scandals were frequent because the

beneficiaries tended to assign the management to concessionaires skilled in the operation of such games, and the assignees proved often to have criminal records and to conduct the games dishonestly for their own greater profit.

During World War II the U.S.S.R. introduced a lottery in which purchasers of government bonds could win prizes, and in 1956 the U.K. adopted a similar lottery, wherein each bond costs £1, and the interest, 4.5% per annum, goes to the lottery's prize fund instead of to the investor.

Under U.S. federal law, any lottery is illegal in that no material pertaining to it may be sent through the mails or passed over state lines. The U.S. Post Office Department and, to a large degree, the federal courts have held any contest or game for prizes to be a lottery, provided the contestant surrenders any consideration, if it is "in whole or in part" determined by chance, even though it is not a lottery as universally defined—that is, a drawing at random for prizes.

The Irish Hospital Sweepstakes, the largest lottery promoted internationally, continues to derive more revenue from the U.S. than from any other country, although all the tickets have to be sold illegally and there is much counterfeiting of tickets, seldom detectable because the purchaser has no further interest in the ticket if he is not announced as a winner. The appeal of the Irish Sweepstakes is in the size of the prizes, which sometimes exceed $200,000.

Policy, a true lottery with random drawings, initiated by Italian-Americans, deriving its name from the Italian *polizza*, "receipt" or "ticket," and later adopted by American Negroes, retains only occasional and local popularity. It has been substantially replaced by the numbers game.

The numbers game is the most widespread lottery game in the U.S., though illegal wherever it is played. Patrons of the numbers game are drawn chiefly from the low-income classes, with the number of Negro players disproportionately high. The player may bet ten cents or even less. He selects his own number, any three-digit number from 001 to 999. The winning number each day is one that the promoters of the game cannot control—financial balances, pari-mutuel payoffs at racetracks, spot cards held by a player in a bridge hand reported in newspapers, etc. The odds against winning are 998 to 1; as the game is usually played, the person who selects the winning number is paid 540 to 1, the "runner" who accepted his bet receives 60 units, and the gross profit of the promoters is nearly 40% of the amount wagered. The inducement to the bettor is that a ten-cent risk may yield $54. Promoters pay large sums to political leaders and police in cities (northern metropolises and throughout the South) where there are large Negro populations. In 1935–37 Thomas E. Dewey proved political corruption in New York in connection with the numbers game, but no diminution of it was discernible thereafter. The amounts bet on numbers annually in the U.S. have been estimated as high as $3,000,000,000, but objective analysis of verifiable figures can place the total no higher than one-quarter to one-fifth of that amount.

Bingo and other forms of lotto attract some millions of players daily, chiefly women, and are a fixture at casinos. The average amount risked or lost by each player, however, hardly exceeds $3 per session, and the significance of this game in gambling statistics is not great since the amount of money lost at it can hardly exceed $200,000,000 per year.

Bolita, a form of lottery popular among Latin Americans (the etymology is similar to that of the word policy), plays an even less important role, quantitatively, in world gambling.

Pools on football and (in the U.S.) professional baseball are popular in various forms. In Great Britain football pools are in effect a national lottery, patronized in bets from 6*d*. upward because the maximum prize can be—and several times has been—as high as £100,000 ($280,000) on a shilling bet, in a country where gambling winnings by its citizens are not taxed. Usually the bettor's task is to select the winning teams in three or more games, or, in baseball, to predict the number of hits or runs each named team will make during a week. Payoffs range from 3 to 1, when the actual odds are 15 or 16 to 1, up to 100 to 1, when the actual odds are 300 to 1. The largest payoffs are made when the odds are as much as 250,000,000 to 1 against the bettor, and such winnings have occurred in Great Britain only as often as might mathematically be expected, considering the fact that about 150,000,000 such bets are made each year.

The daily double and similar parlay bets on horse races (twin double, quinella, etc.) are in the U.S. equivalent to lotteries and pools in other countries. The bettor must attend a racetrack and place his bet through the pari-mutuel system on two or more horses. In 1964 a $2 ticket on a combination of four horses paid $172,726.80 at Roosevelt Raceway, a harness-horse track near New York City. Legally such betting and winnings are permissible if pari-mutuel betting is permitted by the state, and they do not come under the lottery laws, since horse racing is treated as a test of skill. Logically the judicial view is defensible, since the winner of the large prize does not invest merely $2, as would the holder of a lottery ticket, but often several thousand dollars backing all combinations that, in his estimation as a handicapper, might win.

The Casino, Gambling House, or Gambling Club.—Places where gamblers can risk their money against a common gambler, called a banker or the house, have existed at least since the 17th century; in the 20th century they are commonplace and have assumed almost a uniform character throughout the world. In Europe and South America they are permitted at many or most holiday resorts and not elsewhere. In the U.S. they are legal only in Nevada and, by special licence, in Puerto Rico, but they operate illegally, through corruption of political authorities, in all other states. A survey made in 1944 by S. Michael MacDougall indicated that, except in a few sparsely settled sections, a gambling house could be found within a 30-mi. radius of any point in the U.S. More than 20 years later there seemed no reason to change this estimate except to increase the distance to 40 or 50 mi., perhaps because of better transportation.

Until 1917–18 overt though illegal gambling houses operated in most U.S. cities. When the armed services during World War I placed such establishments out of bounds, they moved to counties adjacent to the metropolitan centres (where presumably law-enforcement officers were more easily or cheaply bribed), providing frequent and free shuttle service, in large automobiles or buses, between the centre of the city and the gambling house. This pattern has persisted. New York City residents and visitors are so transported to casinos in New Jersey and on Long Island beyond the city limits; Chicagoans, to Cicero or other contiguous municipalities; and persons in nearly all other metropolitan centres, to their suburbs. Some smaller cities remained "wide open," but their numbers diminished.

The casino typically accepts all bets made by its patrons, within a limit established so that the patron cannot luckily win more than the casino can afford to pay. Every game offered gives the casino a mathematical expectancy of winning. Even for one day it is unlikely that a casino might lose money, and over the course of one year it is incredible (about 1 chance in 50,000,000,000). But because of this virtual assurance of gross profit, casinos regularly offer extravagant inducements to potential patrons, as by presenting expensive entertainment and supplying free transportation and elegant living quarters to big bettors. Such promotional expenses may exceed profits and cause a net loss over the year but only rarely.

The games played regularly at casinos are named below.

Roulette.—Roulette is played at all casinos throughout the world. It is one of the principal gambling games in France, where the casinos, to entice big bettors, reduce their advantage to less than 1%. In the Americas roulette is also standard but appeals more to small bettors, and the casinos take 5.26%.

Crap Shooting.—This game attracts the principal bettors in American casinos. No casino demands an advantage greater than 1.4%, most casinos by various devices reduce this to 1% or less, and some casinos have reduced their advantage to 0.4%; even at this low percentage for the house, the bettor in $100 units has an expectancy of losing $1,500 in a six-hour session.

Chuck-a-Luck.—This dice game, once a fixture at casinos in

North and Central America, since the 1940s has been encountered only at the smallest.

Slot Machines.—Slot machines are not only the mainstay of casinos in the U.S. but also a primary contributor to the support of thousands of private clubs, restaurants, and other establishments. The coin-operated gambling device, the "one-armed bandit" by slang designation, accepts a coin (five cents to $1 in the U.S.) and automatically pays if any of 12 to 16 combinations occurs after three wheels have been spun at random. The highest prize, called the jackpot, may be 100 or 200 times the amount of the stake. Such machines may be adjusted to retain a desired profit, such as 10%, 25%, 35%, etc., for the proprietor. In 1965 Las Vegas, Nev., with a population of about 70,000, had 10,000 licensed slot machines, for each of which the proprietor had to pay a tax of $250 to the U.S. Internal Revenue Service and a further tax, based on income, to the state.

Card Games.—At one time a card game, faro, was the principal gambling game of the U.S.; since the ascendancy of craps, faro has become obsolete (except to a very small extent in Nevada), and no card game has been of great importance in American casinos. Baccarat, in its popular form *chemin de fer*, has remained the principal gambling game in Great Britain and in the continental casinos most often patronized by the English, as Deauville, Biarritz, and the Riviera resorts; in 1960 this game was introduced into Nevada casinos but with no immediate success. Blackjack has remained a fixture in American casinos and was considered to contribute an essential part of their profits until, in the late 1950s and early 1960s, mathematicians with the aid of electronic computers devised a system of play that reduced the casino's advantage below the profitable minimum. *Trente et quarante* is solely a French game.

Other card games are seldom used for casino gambling and are usually played privately, often for no stakes.

Bookmaking.—In the United States there were in 1965, by conservative estimate, 250,000 bookmakers, and only a few thousand of them (in Nevada) operated legally. Some British Commonwealth countries (including the United Kingdom, Australia, and New Zealand), South Africa, France, and West Germany permit off-track bookmaking; and in some U.S. states, notably New York, unremitting agitation by some legislators and large cities made the eventual adoption of off-track bookmaking inevitable.

Illegally operating bookmakers in the U.S. accept bets on horse races and games of baseball, football, and basketball. To set their odds, they established, before 1950, a national organization of expert observers who transmit their prognostications to a network of clearinghouses, which in turn inform individual bookmakers as to what the odds on each game should be.

The bookmaker seeks in every case to achieve a "balanced book," whereby bettors are competing against one another and he will make a profit no matter which bettor wins. For example, if one bettor bets 6 to 5 on *A* and another bets 6 to 5 on *B*, the bookmaker will collect six units and pay only five units no matter which wins. The vagaries of individual bettors, and special information acquired by certain large bettors, often preclude realization of this aim. To protect himself, therefore, the smaller bookmaker "lays off" (rebets) with a larger bookmaker such sums as he is not prepared conveniently to pay if he loses. This system has led to the creation of several large and heavily capitalized bookmaking organizations that accept bets laid off by other bookmakers, but the casual bettor is thereby assured against such losses as occurred often before the 1940s, when local bookmakers, ruined by the victory of some heavily played horse or team, defaulted and vanished.

Cheating Devices.—As long as there has been gambling, there have been devices, such as dishonest dice and marked cards, to victimize opponents in a social game. Such games as the wheel of fortune at carnivals have most often been rigged to protect the operator against loss. Nearly all casinos operate honestly up to a point, but if a plunger, or big bettor, seems likely to achieve a winning damaging to the casino, there is usually a dealer available with skill at prestidigitation equal to that of a stage magician who can manipulate cards or dice so as to recover the losses of the house. In some gambling houses the roulette wheel can be controlled by mechanical or magnetic means. The smaller the gambling operation, the greater the player's risk. The large casinos in Nevada and at European and Latin-American resorts usually have income from their mathematical advantage sufficient to cover their infrequent losses, so they make no preparation for cheating; but none of them long continues to admit a player who has sufficient skill to win regularly.

Bookmakers are prey to bettors who, by bribery or other means, gain prior knowledge of the results of athletic contests; examples are the Black Sox case of 1919 (*see* BASEBALL: *History of Baseball*) and several instances in which basketball players have been bribed. Schemes to "past-post" a bookmaker—that is, bet on a horse race after it has been run—have been developed repeatedly. By the 1930s professional wrestling had become so corrupt that bookmakers refused bets on wrestling matches, and a similar condition was threatened in professional boxing in the 1950s and '60s.

See also separate articles on games used in gambling, HORSE RACING AND BREEDING, etc.

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(A. H. MD.)

GAMBOGE, a gum resin from *Garcinia hanburii*, a dioecious tree with leathery, laurellike leaves, small yellow flowers and usually square-shaped and four-seeded fruit, indigenous to Cambodia and parts of Thailand and South Vietnam. The juice, which when hardened constitutes gamboge, is contained in ducts in the middle layer of the bark, and from this it is procured by making incisions, bamboo joints being placed to receive it as it exudes.

Gamboge occurs in commerce in cylindrical pieces, known as pipe or roll gamboge, and also, usually of inferior quality, in cakes or amorphous masses. It is of a dirty orange colour externally, is hard and brittle, breaks with a conchoidal and reddish-yellow, glistening fracture, and affords a brilliant yellow powder; is odourless and has a taste at first slight but subsequently acrid; forms an emulsion with water; and consists of from 20% to 25% of gum soluble in water and from 70% to 75% of a resin. Its commonest adulterants are rice flour and pulverized bark.

Gamboge is a drastic hydragogue cathartic, less active only than croton oil and elaterium. A small quantity is absorbed, adding a yellow ingredient to the urine and acting as a mild diuretic. Its irritant action on the skin may cause the formation of pustules. Gamboge is used as a pigment and as a colouring matter for varnishes. It appears to have been first brought into Europe by merchants from the east at the close of the 16th century.

GAMBREL ROOF, a roof which has on each side of the ridge two slopes, the lower more steep, the upper less so, and which has gables at the end walls. It is particularly characteristic of American colonial work in New England, New York and New Jersey, although found in many parts of the world. The origin of

its common use in America is not definitely known; it may have been purely an invention in the effort to obtain greater headroom in the attic or upper floor.

In the New England examples the slope of the lower portion approximates 60°, that of the upper portion varying from 30° to 40°; in places where Dutch influence was strong, the lower slope was more nearly 45°, and the upper about 30°, and frequently there was a large projection at the eaves. In Europe the form occurred spasmodically in work of the 17th century and later throughout the Teutonic countries, especially in Scandinavia. There are also rare examples which may be seen in the south of England. *See* ROOF.

GAME AND WILDFOWL SHOOTING: *see* HUNTING.

GAME BIRDS. In North America the term game birds includes the so-called upland game birds (gallinaceous or chickenlike birds) such as quail, pheasant, grouse and partridge; aquatic game birds such as ducks, geese and swans; and the shore birds—woodcock, snipe and plover. In Great Britain the term applies only to grouse, pheasant and partridge.

This article deals with game-bird farming, or the production of game birds under artificial conditions for restocking areas for shooting purposes and for the sale of game birds for food. For description, classification, food habits, breeding, etc., of the various species of game birds *see* the separate articles QUAIL; PHEASANT; etc. *See* also HUNTING.

The propagation of these birds involves two distinct phases. The first, raising game birds in captivity, began with the desire to assist in the restoration of game in depleted areas to produce birds for hunting. Some still believe that this method of stocking game is necessary to insure good hunting. Although research has indicated that in North America it is far too costly, and thus impractical, it is still an important undertaking in areas in which hunters are willing to pay the cost. Specialists in game production and management agree that suitable cover and food in the wild is of first importance in supporting a natural abundance of game birds; and with intelligent supervision and frugal cropping, this situation should maintain a reasonable supply. This was the concept of game management in the second half of the 20th century. (*See* also WILDLIFE CONSERVATION.) The second phase, a later development that rapidly gained in magnitude, was the raising of game birds for meat. It was thought that eventually pen-raised game birds would become as common in the diet of ordinary citizens as turkey and duck.

In both North America and Great Britain game farming is a long established practice, but there is a difference in the purpose of it. In North America, where it is illegal to sell wild birds, the major purpose is to supply the food market with artificially reared birds. In Great Britain the object is to restock ground where shooting takes place. The reasons for this difference are both social and climatic.

In North America the right to hunt is in theory, and largely in practice, free to all. Hunters do not expect to kill particularly large numbers of birds and conservation measures are aimed at enabling each hunting licence holder to take a fair share (say, four to ten birds) in a day. In Great Britain game birds are the property of the owner of the land on which they exist and as such they form part of the crop. Since game-bearing land carries an extra revenue assessment which the landlord must pay, it follows that he must make this crop as large as possible. The British climate militates against this to a greater extent than the American climate does, since in Britain the nesting and hatching period of the year is likely to be afflicted by storms which, if the whole process of game reproduction were left to nature, might decimate the stock in any particular year. Therefore, while America relies on carefully fostered natural reproduction for all purposes, except to supply the food trade, Britain relies to a great extent on artificial rearing in order to make the game crop pay its way.

Game farming was a 20th-century introduction both in North America and Great Britain, though in Britain its roots went farther back, probably to the mid-19th century when the substitution of the breech-loading for the muzzle-loading shotgun and the improvement of the cartridge made it possible to kill large numbers of birds and thus supply a poultry market. Probably the first game farmers were keepers (wardens) who set up on their own account to supply fertile eggs, chicks and grown young birds to estates in the vicinity. Changes in farming practice in the early years of the 20th century induced them to specialize in game farming as opposed to gamekeeping, and about 20 established game farms in Great Britain were in business on a very considerable scale in the 1960s.

The farming change which had the greatest effect was the introduction of fall plowing on arable land. The effect of this was to bury the stubbles on which game birds used to feed throughout the winter months and to replace it with equivalent areas of plowed land which contained no grain or seed for the birds to live on. Thus there was a marked change in the game-carrying capacity of a good area of land before and after plowing. A heavy stock had to be heavily shot to save it from starvation and then artificially replenished the following summer when food again became available.

Species Raised.—Quail and pheasant are raised in every section of the United States and in parts of Canada. The bobwhite quail is the most numerous, most popular and best known of the upland game birds. In the northern United States it is called "quail," but in the south it is commonly referred to as "partridge." California and valley quail are also produced in captivity. In addition, there are gambel, mountain and scaled quail and the Texas, Mexican, masked and mearns bobwhite quail.

More ring-necked pheasants are raised in pens than any other species of game bird. The true pheasant has no white ring around the neck, a common characteristic of the Chinese and Mongolian species which have been mixed considerably in breeding. The ordinary wild pheasant, so abundant in the United States, is in reality a hybrid. There are also golden, amherst and silver pheasants. Other upland game birds raised successfully include the partridge. The chukar (*Alectoris graeca*) from India and the Hungarian or European partridge (*Perdix perdix*) are the more important species. Some attempts have been made to raise grouse and the prairie chicken, or pinnated grouse, but with little success.

Aquatic game-bird production (wild ducks and geese) was a small but growing industry in the second half of the 20th century. The market for mallard ducks and the Canadian goose as food was increasing. Other species were produced only in small numbers.

Licences and Permits.—In the United States a state licence is required to raise game birds in captivity. Such a licence and copies of laws pertaining to game bird production may be obtained from the state game or conservation commission. In most states, usually under certain restrictions, game birds raised in pens may be sold for food. Over 30 states allowed the sales of all kinds of pen-raised game birds for meat; three states restricted sales to pheasant exclusively, and one state limited sales to exotic species.

The canning of pheasant was carried on in several states and quick-freezing was used in others. To buy or sell migratory waterfowl, including wild ducks, geese or swans raised in captivity, a federal permit is required from the U.S. department of the interior's fish and wildlife service.

Developments.—Raising game birds often has been a profitable undertaking, if operated as a business. In the suburbs, persons sometimes have raised birds in back yards and on adjacent land, rented for the purpose. In this manner, the overhead was kept at a minimum and the cost of experience was low. Poultry dealers in the United States and Canada showed more interest in raising and selling game birds and the public was developing a taste for game-bird meat.

In the United States, pheasants were raised more extensively in the east, north central, middle Atlantic and Pacific coast states. Bobwhites were produced more extensively in the south Atlantic and east north central states. California quail were confined to the Pacific coast. In the second half of the 20th century 1 game bird was raised for every 38 domestic turkeys produced; 1 for every 16 ducks; 1 for every 2 pigeons; 1 for every 1.5 geese and 1 for every 1.3 guineas.

Most of the British game farms were established in their present

form in the first decade of the 20th century. They received a considerable stimulus after the end of World War I when many estates, from which the keepers had gone to war, needed to re-establish a breeding stock on short notice. From that date on, the idea of replenishing breeding stock from game farms spread to other countries outside Great Britain, of which Denmark and Hungary perhaps deserve special mention.

A considerable export trade had been built up and this, though sometimes limited by restrictions imposed by agricultural departments, was increasing in the second half of the 20th century. British game farms were exporting great numbers of birds to the countries of western Europe and Scandinavia and to some countries in South America, where high-density game production was becoming better understood and appreciated. Before World War II a considerable export trade had been carried on with countries in eastern Europe and with some of the Arab countries in the middle east.

Techniques.—In North America, feeding, breeding, management and marketing are similar to those of poultry production. The problems involved in game-bird farming were greatly simplified because of research conducted by federal and state experiment stations and by commercial feed companies.

Those raising game birds found that the completely mixed and balanced rations developed by the feed companies were quite satisfactory.

The cost of producing game birds in the second half of the 20th century was largely a labour cost. Practically all the equipment required to raise upland game birds could be built at home. Metal equipment (purchased from manufacturers and dealers) proved to be more durable than that made of wood and wire netting; it was also easier to clean and disinfect.

Birds adapted to small-scale production are quail, chukar and Hungarian partridge. It makes little difference whether a beginner starts with the bird or the egg. Eggs may be purchased for incubation by a hen or in an incubator. A small number of day-old chicks is also an inexpensive way to start raising game birds. Quite a few new game breeders begin operations with mature birds. The best location for pens is on high ground, sloping toward the east, with no wet places nearby where mosquitoes might breed. It was found that game birds should not be raised on ground previously occupied by poultry or other domesticated birds because of the danger of contracting their diseases; that the area about the pens should be kept free of manure piles, garbage heaps and other sources of contamination; and that the bird area should be enclosed with a 6-ft. chicken-wire fence to keep out stray dogs, cats and other animals.

Marketing.—Game birds may be sold alive as breeders, for restocking purposes and for meat. Those for food purposes are sold in feather or oven-dressed. The meat may be marketed fresh, quick-frozen or canned. In the second half of the 20th century clubs, restaurants and hotels offering game birds on their menus were increasing in the United States and Canada. Some larger and older game farms developed a lucrative business especially featuring game-bird gift packages. The leading food magazines carried advertisements offering birds in feather or oven-dressed, attractively wrapped and boxed.

In addition to marketing native game birds, several of the larger farms imported and sold birds such as Scotch grouse and English red-leg partridge.

See also POULTRY AND POULTRY FARMING.

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(F. G. A.)

GAMELAN, the name for the indigenous orchestras of Java and Bali. The bulk of the orchestra consists of several varieties of gongs and of instruments of the xylophone type. The gongs are either vertically suspended or, as with the kettle-shaped *bonang*, are placed flat. The xylophone type includes instruments with metal plates, or "keys," freely suspended (the *saron*) or placed on top of resonance tubes (the *gendèr*) and xylophones proper, viz., with wooden keys (the *gamban kayu*). The task of playing a sustained melody falls either to the bamboo flute (*suling*), to a bowed string instrument (*rebab*) or to the human voice—especially when, as often occurs, the gamelan is used in theatrical performances, known as *wayang*. The voice is then part of the orchestral texture. Dominating these two groups is the drum (the *kendang*), uniting them and acting as leader.

The highly developed polyphony or heterophony of the gamelan has a rhythmic origin. A nuclear theme extends over a number of "bars" (almost invariably in 4/4 time), against which other instruments play a largely independent countermelody. Another group plays rhythmical paraphrases of this theme, and a fourth group fills out the texture with delicate rhythmical improvisations. Highly important are the punctuating, or colotomic, instruments that divide the musical sentence, marking, as it were, the commas, semicolons and full stops. This last-named function is entrusted to the big gong. Over this scintillating pattern of hammered sound floats the uninterrupted melodic line of the voice, the flute or the *rebab*.

This type of music with its peculiar tonal system is not confined to the Indonesian archipelago but has close relatives in other parts of southeast Asia, particularly in Burma and Thailand. Nowhere else, however, has it attained such refinement. In view of undeniable kinship with prehistoric lithophones (stone chimes) discovered in Indochina, it seems likely that the music of the gamelan was brought to the Indonesian archipelago by migrant tribes from the mainland. Some scholars believe that the scales of Java and Bali are of Chinese origin, possibly from the pre-emigration period. The main outside influences certainly came from China and—until about A.D. 900—from India. Following the conversion (*c.* 1300) of the archipelago (except Bali) to the Islamic religion, Persian-Arabic influences made themselves felt. In view of the basically different scale systems of India and Indonesia, Indian influence is not immediately apparent, but it is possible that the Indonesian modal character and the connection of its modal patterns (*patet*) with special episodes of dramatic performances are derived from Indian conceptions. The name of one of the two scales in use, the pentatonic *sléndro*, is sometimes thought to have been derived from Shailendra, the name of an Indian dynasty during the latter half of the first millennium. Certainly the *sléndro* scale, if it is of Indian origin, has completely coalesced with the indigenous system and flourishes side by side with the heptatonic *pélog*. Many of the Indian instruments, however, that are depicted on ancient Hindu-Javanese temples have disappeared. The melody-carrying *rebab* is of Persian-Arabic origin.

Although the gamelan styles of Java and Bali are closely related they are strongly differentiated individually, perhaps because the finest of the Javanese gamelans were developed at the highly formalized courts of middle Java, whereas in Bali art belongs to people of all strata of society and is an expression of their natural exuberance.

See Jaap Kunst, *Music in Java* (1949); Mantle Hood, *The Nuclear Theme as Determinant of Patet in Javanese Music* (1954).
(AR. A. B.)

GAMELIN, MAURICE GUSTAVE (1872–1958), French army officer, was born in Paris on Sept. 20, 1872. Commissioned from St. Cyr in 1893, he served in World War I, first on Gen. Joseph Joffre's staff, then as division commander. After that war he headed a military mission to Brazil until 1925, when he assumed command of French forces in the Levant. He became army chief of staff in 1931, vice-president of the Conseil Supérieur de la Guerre and army inspector general in 1935, and finally chief of staff of national defense in 1938.

In World War II Gamelin commanded the Allied forces on the western front until May 1940, when his armies fell before the German offensive. Relieved of his command, he was subsequently arrested, placed on trial to answer for the defeat and then, in 1943, interned in Germany, where he remained until May 1945. He died in Paris on April 18, 1958.

Gamelin's memoirs were published under the title *Servir*, three volumes (1946–47).
(M. V.)

GAMELINE (?–1271), lord chancellor of Scotland and bishop of St. Andrews. He was named lord chancellor in 1250 and was made one of Pope Innocent IV's chaplains in 1254. In the following year he was elected bishop of St. Andrews by the prior and canons and subsequently confirmed by the king and council. During a political upheaval Gameline fell into disfavour at court and was forced to leave the country. His enemies accused him on several charges, but when he submitted his case to the pope he was acquitted and later returned to his see. In 1267 he was again involved in a controversy with the court. He died on April 29, 1271, and was buried in his cathedral at St. Andrews.

GAMELYN, THE TALE OF, a verse romance written about the middle of the 14th century and once ascribed to Geoffrey Chaucer because the only existing version was found in a manuscript of his *Canterbury Tales*. It is generally believed that Chaucer planned to develop it as one of the *Tales*.

The tale, about 900 lines in length, concerns the youngest of three brothers who is robbed of his inheritance and persecuted by the eldest brother and finally triumphs with the aid of a band of outlaws. The story was used by Thomas Lodge in his novel *Rosalynde*, which was later to provide the basis for Shakespeare's comedy *As You Like It*. The original story has no "love interest" as embodied in Rosalind and Celia of Shakespeare's version but is simply an account of the young brother's adventures.

GAME RESERVES: *see* NATIONAL PARKS AND NATURE RESERVES; WILDLIFE CONSERVATION.

GAMES (ARTICLES ON). Histories of games exhibit significant links between widely separated eras and cultures. Among the articles in which these relationships are discussed is BOARD GAMES, which describes the origins and variants of familiar games, some more than 4,000 years old, others built around present-day fads. Individual articles dealing with board games include BACKGAMMON; BINGO; CHECKERS; CHESS; CRIBBAGE; DOMINOES; GO; MAH-JONGG; NINE MEN'S MORRIS.

CARDS, PLAYING summarizes the lore of cards in the east and west. Articles devoted to individual card games include BOSTON; BRIDGE; CANASTA; HEARTS; POKER; RUMMY; SOLITAIRE; WHIST.

DICE traces the history of these ancient instruments of chance, and describes modern dice games. The odds in favour of various simple combinations are discussed in this article, as well as in POKER. The computation of more intricate factors is treated in the mathematical articles GAMES, THEORY OF, and PROBABILITY, MATHEMATICAL.

The widespread occurrence of wagering, its history and modern legislation on the subject are discussed in GAMBLING.

The folklore and present-day practice of children's games are discussed in CHILDREN'S GAMES AND SPORTS. Supplementary articles deal with these in detail; for example, JACKSTONES cites the contributions of Greek classics to the history of this simple form of play. In cases where a game is known by a variety of names, it is listed in the Index volume under each of the names.

For articles on athletic games *see* SPORTS (ARTICLES ON).

GAMES, CLASSICAL. Contests, mostly athletic, were a common feature of religious festivals, especially in Greece; to the Romans they were largely but not wholly a Greek importation. It is therefore convenient to discuss the two countries separately.

Greece.—The Greek name for competitive games was *agones*, probably in its original meaning of "assemblies"; the "events" were known as *athla*. The earliest of which any record remains were funeral games, for instance the games at Patroclus' funeral in the *Iliad* of Homer, book 23. Hence, attempts have been made to deduce all Greek *agones* from funerals or other commemorations of the dead. This view, however, is not sufficiently supported by the known facts and is especially opposed to the clear evidence that most *agones* of any importance were held in honour not of underworld gods but of celestial gods such as Zeus or Poseidon (*see* below). Some have also tried to make out that the events themselves originated in ritual of some kind, for example the foot races from certain rites involving running. This again lacks evidence and is not very likely in itself. The Greeks, from the earliest times of which anything is known, were a sport-loving people and, given a holiday crowd whose time was not wholly occupied with sacrifices, funeral ceremonies or other rites, it would be natural for them to begin racing, wrestling, boxing and the like. These were the normal events at almost every *agon* of which any accurate record remains; for instance, at Olympia (*see* below) the oldest event was traditionally the *stadion*, roughly equivalent to the modern 220-yd. race (1 *stade* = 600 Greek feet = a little over 200 English yards).

In historical times the Greek *agones* were divided into two classes: those which gave no prize of monetary value but only a wreath to victors, and those which offered prizes of some worth in themselves, such as olive oil (at the Panathenaea) or a cloak of local manufacture (at Pellene). To the former category there belonged but four *agones*, often known as *hieroi* ("sacred") or *stephanitai* ("garlanded"). These, however, were by far the best known and most popular.

Olympic Games.—The oldest and most famous of all were the Olympic games in honour of Zeus, held at Olympia in the territory of Elis in the northwestern Peloponnese. Traditionally the first celebration was held in 776 B.C., or earlier still, for Heracles was often credited with having held it. The festival was held every four years or, to speak more accurately, at intervals of alternately 49 and 50 lunar months; the difference was the result of intercalation (*see* CALENDAR; *Greek Calendar*). Chronologers, but unfortunately not very early ones, found in this regular recurrence a handy basis for their calculations, and record for instance that the battles of Thermopylae and Salamis occurred in Olympiad 75, year 1, now called 480 B.C. An Olympiad is the space of time from one celebration of the festival to the next. The meeting place was a great precinct sacred to Zeus, though other deities, including Hera and Kronos, were also worshiped in it, and offerings were made to the hero Pelops, whose burial place was supposed to be there. The site has been excavated; for a description of the remains, *see* OLYMPIA. Visitors and competitors came from all parts of Greece. Apart from the priestess of Demeter Chamyne, married women were debarred from watching the games; prohibition of women spectators is not peculiar to Olympia, though by no means universal.

The athletes, who had to be Greeks (later, with the help of mythological genealogies and the like, Macedonians and afterward Romans were admitted), had undergone a long and rigorous training and were protected, as were all pilgrims to the holy place, by a sacred truce (*ekecheiria*) to violate which was a most grievous sacrilege, strongly resented by public opinion. The management of the athletics was in the hands of Elean officials, the *Hellanodikai*, whose fairness to all concerned was a byword in Greece. The territory of Elis itself was generally held sacred and spared invasion in consequence.

The program was extremely varied; it included horse and chariot races, foot races of different lengths, wrestling, boxing, the *pankration* (a kind of ground wrestling, with striking, etc., allowed) and an event called the *pentathlon* ("fivefold contest"), comprising standing broad jump, short foot race, discus throwing, javelin throwing and finally wrestling. All these were normally to be found in other games also, though local peculiarities and special events occurred. Contestants were entirely naked and classification was by age alone (boys, adolescents, men), no such distinction as that between heavyweight, lightweight, etc., being known. In chariot races the owner of the team was the official victor, not the actual charioteer, who was generally a hired expert in the owner's service; the same applied to horseback races.

To win any event at Olympia was a great distinction not only for the victor but for his city. He would hold a celebration, attended by his friends, on the spot after the contest, and then make a triumphal return to his home, wearing his garland, which was cut from a sacred wild olive. His entry was often through a breach in the town wall made especially for him; a feast was held in his honour and at it an ode specially composed, often by a distinguished poet, was performed by a choir in praise of him and his family. Four nearly complete books of such odes by Pindar, one for each of the four great games but including a few pieces intended for victories at minor festivals, survive. Far from being monotonous or jejune, they have been made by Pindar's genius into some of the greatest lyric poems in Greek literature. Inferior to Pindar,

but still very good, are some poems on the same kind of themes by Bacchylides, nephew of Simonides, which came to light at the end of the 19th century.

Pythian Games.—The Pythian games, held at Delphi in honour of Apollo, were again quadrennial, the interval being known as a Pythiad and each Pythiad beginning in the third year of an Olympiad. The horse and chariot races were not held, like the other events, in the sacred precinct, which is a rocky terrace on the slope of Mt. Parnassus and not large enough for such events. Instead, they took place in the Crisaean plain at the foot of the mountain, which was regarded as the property of Apollo. A distinctive feature of the festival was that it included a musical competition. The wreath was of sweet laurel (bay), Apollo's plant. Originally, it is said, the Pythian games were held but once in eight years; they became quadrennial and Panhellenic in 582 B.C.

Isthmian Games.—The Olympic and Pythian festivals occurred late in the summer, about August; the Isthmian games seem to have been held about April or May. They were biennial, in the second and fourth year of every Olympiad. Generally presided over by Corinth and being at a spot as central and accessible as the isthmus, they were popular and well attended, though a victory at them had nothing like the prestige of one at Olympia. As with all the great games, competitors and visitors were protected by a sacred truce. The god in whose honour the festival was held was Poseidon; with him was worshiped Melicertes-Palaemon, in mythology the little son of Athamas and Ino, who became a sea-god when his mother leaped with him into the sea to escape his father. Apart from a few legends, next to nothing is known of the early history of the Isthmia, but they were reorganized about the same time as the Pythian games. The wreath was of dry wild celery (*selinon*, commonly miscalled parsley); later, Poseidon's sacred tree, the pine, furnished the material.

Nemean Games.—Finally, the Nemean games were held in honour of Zeus, who had a sanctuary in the valley of Nemea, near Phlius in the Argolid. Becoming Panhellenic in 573 B.C., they were presided over by Cleonae until, in 460 or thereabouts, Argos seized and kept the presidency. They again were biennial, occurring about July in the same years as the Isthmia. The wreath was of fresh wild celery. Here the god was associated with a dead child, Archemorus, whose funeral, elaborately celebrated by the Seven against Thebes, was alleged to have been the origin of the games.

Others.—The great age of all these and similar events was the classical period (5th century B.C.). Later athletics degenerated into professionalism and experts in the various sports spent their time in going from one contest to another, sometimes winning at them all and styling themselves *periodonikai* or "all-round victors" in consequence. Sports of all kinds were the hallmark of a Greek gentleman of the old school from the time of Homer onward (in *Odyssey* viii an impudent young Phaeacian taunts Odysseus with knowing no *athla;* Odysseus, by way of rejoinder, catches up a heavy discus, throws it much farther than any of the local competitors and challenges all and sundry to any event except running, for which he feels too tired and stiff after his shipwreck). Some sports at least were apparently of military origin: it clearly was needful for a Greek soldier to be able to run, jump and throw a javelin, and one event found in the programs of many games was the hoplite race, competitors in which, instead of being naked, wore their armour or at least, to judge from vase paintings, carried helmets and shields.

Competition in all manner of skills was also characteristically Greek; hence athletic festivals were numerous and varied, though none of the others attained the celebrity of the great games. Athens, for instance, had its quadrennial Great Panathenaea in which the prizes were large jars of oil from the sacred olives, each jar having a representation of an archaic and hieratically stiff Athena. The program there included an event very characteristic of a naval power, a sort of regatta in the harbour. Thebes had a festival in honour of the hero Iolaus; Argos had its "shield" or "bronze" associated somehow with an ancient shield said to have been dedicated by Diomedes. Sparta had several local festivals; indeed it would be hard to name a place of any importance that had not some such event held annually or at longer intervals.

Gymnasiums and wrestling schools (*palaestrae*) were among the commonest of public buildings; they were generally well laid out, surrounded by colonnades in which onlookers or resting competitors could walk or sit and of course talk. Aristotle's followers got their name of Peripatetics from having originally used these *peripatoi* ("walk-around places"), as they were called, for their meetings, and more than one Platonic dialogue has such a setting. The widespread dislike of handicrafts and trade among the upper classes was connected with all this; a man who is busy at his counter or in his workshop has not time to become a good athlete.

Methods and Rules.—The methods employed differed somewhat from those of modern times. Rules there undoubtedly were, and umpires armed with sticks stood by to deal with anyone who broke them. Runners had much the same action as those of modern times; vase paintings give surprisingly accurate pictures of the leg action of both sprinters and long-distance racers, although, apparently by a mere convention of art, the right and left arms are frequently shown swinging with the right and left legs respectively. Boxers seem to have aimed mostly at the head and not to have recognized the importance of body blows; they protected their hands with *himantes*, long straps of soft leather wound around the fists. Wrestlers, after rubbing themselves over with olive oil (a regular feature of the toilet; everyone carried a small oil flask, *lekythos*, and a word for a well-groomed man is *liparos*, "oily"), threw dust over their bodies, presumably to give the opponent a grip, for the wrestling seems always to have been catch-as-catch-can (*see* WRESTLING). Only clean falls counted; the winner must still be on his feet when his opponent is down. Thus in Homer, when Odysseus comes down on his back with Ajax on top of him, the bout is a draw. No accurate information is available about ancient "records." An epigram concerning a notable athlete named Phayllus, from Croton, says that he leaped 55 ft., an obvious impossibility for a standing broad jump, and threw a discus 95 ft., which is quite credible, given the Greek method of throwing without a turn. As 50 is a conventional number in Greek, like 40 in Hebrew, the statement about his jump may mean merely that he leaped a surprising distance, surpassing everyone else. Jumpers helped themselves by swinging *halteres*, a kind of dumbbell. A few stories concerning the prodigious strength of this or that noteworthy athlete are of no help.

Other Pastimes.—As well as these sports, the Greeks had a number of pastimes, both indoors and out. Of the latter, it is known that they had the tug of war and various ball games, including one played with sticks shaped something like the letter *J* that seems to have resembled hockey. Nothing of the rules is known, however, nor even whether or not they were played between organized teams. In their climate they had of course no winter sports. Indoors they had various games played with dice, one of them with three dice (the usual number) and a board suggestive of backgammon, and it is known that the pieces were moved in accordance with the throw of the dice. There was another board game, *pessoi*, which seems to have been something like checkers (draughts). Knucklebones, whether the actual bones from a sheep's hind legs or models of them, were often used, especially by children, as a substitute for dice or for other games of a simple kind. Card games did not then exist.

Cottabus, a game of Sicilian origin, was popular at drinking parties all over Greece. In its simplest form the reclining guests attempted to throw the remains of their wine from their cups into a metal bowl; the important conditions were that no drop should be spilled in the process and that a distinct splashing noise should be made on impact. Variations, which required considerable skill, included the sinking of shallow saucers floating in a basin of water under the same conditions, and casting the wine into a scale pan, apparently to make it sink and touch a figure called Manes placed beneath.

Rome.—The Romans had, traditionally as an importation from Etruria, the savage amusement of gladiatorial combats; that this practice, which seems to have been characteristic especially of elaborate funerals, was a substitute for human sacrifice is the ancient and plausible explanation. A funeral in 264 B.C. is said to have been the first occasion. To the gladiatorial combat were

added fights with wild beasts (*venationes*) and both became extremely popular at public exhibitions. They were called *munera* ("public functions" or "duties"), however, not *ludi* ("games"). Another rite, this one native Roman, had a flavour of sport about it. On Oct. 15 every year the October horse (*equus October*) was sacrificed. This was the off (*i.e.*, right-hand) horse of the winning team in a chariot race held in honour of Mars in the Campus Martius. Certain curious and archaic ceremonies were gone through in connection with the horse's body.

Public Games.—Hence some materials for a public spectacle were ready to hand when first the practice of offering games (*ludi*) to the gods was instituted. Originally they were occasional affairs, the result of a vow by some person in authority, for instance a general on campaign. The basic idea appears to have been simply that the gods, like human spectators, would be pleased and amused with what went on.

The regular place for the games was the Circus Maximus in the valley between the Palatine and Aventine hills and the most characteristic event was the chariot race. Most often run with four-horse teams, this was obviously a great test of the skill and courage of the charioteers, as it was also in Greece, for the chariots, long disused in warfare but retained for sporting purposes, were light, fragile affairs, easily smashed in a collision, when the driver was very likely to be entangled in the long reins and dragged to death or serious injury. This no doubt was an added attraction for the crowd that watched; there was a vein of cruelty in the Roman temperament. In imperial times there were four chariot factions, each having its supporters. The principal ones were the Blues and the Greens and enthusiasm for the favourite colour often led to disorders; the poet Juvenal sarcastically says that if the Greens lost the whole city would be as downcast as if some great national defeat had been incurred.

The oldest of the regular games, the *Ludi Romani*, or *Magni*, in honour of Jupiter, seem to have been made annual in 366 B.C. Several others followed in republican times in honour of sundry deities native and foreign (*Ludi Apollinares*, in honour of Apollo; *Megalensia* or *Megalesia*, in honour of Cybele, the Great Mother of the Gods, whose cult was imported toward the end of the Second Punic War).

Most of these differed in no serious respect from the *Ludi Romani* as regards the program. The *Megalensia*, however, and following them several other festivals, took on a new aspect and came to be known as *ludi scaenici*, literally "stage games." A sort of theatrical performance consisting of songs and dancing had long been known; it was an Etruscan importation, the actors being called by their Etruscan name of *histriones*. But from the 3rd century B.C. onward there was a demand for regular drama of Greek type, both tragedy and comedy, the first author of both being Livius Andronicus (*q.v.*), the earliest Latin poet known, though he was in fact a Greek from Tarentum. Temporary stage buildings and rough accommodation for the audience were provided. The *ludi scaenici*, like other games, were managed by magistrates, especially the aediles. A grant of money was made by the state but it regularly proved insufficient and the senior presiding magistrate would furnish the extra money himself, sometimes to a ruinous amount, for to give a fine spectacle was a sure way of winning popularity and consequently support at elections.

All games regularly began with a procession, the *pompa circensis*, much resembling a triumph. The magistrate responsible for the performance rode in a chariot, wearing a special costume, obviously royal, with a huge crown held over his head by a slave. A special feature of the procession was the carriages (*tensae*), which carried figures or emblems of the gods and were conducted by boys both of whose parents were alive. In later times deified emperors were added to the older deities. As time went on sundry elaborate buildings were put up in addition to the ancient Circus, the best known being the Flavian amphitheatre, or Colosseum.

In the *ludi scaenici* serious plays and regular comedies gave way in time to farces (*mimi*) and the performances of *pantomimi*, ballet dancers. But the gladiatorial shows and the chariot races held their own until well after the establishment of Christianity. It is said that a monk named Telemachus in A.D. 404 tried to separate the fighters and was killed, but he achieved his end, for the then emperor Honorius issued an edict abolishing gladiatorial fights.

An exceptional event was the secular games (*q.v.*), of doubtful origin and antiquity but revived splendidly by Augustus in 17 B.C.; they were supposed to occur but once in every *saeculum* ("age"), a space of time computed at 110 years, but a number of other emperors emulated Augustus, using calculations different from his to learn when the last *saeculum* ended. Besides very elaborate religious rites, they included all the performances familiar from the regular games.

Other Pastimes.—As to private amusements, many of the Greek athletic practices were adopted, and indeed Greek athletes, of course professionals, were on occasion shown to Roman audiences. The regular place of exercise was the Campus Martius. There was a certain prejudice, however, against too much indulgence in Greek sports to the neglect of the traditional Roman exercises, which seem to have been of a more decidedly military type. Furthermore the Romans did not strip entirely, being in that respect much more prudish than the Greeks. They also had ball games, one being called *trigon*, possibly something like fives (*q.v.*); others, it would seem, were simply more or less elaborate throwings and catchings of a larger or smaller ball. A traditional sport for the boys of good family was the *lusus Troiae*, "Troy game," a kind of sham fight on horseback. Of indoor games there were several. Children had tops, known also to the Greeks, and nuts with which they played (among others) a guessing game, one player challenging the other to say whether he held an odd or an even number of nuts in his closed fist. Dicing was common among older players, some of whom were as wild gamblers as any English noble of the 18th century; hence various attempts to stop the practice by legislation.

There were also board games, the most celebrated being the "twelve lines" (*duodecim scripta*), something of the type of backgammon, and the *ludus latrunculorum*, "game of robbers," apparently one of pure skill, something like checkers or rather more complicated; certainly it was not identical with chess, which was not then known, at least not in the west, but perhaps was not altogether unlike it.

BIBLIOGRAPHY.—The most convenient book in English for Greece is E. N. Gardiner, *Greek Athletic Sports and Festivals* (1910). For Rome, G. Wissowa, *Religion und Kultus der Römer* (1912) has a short account of the games, and the old work of J. Marquardt, *Das Privatleben der Römer*, 2nd ed. rev. by A. Mau, pp. 834 ff. (1886) is still useful for its abundant citations from ancient authorities. *See* also E. N. Gardiner, *Athletics of the Ancient World* (1930). (H. J. R.)

GAMES, THEORY OF, is a branch of mathematics that aims to analyze various problems of conflict by abstracting common strategic features for study in theoretical models—termed games because they are patterned on actual games such as bridge and poker. By stressing strategic aspects (*i.e.*, aspects controlled by the participants), it goes beyond the classical theory of probability, in which the treatment of games is limited to aspects of pure chance. A theory of games of strategy, broached in 1921 by Émile Borel, was established in 1928 by John von Neumann, who went on, with Oskar Morgenstern, to develop it as a means of dealing with competitive economic behaviour. Their joint work (published in 1944) stemmed from the presence, both in actual games and in economic situations, of several common factors, such as conflicting interests, incomplete information and the interplay of rational decision and chance. Although most actual games elude full-scale analysis because of the amount of intricate cataloguing and computing that would be required, many can be analyzed in miniature or simplified form. Of greater consequence, perhaps, is the opening to mathematical attack of a wide range of gamelike problems not only in economics but also in sociology, psychology, politics and war.

CLASSIFICATION OF GAMES

The theory identifies a game, for analysis, as: (1) singular, dual or plural; (2) extensive or normalized; (3) finite or infinite. This three-way classification highlights strategic likenesses and differences in games, reflecting results of the theory and divisions within it.

Singular, Dual and Plural Games.—In classifying games by the number of players, the significant figure is not the number of individuals involved but rather the number of parties with distinct interests actively represented in the play. It is assumed specifically that these interests are measured in terms of money or some other numerical scale of utility. This assumption is discussed below under *Utility*. The presence of only one such interest, though there may be more than one participant, characterizes a game as singular. Typical are solitaire card games, many types of puzzles and problems of an isolated economic unit with a single goal (*e.g.*, Robinson Crusoe). Such games are distinguished by the absence of conflict; with no opponent to thwart his plans, the single player need only, in theory, list all his possible courses of action and then select the best, as measured on his scale of utility. Conflict enters with dual games (called zero-sum two-person games by Neumann and Morgenstern), played by two parties in diametric opposition—what one wins, the other loses. Each party, in seeking an optimal course of action, must reckon with the possible actions of an opponent with contrary aims. This direct conflict of interests is exemplified by two-person board games such as chess, two-handed card games such as cribbage and two-team card games such as bridge. In contrast, the presence of active interests that are not diametrically opposed stamps a game as plural. All games having more than two active interests fall in this class; so do two-party bargaining situations in which the parties stand to gain by reaching an agreement.

Extensive and Normalized Forms.—From the rules of any game, two abstract forms can be obtained. The extensive form of a game eliminates all features which refer specifically to the means of playing it—all those features which characterize it as a card game, a dice game or an economic conflict. Thus the extensive form amounts to a literal translation of the rules into the technical terms of a formal system designed to describe all games. The normalized form is a more condensed version of the game, stripped of all features but the choice of over-all strategies.

The raw material for the extensive form comes from the common elements of strategic games, such as the interrelations between the players' choices, the variety and character of information available to them and the effect of chance on the play. The object of a systematic description of these features is to isolate those junctures at which a player is called upon to make a choice and the states of information on which his choices are based. From this analysis emerges a precise definition of the first key concept on which the theory of games has been built. This is the notion of a pure strategy for a player; namely, a complete set of advance instructions that specifies a definite choice for every conceivable situation in which the player may be required to act. Such a set of instructions represents a total plan that covers all contingencies the player may face during any playing of the game, whether these are attributable to choices of other players or to events governed by chance; its execution could be delegated perfectly well to an agent without discretionary power. The complexity imposed on a single pure strategy by its completeness, and the enormous number of pure strategies that may need cataloguing, explain the failure of the theory to analyze most common parlour games. However, the practical difficulties do not prevent the enumeration in theory of all the pure strategies of a game.

While the extensive form of a game may have a large number of moves, or junctures at which a player must make a choice, in the normalized form each player makes only one move, which consists of a single choice from his set of pure strategies. As a result, the game is replaced by the following prototype: Each player chooses a pure strategy, making his choice in absolute ignorance of the choices of the other players. After all strategies have been chosen, they are submitted to an umpire who charts the course of the play, making chance moves in accordance with the probabilities dictated by the rules and otherwise using the choices given by the players' pure strategies. In this way there is determined for each player a set of outcomes with associated probabilities, the "expected" value of which constitutes the player's payoff.

Finite and Infinite Games.—In most games the number of pure strategies available to the players is finite because the rules ordinarily make the game terminate after a finite number of occasions for choice by the players, and because, at each occasion, a player is usually confronted by a finite number of alternatives.

Games with an infinite number of strategies often arise as idealizations of situations that are too complicated to handle in their original form (such as replacing the full, but finite, range of poker hands by a continuum of numbers). It has proved possible in this way to treat problems of many sorts as normalized dual games in which the pure strategies for each player are represented by the real numbers from zero to one (called games on a square). Infinite games have also provided a fertile source of pathological examples that offer a contrast to the regular properties found in the finite case. In a different direction, Abraham Wald's theory of statistical decision has shown that the general problem of statistical inference may be regarded as an infinite dual game in which the statistician is pitted against nature.

UTILITY

The fundamental problem of the theory of games is to find the methods by which a player can obtain what is called a most favourable result. In the first development of the theory, the most favourable result was identified with the greatest expected (monetary) gain, since this, or some similar assumption, is necessary if probabilistic methods are to be applied. However, there are strong objections to the principle of maximizing expected winnings as a prescription for behaviour and these led to a re-examination of the concept of utility.

To understand these objections and the modern theory of utility that resulted, consider the following situation: Let a player be required to choose an integer from 1, 2, . . . , n, and then paid a sum of money P_n which depends upon his choice of n. If the player always prefers more money to less, then rational behaviour is clear in this situation of certainty; namely, the player should choose n so as to make P_n as large as possible. If this situation is altered to introduce uncertainty and risk, then the rule is no longer obvious.

To illustrate with the classical example of the St. Petersburg paradox, imagine a player who is confronted with a choice between the status quo and the payment of an entry fee F for an infinite set of lottery tickets numbered 1, 2, . . . , n, ... The lottery ticket n is to pay the amount 2^n with associated odds of one chance in 2^n. The rule of maximizing expected winnings counsels the purchase of the lottery tickets, no matter how high the entry fee F. However, numerical examples persuade many people of the advantages of the status quo; for example, with $F = \$128$, there is but one chance in 64 that a player who chooses the lottery tickets will break even, and he will otherwise lose at least $64. If the game is to be played but once, it would mean assuming a high risk for the prospect of highly improbable winnings.

To resolve this paradox, Daniel Bernoulli suggested that people do not follow monetary value as an index for preferences but rather are concerned with the moral worth of money. Further, in a situation involving risk, they seek to maximize the expected value of moral worth (what has been called moral expectation). Finally, he proposed a quite serviceable function to measure the moral worth of an amount of money; *i.e.*, its logarithm.

Whatever the defects of this function as a universal measure of preferences, there is a need for a numerical index which will reflect accurately the choices of an individual in situations of risk. Interest in this problem was first shown by F. P. Ramsey who went beyond Bernoulli when he defined utility operationally in terms of individual behaviour. Independently, Neumann and Morgenstern confronted this problem while they were laying the foundations for the theory of games. Informally, they showed that if a player is able to express his preferences between every possible pair of gambles on outcomes in a consistent manner, then there exists a utility function defined on the possible outcomes such that its expected value is an accurate guide to the player's choices in situations of risk. This numerical measure of utility permits the definition of the most favourable result as that with the greatest utility.

NORMALIZED DUAL GAMES

Matrix Games; Saddlepoints.—A finite dual game, when normalized, has a very simple conceptual scheme. Each of the players, A and B, chooses a pure strategy from a finite list, without knowing the other's choice. The outcome thus determined can be specified by a single number P, the payoff A stands to receive: positive, negative or zero according as A wins from B, loses or draws. By the diametric opposition characteristic of a dual game, B then stands to win $-P$. In this way the game is described by a rectangular array of numbers, in which each horizontal row corresponds to a pure strategy for A and each vertical column to a pure strategy for B; the entry P common to the row and column is the payoff to A from B that these pure strategies produce. The array of numbers is called the payoff matrix; normalized finite dual games presented in such form are called matrix games. (Examples appear in Tables I and II; in each case the payoff matrix is the central box of arabic numbers.) Since the matrix entries represent gains to A and losses to B, A's aim is to maximize and B's to minimize the result that comes out of the matrix.

As A weighs the consequences of various courses of action open to him in a dual game, the theory of games counsels him to gauge each by the gain it assures him, regardless of what B does. In effect, this is equivalent to the pessimistic assumption by A that B knowns his plan and will counter it to limit his gain to a bare minimum. So, to maximize his assured gain, A is led to seek a maximum of minima, abbreviated max-min; he should act so as to make as great as possible the least gain to which B can limit him. The antithetical aim of B is to choose a course of action that will hold to a minimum the greatest loss A may inflict. Thus, B's goal is a minimum of maxima, abbreviated min-max. The clear fact that A cannot establish a floor under his possible gains that is higher than the ceiling B succeeds in placing over his possible losses is expressed by the formula:

$$\text{A's gain-floor} = \max\text{-}\min \leqq \min\text{-}\max = \text{B's loss-ceiling}$$

With evaluation limited to pure strategies only, this is the most precise statement that can be made for the entire class of dual games. (The effect of further restrictions is considered below under *Extensive Games—A Poker Example.*) The highest gain-floor for A, using a single pure strategy, is obtained by choosing the strategy row in which the least entry is greatest; the lowest loss-ceiling for B, using a single pure strategy, is obtained by choosing the strategy column in which the greatest entry is least. These two values are equal only when there is an entry in the payoff matrix which is, at the same time, the least in its row and the greatest in its column. Such an entry is called a saddlepoint; *e.g., see* Table I, case (3), where the entry 3 is a saddlepoint.

Mixed Strategies; Minimax Theorem.—To close the gap between max-min and min-max in the general case in which the payoff matrix contains no saddlepoint, it is necessary to broaden the concept of strategy. Although the decisive innovation of weighted averages of pure strategies occurred in 1713 (in the solution of Le Her by Waldegrave as reported in the last letter of the correspondence between Raimond de Montmort and Nicholas Bernoulli), it was not exploited fully until it was rediscovered by Neumann (as well as Borel and R. A. Fisher). In the broadened concept the frequencies with which a player uses his pure strategies in the long run are specified by weights (some but not all of which may be zero). Operationally, the selection of the pure strategy to be used in a particular playing of the game is left to a suitable chance mechanism, which selects in a random manner from among the pure strategies in accordance with the weights the player has chosen (*e.g.*, in matching pennies, as ordinarily played, the pure strategy of showing heads uniformly and that of showing tails uniformly are randomized with equal weights by tossing the coin before showing it). This randomization by a chance mechanism avoids a mixture pattern from which the opponent might profit in the long run (*e.g.*, to alternate uniformly between heads and tails in matching pennies would weight them equally but be quite unwise in repeated play). Such a mixture of pure strategies, randomized in fixed proportions, is called a mixed strategy. It is clear that neither player's position is worsened by using mixed strategies since any pure strategy is still tenable as a mixed strategy by assigning nonzero weight only to it.

When A's gain-floor and B's loss-ceiling are re-evaluated in terms of mixed strategies, it turns out that in any matrix game

$$\max\text{-}\min = \min\text{-}\max$$

This minimax theorem of von Neumann (1928) is the main theorem of normalized finite dual games and the keystone of the whole theory. It shows that any such game has a solution consisting of (1) a minimax value (the common max-min and min-max), (2) an optimal mixed strategy for A that assures him a gain of at least the minimax value on the average and (3) an optimal mixed strategy for B that insures him against a loss on the average of more than the minimax value.

Examples of Matrix Games.—A and B choose whole numbers independently; A wins if the sum is odd, B wins if the sum is even. Roman numerals are used throughout to denote the numbers from which A and B make their choices. The first case shown in Table I is a very rudimentary dual game; it is the same as matching pennies, with B winning if head (I) matches head (I) or tail (II) matches tail (II), and A winning otherwise. The other four cases are variants which suggest the range of possibilities that arise even in small-scale dual games. Directly to the right of an A choice and below a B choice there appears the resulting payoff, positive if A wins (and B loses), negative if A loses (and B wins). In the rudimentary first case the amount of the payoff is simply one unit, but throughout the other four cases in Table I the amount of the payoff is the sum of the numbers chosen by A and B; *e.g.*, if A chooses I while B chooses III, as in cases (3), (4) and (5), the payoff entry is -4 because $1 + 3 = 4$, an even number, lost by A, won by B. The vertical column of weights listed for A in each case combines with a parallel column of payoffs to form the weighted payoff sum shown at the foot of that column; *e.g.*, in case (5), column I, $0(-2) + 15(-4) + 13(5) = 5$ is the weighted payoff sum. The horizontal row of weights listed for B combines with a parallel row of payoffs to form the weighted payoff sum shown at the right end of that row. These weighted sums become weighted averages when divided by the sum of the weights, written (with $\div$) at the lower right. By randomizing their choices with the particular weights listed, A and B achieve optimal strategies; on the average, A is assured of winning at least the minimax value shown and B against losing more than this value. To verify the solution in each case shown in Table I, observe that the minimax value is both the minimum of the A-weighted average payoffs and the maximum of the B-weighted average payoffs. Recall that in case (3) the payoff matrix has a saddlepoint; viz., the entry 3.

Symmetric Games.—A and B each show one or two fingers, at the same time calling aloud the numbers two, three or four in an attempt to guess the total number of fingers shown; a right call wins from a wrong call—otherwise it is a draw. This is a two-

TABLE I.—*Games of Odd and Even*

wt.		1	1	B
no.		I	II	
1	I	−1	1	0
1	II	1	−1	0
A		0	0	÷2

(1) minimax = 0

wt.		7	5	B
no.		I	II	
7	I	−2	3	1
5	II	3	−4	1
A		1	1	÷12

(2) minimax = $\frac{1}{12}$

wt.		1	0	B
no.		I	III	
0	I	−2	−4	−2
1	II	3	5	3
A		3	5	÷1

(3) minimax = 3

wt.		1	2	1	B
no.		I	II	III	
1	I	−2	3	−4	0
2	II	3	−4	5	0
1	III	−4	5	−6	0
A		0	0	0	÷4

(4) minimax = 0

wt.		0	17	0	0	11	B
no.		I	II	III	IV	V	
0	I	−2	3	−4	5	−6	−15
15	III	−4	5	−6	7	−8	−3
13	IV	5	−6	7	−8	9	−3
A		5	−3	1	1	−3	÷28

(5) minimax = $-\frac{3}{28}$

TABLE II.—*Two Games of Morra*

wt.			0	1	1	0	
show			I		II		B
		call	II	III	III	IV	
1	I	II	0	1	−1	0	0
0	I	III	−1	0	0	1	0
0	II	III	1	0	0	−1	0
1	II	IV	0	−1	1	0	0
A			0	0	0	0	÷2

wt.			0	20	15	0	
show			I		II		B
		call	II	III	III	IV	
0	I	II	0	2	−3	0	−5
21	I	III	−2	0	0	3	0
14	II	III	3	0	0	−4	0
0	II	IV	0	−3	4	0	0
A			0	0	0	7	÷35

finger form of an ancient game known as *morra* played today in Italy. In the rudimentary first version shown in Table II, the amount of the payoff is simply one unit for a win and zero for a draw; in the somewhat more sophisticated second version the amount of a winning payoff equals the total number of fingers shown by A and B (*e.g.*, if A shows I and calls II while B shows II and calls III, the payoff entry in the second version is −3, because the total number of fingers shown by A and B is 1 + 2 = 3 and hence A's call is wrong and B's right). In either version the game is fully symmetric: both players face identical choices and rewards. This is partly disguised by the tabulation, which presents the payoffs from the viewpoint of A. To interchange A with B, not only must horizontal payoff rows be transposed into vertical columns but also the sign of each payoff must be changed (to B's viewpoint). The net result of such a twofold shift leaves the payoff arrays in Table II just as they are—which is the characteristic property of the tabulation of a fully symmetric dual game. As a result of the symmetry, any optimal strategy for one player must also be optimal for the other and the minimax value must be zero. Consequently, in each of the above versions of *morra*, the listings of weights for A and B which achieve the zero minimax could be reversed and this shows that both players have more than one optimal strategy. Actually, in the first version any weights p, q, q, p yield an optimal strategy; and in the second version any weights o, p, q, o yield an optimal strategy, provided $p/(p + q)$ is a fraction between 20/35 and 21/35.

Computation of Solutions.—The solution of a matrix game with m columns and n rows of payoff entries amounts to the solution of a system of linear inequalities in $m + n + 1$ unknowns, A's m weights, B's n weights and the minimax value. The system comprises n inequalities which express the A-weighted average payoffs as equal to or greater than the minimax value and m inequalities which express the B-weighted average payoffs as equal to or less than the minimax value; in addition, the $m + n$ weights must be non-negative, reduced usually to fractional form with unit sum for each set, so that the weighted payoff sums become weighted averages without division. L. S. Shapley and R. N. Snow have shown that any basic solution of such a system is characterized as the unique solution of a suitably chosen subsystem of linear equations. As a result, the solution (if unique) or the full set of solutions (if more than one exist) can be determined by at most a finite number of arithmetic operations, but this number increases so rapidly, as the numbers m and n of rows and columns increase, that the solution of a large-scale matrix game by this method is formidable or impracticable.

The solution of a pair of dual linear programs, which call for maximizing and minimizing linear functions of several variables subject to constraints given by linear inequalities or equations, is equivalent to the solution of a matrix game, and vice versa, as was shown by George B. Dantzig and by David Gale, H. W. Kuhn and A. W. Tucker (*see* T. C. Koopmans *et al.* [eds.], *Activity Analysis of Production and Allocation*). Hence, the simplex method devised by Dantzig for linear programming can be applied to solve reasonably sized matrix games. Iterative procedures for approximating game solutions were formulated by George W Brown and Neumann to exploit high-speed computers.

Games on a Square.—Imagine the finite array of payoffs of a matrix game replaced by an infinite array of payoffs, one for each point of a square $OMLN$ (*see* fig. 1). Let A choose a point X in the edge OM and, independently, B a point Y in the edge ON; then have A get from B the payoff attached to the point of intersection of the lines XX' and YY' perpendicular to OM and ON. This is an infinite dual game on a square. Fig. 2 presents an example: A and B divide the area $OMJLKN$, formed by the square $OMLN$ and two isosceles right triangles MJL and LKN, by means of the lines XX'' and YY'' based on independent choices by A and B of X in OM and Y in ON; A gets the unshaded area, B the shaded area. By direct calculation, taking $OM = ON =$ one unit and $OX = x$, $OY = y$, the net payoff (A's area minus B's area) is found to be

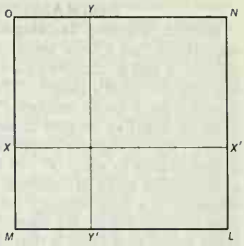


FIG. 1.—GAME ON A SQUARE (*see* TEXT FOR FURTHER EXPLANATION)

$$P = 4x + 2y + y^2 - x^2 - 4xy - 2$$

A wishes to maximize P; B to minimize P (*i.e.*, to maximize $-P$).

By analogy with a matrix game, a saddlepoint for a game on a square is at the intersection of a line XX' and a line YY', for which the payoff at the point of intersection is equal to or less than every other payoff on XX', and is equal to or greater than every other payoff on YY' (*see* fig. 1). (A saddlepoint is so called because it appears as an actual surface saddlepoint in the three-dimensional graph of the payoff over the square.) In the area-division game (fig. 2) $x = 0.8$, $y = 0.6$ give a saddlepoint having payoff 0.2, since the net payoff can be rearranged as:

$$P = 0.2 + (y - 0.6)^2 \text{ if } x = 0.8 \text{ and } P = 0.2 - (x - 0.8)^2 \text{ if } y = 0.6$$

By choosing $x = 0.8$, A assures himself at least 0.2, since $(y - 0.6)^2$ is never less than zero; while, by choosing $y = 0.6$, B guards against losing more than 0.2, since $-(x - 0.8)^2$ is never greater than zero. The claim that this point is a saddlepoint can also be verified by geometric reasoning, based on the fact that it is the critical position at which XX'' and YY'' bisect one another (in fig. 2).

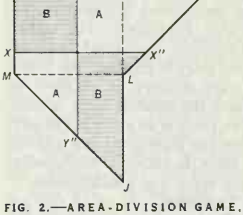


FIG. 2.—AREA-DIVISION GAME, SHOWING SADDLEPOINT DIVISION (*see* TEXT FOR FURTHER EXPLANATION)

The solution in pure strategies possessed by the area-division game is exceptional, because games on a square, like matrix games, do not usually possess saddlepoints. In general, each player must weight the points in his interval, OM or ON, if he is to do the best he can for himself. Such distributions of weights over an interval are known as probability distributions; they play a role analogous to that of mixed strategies in matrix games. Yet, even when both players employ probability distributions, the minimax theorem does not hold without some mild restriction on how the payoffs vary over the square. For the continuous case of payoffs without abrupt jumps, the equality of max-min and min-max was established by Jean Ville in 1938.

EXTENSIVE GAMES—A POKER EXAMPLE

Pure Strategies.—The primary objective of the study of a game in extensive form is the analysis of the combinatorial structure defined by the rules and its influence on the subsequent definition of strategies. This structure can be presented in the form of a branching diagram (of the sort exhibited in Table III) in which the junctures represent occasions at which a player or a chance mechanism (specified by the rules, such as cards, dice, etc.) is called upon to select one of the several branches that continue the course of the play. These branches contain the state of information of the next player. If the branching ceases at any stage, the play is over and the payments specified by the rules are listed.

Several junctures in the diagram may be prefixed with the same information for a single player (*e.g.*, in a card game, these may be situations that differ only in the unrevealed cards held by his opponents). For strategical purposes, a player must consider such junctures to be the same, since he cannot distinguish between two such junctures and hence cannot decide in advance to make distinct choices should one or the other occur in the course of play. This means that the problem of formulating a pure strategy for a player is solved by listing all his junctures with distinct states of information and making a definite choice of a branch for each. Such a plan fulfils the requirements for a pure strategy set forth previously.

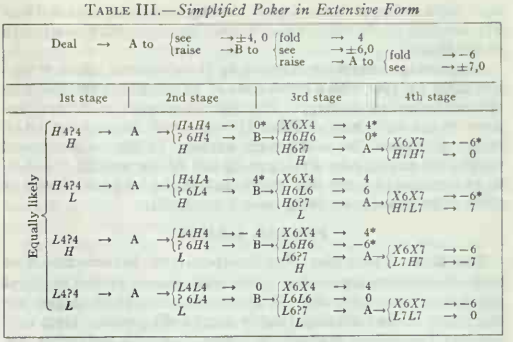
Historically, the first result on games in extensive form was stated (for the game of chess) by E. Zermelo and given a complete proof by Neumann. It applies to games with perfect information; that is, games in which a player is always informed of the complete previous history of the play. The theorem asserts that finite dual games with perfect information can always be solved by pure strategies without randomization. In other words, there is always a saddlepoint in the payoff matrix of such games. As regards chess, in particular, this means that exactly one of the following three alternatives is valid: (1) White has a pure strategy that wins, no matter what Black does; (2) both players have pure strategies that ensure at least a draw, no matter what the other does; (3) Black has a pure strategy that wins, no matter what White does. However, the theory gives no practical method for deciding which assertion is true.

Behaviour Strategies.—The lack of a solution in pure strategies for a general finite dual game means that a player must randomize his actions in some manner to obtain the amount due him (as measured by the minimax value). In the extensive form of a game, it is possible to introduce a method, alternative to that of mixed strategies, for varying his choices from contest to contest of the game in an undecipherable pattern. This method specifies by weights the long-run frequencies with which a player chooses the various alternatives presented to him in a given state of information. Rather than using a chance mechanism to select a complete plan prior to the playing of a game, a player employs such a device throughout the play, at each occasion for choice, to select an alternative in accordance with weights he has chosen. Such a decentralized system of play, randomizing the choices for each distinct state of information in fixed proportions, is called a behaviour strategy, since these weights are the statistics of a player's behaviour that an external observer could gather from a long series of contests.

Since the number of weights needed to specify a behaviour strategy is, in general, much smaller than the number of weights in a mixed strategy, it is useful to know when they produce the same results. H. W. Kuhn showed that a player can use either with equal success in any game with perfect recall; *i.e.*, any game in which a player's state of information always includes everything he has done or known previously. Poker is a game with perfect recall and hence can be played effectively with behaviour strategies. Bridge, on the other hand, does not have perfect recall since each player is a pair of persons, neither of whom is informed of the other's hand. Since there can be no correlation between the selections made by the chance devices for different states of information when a player employs a behaviour strategy, it is possible that bridge players must use mixed strategies to achieve the minimax value.

Simplified Poker.—A simplified version of poker is played by A and B with a deck containing a large number of cards marked high (*H*) and low (*L*). First, each player antes four chips and is dealt a single card; the four possible deals are assumed to be equally likely. Then A has two options: to "see," or to "raise" by adding two chips to the pot. If A decides to see, the higher hand wins the pot and equal hands split the pot equally. If A decides to raise, B has three options: to "fold," to see by adding two chips to the pot or to raise by adding three chips to the pot. If B folds, A wins the pot (with no hands revealed). If B sees, the higher hand wins the pot and equal hands split the pot equally. If B raises, A has two options: to fold, or to see by adding one chip to the pot. If A folds, B wins the pot (with no hands revealed). If A sees, the higher hand wins the pot and equal hands split the pot equally. (This simplified poker adds the possibility of a raise by B to the two-handed case [$S = 2$] of a simplified poker treated in Neumann and Morgenstern, *Theory of Games and Economic Behavior*, pp. 211–219.)

TABLE III.—*Simplified Poker in Extensive Form*



The possible sequences of choices by the players, independent of the actual cards held, are shown at the top of Table III. The player to act precedes, and his alternatives follow, each juncture. The possible payoffs (listed as A's gain, since this is a dual game) are given when the play is over. The precise payoff that occurs is determined by the cards held. In the body of Table III appears the complete branching diagram, taking account of the deal. Four-place symbols present the states of information. The first two symbols give the hand and current bet of A, the last two symbols give the hand and current bet of B. All are given as known to the player who is next to act; *e.g.*, the symbol ?6*L*4 preceding B means that B is to act, not knowing A's card, but knowing that A has bet six chips, and B holds a low card and has bet four chips. For ready reference, the actual card held is listed below each question mark. Whenever the play ends, the payoff to A is listed; if either player has folded, the symbol *X* is used to indicate that neither hand need be revealed.

Certain terminal situations (starred in the table) will never occur in rational play; *e.g.*, player A will never see in the second stage while holding a high card since he stands to win at least as much (and sometimes more) by raising. Similar arguments advise both players to bet the limit at every juncture where they hold a high card. Reduced in this manner, a pure strategy for either player consists merely of how high he should carry his bet on a low card. These pure strategies are listed as two-place symbols to the left and above the payoff matrix in the left half of Table IV. The first number (7) gives the limit a player will bet on a high card, the second (4, 6 or 7) gives the limit on a low card. To compute the payoff to A when two of these strategies are played, an average is taken over the four terminal situations that can follow the four possible deals; *e.g.*, when A plays 76 against 74 for B, the play ends in *H*7*H*7, *X*6*X*4, *X*6*X*7 or *X*6*X*4 and the corresponding entry is $\frac{1}{4}(0) + \frac{1}{4}(4) + \frac{1}{4}(-6) + \frac{1}{4}(4) = \frac{2}{4}$. (The unreduced payoff matrix would consist of nine rows and nine columns, labelled 44, 46, 47, 64, 66, 67, 74, 76, 77.)

The weights listed are the only weights that achieve the mini-

TABLE IV.—*Simplified Poker*

(Optimal mixed strategies and optimal behaviour strategies)

wt.		9	1	2	
	HL	74	76	77	B
6	74	0	$\frac{1}{4}$	$\frac{1}{4}$	2
2	76	$\frac{1}{4}$	0	$-\frac{1}{4}$	2
4	77	$\frac{1}{4}$	$-\frac{1}{4}$	0	2
	A	2	2	2	÷12

minimax = $\frac{1}{6}$

Player	Information	Option	Weight
A	*L*4?4	see	6
		raise	6
	*L*6?7	fold	2
		see	4
B	?6*L*4	fold	9
		see	1
		raise	2

max value. Player A must play bluffing strategies (either 76 or 77) one-half of the time, while B must decide to bluff one-fourth of the time.

The average behaviour imposed by these optimal mixed strategies upon a player with a given state of information constitutes an optimal behaviour strategy. The optimal weights, so defined, are given in the right half of Table IV (*e.g.*, with information L4?4, player A assigns the seeing pure strategy 74 the weight 6 and assigns the raising pure strategies 76 and 77 the weights $2 + 4 = 6$; in common parlance this means that, in the long run, A sees as often as he raises upon being dealt a low card).

PLURAL GAMES

Economic Example: Non-Co-operative Solutions.—Two basically different approaches to the behaviour of parties to plural games have been proposed. The solutions that they suggest are contrasted in the following (highly simplified) problem from economics: Two sellers, A and B, in competition with each other, are contemplating a price cut of the same amount. Each knows that if they both sell at the same price they will divide the market evenly, while if one cuts his price and the other does not, then the former will capture the entire market. If the total profits at the higher and lower prices are known, this situation gives rise to a symmetric two-party plural game. The top part of Table V lists the payoffs for four of these games; in all cases, six units of profit are available at the higher price, while the lower price, in the four cases, yields four, two, zero and minus two units of profit respectively (negative profit is positive loss). The profits of A and B in each of the four games are shown to the right of each pair of prices (*i.e.*, pure strategies).

As a solution to the sellers' problem, the non-co-operative theory of John Nash suggests and proves the existence of a pattern of independent action in which there is no incentive for deviation by any player alone. As such, it is an extension of the minimax theory for dual games. A price cut by each seller is a Nash equilibrium point in each of the first three games, and if both keep the higher price, the result is an equilibrium point in the last three

TABLE V.—*Price Cut Example*

Prices		Profits (1)		(2)		(3)		(4)	
A	B	A	B	A	B	A	B	A	B
high	high	3	3	3*	3*	3*	3*	3	3*
high	low	0	4	0	2	0	0	0	−2
low	high	4	0	2	0	0	0	−2	0
low	low	2*	2*	1*	1*	0*	0*	−1	−1

Coalition	Maximum assured profit			
A with B	6	6	6	6
A alone	2	1	0	0
B alone	2	1	0	0

games. These solutions (starred in the top part of Table V) can be checked by verifying that unilateral changes in strategy are not rewarded. In the first game, the stability of the solution derives from the fact that a lone decision by either party to sell high would decrease his profit from two units to nothing. Although it is clear in this case that both sellers would benefit from an agreement binding each other to the higher price, this pattern is considered unstable since either seller could increase his profit by unilateral action.

In like manner, a cut by a single seller can be considered a (fictitious) coalition between that seller and the buyers of the market, but can be upset by lone action by the other seller to his advantage. Indeed, the dilemma posed by the first game consists of the instability, with respect to unilateral defections, of each of the three possible two-party coalitions that may form among the two sellers and the market.

Co-operative Solutions.—The co-operative theory of Neumann and Morgenstern for plural games (their general n-person games) is built upon these coalitions and introduces the possibility that the parties to an agreement may distribute their payments so as to maintain the coalition. The bottom part of Table V continues the analysis of the sellers' problem from this point of view. It lists for each of the four games the maximum assured profit for A and B acting together, for A alone and for B alone (*e.g.*, the greatest profit A can assure himself in the fourth game is zero; to do this he holds to the higher price). The co-operative theory suggests, for all four games, that (1) the sellers agree to hold to the higher price; (2) that each receive at least as much from the coalition as by independent action; (3) that the remainder be distributed in some manner between them (*e.g.*, in the second game, each seller surely receives one unit and the four additional units are divided in an unspecified manner). No mode of distribution is singled out, because even though one seller may prefer one division to another, he cannot enforce it by a unilateral change of his strategy or his allegiance. On the other hand, every other distribution of the profits is less advantageous to the collective interest of the two active parties, the sellers. In general, the stability of a co-operative solution derives from these two sources: internal consistency and external domination.

In 1953 D. B. Gillies showed that a sizable swath of plural games possess co-operative solutions.

Simple Games; A Power Index.—The co-operative theory has a political aspect when the only prospects of a coalition are

TABLE VI.—*Committee Voting Example*

Voting	24 possible orders																							
First	A	A	A	A	A	A	b	b	c	c	d	d	b	b	c	c	d	d	b	b	c	c	d	d
Second	b*	b*	c*	c*	d*	d*	A*	A*	A*	A*	A*	A*	c	d	b	d	b	c	c	d	b	d	b	c
Third	c	d	b	d	b	c	c	d	b	d	b	c	A*	A*	A*	A*	A*	A*	d	c	d	b	c	b
Fourth	d	c	d	b	c	b	d	c	d	b	c	b	d	c	d	b	c	b	A*	A*	A*	A*	A*	A*

to win or lose; this is the case in voting systems, such as legislatures, committees and voting stockholders. Such games are called simple, and the only two possible outcomes, win or lose, for the coalitions are indicated numerically by one and zero. L. S. Shapley proposed an *a priori* numerical indicator of the relative equities of the players of any co-operative game, which is easily calculated for such a situation. This power index measures the average contribution of a player to the coalitions to which he might belong, taking account of the order in which the members join the coalition; *e.g.*, a participant in a simple game contributes to a coalition only if his entrance changes it from a losing to a winning coalition.

As representative of this class, consider a four-man committee composed of a chairman, with three votes, and three other members, with one vote each. A simple majority of votes wins, while ties are considered as a loss for both sides. The 24 possible sequences in which the members might vote are listed in Table VI; the chairman is denoted by A and the three ordinary members by b, c and d. The pivotal player, the first to complete a majority in each voting order, is starred in each column. Since the chairman is pivotal three-fourths of the time, his power index is 75%. The ordinary members share the remaining fourth equally and have as indices $8\frac{1}{3}\%$. Thus the voting ratio of 3:1 results in a power ratio of 9:1 in this simple game.

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(A. W. T.; H. W. Kn.)

GAMETE (GERM CELL), in biology, the name given to the special cells set apart in most plants and animals for sexual reproductive purposes. They are usually of two kinds: (1) the ovum (egg cell), which is large, stationary and heavily laden with food materials (yolk); and (2) the spermatozoon (sperm) or (in plants) spermatozoid, which is small, actively motile (except in most higher plants) and, in all animals except the Arthropoda (insects, spiders, crabs, etc.) and nematode worms, consisting of a head of nuclear material (*see* CYTOLOGY) and a long vibratile tail.

In the higher plants (conifers and flowering plants) and in many fungi the spermatozoids are much modified (*see* PLANTS AND PLANT SCIENCE), but in most of the lower plants the spermatozoid closely resembles the animal spermatozoon. In some Algae (*q.v.*) both gametes are spermatozoonlike; and in certain Algae and Protozoa the whole organism acts as a gamete.

When mature, the two kinds of gametes, in all the above cases, fuse to form a zygote, which develops into the adult organism. An organism producing ova is said to be female; one producing spermatozoa, male; one producing both, hermaphrodite. The development of gametes by an organism is called gametogenesis. *See* REPRODUCTION; SEX; EMBRYOLOGY; FERTILIZATION; *see* also references under "Gamete" in the Index.

GAMETOGENESIS, in embryology, the process by which gametes, or germ cells, are produced in an organism. The formation of egg cells, or ova, is technically called oögenesis; that of sperm cells, or spermatozoa, spermatogenesis. *See* REPRODUCTION; SEX.

GAMING AND WAGERING: *see* GAMBLING; HORSE RACING AND BREEDING.

GAMMA RAYS (written γ-rays) are electromagnetic radiations of very high frequency emitted by radioactive bodies (*see* RADIOACTIVITY). These radiations have wavelengths of the order of 1 Å or less. (1 Å = 1 angstrom unit = 1×10^{-8} cm.) Among the shortest waves of the electromagnetic wave spectrum, they are similar to and have the same general properties as X-rays, except that they tend toward higher frequency and penetration (*see* X-RAYS).

See also references under "Gamma Rays" in the Index.

(J. D. SN.)

GAMUT, in music, a term used loosely to mean the complete compass of an instrument or voice; in the middle ages and Renaissance it had a more precise meaning in relation to a series of notes. The word is a contraction of the Greek letter "gamma" and "ut," a syllable used to denote the first note of a scale in the system known as solmization (*q.v.;* the syllable "do" now normally replaces "ut").

Ut and the other solmization syllables of the Aretinian system (*see* GUIDO OF AREZZO) have no fixed equivalent in staff notation but denote only relative positions. The Greek gamma had, however, a fixed equivalent: it stood for the lowest musical note officially recognized in medieval and Renaissance theory (lower notes were used in practice, especially in the Renaissance period). This note is G, the note standing on the bottom line of the stave with the bass clef in staff notation.

The scale was then regarded not as a recurrent series of seven diatonic notes but as an overlapping series of six diatonic notes (*see* HEXACHORD). When ut was the same as gamma or any octave repetition of gamma (*i.e.*, any G, high or low) it was the first note of the first such series (hard hexachord); when ut was any C, it was the first note of the second such series (natural hexachord); when ut was any F, it was the first note of the third such series (soft hexachord). But there could only be one note called gamma ut, and since this was the bottom note on which the entire system stood, the name of this note, compressed to gamut, came to be used, inaccurately but understandably, for the system itself. By the time seven hexachords (hard, natural and soft) have overlapped one above the other, the highest note officially recognized in medieval and Renaissance theory has been reached (higher notes were used in practice): this note is e″, or ee, the second E above middle C. The gamut is thus, in this sense, the range of notes of which music was officially comprised.

From this usage, other meanings equally convenient, though less and less accurate, were derived. When a continuous scale of seven diatonic (or 12 chromatic) notes replaced the overlapping system of hexachords in textbook theory, this continuous scale (which is still the basis of modern theory) became known as the gamut; here, gamut is simply an equivalent to scale. Again, since any voice or instrument has in practice a limited compass from the bottom note available to the top note attainable (the limits being sometimes indefinite, as at the top of the violin or at either end of the horn, and sometimes definite, as on the piano), gamut has been used as the equivalent of compass. Finally, by a very natural metaphor, there exist such phrases as "to range over the whole gamut of human emotion."

See T. Morley, *Plain and Easy Introduction to Practical Music,* ed. by R. A. Harman (1952).

(R. Do.)

GANDA (BAGANDA, WAGANDA), an east African people of the Interlacustrine Bantu group (*see* BANTU [INTERLACUSTRINE]). The Ganda were traditionally organized into a powerful kingdom which in the 19th century dominated the area to the north and west of Lake Victoria (Victoria Nyanza). Under agreements signed in 1894 and 1900, the kingdom became a British protectorate, to which a belt of surrounding peoples was subsequently added through joint Ganda-British conquest. The protectorate, which became independent in 1962, was known by the Kiswahili form of the tribal name—"Uganda." The Ganda kingdom, which forms the core of the country and enjoys a wide measure of political autonomy, is known by the people's own word for their country—"Buganda." The Ganda themselves number about 1,000,000, but nearly as many immigrants of other tribes have been attracted by the country's prosperity.

The Ganda are settled hoe cultivators, securing their staple food from the plantain and keeping sheep, goats, chickens and a few cattle. In recent times Ganda have also grown cotton and coffee for export. Traditional crafts included the construction of elaborate buildings from reeds and grasses; road, bridge and causeway building to provide transport and communications for the political hierarchy; ironworking; pottery, basket and bark cloth making; and the building of large planked and dugout canoes for fishing and transport. Instrumental and vocal music were highly developed, but the plastic arts were not.

The people were organized into patrilineal clans and lineages which, through their hereditary heads, controlled inheritance and succession. A few clan or lineage heads held political office, but the kingdom was mainly governed by the hereditary *kabaka* ("king") through a hierarchy of appointed commoner officials, many of whom were chosen from among the hundreds of pages sent by their families to serve in the palace. Girls, similarly sent, might become the king's wives, the Ganda being polygynous. The *katikkiro* ("prime minister") was the chief officer at the capital, while the remainder of the kingdom was divided into districts, each governed by a royal appointee. These, and other officials with specialized civil or military functions (*batongole*), were given estates for their support. They served as judges and administrators, but their most important tasks were military; the kingdom was almost constantly engaged in warfare and raiding against neighbouring peoples and each official led the militia raised from his territory. Since 1900 this political organization has been modernized; through an elected legislature and a salaried civil service, the government of the *kabaka* exercises a large measure of local self-determination.

In the traditional Ganda religion, ancestors, past kings, nature spirits and a pantheon of gods were communicated with through spirit mediums. Most modern Ganda, however, are Anglicans, Roman Catholics or Sunni Muslims.

See also UGANDA.

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(L. A. Fs.)

GANDAK, a river of northern India, is formed in the Nepal Himalayas by the union of the waters of the Kali Gandak, Burhi Gandak, Trisuli and other streams. The united stream, at first called Trisulganga, flows southwest until it reaches Indian territory.

where it turns southeast across the Gorakhpur district of Uttar Pradesh, and then between the Champaran and Saran districts of Bihar. It falls into the Ganga (Ganges) opposite Patna, after a 475 mi. course. It is a snow-fed river, its floods endangering the surrounding plains.

The LITTLE GANDAK rises in the Nepal hills, enters Gorakhpur district about 8 mi. W. of the Gandak and joins the Gogra just within the Saran district of Bihar.

The BURHI (or old) GANDAK also rises in the Nepal hills, and runs roughly parallel to and east of the Gandak, of which it represents an old channel, passing Muzaffarpur and joining the Ganga nearly opposite to Monghyr. Its principal tributary, the Baghmati, rises in the hills north of Katmandu, flows southward through Tirhut and joins the Burhi Gandak close to Rusera. (L. D. S.)

GANDHARA, a region of ancient India, now in northwestern Pakistan, corresponding to the vale of Peshawar, with extensions into the lower valleys of the Kabul and Swat rivers, and the eastern plain of the Indus northwest of Taxila.

Gandhara appears in the inscriptions of the Achaemenid rulers of Persia. The region probably came under their influence during the reign of Cyrus the Great (559–530 B.C.), although records only exist from the time of Darius I (522–486 B.C.). Herodotus confirms the inscriptions and mentions the presence of Gandharans in the army of Xerxes.

In Indian sources references to Gandhara and its inhabitants go back to the Rigveda and Brahmana literature; the early Buddhist texts also contain many references. Taxila is mentioned as the capital and as a great centre of learning. Pushkalavati (modern Charsadda) is also sometimes mentioned as the capital. The ruler of Taxila submitted (327 B.C.) to Alexander the Great. Later Gandhara became a province of the Mauryas and thereafter was ruled successively by Indo-Greeks, Sakas and Parthians. The monuments of Gandhara have been famous for more than a century; excavations were carried out by the archaeological survey of India at Taxila and in the vale of Peshawar.

From the 1st century A.D. Gandhara became the centre of a flourishing school of sculpture and architecture. The origins of this school have been much disputed, but it contained both Indian and Hellenistic (or Roman) elements. The former were largely associated with the spread of Mahayana Buddhism, while the latter owed their introduction to the extensive trade of the Parthians with the Mediterranean, and their development to the Kushans. The earlier view that the art style arose from the Greek dynasties in Bactria and northwest India appears to be incorrect. The Gandhara school lasted, at least locally, until the Muslim invasions in the 7th and 8th centuries. The architecture is mainly of stone, frequently adorned with sculpture in either schist or stucco. The monuments take the form of Buddhist stupas and monasteries, often of locally developed varieties. The sculptures are almost entirely Buddhist: many of the details and motifs find close parallels in the contemporary art of Rome. *See* INDIAN ART: *Gandhara (Greco-Buddhist) Sculpture.*

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GANDHARVA, in Vedic mythology, is a complex character closely associated with waters and also showing certain equine connections. In the Atharvaveda he appears as a lascivious being who seeks to seduce women or damage embryos. It was also believed that, for the first three nights after her marriage, a woman belonged to the Gandharva Vishvavasu (the name given in later mythology to one of the main Gandharva attendants of Indra). Gandharva is further regarded as the custodian of Soma. Such traits suggest the likeness of the Vedic Gandharva to Gandarewa, the golden-hoofed aquatic demon of the Avesta, and to the Greek Centaurs. In the epics and the Puranas he becomes multiplied into a class of stereotyped minor deities. They are the musicians of Indra's court and, together with the Apsaras, the celestial damsels, contribute to the sensuous pleasures of Svarga (heaven). The word *gandharva* is traditionally related to *gandha* (odour), and Gandharvas are said to partake of the odour of waters and plants.

Derived from the various features of the Gandharva mythology are the words *gandharva-nagara* (a spectacle of evanescent splendour), *gandharva-vivaha* (love marriage), *gandharva-vidya* (science of music) and *gandharvas* (a breed of horses). (R. N. D.)

GANDHI, MOHANDAS KARAMCHAND (1869–1948), architect of India's freedom through a nonviolent revolution, was born at Porbandar, Kathiawar, on Oct. 2, 1869. His father and grandfather, of the Vaishya (trading) caste, were both chief ministers in Kathiawar princely states. His mother, Putlibai, was deeply religious and possessed a strong personality. Her influence, more than any other, formed his character.

His Life.—When 12 years old, Gandhi was married to Kasturbai who was of the same age and by whom he had four children. He attended Alfred high school at Rajkot and matriculated at 18. After three years' stay in London he was called to the bar (Inner Temple). For two years he practised in Bombay and Rajkot with little success, but an unexpected offer to proceed to South Africa opened a new vista before him. A week after his arrival in Durban in May 1893 he visited the court only to be asked by the magistrate to take off his turban. His second shock came at Pietermaritzburg when, holding a first-class railway ticket, he was pushed out of the compartment by a white guard and left shivering in a dark waiting room. This was a critical experience: "There was a white man in the room; I was afraid of him. What was my duty, I asked myself. Should I go back to India or should I go forward, with God as my helper, and face whatever was in store for me? I decided to stay and suffer. My active non-violence began from that date."

He founded the Natal Indian Congress party in 1894. He came to the aid of the British empire in the South African War and in the Zulu rebellion by organizing an ambulance corps. Meanwhile his reputation as a lawyer was rising; he varied his work with visits to India, where G. K. Gokhale (*q.v.*) became his friend and guide. In 1904 he took over a weekly publication, *Indian Opinion,* to fight the Indian settlers' cause. As the struggle advanced Gandhi found the term "passive resistance" inadequate. He changed it to *satyagraha,* "force which is born of truth and love or non-violence." *Satyagraha* in South Africa lasted eight years, beginning in 1906, when the Transvaal government passed a bill which required every Indian to register his fingerprints. Under Gandhi's leadership the Indians refused to obey this humiliating law; 2,000 men and women courted imprisonment by marching in protest and ultimately the Indians won their case.

Gandhi's outlook was changing rapidly. He studied the Upanishads, the Koran and the Bible. He memorized the Bhagavad Gita as a dictionary of daily reference. Ruskin's *Unto This Last* affected him profoundly with its message that the good of the individual is the good of all, that the life of the labourer is the life worth living. In his Phoenix settlement (1904) and Tolstoi farm (1910) Gandhi worked as scavenger, cobbler, farmer and printer, a practical idealist bending mind and body in unison. He abandoned his law practice and embraced voluntary poverty.

In 1909 Gandhi wrote *Hind Swaraj or Indian Home Rule,* which is the quintessence of his ideas. The goal set forth in the book is "an exploitation-free society in which the ordinary individual can claim and defend his rights." His ideas were almost anarchical and as a condemnation of modern machine civilization the book remains a classic. Correspondence followed with Leo Tolstoi, who liked the book and considered *satyagraha* an idea of world-wide importance.

Gandhi returned to India in Jan. 1915 and Rabindranath Tagore hailed him as *Mahatma* ("great soul"). In May 1915 Gandhi founded a *satyagraha ashram* at Ahmedabad with 25 inmates, who took vows to observe truth, nonviolence, celibacy and fearlessness; to practise self-control; to work for the removal of untouchability and for education through the mother tongue; and to wear only *khadi* (hand-spun and hand-woven cloth). They were to practise *swadeshi* (the use of products made in the home country), accepting only what was offered by their immediate neighbourhood.

For two years Gandhi traveled extensively. In April 1917 a peasant from Champaran in Bihar took him to study the plight of ryots who were compelled by law to plant indigo on their land for

sale to European planters. Gandhi began his inquiry assisted by Rajendra Prasad, and was ordered to leave the district. He disobeyed the order and was summoned to court and tried. He simply pleaded guilty. The governor intervened and appointed an inquiry committee with Gandhi as a member. The committee's recommendations, favourable to the ryots, were translated into the Champaran Agrarian act. This was the first case of *satyagraha* in India.

In April 1918 Lord Chelmsford, the viceroy, invited Gandhi to a war conference. Gandhi told the viceroy: "In Champaran by resisting an agelong tyranny I have shown the ultimate sovereignty of British justice . . . . If I could popularize the use of soul force, I know that I could present you with an India that could defy the whole world."

He plunged himself into recruiting, but the response was meagre. The war soon ended and in March 1919 the government, aware of widespread discontent, enacted the Rowlatt bills which empowered the authorities to imprison without trial those suspected of sedition. In protest Gandhi called upon the people to observe a *hartal* ("suspension of business") on Sunday, April 6, preceded by a fast and prayer. On the way to Delhi he was arrested, which led to mob violence. He owned to a "Himalayan" miscalculation and suspended civil disobedience. In the same month 10,000 people who had assembled at Jallianwalla Bagh in Amritsar were machine-gunned. Martial law was declared in the Punjab. In Oct. 1919 Gandhi started two weeklies, *Young India* in English and *Navajivan* in Gujarati, to teach nonviolence and fearlessness.

In 1920 Gandhi took up the *Khilafat* (Caliphate) question over which the minds of Muslims were agitated. They strongly resented the terms to be imposed on Turkey by the treaty of Sèvres (1920). Gandhi proposed that a non-co-operation movement should start on Aug. 1 with the surrender of all titles and honours and with a boycott of schools, colleges, law courts and councils. He himself returned his Kaisar-i-Hind medal (awarded for distinguished humanitarian work) and the decorations he had received in South Africa.

There then began for India, with Gandhi as leader, a period of struggle and transformation. In his speeches and writings, Gandhi was unsparing in his denunciation of British imperialism as "a satanic system." "Non-co-operation," he declared, "though a religious and strictly moral movement, aims at the overthrow of the government." Critics meanwhile made fun of his insistence on hand-spinning. Gandhi knew that the spinning wheel was an uneconomic machine, but it was cheap, needed little skill and brought in a supplementary income to families which were unemployed or underemployed for several months in the year. Further, he saw in the spinning wheel the means of freeing India from its dependence on Lancashire. India, in his view, could dispense with most of its imports but cloth it must have. That is why the *charkha* (spinning wheel) became for Gandhi the symbol of *swaraj*. He intensified the campaign by taking to the loincloth in Sept. 1921. "Millions are too poor to buy enough *khadi* to replace their discarded cloth. Let them be satisfied with a mere loin cloth."

In Feb. 1922 Gandhi decided to lead a mass campaign of civil disobedience in the Bardoli district (Gujarat). The payment of taxes to the government would be discontinued. On the eve of the campaign, however, the people of Chauri Chaura (in Uttar Pradesh) were provoked into attacking the police. Gandhi then decided to suspend his mass campaign and imposed on himself a five days' penitential fast. He was arrested at his *ashram* at Ahmedabad on March 13, 1922, and was tried by C. N. Broomfield, sessions judge at Ahmedabad, on a charge of sedition, based upon his writings in *Young India*. He pleaded guilty. "I am here to invite and submit to the highest penalty that can be inflicted upon me, for what in law is a deliberate crime, and what appears to me to be the highest duty." He was sentenced to six years' imprisonment. Two years after his confinement in Yeravda jail in Poona Gandhi had to undergo an operation for appendicitis; he was released in Feb. 1924.

The Indian political landscape was then rapidly changing, the most decisive event being the collapse of the *Khilafat* movement. C. R. Das and Motilal Nehru founded an independent Swaraj party to oppose the government in the legislatures and did well in the general elections. Since Gandhi realized that the majority of congressmen favoured entry to the councils, he kept aloof from politics. He presided over the Congress at Belgaum in 1924 and spoke only about spinning and the boycott of foreign cloth. As a result the All-India Spinners' association was founded for the development of *khadi* under Gandhi's guidance, and for the next four years his work was to be preaching and organizing *khadi* centres in the villages.

In Nov. 1927 Lord Irwin, the viceroy, summoned Gandhi to apprise him of the appointment of a statutory commission on constitutional reform under the chairmanship of Sir John Simon. Even the moderates were shocked because not a single Indian was appointed to the commission. Congress boycotted it effectively. In Oct. 1929 a statement by Lord Irwin foreshadowed a Round Table conference between British and Indian representatives. Gandhi asked the viceroy whether the Round Table conference would establish full dominion status for India. The viceroy could give no such assurance. Congress then had no choice. Under Jawaharlal Nehru's presidency it declared that its goal was complete independence and called on the people to be prepared for the struggle.

On March 12, 1930, Gandhi started another campaign of civil disobedience, this time against the tax on salt, which affected the poorest section of the community. He set out with 78 followers to cover the distance of 240 mi. that lay between Ahmedabad and the seashore at Dandi. On April 6 he bathed in the sea at Dandi and picked up a lump of natural salt thereby symbolically defying the law under which salt collection was a government monopoly. Everywhere people followed his example and mass arrests followed. On May 4 Gandhi was arrested and interned, but he was released on Jan. 26, 1931. The Irwin-Gandhi agreement by which civil disobedience was discontinued was signed on March 5. The making of salt for personal use was permitted and about 100,000 nonviolent prisoners were released.

On Sept. 12, 1931, Gandhi reached London to represent the Congress at the second Round Table conference. Through his personal contacts, he brought India nearer to the British intelligentsia and the commoner. At the conference he sensed that attention was concentrated on the problem of minorities and that this took precedence over the central issue, the transfer of power. Then, as always, he was convinced that it was British rule which had driven a wedge between India's creeds and classes; once this foreign influence was removed, Indians would solve their communal differences. He spent a week in a vain endeavour to reach an agreement with Muslims and other minorities. Confronted with the imposing numbers against him, he had to remind the conference that Congress represented 85% of the Indian population. He argued that the proposed scheme for minorities would vivisect the nation.

On his return to India at the end of 1931, he had to face a grim situation. Jawaharlal Nehru and Ghaffar Khan, the Congress leader in the North-West Frontier province, were imprisoned and special ordinances had been issued. Gandhi requested Lord Willingdon, the viceroy, to see him "as a friend," but he wound up by enclosing a copy of the resolution just passed by the Congress Working committee "tentatively sketching a plan of civil disobedience," which would be suspended "pending our discussion."

On Jan. 4, 1932, Gandhi and Vallabhbhai Patel were arrested and again interned in Yeravda jail. In March the struggle against the government entered a new phase. A communal (electoral) award was imminent. Gandhi sent from prison to the secretary of state for India a reminder of his own objection to the segregation of untouchables in a separate electorate, and warned him that he would resist this by a fast unto death. When, in August, an award was published that ignored his objections Gandhi announced that he would start a fast on Sept. 20. The first day of the ordeal was celebrated all over India as a day of prayer and fasting. Many temples were thrown open to the untouchables. B. R. Ambedkar (*q.v.*), a leader of the depressed classes, was induced to join a representative conference and by the fifth day of the fast a solution had been found. Gandhi then broke his fast.

Gandhi then identified himself with the untouchables, whom he called Harijans ("children of God") for "the most despised people are the most favoured of God." In Feb. 1933 he started *Harijan*, a weekly which was his mouthpiece for the rest of his life; by 1942 it was published in ten Indian languages.

After his many fasts Gandhi withdrew to recover his strength in an *ashram* at Wardha (in central India). Then he toured extensively for ten months on behalf of the Harijans. He collected Rs. 800,000 for their cause, much of it in copper coins, some of it in women's jewelry.

Gandhi resigned not merely his leadership but even his membership of Congress in 1934. He had gained the impression that congressmen had adopted nonviolence, for him a fundamental creed, only as a political expedient.

His work now lay in the villages and with the newly founded All-India Village Industries association. He settled at Sevagram, a village near Wardha. By 1934 the making and marketing of *khadi* had been organized in 5,000 villages. "The movement of the spinning wheel is an organized effort to displace machinery from the state of exclusiveness and exploitation and to place it in its proper state," said Gandhi. "Under my scheme, therefore, men in charge of machinery will not think of themselves or even of the nation to which they belong, but of the whole human race."

Congress swept the polls in 1937 because of Gandhi's constructive program. "India," Gandhi wrote, "is still a prison, but the superintendent allows the prisoners to elect the officials who run the jail." So he advised Congressmen to enter the councils. Presently he was drafting a program for the ministries which Congress formed in 9 of the 11 provinces. He stressed prohibition, basic education and the relief of indebted peasants; broadly he hoped that the interests of the villages would be a first consideration.

At the outbreak of war in Sept. 1939, Gandhi found himself alone at a Congress Working committee meeting in seeking that whatever support was to be given to the British should be given unconditionally; nevertheless, recognition of India as a free and independent nation seemed to be "the natural corollary of the British profession as to democracy." When the viceroy took India into the war without consulting the leaders or legislatures the Congress ministries resigned.

In Jan. 1940 there was an exchange of letters between Gandhi and M. A. Jinnah, the leader of the Muslim league and later founder of Pakistan. "You start with the theory of the Indian nation that does not exist," wrote Jinnah. "Your reply dashes to the ground all hope of unity," replied Gandhi.

The events in Europe of May 1940 had their repercussions in India. The Congress Working committee found itself unable to accept in its entirety Gandhi's attitude to the war and, in particular, his view that India should not maintain its own armed forces to defend its freedom against external aggression and internal disorder. In fact, he was against all war. The Working committee absolved him from further responsibility for Congress activities. In July the Working committee offered its co-operation in the war effort and in return called for an acknowledgment by Britain of the complete independence of India and a declaration that, as an immediate step in giving effect to it, a provisional national government at the centre would be formed. When the viceroy rejected the offer Congress sought Gandhi's lead.

In Oct. 1940 Gandhi launched individual civil disobedience to win freedom of speech against war. Vinoba Bhave was the first of hundreds of *satyagrahis* to court jail. In Dec. 1941 the government released the *satyagrahis* and, as the Japanese swept across the Pacific and through Burma and Malaya, the urgency of some settlement in India became clear. In March 1942 Sir Stafford Cripps, a British cabinet minister, came to India with an offer, which Gandhi found worthless. The conception of the slogan "quit India" now began to take shape in his mind and was developed in a succession of articles in *Harijan*. On Aug. 8 the All-India Congress committee presided over by Maulana Azad, adopted the "quit India" resolution. On Aug. 9 the government arrested Gandhi and other Congress leaders. A mass rising immediately broke out. Repression was intense. During Gandhi's detention at Poona, his devoted secretary, Mahadev Desai, and wife Kasturbai, who stood by him for 63 years, died in the camp.

In Jan. 1943, Gandhi wrote a letter to the viceroy, Lord Linlithgow, blaming the government for their "leonine violence" and announced a fast of 21 days, which began on Feb. 10. He was released on May 6, 1944, on grounds of health.

In March 1946, after the end of the war and the advent of a Labour government in Britain, a British cabinet mission consisting of Lord Pethick-Lawrence, Sir Stafford Cripps and A. V. Alexander arrived in Delhi. Gandhi declared himself completely opposed to the two-nation theory on which Jinnah's claim for Pakistan was founded. The cabinet mission would have to decide this main issue.

On May 16 the cabinet mission issued a statement proposing the complete withdrawal of the British authority from India. They recommended a united India, with one federal government to deal with foreign affairs, defense and communications.

The Muslim league then decided to withdraw its previous acceptance of the mission's proposals and to prepare a program of direct action. Fresh efforts were made by the viceroy, Lord Wavell, to form an interim government but Jinnah declined. A new government headed by Jawaharlal Nehru took office on Sept. 2, 1946. For Gandhi it was a day of deep significance. He wrote a note for Nehru and his colleagues: "Abolish the salt tax; remember the Dandi march; unite Hindus and Muslims; remove untouchability; take to *khadi*."

Meanwhile communal differences were taking an ugly form. In Calcutta, riots broke out on Aug. 16, the Muslim league's Direct Action day, and massacres followed. They spread to other parts of Bengal and to Bihar. During the cold weather of 1946–47, Gandhi went to live in East Bengal. He walked barefoot from village to village in the devastated areas of Noakhali and Tippera and mingled freely with Muslims and Hindus and expounded his gospel of nonviolence to them equally. In March 1947 he moved to Bihar to instill courage in the Muslim minority and to help them in their distress.

On June 3, 1947, Clement Attlee, the British prime minister, announced the plan for partition; it was accepted by Congress and the Muslim league. Gandhi considered partition "a spiritual tragedy": "I do not agree with what my closest friends have done or are doing; 32 years of work have come to an inglorious end." On Aug. 15, 1947, Independence day, he was fighting riots in Calcutta. He fasted all day and prayed. He issued no message to the nation. At the end of August fresh riots broke out in Calcutta. Gandhi embarked on a fast unto death to be broken only if the communal killing stopped. This had an immediate effect. On Sept. 9 Gandhi reached Delhi. At his first prayer meeting he expressed his regret over the terrible atrocities which were being committed all round. A few days later he spoke about the wholesale migrations which were taking place both ways across the frontier between India and Pakistan. It was the duty of both governments, he said, to protect their minorities. He advised the Hindus, Muslims and Sikhs that they should all be prepared to die to a man rather than leave their homes.

He could bear it no longer. On Jan. 12, 1948, he announced that he would undertake yet one more fast. "I have no answer," he said, "to the Muslim friends who see me from day to day as to what they should do. My impotence has been gnawing at me of late. It will go immediately the fast is undertaken." The fast began the following day and went on until Jan. 18 when the news reached him that a peace committee representative of all communities in Delhi had signed a pact pledging brotherly amity and the protection of the life, property and faith of the Muslim minority.

On Jan. 20, during a prayer meeting outside Gandhi's residence in Delhi, a bomb was thrown by a youth. It exploded harmlessly. Referring to the incident next day, Gandhi said that no one should look down upon the youth, who probably regarded him as an enemy of Hinduism.

On Friday, Jan. 30, 1948, shortly after 5 P.M., Gandhi was on his way to attend his usual prayer meeting. As he was going up the steps to the prayer platform, a Hindu fanatic suddenly broke through the congregation and fired three shots. Gandhi uttered *"He Rama"* (O God), and died.

His Teaching.—Gandhi was one of the very few who have set the stamp of an idea on an epoch. That idea is nonviolence. His emphasis on truth and purity of means from which he evolved his creed of nonviolence was but another aspect of his deep humanity, for it insisted that men in their fight for their rights, whether as individuals or as groups, should never violate their basic obligation to respect life. "As man has not been given power to create, he has not the slightest right to destroy the smallest creature that lives." Gandhi, like all dynamic personalities, needed a vast medium for the expression of his creative will. This medium he developed for himself when he assumed the responsibility of leading a vast country into freedom, crossing countless social, economic and political hurdles.

Great as he was as a leader of men and as a political and social rebel, he was far greater as a man who put no limit to his humanity. "My life is an indivisible whole," he said, "and all my activities run into one another; they all have their rise in my insatiable love of mankind. . . . I do not know any religion apart from human activity. It provides a moral basis to all other activities. . . . We needlessly divide life into watertight compartments, religion and other; whereas if a man has true religion in him, it must show itself in the smallest details of life. The slightest irregularity in sanitary, social and political life is a sign of spiritual poverty."

Gandhi was a Hindu influenced by the Vaishnava and Jain traditions. In his student days in London he was in the main stream of the thought of Marx, Darwin, Morris, Kropotkin and the Fabians. He came under the influence of Thoreau, Ruskin and Tolstoi. At 75 he read *Das Kapital*. He was an extraordinary blend of the east and the west, of the ancient and the modern. His own writings, mainly published by the Navajivan trust, Ahmedabad, were numerous and include *An Autobiography or the Story of My Experiments With Truth*, originally written in Gujarati, Gandhi's mother tongue (Eng. trans. by Mahadev Desai, 1940). The publications division of the government of India published eight volumes of his collected writings during 1954–63.

Gandhi's life and thought underwent a continual process of evolution. For him to know was to act. He imposed silence on himself every Monday for the purpose of rest, introspection, the writing of articles and letters and as "a part of the discipline of a votary of truth." His whole life was devoted to translating his thoughts, or to what he called his "experiments with truth." He always strove to correlate his thoughts and actions to be able to see in the right perspective the apparent inconsistencies and compromises which, on the surface, seem to be irreconcilable. When he was asked to define what he understood by God, he explained how, among the noblest attributes which the Hindu scriptures ascribed to God, he had in youth chosen the word "truth" as most truly defining the essential element of Godhood. He had said, "God is Truth." "But," he added, "two years ago (1929) I advanced another step. I now see, Truth is God. For even the atheists do not doubt the necessity for the power of truth. In their passion for discovering the truth, the atheists have not hesitated to deny the existence of God, and, from this point of view, they are right."

"The only virtue I claim," he said, "is truth and non-violence. I lay no claim to superhuman power. I want none."

"The moral influence which Gandhi has exercised upon thinking people may be far more durable than would appear likely in our present age, with its exaggeration of brute force," said Albert Einstein. "We are fortunate and grateful that fate has bestowed upon us so luminous a contemporary, a beacon to generations to come."

See also references under "Gandhi, Mohandas Karamchand" in the Index volume.

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GANESHA (GANESH or GANESA) in the post-epic Hindu mythology is the eldest son of Shiva and Parvati. His name means leader of (Shiva's) attendants; he is a creator of obstacles and as such came to be placated for their removal. Depicted with an elephant's head, to symbolize his sagacity, he is the god of worldly wisdom; and is invoked on the first page of every book, especially in ledgers, as he bestows prosperity in trade.

He is one of the five chief cult deities of modern India, being worshiped all over the country, especially in the south. He is affected by six sects, under his six titles, Maha-Ganapati, etc. These hold him, not Shiva, to be the real first cause. *See* HINDUISM.

GANGA: *see* GANGES.

GANGANAGAR, a district and town in Bikaner division of Rajasthan, India, was part of the former princely state of Bikaner which merged with Rajasthan after Indian independence. It lies in the extreme north of the state and forms part of the Rajasthan dry area. Area 8,000 sq.mi. Pop. (1961) 1,037,423. The surface of the country is for the most part covered with undulating sand hills, varying in height from 20 to 100 ft. with the force and direction of the wind. There are no forests and only a few scattered *jors* (areas of grassland). The climate is dry and rainfall scanty. More than 1,806,000 ac. are, however, under cultivation. The main crops are wheat, barley, rice, bajra millet, gram, sugar cane and cotton. Considerable benefit was foreseen by the 1960s from the Rajasthan canal development plan. There are also collective farms for the breeding of sheep and camels. Modern industries include oil mills, sugar refineries and a distillery, and there is handloom weaving.

GANGANAGAR TOWN (Sri Ganganagar) is the administrative centre of the district. Its population grew from 1,700 in 1911 to 63,854 in 1961. It has a meteorological station. (S. M. T. R.)

GANGAS, WESTERN, the name of an Indian dynasty which ruled in Mysore state (Gangavadi) from *c.* A.D. 250 to *c.* A.D. 1004. Remotely connected with the Eastern Gangas their alleged northeastern origin is to be doubted. Their capital was Kolat until about 440, when it became Talekad, at the head of the Cauvery valley, strategically and commercially a commanding site. Madhava I and his son Harivarman were feudatories of the Pallavas, who exploited the gold and other mineral resources of the plateau. Most of the Gangas were Jainas, but some patronized the Brahmanical religion. They intermarried with Pallavas, Chalukyas and Kadambas. The Rashtrakuta and Chalukya emperors could not do without Ganga fighting men, and this gave the Gangas a unique influence and often led them into danger. By the end of the 8th century a dynastic dispute weakened them, but Butuga II (*c.* 937–960) obtained extensive territories between the Tungabhadra and the Krishna rivers and also in the Tamil country. From Talekad the kingdom stretched to Vatapi, and Ganga power was at its height. Reacting to Deccan dependence upon Ganga power, the Chola repeatedly invaded the plateau, and cut contact between Gangavadi and the imperial capital. Talekad fell into Chola hands *c.* A.D. 1004.

But for the ability of the warriors at their disposal the Gangas would have remained a somewhat unenterprising dynasty, but this factor added to their resources and encouraged their characteristically independent behaviour. They patronized scholarly work in Kanarese and built temples in a solid but unassuming style. The plateau advanced greatly with deforestation, irrigation and settlement; cultural institutions were endowed and cross-peninsular trade was fostered.

See M. V. Krishna Rao, *The Gangas of Talkad* (1936); S. Srikantha Sastri, *Early Gangas of Talakad* (1952). (J. D. M. D.)

GANGES, officially GANGA, its name in Hindi and other Indian languages, is the great river of northern India where it receives the drainage from the central Himalayas and flows through a vast, fertile and densely peopled plain. The general direction of the river is from northwest to southeast and it falls into the Bay of Bengal after a course of about 1,557 mi. The greater of its two main headstreams, the Alakananda, rises near the Tibetan border in the Garhwal district of Uttar Pradesh about 30 mi. N. of Nanda Devi. The lesser, the Bhagirathi, issues from an ice cave at the foot of a Himalayan snow bed near Gangotri in Tehri-Garhwal district, 10,300 ft. above sea level. Unlike the Indus and its tributaries and the Brahmaputra, the Ganges is wholly a river of the India-Pakistan subcontinent.

Below the junction of the headstreams the united Ganges cuts

through the outer rampart of the Himalayas and emerges from the mountains at Hardwar. There are great seasonal variations in the flow of water but, derived partly from melting Himalayan snows and partly from monsoon rainfall, the volume is less liable to violent fluctuations than in some other Indian rivers. At first its course over the dry plains of western Uttar Pradesh is southerly, then southeasterly past the great city of Kanpur (Cawnpore) to Allahabad where it is joined on the right by its greatest tributary, the Jumna (Yamuna). Thence the meandering course is mainly easterly, past Varanasi (Benares) where it is joined by the Gogra (Ghaghra) from the north and the Son from the south. Passing eastward through the heart of Bihar it receives from the north the Gandak and the Kosi (both of which rise in Nepal). In Bihar the edge of the Chota Nagpur plateau lies a short distance to the south and the river swings around the corner of the plateau before crossing East Pakistan in a southeasterly direction. There, in times past, the waters of the Ganges have found their way to the Bay of Bengal by innumerable channels from the westernmost one, the Hooghly, to the main active channel, known as the Meghna, on the east. In the heart of East Pakistan the Ganges and Brahmaputra unite to form the Padma.

In the broadest sense the Ganges-Brahmaputra delta coincides roughly with the old province of Bengal. West Bengal, now a state of India, has been called the land of dead and dying rivers since little water passes down them to the sea. The chief river is the Hooghly, on which stands Calcutta. In the remainder of the delta, lying in East Pakistan, there are innumerable connecting creeks; during the rains the greater part of the country is flooded except for the villages or isolated huts built on mounds above the floodwaters. Seaward lies a vast stretch of tidal forest swamp, the Sundarbans (*q.v.*).

The Ganges is a sluggish river. A thousand miles from its mouth the river level is scarcely 700 ft. above sea level; the fall from Allahabad to Varanasi is only 6 in. per mile and from there to the sea only about 4 in. Great changes have taken place, and are liable to take place, in the course of the river; disasters are apt to occur, especially in the delta when tropical cyclones causing tidal waves coincide with the high-water season. In the Bakarganj cyclone of 1876 about 100,000 people were drowned in half an hour and a similar disaster occurred in 1959.

Economic Importance.—The Ganges below Hardwar, and its tributaries over their plains courses, have long been used by innumerable country boats of shallow draft but the use of steamers was always hindered by fluctuating water levels and became steadily less important with the construction of railways. Old river ports tended to decay except in the delta where many places are still only accessible by water and where regular services ply below Buxar. Most of the Ganges plain has a great thickness of alluvium which yields very fertile soils, though of varying texture, and the water table can usually be reached by hand-dug wells. Water is still drawn by oxen walking down an inclined slope from tens of thousands of such wells while the waters of the Ganges, Jamuna and other streams are used to irrigate vast areas, especially in Uttar Pradesh. The dam at Hardwar was begun as early as 1839 and from it the Upper Ganges canal (opened 1855–56) watered the Ganges-Jamuna Doab. Hydroelectric works at Hardwar were completed in 1956. Water seeps back into the river so that lower down another barrage at Narora supplies the Lower Ganges canal (1879–80). Land north of the Ganges too high to be commanded by water from the irrigation canals fortunately has water at depths which can be reached by modern tube wells pumped by electricity —a plan initiated in 1929. There has thus been a combined expansion of irrigation with generation of power.

Religious Significance.—The religious significance of the Ganges is probably greater than that of any river on earth since it is the great holy river of 350,000,000 Hindus. Though *tirthas*, or places of pilgrimage, are scattered throughout India, those along the Ganges have a special significance. Among the chief ones are the holy city of Varanasi or Kasi (Benares), Hardwar, where the Ganges leaves the mountains, and the point where the Ganges and Jamuna join at Allahabad. More distant places of pilgrimage are Gangotri and the point of union of the Ganges headstreams but many other places have their special devotees. When the barrage was constructed at Hardwar care had to be taken not to imprison completely the sacred stream and elsewhere holy places are protected against the dangers of modern progress. In some places, as at Varanasi, there are always throngs of pilgrims; elsewhere there are special festival periods—notably Magh Mela at Allahabad. *See* also references under "Ganges" in the Index volume.

(L. D. S.)

J. ALLAN CASH

HINDU PILGRIMS ON THE GHATS (STEPS) THAT RISE FROM THE GANGES RIVER FRONT AT VARANASI (BENARES)

GANGOTRI, a celebrated place of Hindu pilgrimage in the Himalayas located 50 mi. N.E. of Tehri. It is in Tehri-Garhwal district in Uttar Pradesh, India, on the Bhagirathi, one of the two chief headstreams of the Ganges. Gangotri contains a small temple about 20 ft. high, in which there are images representing Ganga, Bhagirathi and various other figures of mythology.

The bed of the river adjoining the temple is divided by the Brahmans into three basins, where the pilgrims bathe. One of these basins is dedicated to Brahma, another to Vishnu and the third to Shiva. The pilgrimage to Gangotri is considered efficacious in washing away sin and ensuring eternal happiness. The water taken from this sacred spot is exported by pilgrims to other parts of India. The temple is 10,319 ft. above sea level.

GANGRENE refers, in medicine, to the death (mortification) of tissue. It is caused by prolonged impairment of nutrition due to interruption of the blood supply and may result from injury or infection. Diseases in which gangrene is prone to occur include arteriosclerosis, diabetes, Raynaud's disease, thromboangiitis obliterans (Buerger's disease) and typhus. It also may occur after severe burns, freezing or prolonged bed rest (bed sores). Gas gangrene is caused by infection with Clostridia bacteria, which grow only in the absence of oxygen. It develops in deep wounds that are improperly cleansed. Treatment varies with the cause. *See* also NECROSIS.

GANGSTER, a U.S. colloquial term denoting a member of a criminal organization, the "gang" (or "mob"). Although the members of 19th-century bands of thieves were sometimes called gangsters, the modern gangster belongs to a complex organization which systematically makes money from gambling, prostitution, narcotics and industrial extortion. Within such a criminal organization the gangster may be one who steals, extorts or murders on orders from above, or an executive who plans the gang's operations, lives in luxury and rarely appears in newspaper headlines or in the courts.

The gangster became an international sensation during the prohibition era of the 1920s as a result of a violent struggle in the U.S. underworld for control of the illegal manufacture and distribution of liquor. Gang murder became commonplace, especially in New York and Chicago, where more than 2,000 killings between 1920 and 1930 were ascribed to gangster warfare. The manner as well as the number of these killings made them notorious. Usually they were carefully rehearsed and involved sophisticated techniques for stealing and disguising the "get-away" car; for obliterating all means of identification from the murder weapons; for luring the victim into a defenseless situation (as when one killer shook hands with the victim to prevent his reaching for a gun, while associates opened fire); and for disposing of the body. The most famous gangster shooting was the "St. Valentine's Day massacre" in Chicago on Feb. 14, 1929, when the murderers, by disguising themselves as policemen, induced seven rival gangsters to stand against a garage wall with their hands raised—and then shot them down. Because such killings were carefully planned, and also because the criminals had influence with local political leaders, gang murderers were rarely identified, still less often prosecuted, and almost never convicted. In Chicago, for example, between 1927 and 1930 there were 227 killings and only two convictions.

Gangsters lived more openly in the United States during the 1920s than at any time before or since. Lurid weddings and funerals of prominent gangsters were attended by leading politicians. Alphonse "Scarface Al" Capone of Chicago, who by the end of the decade enjoyed an income of more than $20,000,000 a year, maintained a seven-ton armoured sedan; a suite of 50 rooms in a Chicago hotel (complete with private bars and elevators and a cache of liquor in an underground vault); a clerical staff of 25 persons to manage his varied enterprises; and a villa in Florida.

The notoriety of the gangster in the era of national prohibition (1920–33), however, should not obscure the fact that the foundations of his power had been laid earlier, nor the fact that after prohibition was repealed his activity became more highly organized and no less ruthless. At least as early as the 1850s in New York and the 1870s in Chicago, systematic co-operation between criminals and politicians had become habitual. In return for campaign contributions and the intimidation of voters, the politician protected the criminal in the courts and winked at the existence of gambling and prostitution. The extortion of money—called "protection"—from a business by threats of bombing or otherwise disrupting it was solidly established on the docks of New Orleans and in the gambling houses of Chicago before the turn of the century. Gang murder, too, was common before the prohibition era. In one building on 108th street in New York, 23 murders took place between 1900 and 1917. Then, as later, organized gangs divided the great American cities into "territories," in each of which a particular gang monopolized the income from vice and extortion. The typical gangster came from a slum neighbourhood (particularly the lower east side of New York), and served an apprenticeship in petty crime before gaining access to the more lucrative branches of criminal activity.

The main lasting effect of the prohibition era on gang activity was the development of more highly centralized and better disciplined criminal organizations, sometimes called "syndicates." Effective bootlegging (*q.v.*) required notification by radio of incoming liquor shipments from Canada or the West Indies; elaborate arrangements for distribution (for example, by infiltrating the labour unions of longshoremen and truckers); collaboration with liquor distillers inside the United States; and agreement as to quotas and prices among the different smuggling organizations. Crime on this scale was, as Dion O'Banion of Chicago put it, "big business without high hats." Following the examples of legitimate business concerns, the distributors of illegal liquor reached out to control its manufacture. Specialists in gambling invested in the manufacture of slot machines, and fought for possession of a national wire service that circulated race track information. Moreover, the 1920s witnessed the rapid invasion by gangsters of loosely-organized legitimate businesses, such as building, garment manufacture, cleaning and dyeing, and food supply. Louis Lepke, the dominant figure in these industrial "rackets," extracted $1,000,000 a year from the New York garment industry alone. In 1930 the U.S. bureau of internal revenue estimated the profits of the criminal organizations in which Capone participated as $25,000,000 per year from gambling, $10,000,000 from prostitution, $10,000,000 from narcotics and $50,000,000 from the illegal liquor trade.

This vast expansion in the scale and complexity of criminal activity led, in the late 1920s and early 1930s, to the formation of a national organization. It has been compared with a cartel among legitimate business firms in that each gang apparently agreed not to "muscle in" on business controlled by other gangs. Henceforth differences were to be arbitrated rather than settled by anarchic violence. It was agreed, apparently, that approval at the national level should be required for all gang murders. Thereafter, one local gang (of the Brownsville neighbourhood in Brooklyn, N.Y.) carried out murder "contracts" for the national organization all over the United States, accounting for perhaps 1,000 killings in the 1930s. Top-ranking gangsters were eliminated only after judgment by their peers sitting as a court: this procedure, according to informers, was invoked in the killing of "Dutch" Schultz in 1935, "Buggsy" Siegel in 1947 and Charley Binaggio in 1950.

Understandably, much obscurity remains as to this inner organization of American criminals. Some observers believe that the Mafia (*q.v.*), a Sicilian secret society, plays a key role. This opinion was reinforced when in Nov. 1957 police surprised a conference of more than 60 leading gangsters at Apalachin, N.Y.: without exception the criminals at that gathering were of southern Italian birth or extraction. Other observers maintain that the power of the Mafia was destroyed by an underworld purge of Italian criminals in Sept. 1931. But it seems clear that the Mafia retained great power at least in the international smuggling of narcotics.

Profits from gangster activity continued to be staggering after the repeal of national prohibition in 1933. The decrease in income from bootlegging was more than compensated for by the increased trade in narcotics. The sales of heroin alone in the 1950s and early 1960s have been estimated as totaling $300,000,000 per year. Congressional committees in the 1950s made extensive investigations of alleged gangster influences among labour unions.

The power of the U.S. gangster has not been broken by occasional successful prosecutions. That power rests, ultimately, not on violence but on political protection and on the ordinary citizen's lack of interest in the suppression of organized crime or his feeling of impotence in the face of criminals who have political influence.

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GANIVET, ANGEL (1865–1898), Spanish essayist and novelist whose chief works discuss the "regeneration" of Spain, was born at Granada on Nov. 13, 1865. After his education at the University of Granada he worked in the records office in Madrid and in 1892 entered the consular service. He became vice-consul at Antwerp and then consul at Helsinki (where he published his first book, *Granada la Bella*, 1896) and at Riga. He committed suicide there on Nov. 29, 1898.

Ganivet shows brilliant powers of evocation in *La Conquista del reino de Maya* (1897), a satire of modern culture through its application to an African tribe, and *Los Trabajos del infatigable creador Pio Cid* (1898), an uncompleted autobiographical novel. His best work is the volume of essays *Idearium español* (1897; Eng. trans., *Spain: an Interpretation*, 1946), a philosophical interpretation of Spanish history which discusses a rebirth of Spain

based on the national characteristics of its people, especially that of Senecan stoicism. Other works by Ganivet include the drama *El escultor de su alma* (1904) and studies of Jonas Lie, Bjørnstjerne Bjørnson and Henrik Ibsen entitled *Hombres del norte* (1904).

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GANJAM, a district of Orissa state, India, was transferred in 1936 from the old Madras presidency to the newly created province of Orissa. It lies between the Eastern Ghats and the Bay of Bengal, and is bounded north by the district of Puri and south by Srikakulam. Area 4,824 sq.mi. Pop. (1951) 1,624,829; (1961) 1,872,530.

The northwestern and southwestern extremities of the district are covered with thick sal forest, and the southern region is generally hilly and well watered. The district is divided into two natural and administrative areas: the fertile plain and the hilly, forested region. Of the total population, about 1,500,000 live in the plain. The forested areas are inhabited in the south by the Savara tribe and in the north by the Kondh tribe. The administrative head acts as district magistrate in the plain and as agent of the Orissa government, and also sessions judge, in the tribal areas. The district has four colleges affiliated with Utkal university at Bhubaneswar.

Ganjam was part of ancient Kalinga, and rock inscriptions of Asoka (*q.v.*) are found at Jaugada on the Rushikulya river. The region was conquered by Samudra Gupta (4th century B.C.), and a series of dynasties including the Matharas, Sailodbhavas and Gangas ruled there in the medieval period. It came under Muslim rule in the 16th–18th centuries, and in 1753 the French took possession of the area as part of the northern Circars. A little later it passed to the British, who, in 1768 founded a factory at Ganjam, which continued as the district headquarters until 1815. It was abandoned, owing to repeated epidemics of cholera, for the new towns of Berhampur and Chatrapur.

The present district headquarters are at Chatrapur (pop. [1961] 7,835), and other towns are Berhampur (76,931) and the ancient town of Parlakimedi (22,708). Chatrapur and Berhampur are both on the South-Eastern railway, and the national highway from Calcutta to Madras passes through Berhampur.

Ganjam district has no heavy industries, but there is a cooperative sugar factory at Aska (pop. [1961] 9,024) and a government factory for the preparation of salt by the evaporation of sea water at Huma. Spinning and weaving of cotton are cottage industries. The majority of the population are engaged in agriculture, and although the rivers are short there are good minor irrigation systems watering more than 100,000 ac. The main crops are rice and pulse, sugar cane, peanuts, sesame and cashew nuts. (N. K. S.)

GANNET, a name applied in the United States to any of several species of large gull-like sea birds (*Morus* or *Moris*); together with the boobies (*Sula*) they constitute the family Sulidae, order Pelicaniformes. The gannets inhabit the cooler temperate seas. In England there is no generic distinction between gannets and boobies, all of them being grouped in the genus *Sula.*

The North Atlantic gannet or solan goose (*M. basana*) is 36 in. long, white tinged with pale yellowish straw on head and neck and has a cigar-shaped body with stout pointed beak, pointed tail and long slender black-tipped wings. It breeds locally in large colonies on steep island cliffs and offshore rocks, principally about the British Isles but also at the Faeroes, Iceland, Labrador and islands in the Gulf of St. Lawrence, ranging south in winter to northwest Africa and the Gulf of Mexico. The most famous gannetry is located on Bass Rock, off the coast of Scotland.

After attaining full plumage, at three years of age, the birds breed once a year after mutual courtship performances. A crude nest of seaweed and grasses is built on a ledge; one egg, rarely two, of pale blue, later becoming chalky and nest-stained, is incubated by both birds in turn for about 44 days. The young are hatched naked and blind, but soon become covered by white down, which is replaced by brown feathers speckled with white. The

AUTHENTICATED NEWS

SOUTH AFRICAN GANNET (MORUS CAPENSIS)

bird waddles on land, but is an expert flyer, moving in single file 30 to 40 ft. above the sea, alternating rapid wing beats with gliding. With half-closed wings it plunges into the sea for fish, which it swallows whole.

While diving, the gannet is cushioned by subcutaneous air spaces connected with the lungs; the nostrils are closed. The bird floats high while sitting on the water. Young at the nest take regurgitated food from the wide-opened mouth of the parent.

There are two slightly smaller southern species: the South African or cape gannet (*M. capensis*), breeding on islands off the Cape of Good Hope; and the Australian gannet (*M. serrator*), middle tail feathers dark, breeding on islands about Tasmania and North Island, New Zealand.

The smaller species of the Sulidae, the booby gannets or boobies (*Sula*), so called because of their stupid appearance and reaction to man, breed on tropical and subtropical islands, ranging far over the sea. Several are cosmopolitan: the white-bellied brown booby (*S. leucogaster*); and two white species, the red-faced or red-footed booby (*S. sula*), which usually nests in low trees, and the masked or blue-faced booby (*S. dactylatra*).

Two are important guano birds along the northwest coast of South America; the blue-footed booby or *camanay* (*S. nebouxii*), brown and white streaked in colour, found from western Mexico to northern Peru and the Galapagos Islands; and the Peruvian booby or *piquero* (*S. variegata*) of islands off the coast of Peru and northern Chile. The latter fishes in the cold Humboldt current offshore, has a white head and body and variegated brown and white back, wings and tail. *S. abbotti* breeds on Assumption and Christmas islands in the Indian ocean. Boobies usually lay two eggs, in a slight depression in the sand or rock, with the exception of the red-footed booby, which builds a nest of twigs in low bushes. They are often intimidated by the frigate bird (*q.v.*) to give up fish that they have caught. (G. F. Ss.; X.)

GANOID, an obsolescent term for a group of fishes having ganoid scales, rhombic bony scales covered on the outer surface with a layer of ganoin, an enamellike shiny substance. It is now known that ganoid scales differ considerably in structure, and that the ganoid fishes are not a natural taxonomic group. Most fishes with ganoid scales are extinct, but the gar (*Lepisosteus*), sturgeon, paddlefish or spoonbill, and bowfin survive in the fresh waters of North America and elsewhere, and the bichir and reed fish in the rivers of Africa. *See* FISH.

GANYMEDE, son of Tros (or Laomedon), king of Troy. Because of his surpassing beauty, he was carried off by the gods, or Zeus or, according to a later myth, the eagle of Zeus or the god himself in eagle shape, to serve as cupbearer. In compensation, Zeus gave his father a stud of immortal horses (or a golden vine). From fairly early times (Theognis, 6th century B.C.), and perhaps especially among Dorians, his kidnapper was supposed to have a

homosexual passion for him, hence the connotation which Catamitus, the popular Latin form of his name, had and has. A Cretan variant of the legend makes Minos, the island's primitive ruler, Ganymede's ravisher. He was later identified with the constellation Aquarius.

GAON, a Hebrew word (plural *geonim*) meaning "excellency," describing the head of a talmudic academy. The *geonim* were the spiritual leaders of post-talmudic and early medieval Jewry, and they functioned, with occasional lengthy interruptions, from the middle of the 7th century to the end of the 13th. *Gaon* is the fourth of a series of titles—*sofer, tanna, amora* and *gaon*—of Jewish postbiblical teachers (*see* TALMUD). The geonic academies —which were engaged in the interpretation and development of the talmudic law, and thus served also as high courts adjudicating controversies over the law—appeared in Babylonia and Palestine. The teaching of the *geonim,* like that of their predecessors, safeguarded tradition, and their advice or decisions on points in the law (*responsa*) were often invoked far beyond the limits of their schools or communities. The *responsa* are of special importance for Jewish history and theology.

Among the great *geonim* may be mentioned Sherira ben Hanina (d. 1000) of the academy at Pumbeditha, author of the famous letter addressed to Jacob ben Nissim of Kairwan in which the history of the talmudic and geonic periods is set forth; Amram ben Sheshna of the Sura academy, the first authority to arrange a complete domestic and synagogal liturgy; Saadia ben Joseph (*q.v.*) of Sura, who fought Karaism, translated the Scriptures into Arabic, compiled a dictionary and was a pioneer in the fields of theology and philosophy; and his contemporary and adversary, Aaron ben Meir of Jerusalem. The last great *geonim* were Samuel ben Hofni (d. 1034), Hai ben Sherira (*q.v.*) and Samuel ben Ali, *gaon* of Baghdad, contemporary and adversary of Maimonides (*q.v.*).

Jewish scholars usually differentiate between the Babylonian and Palestinian *geonim.* There existed a constant rivalry between the two gaonates, a rivalry which broke out in open struggle at the time of Saadia. Ben Meir lost the battle for supremacy, and thereafter the superior authority of the Babylonian gaonate was rarely questioned.

The spread of talmudic studies during the geonic period to many Jewish communities in other countries brought about the establishment of talmudic academies outside Babylonia. There thus occurred a gradual weakening of the Babylonian gaonate, which by the end of the 13th century had disappeared altogether. The age of codifiers succeeded, and their codes exercised great unifying influence over scattered world Jewry. The codes, especially Joseph Qaro's (*q.v.*) *Shulhan Arukh,* became the halakic authority in Jewry, and later activity in the field of Halakah centred in them.

After the end of the geonic period the word *gaon* was used in Jewry merely as a title of honour, to describe excellence in learning. In later centuries one outstanding halakic authority, Elijah ben Solomon (*q.v.*), was called the Vilna Gaon or the Gaon. *See* also TALMUD; YESHIBA.

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(J. M. RL.)

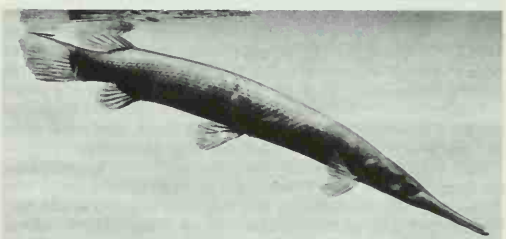
GAP, the chief town of the *département* of Hautes-Alpes, France, is 103 km. (64 mi.) S.S.E. of Grenoble by road. Pop. (1962) 18,116. It stands at a height of 743 m. (2,418 ft.) on the right bank of the Luye (an affluent of the Durance), and was the Vapincum of the Romans, founded by Augustus about 14 B.C. In 1232 most of the region passed from Provence by marriage to the dauphins of Viennois, but the town itself, as the centre of the medieval district of Gapençais, remained under the rule of the bishops until 1512, when it was annexed to the crown of France. It was the birthplace of the reformer Guillaume Farel (1489–1565), who first preached there about 1561–62. In 1567 it was sacked by the Huguenots, in 1577 by François de Bonne, duc de Lesdiguières, and by the duke of Savoy in 1692. Napoleon I, after leaving Elba, arrived at Gap on March 5, 1815. In World War II Paul Héraud (commandant Dumont) of Gap was a distinguished resistance leader.

Gap is an episcopal see (first mentioned in the 6th century), in the ecclesiastical province of Aix-en-Provence. The town produces and exports wheat products, flour, woodwork, underwear, foodstuffs and sheep of Savournon breed from the district.

(P. AI.)

GAR, a name most properly applied, especially in North America, to rather large archaic fishes of the genus *Lepisosteus* (family Lepisosteidae) of North and Middle America. They are confined chiefly to fresh waters, though some species descend to brackish or even salt water. Gars frequently bask like logs at the surface in sluggish waters and commonly breathe atmospheric air. Their bodies are encased in an armour of thick, shiny enameled (ganoid) scales of rhombic form. Fishes with such scales abounded in Paleozoic and Mesozoic times, but persist only as isolated relicts. During the Eocene period gars occurred in Europe as well as in America. One reason for the survival of these "living fossils" is thought to be the high toxicity of the relatively large, yolk-filled, greenish eggs. The eggs are laid in shallows in the spring, and the hatchlings grow remarkably fast, feeding from the start on minnows. They soon become such voracious predators that control measures are often applied to reduce their numbers. The long rows of needlelike teeth are very effective in capturing prey. The jaws are produced into a beak, which is broad and relatively short in the alligator gar (*Lepisosteus spatula*) and very long and forcepslike in the longnose gar, or billfish (*L. osseus*). The alligator gar of the southern U.S., reaching a length of ten feet, is one of the largest of all fresh-water fishes. Gars are edible, but are almost never eaten in the central and northern United States. They are sometimes baked in their own armour. The enameled scales are fabricated in New Orleans, La., into novelty jewelry.

The name gar, and the variant forms garfish and gar pike, are also applied, especially in Europe, to the needlefishes, or Belonidae, which are coastal fishes of warm seas, with very long and slender jaws armed with needle-sharp teeth. These fishes are not closely related either to the gars described above or to the pikes, but are cousins of the halfbeaks (which are also called "gars" in Australia) and the flying fishes. *See* FISH: *Survey of the Bony Fishes.*



BY COURTESY OF MIAMI SEAQUARIUM

FLORIDA GAR (LEPISOSTEUS PLATYRHINCUS)

(C. L. HS.)

GARAMOND (GARAMONT), **CLAUDE** (*c.* 1480–1561), French type designer and publisher, one of the first punch cutters to work independently of printers, who perfected the design of roman type faces and so assisted the roman letter in ousting the gothic from European typography outside Germany, was born in Paris about 1480. He was apprenticed about 1510 to A. Augerau and by 1520 was working with Geoffroy Tory. His first romans, and his *grecs du roi,* were cut for the firm of Estienne. In 1545 he began to publish books, with P. Gaultier as his printer. He died in poverty in Paris in 1561. His roman fonts, cut from 1531 on-

ward, surpassed the best Aldine romans in grace and clarity, and influenced European punch cutters for 150 years. His Greek set the pattern for Greek printing until the early 19th century; cut for Francis I in the 1540s, the *grecs du roi* displayed larger and more emphatic capitals than the Aldine Greek, but retained a larger number of ligatures and contractions. Garamond may have cut no italics until 1545, and then perhaps only two fonts; these followed the Aldine style in general, with a reduced number of ligatures, but were the most influential early italics to be designed with sloped and flourished capitals.

Eighty years after his death, his types were copied and adapted by J. Jannon; revived forms of these copies bear Garamond's name today, but do not bear witness to his skill. (H. A. F. W.)

GARASHANIN, ILIYA (Ilija Savic, known as Garasanin) (1812–1874), first statesman of modern Serbia and its ablest administrator, twice prime minister, was born at Garashi on Jan. 28 (new style; 16, old style), 1812, the son of a wealthy merchant. Educated in Greek and German schools, he was appointed customs officer in 1834, then colonel and commander of the newly formed army in 1837. After Prince Milosh Obrenovich's abdication (1839) he went into exile but took a leading part in Prince Michael Obrenovich's deposition and Prince Alexander Karageorgevich's election (1842). He was successively appointed permanent home undersecretary, home secretary (1843) and prime minister and foreign secretary (1852). Because of his pro-western tendencies he was dismissed under Russian pressure on the eve of the Crimean War. He was again appointed home secretary (1858) and was mainly responsible for Prince Alexander's abdication (1858). During Prince Milosh Obrenovich's second reign he retired from politics. When after Milosh's death in 1860 Prince Michael ascended the throne, he entrusted the premiership and foreign affairs (1861) to Garashanin, but Garashanin was dismissed in 1867 as he disapproved of the prince's intention to marry his cousin Katarina Konstantinovich. When Prince Michael was assassinated (1868), Garashanin, although out of office, saved Serbia from chaos by his authority and *sang-froid*. When Prince Milan Obrenovich ascended the throne, Garashanin retired. He died in Belgrade on June 28 (N.S.; 16, O.S.), 1874.

During his first tenure of office (1843–53) Garashanin was mainly concerned with westernizing Serbia and introducing modern institutions, a good bureaucracy and contemporary legislation. Even so, his *Nachertaniye* (plan) for foreign policy dates from 1844 and it was due to Garashanin that the treaty of Paris (1856) placed Serbia's autonomy under the collective guarantee of the powers. A conservative in home policy, Garashanin was a liberal in foreign policy. During his second tenure (1861–67) he carried out his *Nachertaniye*, which anticipated a South Slav state under Serbian leadership; formed alliances with Montenegro (1866), Greece (1867) and Rumania (the latter was signed in 1868, after his departure from office); entered into secret arrangements with Albanians, Serbs from Bosnia and Bulgarian exiles; and obtained the evacuation of all civilian and military Turks (1863)—except the Turkish garrisons of four fortresses, whose surrender he finally negotiated (1867).

His son Milutin Garashanin (1843–1898), who was born in Belgrade on Feb. 22, 1843, was educated at the École d'Artillerie in Metz, entered parliament (1874), was home secretary (1880–83), minister in Vienna (1883), prime minister (1884–87), minister in Paris (1894), speaker of the Skupshtina (1895–96) and again minister in Paris, where he died on March 5, 1898. He was the leader of the Progressist party and a member of the Serbian Academy of Sciences. (K. St. P.)

GARBETT, CYRIL FOSTER (1875–1955), archbishop of York, was born at Tongham, Surrey, the son of the vicar, on Feb. 6, 1875. Educated at Portsmouth grammar school and Keble college, Oxford, he was curate (1900–09) and then vicar (1909–19) of a then-important Portsmouth parish before becoming bishop of Southwark (1919–32). There he restored discipline, built churches and drew public attention to the evils of slums. Translated to Winchester (1932–42), he felt the scope inadequate to his energies and chief interests. In 1942 he became archbishop of York, in which office his common sense, careful preparation of speeches and gift for expressing in simple language the thoughts of laymen on all matters of social, some of political and a few of religious interest made him a national figure. Masterful, yet shy, he was influential through his character, energy and ordered life. His books of this period, *The Claims of the Church of England* (1947), *Church and State in England* (1950), *In an Age of Revolution* (1952) and *The Church of England Today* (1953), provided a balanced account of his church. He died at York on Dec. 31, 1955.

See C. Smyth, *Cyril Foster Garbett* (1959). (J. S. Be.)

GARBO, GRETA (1905–), Swedish-born film actress, the epitome of glamour on the screen and a legendary recluse in private life, was born in Stockholm on Sept. 18, 1905, the third child of poor parents, and was christened Greta Lovisa Gustafsson. At age 14 she graduated from grammar school and, because of her father's death, went to work. She was successively a lather girl in a barbershop, a clerk in a department store, and a model, until a chance meeting with the actor-director Erik Petschler began her career in films.

She made her first motion picture, *Peter the Tramp*, in 1922, playing the part of a bathing beauty. From 1922 to 1924 she studied at the Royal Dramatic Theatre, Stockholm; at this time she met Mauritz Stiller, the foremost Swedish director, who gave her an important role in *The Story of Gösta Berling*, changed her name to Greta Garbo, and trained her in cinema techniques. In 1925, when Stiller went to the U.S. to work for Metro-Goldwyn-Mayer, he insisted that Garbo be given a contract also, describing her as "an actress who will be the greatest in the world."

During Garbo's 16 years with MGM she starred in 24 films, and her salary rose from $400 a week to $300,000 a picture. Her major films were *The Torrent* (1926); *Flesh and the Devil* (1927) and *Love* (1927), both with John Gilbert, whose name was linked with hers in a much-publicized romance; *Wild Orchids* (1929); *Anna Christie* (1930), the talking picture which disclosed her rich, low voice; *Mata Hari* (1931); *Grand Hotel* (1932), with John and Lionel Barrymore; the tragedies *Queen Christina* (1933), *Anna Karenina* (1935), and *Camille* (1937); and *Ninotchka* (1939), in which she displayed a surprising gift for comedy.

At age 36 Garbo withdrew from the entertainment field, and nothing could induce her to return. Yet her popularity remained phenomenal: in 1950 a *Variety* poll of the film industry named her the best actress of the half century. After retirement she lived in seclusion in New York City. She became a U.S. citizen in 1951.

Garbo had, in the opinion of her directors and most critics, a perfect instinct for doing the right thing before the camera. Her talent, her great beauty, and her indifference to public opinion—"I want to be let alone," she insisted, and the remark became a byword—made her career unique in the history of the cinema.

See John Bainbridge, *Garbo* (1955). (N. R. C.)

GARBORG, ARNE EVENSEN (1851–1924), Norwegian author, one of the first great writers in "New Norwegian," was born on Jan. 25, 1851, at Thime. He joined the movement for the creation of a Norwegian literary language based on the landsmaal or peasant dialect derived from old Norsk, in place of the Dano-Norwegian literary medium. He wrote a series of novels deeply penetrated by religious feeling. His cycle of lyric poems in the landsmaal, *Haugtussa* (1895), describes a young girl's belief in the supernatural. He also translated the *Odyssey* (1918) and a selection from the *Mahabharata* (1921), and, for representation at the landsmaal theatre, which he and his wife had founded, Baron Holberg's classical comedy *Jeppe paa Berget* (1921).

His collected works, *Skrifter i samling*, which began to appear in 1908, were published in eight volumes in 1944. Garborg died on Jan. 14, 1924, at Asker.

GARÇÃO, PEDRO ANTÓNIO CORREIA (1724–1772), one of the principal neoclassical Portuguese poets, was born in Lisbon on April 29, 1724. He was the son of a foreign office official; his mother was of French descent. He studied law at Coimbra but does not appear to have taken his degree. In 1751 his marriage brought him a rich dowry and he had a moderately lucrative post in the *Casa da India*, but later a lawsuit reduced him to poverty. From 1760 to 1762 he edited the *Lisbon Gazette*. In 1756 he became a member of the *Arcádia Lusitana*, a literary so-

ciety founded to rid Portuguese poetry of the still-persisting 17th-century liking for conceits, windy words and rhetorical phrases. For reasons which are still obscure Garção was arrested in April 1771 and imprisoned, but he was never brought to trial. He died in Lisbon on the day of his release, Nov. 10, 1772.

Taking Horace as his model, and aided by sound judgment, scholarship and wide reading, Garção adopted a classical simplicity of form and expression. His sonnets and epistles reveal him as a man of good taste and good sense, devoted to his friends and possessing high ideals of conduct and of art. His verse comedies, the *Teatro Novo* (1766) and the *Assembléia ou Partida* satirize respectively the theatre and the social life of Lisbon. In the "Cantata de Dido," included in the latter play, he combined the spirit of classical art with perfection of form to produce one of the most celebrated 18th-century Portuguese poems.

BIBLIOGRAPHY.—Garção's works were published posthumously (1778). The most complete edition is by J. A. de Azevedo Castro, *Obras poéticas e oratórias* (1888). *See* also T. Braga, *A Arcádia Lusitana* (1918); F. de Figueiredo, *História da literatura clássica*, 2nd. ed. (1924); H. Cidade, *Lições de cultura e literatura portuguesas*, vol. 2 (1940). (N. J. L.)

GARCÍA, the name of five kings of Pamplona.

GARCÍA I, self-styled king of Pamplona, is recognized as the first Navarrese king of this name. He lived at least until 860. GARCÍA II (d. 970), king of Pamplona from 925 to 970, was the son of Sancho Garcés I and Queen Toda Aznar. He succeeded at the age of six and owed his throne to the support of his cousin Abd-al-Rahman III, caliph of Córdoba. García intervened in Leonese internal politics and captured Fernán González, count of Castile, in battle in 960. GARCÍA III (d. 1005), king of Pamplona and Aragon from *c.* 994 to 1005; his chief claim to fame is as the father of Sancho III the Great of Navarre. GARCÍA IV (d. 1054), king of Pamplona from 1035 to 1054, was the eldest son of Sancho the Great, from whom he inherited the kingdom of Pamplona enlarged by portions of Old Castile and the Basque provinces. Though he helped his brother Ferdinand I of Castile against the Leonese, Ferdinand made war on him to recover the territories annexed from Castile, and García was killed at the battle of Atapuerca in 1054. GARCÍA V (d. 1150) the Restorer, king of Pamplona from 1134 to 1150, was the son of the Cid's daughter Cristina and Ramiro Sánchez, lord of Monzón. He broke the union (1076–1134) of Aragon and Navarre by declaring himself a vassal of Alfonso VII of Castile. (P. E. R.)

GARCIA, CARLOS POLESTICO (1896–), fourth president of the Republic of the Philippines, was born on Nov. 4, 1896, at Talibon in the province of Bohol in the southern Philippines. He was educated in his native province and in Manila, graduating from the Philippine Law school in 1923. He was successively a school teacher, representative in the Philippine congress from Bohol, governor of his province and senator from Bohol (from 1941 to 1953). During the Japanese occupation of the Philippines, Senator Garcia was active in the resistance movement. He was nominated for the vice-presidency by the Nacionalista party in 1953, and elected. While in that office from 1953 to 1957 he was also minister of foreign affairs.

Garcia became president of the Philippines in March 1957 when Pres. Ramón Magsaysay was killed in an airplane accident. He was re-elected president for a full four-year term in Nov. 1957. He defined his policies as the improvement of political administration; elimination of graft and corruption; fiscal stability; more economic nationalism; and independence in foreign affairs. He stood for "frank, wholehearted and open co-operation with the United States," and closer relations with his country's noncommunist Asian neighbours. In the election of Nov. 1961 he was defeated by Vice-Pres. Diosdado Macapagal. (C. A. B.)

GARCÍA, MANUEL (DEL POPOLO VICENTE) (1775–1832), Spanish tenor and composer, was born in Seville on Jan. 22, 1775. At 17 he made his debut on the stage at Cádiz in an operetta that included songs of his own composition. In 1800 the first of his numerous operas, *El preso*, was produced in Madrid. From 1808 until 1811 García was active as singer and composer in Paris, and from 1811 until 1816 in Italy, where Rossini composed for him the role of Almaviva in *The Barber of Seville*. Thereafter he principally worked in London and Paris, singing, teaching and composing, though in 1825 he formed an opera company (which included his son Manuel and his two daughters Marie Malibran and Pauline Viardot-García) and took it to New York and Mexico. García's singing was everywhere praised for vivacity and intelligence. His principles and method were subsequently incorporated by his son Manuel in his admirable *Traité complet de l'art du chant* (1847). He died in Paris on June 2, 1832.

His son MANUEL GARCÍA (1805–1906), who celebrated his 100th birthday in London on March 17, 1905, was born at Madrid, and as a teacher became no less famous than his father. Some of his renown was attributable to his invention of the laryngoscope, which he described to the Royal society in 1855. *See* also VOICE: *Laryngoscopy*. (WI. S. M.)

GARCÍA DE LA HUERTA Y MUÑOZ, VICENTE ANTONIO (1734–1787), Spanish playwright, poet and critic, achieved success with *Raquel* (1778), a drama of national history, but of modern outlook, and the only actable Spanish tragedy of his era. He was born at Zafra, March 9, 1734, and died at Madrid on March 12, 1787. His translations from Sophocles and Voltaire and his affection for the traditional Spanish stage indicate a breadth of interest which sometimes confused his critical judgment; *e.g.*, in his eccentric collection *Teatro Hespañol* (1785–86). As a polemist, defending Spanish literature, he was inefficient, but as a poet he had lyrical moments which are unjustly forgotten. (I. L. Mc C.)

GARCÍA GUTIÉRREZ, ANTONIO (1813–1884), Spanish Romantic dramatist, was born at Chiclana (Cádiz), July 5, 1813. After abandoning a medical course, he walked to Madrid and found success as a playwright. He later worked for press and theatre in Cuba and Mexico; held official posts in London, Bayonne and Genoa; and became a member of the Spanish academy (1862). He died in Madrid, Aug. 26, 1884.

His first play, *El trovador* (1836), with its juxtaposition of passionate love and long-delayed revenge, its colour, pathos and melodious verse, was the most popular of the early Spanish Romantic dramas and formed the basis of Verdi's opera. Its improbability and sensationalism are shared by many subsequent works, and to a repellent degree by *El paje* (1837). These are "period" pieces, strongly influenced by French Romanticism. His best plays, *Simón Bocanegra* (1843) (also used by Verdi), *Venganza catalana* (1864) and *Juan Lorenzo* (1865), while confused in plot, have a more solid historical foundation and greater maturity of characterization. (H. B. HL.)

GARCÍA LORCA, FEDERICO (1899–1936), Spanish poet, notable for his poems of death, was born on April 15, 1899, in Fuente Vaqueros, Granada, where he spent his early years on his father's farm. His delicate health encouraged in him a contemplative attitude toward life and the characteristic Granadine love of diminutive objects in nature. During his youth in Granada in the intervals of reading the Spanish classical and romantic poets he studied music and came under the influence of Manuel de Falla. He studied law at Granada and Madrid, but that his main interests were literary is evident from the small book *Impresiones y paisajes* which describes a Spanish town. It was at this time that Lorca began to affirm himself as poet and dramatist. His first work was a collection of poems called *Libro de poemas* (1921), which contains images that recall the *greguerías* (humorous metaphors) of Ramón Gómez de la Serna. From the outset García Lorca's cult of children's songs was striking. Through them he penetrated into the life of the people and their folklore. In later years he devoted his energies to La Barraca—the vagabond theatre with which he roamed through the towns and villages of Spain.

In 1922 Lorca collaborated with Falla and Ignacio Zuloaga, the painter, in the *Fiesta de cante jondo*, which marked an important epoch in Andalusian folk art and music. In the following year he produced a children's fiesta with an interlude of Cervantes, an Andalusian tale in dialogue and a 13th-century auto sacramental entitled the "Mystery of the Three Wise Men." The music was arranged by Falla. The result of the struggle in him between poetry and music was his masterpiece *Primer romancero gitano*

(1928) which won great fame in Spain and South America. In 1931 he published *Poema del cante jondo*—a subtle evocation of the celebrated Andalusian gypsy singers. In these two volumes we find continually in the background the theme of death when discussing the blood feuds of the gypsies, who in Lorca's poems are always heroic dreamers vanquished by reality. Tragedy was implicit in Lorca's genius from the beginning, and the poems of death culminate in the "Lament" on the death of his friend, the bullfighter Sánchez Mejías, in the bull ring. The finest elegy in modern Spanish literature, this is an expressionistic monodrama with phantom voices repeating again and again the fatal phrase *A las cinco de la tarde* ("At five o'clock in the afternoon").

In 1929 Lorca visited New York. This marked an important stage in his career for it revived his poetic demon, and the result was *Poeta en Nueva York* and the odes to the king of Harlem and to Walt Whitman in which surrealistic influences appear, and the poet adopts the tone of a seer. On his return to Spain his experiences with his vagabond theatre inspired him to write his two striking gypsy plays *Bodas de sangre* (1933) and the more romantic *Yerma* (1934). When the Spanish civil war broke out in 1936 he was finishing his play *La casa de Bernarda Alba* (1936). Although invited to visit Mexico he decided to remain in Granada. On the outbreak of the civil war some friends invited him to their house to protect him against irresponsible fanatics. According to trustworthy accounts an armed group broke in while his friends were absent, carried him off and murdered him in the outskirts of Granada on Aug. 19, 1936.

García Lorca's complete works were published in Buenos Aires (1938-49); *Poems of F. García Lorca*, with English translation by Stephen Spender and J. L. Gili, R. M. Nadal (ed.), were published in 1939.

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GARCÍA MORENO, GABRIEL (1821–1875), established a unique semitheocratic dictatorship in Ecuador between 1861 and 1875, when he was assassinated. Born in Guayaquil on Dec. 24, 1821, he was educated at the university in Quito and in Europe. Informed in political theory (as well as in the sciences), he early began to participate in Ecuador's turbulent politics. He convinced himself that the only remedy for Ecuador's political instability and economic feebleness was not in further unsuccessful doses of European liberal doctrine but in the application of moral principles by a powerful leader. With the help of Juan José Flores, García Moreno seized power in 1860. From 1861 to 1865 and from 1869 to 1875, and to a considerable degree between those two presidential terms, García Moreno by his strong will and active intelligence imposed his ideas on Ecuador. He centralized the government, reduced corruption, maintained relative peace, strengthened the economy, placed education entirely in the hands of the Roman Catholic Church, signed a wide-ranging concordat with the Vatican (1863) and officially dedicated Ecuador to the Sacred Heart.

His often effective but oppressive rule ended in his assassination at Quito on Aug. 6, 1875, by young liberals. Neither his efforts as dictator nor his assassination cured Ecuador's defects. *See* also ECUADOR: *History*. (T. F. MCG.)

GARCILASO DE LA VEGA: *see* VEGA, GARCILASO DE LA.

GARD, a *département* in southern France, part of the ancient province of Languedoc (*q.v.*). Pop. (1962) 435,482. Area 2,271 sq.mi. It is bounded north by Ardèche and Lozère, west by Aveyron, southwest by Hérault, and across the Rhône to the east by Vaucluse and Bouches-du-Rhône. It consists physically of a succession of belts aligned northeast to southwest between the Cévennes and the lower Rhône and the Mediterranean coast west of its delta. The wall-like edge of the crystalline plateau of the Cévennes in the northwest dominates the lower limestone platforms, beneath which, fringing the young alluvium of the Rhône delta, is the sharply defined gravel terrace known as the Costière. The Cévennes plateau surface is largely resolved into narrow ridges as a result of its deep dissection by the torrential headstreams of the Cèze, Gard, Vidourle and Hérault. The westernmost part of the *département* projects into the upper basin of the Hérault in the *arrondissement* of Le Vigan. The steep sides of the Cévennes valleys, largely deforested and subject to deep gullying, have been extensively terraced for mulberry. But mulberry cultivation and the associated rearing of silkworms, as well as the cultivation of the sweet chestnut, are declining, and the terraced slopes have been largely abandoned. Over extensive areas the limestone tracts are sparsely covered with Mediterranean scrub (*garrigue*), with scattered patches of cultivation, including olive, almond and especially vine. In the lowlands the vine reigns supreme, the *département* containing the eastern part of the great vine-growing region of Languedoc round Nîmes. The vine is grown by smallholders, with a strongly developed co-operative organization.

To the old woolen industry of Languedoc the silk industry was later added and thrived from the 16th century, with mulberry growing and sericulture in the valleys of the Cévennes. Nîmes is still an important centre of silk spinning and has carpet and clothing industries. There are scattered surviving textile mills in the Cévennes valleys, some of which are now concerned with new synthetic fibres. These valleys are strongholds of Protestantism. At the foot of the Cévennes is the small coalfield of Alès, which has provided the basis for some heavy industry, but the coal is difficult and expensive to mine and production is small and declining. There are also some small deposits of lignite nearer the Rhône, and ore bodies, silver-lead and zinc, have been worked at a number of places in the mountains.

In 1951 France's first nuclear power station was opened at Marcoule on the lower Rhône; it produces plutonium and supplies power to the national electricity grid. Most of the personnel are accommodated six miles away in the town of Bagnols-sur-Cèze. Near Marcoule, at L'Ardoise, is an electrometallurgical plant.

Nîmes, on the great highway (Via Domitia) through Languedoc from the Rhône to Spain, is the chief town of the *département*, and is the seat of the bishopric and court of appeal. It is famous for its Roman remains. The famous Pont du Gard aqueduct that supplied the Roman city is well preserved as it crosses the river farther north and is a great tourist attraction. The *département* comes under the *académie* of the ancient university city of Montpellier. It is divided into the three *arrondissements* of Nîmes, Le Vigan, and Alès.

On the edge of the Costière is St. Gilles, the abbey church of which has a magnificent Romanesque facade. Behind the coastline in the westernmost part of the Rhône delta is the dead port of Aigues-Mortes, a planned bastide founded in the 13th century by Louis XI. Set amid the marshes, it is now a fossil town, preserved intact within its encasing ramparts. The canal linking the Rhône with Sète, at the terminus of the Canal du Midi, traverses the edge of the delta from Beaucaire to the coastal lagoons west of Aigues-Mortes. (AR. E.-S.)

GARDA, LAKE (LAGO DI GARDA; the LACUS BENACUS of the Romans), is the most easterly and most extensive of the Italian Lombard lakes, surpassed in the Alpine region only by those of Geneva and Constance. The lake is divided between the provinces of Verona, Brescia and Trento. Its broad basin orographically represents the southern portion of the valley of the Adige, though that river now flows through a narrow trench which is separated from the lake by the long narrow ridge of the Monte Baldo (7,277 ft.). The lake is fed by the Sarca at its north end, while at the southern end the Mincio flows out toward the Po. The area is 370 sq.km. (143 sq.mi.), length 52 km. (32¼ mi.), greatest breadth about 17½ km. (10.9 mi.), height of surface above sea level 64 m. (213 ft.) and the greatest depth 346 m. (1,135 ft.). Its upper northern end is narrow, but between Garda (east) and Salò (west) the lake expands gradually into a nearly circular basin. This shape gives rise to sudden, violent winds. The steep gray limestone crags of Monte Baldo to the east contrast strongly with the rich vegetation on the western and southern shores. The portion of the western shore that extends from Gargnano to Salò is the most sheltered and warmest part of the region, so that it forms one continuous garden (producing lemons, figs, mulberries and olives) and is frequented in winter. The picturesque promontory of Sirmione (Lat.

Sirmio) at the southern end also has an extremely luxuriant vegetation. It was a favourite residence of Catullus; however, the large ruins of a Roman villa on the promontory belong to the imperial period. There are also remains of the Lombard period and a fine castle of the Scaligers.

At the south end of the lake are the towns of Peschiera del Garda (23 km.; 14¼ mi. by rail from Verona on the east) and of Desenzano del Garda (28 km.; 17½ mi. by rail from Brescia on the west). There are shipping services from these two towns. On the west shore of the lake are Salò, Maderno, Toscolano (a place important in the early history of the printing press), Gargnano and Limone sul Garda, while on the rugged east shore are Lazise, Bardolino, Garda, Torri del Benaco, Brenzone and Malcesine. At the northern end is Riva. There is fishing for eels, tench and trout. (G. KH.)

GARDEN, MARY (1877–), Scottish-American soprano who achieved fame for her portrayal of French operatic roles, was born at Aberdeen, Scot., on Feb. 20, 1877. She went to the U.S. in her childhood and first studied at Chicago. In 1895 she was sent to Paris, where she studied with Mathilde Marchesi and others and made her debut at the Opéra Comique in Charpentier's *Louise* in 1900. Two years later Debussy chose her to play the heroine in the first production of *Pelléas et Mélisande*, which she sang with an effect enhanced, rather than marred, by her foreign accent. She later sang in operas by Saint-Saëns and Massenet, who rewrote the tenor name part of his *Le Jongleur de Notre Dame* for her. Her U.S. debut was made in New York in 1907 in Massenet's *Thaïs*. In 1910 she joined the Chicago Civic opera and was general director of the Chicago Opera association (1921–22). She retired in 1934.

See Mary Garden and Louis Biancolli, *Mary Garden's Story* (1951). (WI. S. M.)

GARDEN: *see* HORTICULTURE; LANDSCAPE ARCHITECTURE; and, for a special kind, JAPANESE GARDEN.

GARDENA, a city of California, U.S., on the southern plain of Los Angeles county, 9 mi. S. of Los Angeles. Founded in 1883 as a farming community, it was known as a garden spot in a semi-arid region. Its growth was very slow for more than 25 years. In 1909, the town moved farther west to avoid being included in the "shoestring strip" connecting Los Angeles with San Pedro harbour. It was incorporated in 1930 with less than 3,000 residents.

Following World War II, Gardena changed rapidly into a commercial and residential city. Its citizens include a broad cross section of economic, cultural and religious groups. Manufacturing and oil production in neighbouring areas provide the principal means of employment. Local schools have been a part of the Los Angeles school district since 1907.

For comparative population figures *see* table in CALIFORNIA: *Population.* (R. C. GM.)

GARDEN CITY, a village of Nassau county, on west Long Island, 18 mi. E. of New York city, in southeastern New York, U.S., is one of the few communities in the United States that was planned as a model town from its beginning. In 1869 Alexander T. Stewart, one of New York's leading merchants, bought a tract of over 7,000 ac. of the Hempstead plain with the idea of creating a "garden city," a term adopted later by the pioneer English city planner Sir Ebenezer Howard. (*See* GARDEN CITY.) Stewart envisioned parks and tree-lined avenues not less than 80 ft. wide. His heirs founded The Garden City company, which guided the affairs of the community until its incorporation as an independent village in 1919.

Garden City is distinguished for its handsome residential areas and for the beautiful Cathedral of the Incarnation, the see of the Episcopal diocese of Long Island. Industries include publishing and printing. Points of interest are Adelphi college, founded in Brooklyn in 1896 (moved to Garden City in 1929) as the first degree-granting liberal arts college on Long Island, and Roosevelt field, named for Theodore Roosevelt's son Quentin, a World War I aviator, and noted as the airport where Charles A. Lindbergh began his transatlantic flight in 1927. (The field was closed to flying in 1951 and became the site of a large shopping centre, dedicated as the Roosevelt Field Development International Flight mall in 1956.) For comparative population figures *see* table in NEW YORK: *Population.* (WI. M. D.)

GARDEN CITY. This term, first used in 1869 by A. T. Stewart in connection with the development of an estate on Long Island, N.Y., was adopted by English social reformer Ebenezer Howard in writing *Tomorrow: a Peaceful Path to Real Reform* (1898), in which he outlined a scheme for building a new model town to be called "Garden City." Apart from the name and the fact that Howard's proposal included the idea of houses with gardens in a planned area there was nothing in common between Stewart's scheme and his. In fact Howard owed much to Edward Gibbon Wakefield's *A View of the Art of Colonization* (1849). The publication of Howard's book led to the formation in England of the Garden Cities association in 1899 and to the establishment of Letchworth, the first garden city, in 1903, and Welwyn, the second, in 1920. The main features of Howard's scheme were: (1) the purchase of a large area of agricultural land within a ring fence; (2) the planning of a compact town surrounded by a wide rural belt; (3) the accommodation of residents, industry and agriculture; (4) the limitation of the extent of the town and prevention of encroachment upon the rural belt; (5) the rise in land values to be secured for the town itself.

Howard based his scheme upon the urgent need for remedying the congestion of towns and the depopulation of the countryside. He suggested that, since towns grew because people were attracted to them from country districts which they did not like, the country must be made attractive by establishing there the qualities of town life. The new town could be limited in extent because it is possible, he considered, to get everything that is required in a town of about 30,000, while a group of such towns would between them provide all the advantages of a big city; and because the inhabitants of the rural belt would be kept in close touch with town life and rural interests would form part of the town's economy. Such towns scattered over the country would, he believed, check rural depopulation and the overgrowth of the great towns.

The garden city was to be created by a private corporation and would raise money on loan, lay out the town, construct the roads, drainage, public services, etc., and let the land on revisable leases, rents increasing with the growth of population. Howard showed that reasonable rents would be amply sufficient to pay a return on the expenditure, leaving a considerable surplus. The rents, moreover, were to be "rate-rents," that is to say they were to include such charges on property as were normally required to meet the expenditure of the local authority. Howard contended that his scheme was practicable for two main reasons: (1) if land were purchased at agricultural value and a large population brought to it, the increment in land value would be sufficient to provide a substantial economic foundation; (2) as manufacturers were establishing works on the outskirts of towns and in country villages because they found the costs and conditions of working in the cities too onerous, a concerted movement of industry could be organized from the overburdened cities to the garden cities.

Howard's proposals attracted many people interested in the question of industrial housing: in the garden cities good houses could be cheaply provided for the working classes. When Howard put forward his scheme there was no public interest in England in town planning, but the advantages of planning a town before building it were appreciated and gave additional point to his contentions. The housing and town-planning movements of the 20th century were thus profoundly influenced by the garden city movement, but the specific proposals for garden cities and the general ideas on which they were based were by no means expressed in the housing and town-planning activities that reached their heights in England in the years immediately after World War I. In particular the development of "garden suburbs" was contrary to Howard's idea, which was concerned with a town as a whole.

Letchworth.—In 1903 the first garden city was established on Howard's plan. An area of 3,822 ac. (afterward increased to 4,552) was purchased, 35 mi. from London and within 2½ mi. of the old market town of Hitchin in Hertfordshire. A joint-stock company, First Garden City Ltd., was formed to carry out the

enterprise, with an authorized capital of £300,000, the dividend limited to 5% per annum. A plan was prepared for a town of 32,000 inhabitants (afterward increased to 35,000), with areas for houses, schools, etc., shops and factories and a rural belt. Development started in 1904. The company installed the roads, drainage system, water, gas and electricity supplies. By 1961 the town had a population of 25,515, occupied with engineering, corset making, printing and bookbinding. Industrial growth continued. London county council in 1960–61 built houses for London's overspill. In 1956 the company surrendered the limited-dividend principle, and in 1960 attempts were made by outside speculative interests to secure control, one of which succeeded.

Welwyn Garden City.—The second garden city was started in 1919–20 by a joint-stock company (an authorized share capital £250,000, dividends not to exceed 7%). Welwyn, 20 mi. from London, north of Hatfield, consisted of 2,383 ac. (afterward increased to 5,071), on which a town of 50,000 with a rural belt was planned. The estate purchased was completely rural, and the company provided roads, drainage, water, electricity and other supplies. By 1961 the town had a population of 34,944 with engineering, breakfast food and radio factories, plastics, printing and many other industries.

Although the Welwyn scheme at its inception aroused great interest the company experienced difficulties owing to shortness of capital and underwent two financial reconstructions, at the end of which it abandoned the limited-dividend principle. The scheme made slower progress than was expected; but it demonstrated the economic advantages of a town site held in a single hand. The features of Welwyn are its consistent architectural development, site planning, public gardens, and large central departmental stores owned by the company, with other individual shops. As at Letchworth, land was let on building lease.

Planning After World War II.—World War II had a very adverse effect on the two garden cities: virtually no houses, factories or other buildings could be erected except for war purposes; both towns became overcrowded as evacuation areas; and there was some change in industry and population. Furthermore, the effect of the Town and Country Planning act, 1947, was to remove for nearly five years the economic basis upon which the garden cities were established, for the unearned increment (or improved value) of land was appropriated by the state in "development charges" (abolished in Nov. 1952).

Under the New Towns act, 1946, however, Welwyn Garden City was expropriated, its building and development organization scrapped and the completion of the town entrusted to a new development corporation financed by the British treasury. The Garden City company was thus forced into liquidation. But even though the basis of compensation did not permit recognition of the full value of the property, total compensation of £3,550,000 in cash was paid for the land and building expropriated, a sum far in excess of all that the company had spent. If the town had been completed as projected so that the economic results could have been fully realized and preserved for the town, Howard's idea of rate-rents might well have been proved right, at least in part. At Letchworth the minister was content to lay down conditions for development and to put a representative on the board of directors. The urban district council presented a private bill in parliament which became law as the Letchworth Garden City Corporation act, 1962, and under which the estate became a public trust.

Letchworth and Welwyn Garden City were the only garden cities in Great Britain, or indeed in the world, and now exist as such only in name. Their influence is directly evident in the New Towns (*q.v.*) policy of the British government, as well as in town development schemes in the U.S. and throughout the continent of Europe. They are therefore to be regarded as major contributors to national well-being which was the aim of their founders.

(C. B. P.)

United States.—In the U.S., there was a long tradition in the development of industrial communities by private corporations, sometimes well-planned but more often lacking in spaciousness or attractiveness. The stigma of the "company town" frequently detracted from those which were built to high standards of design and construction, and no attempt was made in the early years of the 20th century to follow the conception of the garden city developed in the writings of Ebenezer Howard. Among better examples of well-planned industrial communities were Chicopee, Ga.; Kingsport, Tenn.; Kohler, Wis.; and Longview, Wash.

Planning of new communities in the United States along lines similar to those of the English garden cities of Letchworth and Welwyn came during World War I. New housing communities were designed for the United States Shipping board by teams of town planners, architects and engineers, some of the best of them having many of the features of the English garden city. The plans for these communities were also influenced by the examples of Forest Hills Gardens, N.Y., planned in 1911 by Frederick Law Olmstead, Jr., in collaboration with Grosvenor Atterbury as architect, and of Kingsport designed by John Nolen in 1915.

However, the nearest approach to the development in the United States of garden cities which followed the principles laid down by Howard was exemplified by Radburn, N.J.—the "Town for the Motor Age," designed by Clarence Stein and Henry Wright for the City Housing corporation in 1928—and the various Greenbelt towns built by the Suburban Resettlement Division of the U.S. Resettlement administration during the late 1930s. While these communities had many of the features of the garden city such as comprehensive planning, low residential densities and controls over the extent and type of future development, none was self-sufficient industrially or was surrounded by a permanent belt of rural land. While the Greenbelt towns were originally owned by the federal government, they were later sold in whole or in part to private individuals or co-operatives.

During World War II a number of new communities were built by agencies of the federal government, such as Oak Ridge, Tenn., constructed by the Atomic Energy commission. The privately sponsored "new town" of Park Forest, Ill., in suburban Chicago, designed by Elbert Peets for American Community Builders, Inc., was an excellent example of a well-planned residential community. It lacked diversity in its social structure and was dependent on the larger city for its economic base, but it provided a low density residential development surrounded largely by publicly owned reservations giving the community many of the advantages of the English garden city. Another postwar example of a large-scale residential community which was planned and completed in its entirety by private interests was Levittown, N.Y. (*q.v.*). Levittown, Pa. (*q.v.*), was developed primarily to serve the needs of employees of a new steel plant built at a considerable distance from established population centres.

During the latter part of the 1950s a number of new self-contained communities were started by private development companies, particularly in California and Florida, which had some features of the English garden city. However, there has been no attempt in the U.S. to follow the government-sponsored New Towns program initiated in Great Britain in 1946. (F. J. A.)

BIBLIOGRAPHY.—Ebenezer Howard, *Garden Cities of Tomorrow* (1902); Sir Patrick Abercrombie, *Greater London Plan* (1944); C. B. Purdom, *The Building of Satellite Towns*, rev. ed. (1949), *The Letchworth Achievement* (1963). (C. B. P.)

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FLORISTS' GARDENIA (G. JASMINOIDES)

GARDENIA, a genus of evergreen shrubs and trees of the madder family (Rubiaceae; *q.v.*), containing about 60 species, natives of subtropical parts of the old world. Several are grown in greenhouses for their handsome, sweet-scented white flowers, which are developed singly at the end of a branch or in the leaf axils and are funnel- or salver-shaped, with a long tube.

The Cape jasmine, or gardenia of the florists, is *Gardenia jasminoides*, a native of China. Its large, often double flowers are

among the most beautiful and highly perfumed of any in cultivation. Gardenias are readily propagated by cuttings.

The outdoor culture of a more hardy form than the gardenia of the florists is common in the warmer parts of the United States. The shrub, usually called *Gardenia jasminoides fortuniana* (or *G. veitchii*), is 6–8 ft. high and produces its very fragrant white flowers in midsummer. This particular gardenia will not stand severe frosts and requires a rich, acid soil. No other plant of outdoor culture is so spicily fragrant.

G. radicans, perhaps only a low, more or less prostrate variety of the Cape jasmine, is widely grown along the Gulf coast in California. (N. Tr.)

GARDENING: *see* Horticulture.

GARDEZ, the chief town of Paktia (*q.v.*; formerly Southern) province in eastern Afghanistan, is situated on the high plains, about 7,500 ft. above sea level, in the western part of the province. It lies on the small Jilga river and is less than 75 mi. S. of Kabul by road via the Logar valley. Pop. (1960 est.) 20,000. Gardez is an old town and contains a fort. It is also a trade centre for lumbering, which is the main industry of the province but has only limited local importance. Old trade routes lead from the town through Kurram to the Kohat and Peshawar districts of Pakistan. (J. P. C. N. H.)

GARDINER, SAMUEL RAWSON (1829–1902), English historian, descendant of Oliver Cromwell and Henry Ireton, whose career was dedicated to the study of the English Civil War, was born on March 4, 1829, near Alresford, Hampshire, and was educated at Winchester and Christ Church, Oxford. For some years Gardiner was a member of the Irvingite Church. From 1871 to 1885 he taught at King's college, London, becoming professor of modern history there in 1876. He was elected fellow of All Souls college, Oxford, in 1884 and of Merton college in 1892 but declined the regius professorship in 1894.

His researches among manuscript collections at Simancas, Venice, Rome, Brussels and Paris, as well as in England, gave unrivaled authority to the monumental undertaking which took shape between 1863 and 1900. Its principal stages were the *History of England From the Accession of James I to the Outbreak of the Civil War, 1603–1642*, ten volumes (1883–84); *History of the Great Civil War, 1642–1649*, three volumes (1886), four volumes (1893); and *History of the Commonwealth and Protectorate, 1649–1660*, four volumes (1903).

At first his style, method and judgment were questioned by critics, but by the late 1870s his reputation as a leading scholar in English 17th-century studies was established. Gardiner's chronological narrative, ostensibly pedestrian, was removed from superficiality by his grasp of the social, economic and intellectual dimensions of events and the skill of their presentation. In analyzing the causes of the Civil War he showed keen perception of individual motives as well as broad understanding of the material factors underlying political conduct. He was ready to credit England with a sense of nationhood wider and deeper than any provided for by the mere forms of government, and this gives drama to his otherwise unadorned chronicle. Inconsistencies and misinterpretations may be found, but the authority of his *History of England* continues to command respect little short of that usually reserved for original sources.

Among the most noteworthy of his separate works are: *Prince Charles and the Spanish Marriage*, two volumes (1869); *Outline of English History* (1st ed., 1881; later ed., 1919); *Student's History of England*, two volumes (1st ed., 1890–91; later ed., three volumes, 1920); *What Gunpowder Plot Was* (1897); *Oliver Cromwell* (1901). His edition of *Constitutional Documents of the Puritan Revolution 1628–1660* (1889) continues to be widely used. He also edited collections of papers for the Camden society and from 1891 was editor of the *English Historical Review*.

See H. B. Learned, *Samuel Rawson Gardiner* (1902); R. G. Usher, "The Historical Method of S. R. Gardiner" in *Washington University Studies*, vol. iii, part ii, no. 1. (1915). (H. G. Ro.)

GARDINER, STEPHEN (1490?–1555), bishop of Winchester and chancellor of England, was the leading exponent of conservatism in the first generation of the English Reformation. Born some time between 1490 and 1503, the youngest son of John Gardiner, clothmaker of Bury St. Edmunds, Suffolk, he was destined for the church. After a brilliant career at Trinity hall, Cambridge, he obtained his doctorate in civil and canon law in 1520–21. He was elected master of his college, an office which he retained throughout his public career (except when briefly deprived under Edward VI), in 1525 and succeeded Thomas Cromwell as chancellor of the university in 1540. Throughout a busy life he retained strong practical and emotional ties with the academic life, even going so far as to engage in a battle (1542–43) over the correct pronunciation of Greek when Sir John Cheke and Sir Thomas Smith endeavoured to introduce at Cambridge what they conceived to be the ancient practice in place of the modern Greek usage generally employed in the early 16th century. Characteristically, Gardiner ranged himself with the existing order and won a short-lived victory. Long before this, in the 1520s, he attracted Cardinal Wolsey's attention, became his secretary in 1525 and, with the opening of Henry VIII's suit for a divorce from Catherine of Aragon, found himself (because of his legal eminence) launched on a career in the royal service. In 1528 and 1529 he was engaged in diplomatic missions to Rome, during the first of which he forced from the pope the concession—illusory as it turned out—of a commission enabling Wolsey to try the case in England. However, for Gardiner the importance of these activities lay rather in the fact that he made a name for himself with Henry VIII; his rewards were the office of principal secretary in 1529 and the bishopric of Winchester, the wealthiest see in England, in Sept. 1531.

At this point his promising career suffered a serious setback. Gardiner was essentially a conservative in religion who hated the new ideas of the reformers as destructive of all order, a lawyer whose sympathies were all with authority and the inherited past. Resentful of the attacks that the house of commons was launching (1529–32) on clerical privilege and especially on the practices of the church courts, he allowed himself to become the leading defender of these last against the commons' "Supplication against the Ordinaries" (1532). In consequence he found himself out of step with Henry VIII and his new adviser, Thomas Cromwell, a chief promoter of the "Supplication." He thus lost the succession to Canterbury, vacant in Aug. 1532, and the see went instead to the obscure Thomas Cranmer, a man with reformist leanings. Late in 1533 Gardiner's absence in France allowed Cromwell to ease him out of the secretaryship, which he surrendered to his rival in April 1534. During these years, then, Gardiner saw power and influence slipping from him, though Henry VIII continued to hold his services in reserve.

The bishop now conceived an inveterate enmity to both Cromwell and Cranmer, in part because they conducted a reformist policy hostile to his own views but in part from injured pride and ambition. In 1535, on Cromwell's advice, he recovered some favour at court by producing the most effective Latin treatise written in support of the royal supremacy in the church (*De vera obedientia*, a powerful attack on the papacy). From 1535 to 1538 Cromwell kept him on embassy in France, but in 1539 Gardiner returned to take charge of the conservative reaction of that year, steer the king into the proclamation of orthodoxy contained in the Act of Six Articles and ultimately secure Cromwell's downfall in June 1540. Despite this he did not gain the position for which he had laboured. Though he remained a leading member of the council during Henry VIII's remaining years, he never commanded the king's real confidence. Henry distrusted both his arrogance and his roughness; while he used him to balance various moves toward a Protestant Reformation among his other councilors, he would not let him destroy Cranmer on charges of heresy and did not make this outstanding conservative churchman of the day an executor of his will.

Gardiner was therefore helpless when the accession (1547) of the boy Edward VI promoted to power the protector Somerset, whose policy promised to destroy all that the bishop of Winchester stood for. In Sept. 1547 he refused to enforce Cranmer's reformist injunctions and was sent to the Fleet prison; though released in Jan. 1548, he continued in opposition and preached a sermon be-

fore the king in June 1548 for which he was imprisoned in the Tower of London. From there he maintained his attacks on the progress of the Reformation; it was not until late in 1550, after the ruthless duke of Northumberland had replaced the uncertain Somerset, that the government felt strong enough to put him through a form of trial and deprive him of his bishopric. He remained in the Tower till Edward died, but in view of what happened to all his own defeated enemies he could be grateful to escape with his life.

The accession of Mary I catapulted him from disgrace and penury into high power; in Aug. 1553 he was appointed lord chancellor and became in effect chief minister. Power had come at last but, as it proved, too late. Gardiner was in no easy position. Mary would rest content with nothing short of the restoration of full obedience to Rome; yet the chancellor had not only accepted, but energetically defended, Henry VIII's triumph over the pope. His treatise on obedience now became a stumbling block to him. He was also at odds with the queen over her proposed marriage to Philip, archduke of Burgundy and son of the emperor Charles V. While he welcomed an alliance with Spain, he wanted Mary to marry an Englishman. However, since the queen proved adamant and there was in any case no suitable English candidate, Gardiner in the end accepted the Spanish match. His administration was further hampered by a vicious party struggle in the council which exploited the marriage problem and religious situation to embarrass him. On the other hand, though not the bloodthirsty monster of Protestant legend, Gardiner had no love for heresy and approved the persecution which started in 1554. He continued in office and favour after the arrival of Cardinal Pole (Nov. 1554), which robbed him once more of the archbishopric of Canterbury; he was reconciled to Rome with the rest of the realm, but as a true Henrician, untouched by the new spirit of the Catholic Counter-Reformation, felt out of step, and out of date, in a court dominated by Spain and the papacy. In 1555 his health began to fail and he died, in harness to the last, in November.

Gardiner was a man of notable talents, possessed of an incisive and energetic mind and inclined to action rather than contemplation. If his fame rested chiefly on his position as the foremost English scholar in civil and canon law of his day, he was also quite capable of holding his own in theological controversy. Aware of his violent temper, he did his unsuccessful best to curb its worst outbursts. Full of ambition and sure of his superior abilities, he found it difficult to hold his tongue when his more ingrained convictions came under attack; he had little sense of timing and thus, during a busy life spent at the centre of affairs, hardly ever gained real influence. Above all he was, to the bottom of his soul, an instinctive and intelligent conservative at a time when events at home and abroad demanded from a statesman the ability to recognize powerful forces of change which a creative conservative would have tried to manage, not simply to resist. He therefore lacked the scope and probably the talent for constructive enterprise granted to Cromwell and Cranmer. His philosophy of action seems to have consisted too exclusively of a determination to resist innovation. But he was no fanatic; though he did not oppose persecution, he saved individuals from it and could never quite understand why men should risk the stake if they could escape it by accepting his authority on disputed points. In private, Gardiner, despite his congenital brusqueness and rough manners, was essentially a man of sense and humour; his surviving letters display much charm and an unfailingly mettlesome spirit.

Bibliography.—J. A. Muller, *Stephen Gardiner and the Tudor Reaction* (1926) tells the story; Muller's edition of *The Letters of Stephen Gardiner* (1933) and P. Janelle's edition of *Obedience in Church and State* (1930) between them embody the essential surviving writings. For Gardiner's origin *see* G. Scott Thomson in *Studies Presented to Sir Hilary Jenkinson* (1957). (G. R. E.)

GARDNER, ERLE STANLEY (1889–), best-selling U.S. detective story writer, author of the Perry Mason series, was born in Malden, Mass., on July 17, 1889. He was admitted to the California bar in 1911 and successfully practised law in Ventura county for more than 20 years. In 1923 he began to write prolifically for the pulp detective magazines, notably *Black Mask*. In 1933 he published his first novel, *The Case of the Velvet Claws*, about lawyer-detective Perry Mason. He soon retired from the law to produce from three to five novels a year. In his first 25 years as a novelist he published 88 volumes of fiction, 54 about Mason, with combined sales of over 75,000,000 copies in North America alone.

Gardner developed his own method in detective fiction, combining an extremely fast-paced narrative with the highest legal ingenuity, which usually enabled his protagonist to solve a case spectacularly during a courtroom cross-examination. Many critics find in the pseudonymous novels by "A. A. Fair," starting with *The Bigger They Come* (1939), a liveliness of dialogue, characterization and humour lacking in other Gardner works. Gardner was also noted for serious research in criminalistics and penology, especially in connection with the Court of Last Resort, established by Gardner and *Argosy* magazine in 1948 to aid persons believed to have been wrongfully convicted in criminal cases.

See A. Johnston, *The Case of Erle Stanley Gardner* (1947); E. S. Gardner, *The Court of Last Resort* (1952). (Av. B.)

GARDNER, PERCY (1846–1937), English classical archaeologist known especially for his contributions to Greek numismatics, was born in Hackney, London, on Nov. 24, 1846, and educated at Christ's college, Cambridge. While on the staff of the British museum he began, with Reginald S. Poole and Barclay Head, the *Catalogue of Greek Coins*, to which he contributed volumes on Italy, Sicily and Thrace, and later, Thessaly to Aetolia and the Peloponnesus. In 1880 he was appointed Disney professor of archaeology at Cambridge, and in 1887 gave up posts at the British museum and Cambridge for the chair in classical archaeology at Oxford, where he taught for 38 years. He was a prolific writer and lecturer on numismatics, Greek art and religious subjects, and a gifted teacher. He helped to found and was first editor of the *Journal of Hellenic Studies*. Among his best-known works on numismatics are: *The Parthian Coinage* (1877); catalogues of the *Coins of the Seleucid Kings of Syria* (1878) and of the *Coins of Greek and Scythian Kings of Bactria and India* (1886); *Samos and Samian Coins* (1882); and *The Types of Greek Coins* (1883). The last is important for showing how coinage reflects the history of Greek cities and the development of Greek art. His *Principles of Greek Art* (1913), an elaboration of *Grammar of Greek Art* (1905), became a standard introduction. Of his theological writings notable are *Exploratio Evangelica* (1899) on the origins of Christianity, *The Religious Experience of St. Paul* (1911) and *The Ephesian Gospel* (1915). He died in Oxford on July 17, 1937.

His brother, Ernest Arthur Gardner (1862–1939), educated at Caius college, Cambridge, was director (1887–95) of the British School of Archaeology at Athens and later became professor of archaeology at University college, London, and dean of the university. His publications include: *Handbook of Greek Sculpture* (1896–97; new ed., 1905); *Catalogue of the Greek Vases in the Fitzwilliam Museum, Cambridge* (1897); *Ancient Athens* (1902); with E. S. Roberts, *Introduction to Greek Epigraphy* (1905; part ii, "The Inscriptions of Attica"); *The Art of Greece* (1925); *Greece and the Aegean* (1933).

See G. Hill, "Percy Gardner, 1846–1937," in *Proceedings of the British Academy*, vol. xxiii (1937); P. Gardner, *Autobiographica* (1933). (M. I. W.)

GARDNER, a city among the hills of northern Worcester county in north central Massachusetts, U.S., 59 mi. N.W. of Boston, was organized as a town on June 27, 1785, on the petition of John Glazer of Westminster and was incorporated as a city on March 15, 1921. It was named after Col. Thomas Gardner, who was killed in the battle of Bunker Hill. Gardner has been called the chair city of the world; the first chair factory was started there by James M. Comee in 1805. Major products include baby carriages and walkers, fabricated structural products, furniture, office machinery, sporting and athletic goods, and toys. A wooden chair near the Boston and Maine railroad station is a landmark that is reputed to be the largest chair ever constructed. For comparative population figures *see* table in Massachusetts: *Population.* (J. F. Z.)

GARFIELD, JAMES ABRAM (1831–1881), 20th president of the United States, was born on Nov. 19, 1831, in a log cabin on a small farm near the town of Orange, Cuyahoga county, O. His father died in 1833 leaving the family in poverty. The mother was a remarkable woman who with the help of an older son continued to run the farm. She saw to it that her children worked hard, went to church and received the educational training of the neighbourhood school. After attending the institute at Hiram, O., James Garfield went for two happy years to Williams college, where he graduated with distinction in 1856.

For a few months after his graduation he returned to the academy at Hiram as a teacher and later as principal. But he was already in demand as a lay speaker in the churches of the Disciples of Christ, of which all the Garfields were devoted members. Like the majority of his neighbours Garfield was an advocate of free-soil principles and became a supporter of the newly organized Republican party. By 1859, when he went to Columbus as a member of the Ohio legislature, he had begun his long career as a politician. In the state capital he gained experience in parliamentary procedure.

The Civil War came to Garfield as an exciting interlude. In 1861 he helped recruit a regiment made up in part of his former students at Hiram and became its colonel. He took part in the second day's fighting at the battle of Shiloh, served as chief of staff under Rosecrans in the army of the Cumberland, fought at Chickamauga and emerged after two years as a major general of volunteers. In the meantime he had been elected to congress from the 19th Ohio district and took his seat in Dec. 1863.

Garfield came from a district in northern Ohio where the normal Republican majority ran two or three to one. With his evident ability, his eloquence, his genius for friendship and above all his growing reputation in congress, Garfield did not have to worry every two years, as many of his colleagues did, regarding nomination or election. In the 18 years that followed his first election in 1862, his secure position was only once in danger. That was in 1874 when the Republican party had been discredited by the revelation of scandals in the Grant administration and had been further weakened by a severe economic depression. Charges were made against Garfield that involved a problem of political ethics which a later generation was to call a conflict of interest. With one or two of these charges Garfield dealt frankly and successfully, but the Crédit Mobilier affair (*see* CRÉDIT MOBILIER OF AMERICA) proved more embarrassing. Garfield, among others, had received in Jan. 1868 an offer of a gift of stock in this company, which was then seeking legislative favours. Without recognizing until later the impropriety of the whole proceeding, he had kept the matter in abeyance for more than two years before refusing, on the urgent advice of a friend, Jeremiah S. Black, to have any more to do with it. For that reason his denials could be only partial and not as convincing as he might have wished.

From that bitter experience in 1874 Garfield learned a lesson. He had been admitted to the bar and in his early years in congress had accepted an occasional brief; but he had now found that clients who desired legal services were not easy to distinguish from those who needed political influence. From that time, in spite of a meagre salary which barely covered the expenses of a growing family, Garfield gave up all legal assignments. He devoted his time and abilities to his position as chairman of the committee on appropriations, where he made himself an expert on the budget, and to legislative issues of which the most important were the South, the tariff and the problem of sound money.

As to the South, Garfield followed a policy that was from the point of view of his party orthodox and consistent. With other members of the radical group, he was bitterly opposed to the mild policy for reconstruction that President Lincoln foreshadowed. Later he voted for the impeachment of Andrew Johnson and during the Grant administrations defended the use of federal troops in the South, a measure which he frankly regarded as essential to the maintenance of the Republican party in those states. In the close election of 1876 he was one of the "visiting statesmen" whose presence in New Orleans strengthened the hand of the returning board of Louisiana in counting the vote of the state for the Republican ticket. Similarly in 1877, as a member of the electoral commission, he voted to resolve every doubtful electoral vote in favour of Rutherford B. Hayes.

As Garfield's attention turned more and more to economic problems, he supported for a long time a policy of moderate tariffs. In the end, only with evident reluctance did he accept the high protective tariffs to which his party was becoming increasingly committed. At all times, even against substantial opposition in his own district, he advocated a conservative money policy. He supported the return to specie payments and argued effectively against the so-called "Greenback" movement of the 1870s. In 1880 the Ohio legislature elected him to the U.S. senate for a six-year term beginning in 1881, but another event soon overshadowed this election.

At the Republican convention of 1880 in Chicago the delegates were sharply divided between the supporters of James G. Blaine and U. S. Grant, neither of whom could command a majority. Garfield, who was present as the chairman of the Ohio delegation, was of course well known. He made a favourable impression by the skill with which he insisted on the individual freedom of the delegates against the unit rule proposed by the "Stalwarts," as the Grant followers were called. After 34 fruitless ballots a break came, and on the 36th ballot Garfield was the unanimous choice of the convention. Chester A. Arthur was named as his running mate. In November, with a popular plurality of only 10,000, Garfield and Arthur were elected with 214 electoral votes against 155, and on March 4, 1881, Garfield became the 20th president of the United States.

President Garfield was unusually well equipped both by personal qualities and long experience for the duties of the office; but in his brief administration he had little opportunity to deal with anything but appointments to office. In the case of the position of collector of customs for the port of New York city, Garfield gained a notable success, forcing the confirmation of his nominee against the bitter opposition of Sen. Roscoe Conkling and his colleague Sen. Tom C. Platt, who regarded the appointment as a victory for their chief rival, Whitelaw Reid. On July 2, while at the Washington, D.C., railroad station on his way for a visit to Williams college, Garfield was shot by Charles J. Guiteau, a disappointed office seeker, probably insane, who shouted that he was a "Stalwart" and wanted Arthur to be president. Guiteau was later tried, convicted and executed.

Garfield's long disability raised for the first time in U.S. history the problem of presidential succession. For 80 days the president performed only one official act, the signature of an extradition paper. The daily bulletins of the physicians made it abundantly clear that the president was unable to perform the duties of his office. Before the end of July the problem was being discussed in letters to the press and later it was analyzed in magazine articles by leading constitutional lawyers.

It was generally agreed that, in such cases, the vice-president was empowered by the constitution to assume the powers and duties of the office of president. Would he then serve merely as acting president until Garfield recovered, or would he receive the office itself and thus displace his predecessor? Because of a certain ambiguity in the pertinent provision (Clause 6 of Section 1 of Article II of the Constitution) and in view of the precedent established in 1841 when, after the death of Pres. William Henry Harrison, the vice-president took the oath of office as president opinion was divided.

Since congress was not in session, the problem could not be debated there. On Sept. 2, 1881, however, it came before a meeting of the cabinet. The seven members agreed that the time had come when the vice-president should be asked to assume the powers and duties of the president. But on the question which had already troubled the constitutional lawyers the cabinet was also divided, three holding to the view that the vice-president would merely become acting president and four, including the attorney general, that Arthur would become president of the United States. In view of this possibility, all seven agreed that no action should be taken by them without first consulting Garfield. Since in the opinion of the doctors this was clearly impossible at the time

without endangering their patient's life, no further action was taken either by the cabinet or by the vice-president before the death of Garfield on Sept. 19, 1881, at Elberon, N.J.

See Theodore Clark Smith, *Life and Letters of James Abram Garfield*, 2 vol. (1925); Robert Granville Caldwell, *James A. Garfield: Party Chieftain* (1931). (Ro. G. C.)

GARFIELD, a city of Bergen county, in northeastern New Jersey, U.S., at the juncture of the Passaic and Saddle rivers, is 12 mi. W. of New York city and 10 mi. N.W. of Newark. Founded in 1679 by the Dutch after purchase of the land from the Hackensack clan of the Delaware tribe of the Algonkin Indians of the Lenni Lenape nation, the city was originally known as Cadmus Melon Patch and later as East Passaic. It was renamed Garfield in 1881 after Pres. James Garfield and incorporated as a borough in 1898 and as a city in 1917. Garfield is an industrial city, whose chief industries include the manufacture of textiles, chemicals, aircraft parts, nonferrous metals, paperboard, machinery and rubber products. For comparative population figures *see* table in NEW JERSEY: *Population.* (D. N. A.; M. P. M.)

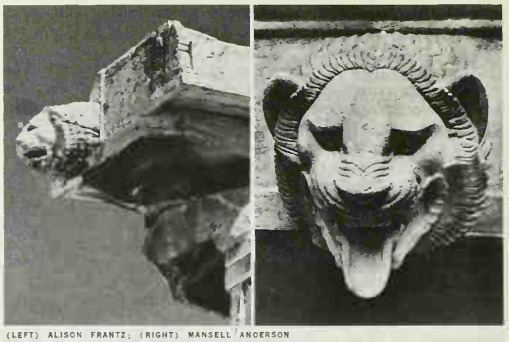
GARFIELD HEIGHTS, a suburban city of Cuyahoga county, in northern Ohio, U.S., is immediately southeast of Cleveland. Named for Pres. James Garfield, whose parents had once lived nearby, Garfield Heights did not receive village status until 1919. The area was part of the original township of Newburgh, organized in 1814, and underwent a gradual process of contraction as sections were annexed to Cleveland. The village of South Newburgh was established in 1904 and 15 years later became Garfield Heights. By 1932 the village qualified for designation as a city. In a rapidly expanding residential area, the city encouraged limited industrial activity, including the manufacture of women's apparel, tools and dies, abrasives and metal products.

After World War II, Garfield Heights experienced a sharp increase in population; for comparative population figures *see* table in OHIO: *Population.* (W. G. K.)

GARGANEY (*Anas querquedula*), one of the smallest of the ducks, is a summer visitant to England (hence locally called "summer teal"), where it breeds in the east Norfolk Broads. Slightly larger than the common European teal (*A. crecca*), the male has a nutmeg-brown beard and a white line behind the eyes. The female resembles the hen teal, but possesses no wing spot. In Ireland and Scotland the garganey is rare. It has not a high northern range, and its appearance in Norway and Sweden is casual. It is nowhere common in Europe, but ranges far to the eastward in Asia and visits India each winter in enormous numbers. It nests very frequently in reed beds. It is related to the blue-winged teal, or summer teal (*A. discors*), of Canada and the United States.

GARGANO (MONTE GARGANO, PROMONTORIO DEL GARGANO), a mountainous promontory jutting into the Adriatic from the east coast of Italy, Foggia province, called the "spur" of the Italian peninsula. It is 65 km. (40 mi.) long, 40 km. (25 mi.) at its widest, with an area of 2,015 sq.km. (778 sq.mi.). The peninsula is composed entirely of limestone, surrounded by terraces of various geological periods. The highest point, Monte Calvo, is 1,056 m. (3,465 ft.). The north coast has splendid citrus and olive groves and vineyards along the shore; the south slopes, facing the Foggia plain, are known for their heavy red wines. The oak forests, famous in ancient times, have largely been cut, and over much of the interior of the Gargano only naked bedrock remains; most famous of the few surviving forest preserves is the Bosco Umbra. Vieste, at the eastern tip, and Manfredonia (*q.v.*), on the south shore, are the main seaside settlements. Monte Sant'Angelo (*q.v.*), an ancient pilgrimage centre, is the largest town of the interior. (G. KH.)

GARGOYLE, in architecture, a decorated waterspout. Although technically speaking the term applies to the carved lions of classic cornices, or to the terra-cotta spout, such as those found frequently in Pompeii, in general usage the word has become restricted to the grotesque, carved spouts of the middle ages, and is even, incorrectly, applied to other grotesque beasts, such as the *chimères* that decorate the parapets of Notre Dame at Paris. The gargoyle of the developed Gothic period is usually a grotesque bird or beast sitting on its haunches on the back of a cornice molding and, in order to throw the water far from the building, projecting for several feet.



(LEFT) ALISON FRANTZ; (RIGHT) MANSELL ANDERSON

(LEFT) GARGOYLE ON THE PARTHENON, ATHENS, GREECE; (RIGHT) DETAIL OF LION-HEADED GARGOYLE ON A TEMPLE IN PALERMO, SICILY

GARHWAL, a district in Kumaon (Kumaun) division of Uttar Pradesh, India. Pop. (1961) 482,327. Area 2,106 sq.mi. The altitude rises from about 1,000 ft. in the south to about 10,000 ft. in the north. A narrow belt of *bhabar* (porous detrital piedmont) skirts the hills to the south. The Ganges, formed by the confluence of the Bhagirathi and the Alaknanda at Devaprayag, controls the drainage. Pauri (pop. [1961] 7,484) is the district headquarters, Lansdowne (6,381) a military cantonment and Kotdwara (8,148) another town.

Chamoli *tehsil* (pop. [1961] 253,137, area 3,525 sq.mi.) was formerly in Garhwal but acquired district status in 1960. (S. S. BH.)

GARIBALDI, GIUSEPPE (1807–1882), Italian patriot and guerrilla leader of the Risorgimento, a republican who by his conquest of Sicily and Naples greatly contributed to the achievement of Italian unity under the royal house of Savoy, was born on July 4, 1807, at Nice, then a French town, but from 1815 to 1860 included within the kingdom of Sardinia-Piedmont. He passed several years as a merchant seaman and then in 1833 was enlisted in the Sardinian navy. He had recently met Giuseppe Mazzini (*q.v.*), chief of Italian nationalists and revolutionaries, and had joined his organization *Giovine Italia* (Young Italy). In 1834 he became involved in a plot designed to provoke a popular revolution in Piedmont: he was to help seize his ship in the port of Genoa at the moment when Mazzini invaded Piedmont from Switzerland. The plot never had any chance of success and in any case was discovered. Garibaldi fled and was condemned to death in his absence.

Garibaldi eventually reached South America where he spent the years 1836–48. He first served as a pirate on behalf of the state of Rio Grande do Sul, which had revolted against Brazil. Later he fought for Uruguay against Argentina and then for one of the rival factions struggling to control Uruguay. He served primarily at sea until in 1843 he helped to form an Italian legion, the first "Redshirts," with whom he gained much of his experience of guerrilla warfare. His most important engagement of these years was the battle of Sant'Antonio in 1846. Meanwhile in 1839 he had carried off from her home Anna Maria Ribeiro da Silva, known as Anita, whom he married in 1842 after her first husband's death. She accompanied him on his expeditions and became a figure only less legendary than Garibaldi himself. (She died on the retreat from Rome in 1849.)

Hearing of the revolutionary situation in Italy (*see* ITALIAN INDEPENDENCE, WARS OF), Garibaldi returned there in 1848 with a few followers and a considerable reputation. When he reached Nice on June 21, he found that revolts had occurred in all the Italian states and that Sardinia was at war with Austria. Although a confirmed republican, he offered his sword to King Charles Albert of Sardinia, but received no encouragement. So he went to the aid of the Milanese. However, in July the Sar-

dinian army was defeated at Custozza, on Aug. 5 Milan was surrendered, and on Aug. 9 an armistice was signed. Garibaldi defiantly led a small band out of the city, to make a nuisance of himself to the Austrians in the hills round lakes Maggiore and Varese. But before the end of August he had to cross to Switzerland, whence he returned to Nice.

Though revolutionary governments still survived in other parts of Italy, for a time none of them seemed anxious to employ Garibaldi. But, soon after Pope Pius IX fled from Rome in November, Garibaldi was invited to the city, which he reached on Dec. 12, 1848. At first he was given little responsibility, but the imminence of French invasion in April 1849 induced the new republican government to entrust to him and to his legion an important part in the defense of Rome. On April 30 he beat off a French attack from the Janiculan hill, and during May he dispersed Neapolitan troops at Palestrina and Velletri. He was the most prominent figure in the siege during June. When the city fell, at the beginning of July, he led such men as would follow him on the remarkable retreat which took him to the republic of San Marino, pursued by the armies of France, Austria, Spain and Naples. He himself ultimately escaped across the Apennines to Piedmont and so into exile in America. The bravery and tenacity of the defenders of Rome, at a time when other revolutionaries were offering but feeble resistance to the return of the old regimes, proved to the world that Italians could and would fight for national freedom. Without Garibaldi's inspiration it is unlikely that the defense would have been so impressive; and the qualities which he displayed during these months—skill as a general, extraordinary personal courage, power of leadership and determination never to surrender to the enemies of Italy—caused him to be regarded as the very embodiment of the Italian national spirit and gave him a European reputation as a superman, the "hero of two worlds."

Garibaldi was allowed to return to Italy in 1854, and in the following year he bought part of the island of Caprera, lying between Corsica and Sardinia, with the idea of settling down there with his family. But his retirement did not last long. The Sardinian government, with Cavour (*q.v.*) as prime minister, was now working for a war against Austria and saw that Garibaldi might be a very useful ally. Garibaldi was ready to serve King Victor Emmanuel II. There were difficulties, of course. It was impossible for a regular government to give full recognition to an international outlaw like Garibaldi: he had to be prepared to be disowned. Furthermore, Garibaldi's aims were not precisely the same as Sardinia's: Cavour naturally thought in terms of the aggrandizement of his own state rather than in terms of the unification of Italy. However, the two men met in Aug. 1856, and came to an understanding, which was confirmed when Garibaldi first talked with the king in March 1859. In that month Garibaldi was made a major general in the Sardinian army and put in command of a brigade of "volunteers." When war broke out in April they were employed to create a diversion in the north; on May 26 they defeated the Austrians at Varese and they liberated Alpine territory as far as the frontier of the Tirol. Then the peace of Villafranca in July terminated the war.

Garibaldi next went to Tuscany, to assist the revolutionary government there. He made preparations to invade the papal state, but was forbidden to do so at the last moment, on Nov. 16, by Victor Emmanuel. Garibaldi ostentatiously gave up his rank in the Sardinian army. In Jan. 1860 he made a very ill-advised second marriage, abandoning his wife, the marchesina Giuseppina Raimondi, immediately after the wedding. He was furious at Sardinia's cession of Savoy and of his birthplace, Nice, to France and took his seat in parliament in order to protest bitterly against it. But, though he blamed Cavour very strongly, he was still willing to obey the king.

The greatest exploit of his life was the expedition to Sicily and Naples (May–Nov. 1860). He set sail from the Genoese coast on May 6, with the object of assisting a revolt in Sicily. His force consisted then of just more than 1,000 volunteers and is therefore known as "the Thousand" (*i Mille*). Insofar as they had a uniform, it was the red shirt. On May 11 they reached Marsala, and Garibaldi was proclaimed dictator of Sicily in the name of King Victor Emmanuel. Though the Sicilian revolt had come to little, Garibaldi's expedition was astonishingly successful. The Neapolitan troops were routed at Calatafimi on May 15; the garrison of Palermo asked for an armistice on May 30, after three days' street fighting; 20,000 Neapolitan regulars capitulated on June 6; and Garibaldi's force, now considerably strengthened, won a battle at Milazzo on July 20. Sicily offered no further resistance and Garibaldi prepared to cross the strait of Messina, which he did on the night of Aug. 18–19. On Sept. 7 he entered Naples. Then the Sardinian army intervened, attacking the papal state on Sept. 11. Garibaldi held his line on the Volturno river against a large Neapolitan army at the beginning of October and, at last, on Oct. 26, the Sardinians joined up with him. Apart from a small pocket round Gaeta, the whole kingdom of the Two Sicilies had now been conquered by Garibaldi, to be handed over to Victor Emmanuel. When the king made his triumphal entry into Naples on Nov. 7, Garibaldi was with him. But two days later he returned to Caprera, refusing any reward.

With this astounding achievement to his credit, Garibaldi, despite his self-abnegation in retiring to Caprera, was a considerable embarrassment to the new kingdom of Italy. He was angered by the government's mean treatment of his followers and by its conservative and unsympathetic administration of the provinces which he had conquered. He became a vigorous critic of official policy, especially in southern Italy. Not only was he a kingmaker: he regarded himself as something of an independent power, immune from ordinary restraints, both of international and of national law. He expected to be given opportunities to complete his work of uniting Italy in the unconventional way in which he had begun it. The Italian government sometimes gave him assurances of support in his schemes against Rome and Venice, but twice in 1862 it frustrated him when he went into action; in May it prevented the departure of an expedition for Venice by arresting a group of Garibaldi's followers; and in August, when he and some volunteers were marching on Rome, the Italian army attacked them at Aspromonte in Calabria. Garibaldi was wounded and captured, though quickly freed.

During his convalescence Garibaldi paid a visit to London, in April 1864, where he received an unparalleled welcome. In the war of 1866 he was allowed a subsidiary role, which he performed well. Then in 1867 he embarked on another expedition to Rome. He was arrested once and sent back to Caprera, which the Italian navy proceeded to blockade. But he found a way back to the mainland and entered Roman territory on Oct. 23. On Nov. 2 his forces were defeated at Mentana by French and papal troops. Recrossing the Italian frontier, he was again arrested and taken back to his island.

In 1870 Garibaldi formed a fresh volunteer corps, this time to assist France against Prussia. (*See* FRANCO-GERMAN WAR.) It gave good service and Garibaldi was elected a member of the Bordeaux national assembly. But he was quite out of his element and soon resigned. He lived most of the rest of his life in retirement and died at Caprera on June 2, 1882.

Garibaldi had great weaknesses. He was not at all intellectual: he did not think and argue; he believed and declaimed. He had many and contradictory enthusiasms, which he recommended to others in vague, high-flown speeches. In some ways he was a prototype of 20th-century dictators. He distrusted parliaments because he did not understand politics and so usually made a fool of himself when he took his seat. He was extraordinarily innocent in some respects: he does not seem to have been able to appreciate that the circumstances of 1860 were altogether exceptional and that guerrilla expeditions had little hope of success at other times. Hence the bathos of his later years. Yet he had remarkable qualities, not least his disinterest in power for himself. In fact he was no had ruler: it is arguable that he provided better government with his simple-minded radicalism when he was dictator of Sicily and Naples than the kingdom of Italy was to provide with its subtle conservatism. However, he was primarily a soldier. There has been no greater master of guerrilla warfare and none more successful.

Garibaldi's writings are collected in the *Edizione nazionale*, six

volumes (1932–37). His *Memorie autobiografiche* had appeared in 1888 (Eng. trans., 3 vol., 1889). *See* also references under "Garibaldi, Giuseppe" in the Index volume.

Bibliography.—G. M. Trevelyan, *Garibaldi's Defence of the Roman Republic* (1907), *Garibaldi and the Thousand* (1909), *Garibaldi and the Making of Italy* (1911); G. Sacerdote, *La Vita di Giuseppe Garibaldi* (1933); D. Mack Smith, *Cavour and Garibaldi* (1954), *Garibaldi* (1957). (D. E. D. B.)

GARLAND, HAMLIN (1860–1940), U.S. author, perhaps best remembered for his autobiographical "Middle Border" series, was born at West Salem, Wis., on Sept. 14, 1860. As his family moved progressively westward, Garland rebelled against the vicissitudes of pioneering and turned to Boston for a literary career. A follower of William Dean Howells, Garland far exceeded his mentor in the bitterness of his realism as he resentfully recorded the frustrations of rural life. The short stories of *Main-Travelled Roads* (1891), *Prairie Folks* (1893) and *Wayside Courtships* (1897), and the novel *Rose of Dutcher's Cooley* (1895) raised a storm of protest.

Garland's critical theories of "veritism," set out in *Crumbling Idols* (1894), were largely derivative but well in advance of contemporary popular acceptance. Garland next turned to the "high country" of the American west and to the occult for materials, producing a series of mediocre novels which were serialized in the burgeoning "slick magazines." His Indian stories, however, written during this period (though uncollected until 1923 in *The Book of the American Indian*), remain one of the earliest accurate and sympathetic appraisals of this minority group. Garland grew increasingly critical of the "excesses" of the naturalists, and in 1917 in mellow autobiographical mood wrote *A Son of the Middle Border*, apostrophizing the vanishing frontier. The book won immediate and deserved acclaim. A somewhat unsuccessful sequel, *A Daughter of the Middle Border* (1921), was the Pulitzer choice for biography. *Trail-Makers of the Middle Border* (1926) nostalgically described the epic sweep of migrations which settled the American continent. In his later years Garland compiled from his journals *Roadside Meetings of a Literary Nomad* (1930) and successive reminiscent volumes. He died on March 4, 1940.

An indefatigable lecturer and promoter of literary organizations as well as a fecund writer, Garland in his lifetime was a force in literary affairs. In youth the spokesman of the "local color school" of realists, he came in time to be the *bête noire* of the naturalistic critics. Later critical opinion was sharply divided as to the extent of his influence upon American letters.

See Jean Holloway, *Hamlin Garland: a Biography* (1959). The Garland Papers (manuscripts) are in the Doheny Library, University of Southern California. (Jn. M. H.)

GARLAND, JOHN (Johannes de Garlandia) (*c.* 1195–*c.* 1272), English grammarian and poet, whose works were important in the development of medieval Latin, was born in England of a noble family. He studied at Oxford under a certain John of London, and about 1202 went to Paris where Alain de Lille was his teacher. Garland taught at Paris until 1229 when he went to the new University of Toulouse. In 1232 or 1233 he had to flee Toulouse because of religious troubles with the Albigensians. Among his grammatical works were *Compendium grammatice* and *Liber de constructionibus*. His *Dictionarius*, a Latin vocabulary, was edited in 1857 by T. Wright, who also published fragments of the *Poetria* (1841), since edited in full by G. Mari (1892 and 1902).

The best known of Garland's poems are *De triumphis ecclesiae* (ed. by Wright, 1856), books iv–vi giving a detailed account of the Albigensian crusade in the south, and *Epithalamium beatae Mariae Virginum. De mysteriis ecclesiae* was edited by B. W. Otto (1842) and the *Morale scolarium*, which covers such topics as general behaviour, table manners, virtue and the defense of the pope against simony, by L. J. Paetow (1927) who in his introduction gives an account of the life and works of Garland.

GARLAND, a city of Dallas county, in northeastern Texas, U.S., is 14 mi. N.E. of Dallas. Known in the 1880s as Duck Creek and later as Embree, it was named in honour of A. H. Garland, U.S. attorney general under Pres. Grover Cleveland. It was long an agrarian town, with a population of only 2,233 as late as 1940. After World War II industrial expansion increased the population. (For comparative population figures *see* table in Texas: *Population.*) More than 50 industrial firms were established in Garland between 1940 and 1960.

In 1951 Garland adopted the council-manager form of government. (E. C. Be.)

GARLIC (*Allium sativum*), a bulbous perennial plant of the lily family (Liliaceae), used for flavouring. It is native to middle Asia west of the Himalayas. The membranous skin of the bulb encloses up to 20 small edible bulbils called cloves, which are quite unrelated to the spice of that name. These bulbils are borne in the axils of the inner leaves of the bulb. The 15 to 20 leaves are long, flat and solid with a ridge on the under side of each. Flower stalks sometimes arise to one foot or more bearing tiny bulblets and sterile flowers but no seeds. Garlic is propagated by planting either cloves or top bulblets and is grown as an annual crop by methods similar to those used in the growing of onions. It is little grown in the United States except in California. (V. R. B.)

JOHN H. GERARD FROM NATIONAL AUDUBON SOCIETY

GARLIC BULB (ALLIUM SATIVUM) SHOWING CLOVES

GARLIC MUSTARD (*Alliaria officinalis* or *A. petiolata*), a plant of hedge banks, low woods and waste grounds, called also hedge garlic, Jack-by-the-hedge and sauce-alone. It is an erect, somewhat branching, biennial or perennial herb, 2 to 3 ft. high, of the mustard family (Cruciferae), native to Europe, northern Africa and temperate Asia and naturalized in North America from Quebec and Ontario to Virginia. The tap root and the long-stalked, coarsely toothed leaves emit, when crushed, a garliclike odour. The plant bears white flowers.

GARMISCH-PARTENKIRCHEN, a health and winter sport resort of Germany, lies in the extreme south of the *Land* (state) of Bavaria, Federal Republic of Germany, almost on the border of Austria, 95 km. (59 mi.) S.S.W. of Munich by road. Pop. (1961) 25,011. It is in a junction of two deep Alpine valleys at the foot of the Zugspitze (2,963 m.; 9,721 ft.), the highest mountain in Germany, and is a noted skiing centre (scene of the 1936 winter Olympics). Among old buildings are the medieval Old church, the chapel of St. Anthony and the Old House in Partenkirchen, and there are examples of old peasant houses. Frühlingstrasse and Ballengasse are typical old streets. Tourist amenities include: climatic, bath and health establishments, a ski school, rack and cable railways, ski lifts, mountain footpaths and hotels. Garmisch-Partenkirchen originally comprised two separate villages which were united in 1935. It is on the main railway from Munich and Augsburg to Innsbrück, Aus.

GARNEAU, FRANÇOIS XAVIER (1809–1866), Canadian historian, whose *Histoire du Canada* established scientific method there, was born June 15, 1809, in Quebec, the son of a carriage maker. Leaving school at 14, he entered the court clerk's office and two years later a notary's firm, becoming himself a notary in 1830. He was in London from 1831 to 1833 as secretary to D. B. Viger, a Canadian political delegate. Back in Quebec, he wrote poetry, started a short-lived paper and dabbled in history. In 1837 he turned bank cashier and became somewhat active in politics. He was appointed translator to the legislative assembly (1843) and was Quebec city clerk (1844–64). His *Histoire du Canada* (1845–48) met with great success and was translated into English. *Voyage en Angleterre et en France* appeared in 1855. Scarcely touching economics, he concentrates on war and politics, being invariably impartial. His inspiration is based on the conservation of Quebec's religion, language and laws. Revitalizing ethnic pride and aspirations, he ranks as the national historian of French Canada. He died at Quebec, Feb. 3, 1866.

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GARNER, JOHN NANCE (1868–), U.S. vice-president during Pres. Franklin D. Roosevelt's first two terms, was born in a log cabin in Red River county, Tex., Nov. 22, 1868. After limited schooling, he studied law and was admitted to the Texas bar in 1890. He served two terms in the Texas legislature, 1898–1902. He was elected a Democratic representative in the U.S. congress in 1902 and continued as such for 30 years. After being successively Democratic whip and leader in the house, he was elected speaker in 1931. In 1932 he was a candidate for the Democratic nomination for president, but released his delegates in favour of Roosevelt. Garner was then nominated for vice-president and was elected; four years later he was re-elected with Roosevelt. Garner opposed a number of New Deal measures during his second term. He retired in Uvalde, Tex.

GARNET is a general name applied to a group of specific silicate minerals having similar crystal structures. The name is from Lat. *granatum*, "pomegranate," and alludes to the resemblance of some red varieties to the seeds of this fruit. Garnets typically occur in metamorphic rocks, but also in certain types of igneous rocks and, usually in minor amounts, in clastic sediments as detrital grains. Excepting bluish tints, garnets show great diversity of colour, including colourless and black, in addition to various shades of red. Garnets are frequently employed commercially in the form of semiprecious gems, jewel bearings in watches and abrasive materials.

Gem Uses.—Use of garnets as gems began with the ancient Egyptians, if not earlier. During the latter part of the 19th century, preparation of garnets for jewelry employed many persons in Czechoslovakia, and garnet jewelry in the form of bracelets and brooches was popular. Tastes in jewelry change according to whims, however, and Bohemian jewelry declined in popularity with an apparent decline in the use of dark-coloured stones that took place during the 20th century. Most familiar during the peak of popularity were varieties of pyrope, cut both *en cabochon* and in faceted forms. Because of the dark colour, larger stones cut *en cabochon* frequently were cut concave on the reverse. Many varietal names have been applied, some of the commonest of which are mentioned below under the specific names. As is true of other gem minerals, garnet varieties have become known by misleading names, frequently consisting of a locality name used as an adjective before the name of another mineral variety, such as emerald or ruby. Although possibly the most attractive in appearance, uvarovite occurs in such small crystals as to be unusable as a gem; otherwise it might rival the emerald in popularity. Except for some of the darker varieties, the hardness of garnets is somewhat less than what would be desirable for mounting in finger rings. Garnet is considered the birthstone for those persons born during January according to an American association of jewelers. As is true of many other gems, mystical significance was attached to the wearing of garnets; they were supposed to ward off accidents during travel. In diabolical apposition is their use as bullets in ancient firearms. (*See* also GEM; JEWELRY.)

Industrial Uses.—The hardness of garnets and their sharp fracture make them suitable as abrasives for wood, leather and plastics, and for lens grinding and metal and glass polishing. (For discussion of these uses *see* ABRASIVE.)

Heating to about 800° C., followed by quenching, improves the toughness and fracture characteristics of iron-bearing garnets, and such a process is used by several manufacturers of garnet-coated abrasive papers and cloths. Fracture is also dependent to a considerable extent on the impurities within the crystals. At Gore mountain, in Warren county, N.Y., garnet crystals averaging five inches, but reaching a maximum of a few feet in size, are produced from a complex metamorphic rock which consists principally of hornblende and garnet. Other commercial deposits are in Benewah county, Idaho. In New Hampshire, almandite has been produced from schistose rocks. Production, sometimes as a by-product of other mining operations, has occurred in Florida, North Carolina and California. Intermittently, notable quantities of garnet have been produced for abrasive use in Canada, Czechoslovakia, India, Madagascar, Spain and South Africa.

Crystallography and Physical Characters.—In their crystallization, garnets are cubic, or apparently pseudocubic for some compositions, and commonly exhibit either dodecahedral or trapezohedral forms or both. The hexoctahedron, trisoctahedron, octahedron and cube are rare. Crystals commonly attain an inch or more in size as isolated individuals, but massive examples, consisting essentially of granular textures of very small crystals, occur also. Within a garnet crystal may be included many small grains of other mineral species.

B. M. SHAUB

THREE EXAMPLES OF GARNET CRYSTALS: (A) RHOMBIC DODECAHEDRON CRYSTAL FOUND IN MINOT, ME.; (B) TRAPEZOHEDRON CRYSTAL FROM RUSSELL, MASS.; (C) COMBINATION OF RHOMBIC DODECAHEDRON AND TRAPEZOHEDRON CRYSTAL FOUND IN ALASKA

The smallest symmetrical unit of the crystal structure contains 96 oxygen atoms arranged in tetrahedral co-ordination about 24 silicon atoms. Combined with the silicon and oxygen, garnets contain calcium, magnesium, iron and aluminum. Interstitially divalent and trivalent atoms occur in the proportions 3 to 2, leading to a general formula $R^{2+}{}_3R^{3+}{}_2(SiO_4)_3$, where the bivalent element, R^{2+}, may be calcium, magnesium, ferrous iron or manganese, and the trivalent element, R^{3+}, may be aluminum, ferric iron, chromium or manganese. On analysis, garnets may be found to contain other metallic atoms in minor amounts as well as nonmetallic constituents other than silicon. (For discussion of type formulas and the replacement of one element by another *see* MINERALOGY.)

Garnetoids are essentially isostructural substances which contain a nonmetallic atom in isomorphous substitution for silicon. Both an arsenate and a phosphate mineral, berzeliite and griphite, fall in this group, as well as hydrogrossularite. The synthetic laboratory analogue of the last is tricalcium aluminate hexahydrate ($Ca_3Al_2[O_4H_4]_3$). In this compound the structure appears to be essentially similar to that of the garnets except for the absence of the silicon atoms and the occurrence of four hydrogen atoms for each silicon atom. Expectably such a hydrated compound decomposes at a considerably lower temperature than does the analogous silicate, the garnet grossularite, $Ca_3Al_2(SiO_4)_3$.

Without taking into account such isomorphous substitutions as sodium for calcium, it is possible to account for the equivalence of the number of structural positions by the formula $X_3Y_2(ZO_4)_{3-m}(OH)_{4m}$. Z is a pentavalent atom for berzeliite and thus requires commensurate substitutions for either X or Y in order to preserve the electrical neutrality of the structure.

The common, silicate species denoted by garnet can be written as pure compounds, although the natural substances are isomorphous intermediates consisting of combinations of two or more end members, thus:

Grossularite	$Ca_3Al_2(SiO_4)_3$
Pyrope	$Mg_3Al_2(SiO_4)_3$
Almandite	$Fe_3Al_2(SiO_4)_3$
Spessartite	$Mn_3Al_2(SiO_4)_3$
Andradite	$Ca_3Fe_2(SiO_4)_3$
Uvarovite	$Ca_3Cr_2(SiO_4)_3$

Other combinations, such as ferrous-ferric and manganous-manganic end members, have been suggested and named (skiagite and blythite, respectively) but the mere introduction of additional names does not contribute toward a better understanding of the crystal chemistry involved. Varieties containing titanium (T) and the rare-earth yttrium (Y) also occur. Indeed, inasmuch as some otherwise normal garnets contain small amounts of phosphorus pentoxide, the supposed failure of some garnets to yield precise stoichiometric proportions may be attributable to the inadequacy of the analyses rather than inherent structural imper-

fections of the crystals. This is emphasized by the possible occurrence of aluminum atoms in tetrahedral co-ordination instead of silicon, as is true of the synthetic garnetoid $Y_3Al_2(AlO_4)_3$.

The physical properties of the garnets are variable, depending upon the composition. Grossularite has a hardness of about 6.5, whereas other varieties may be as high as 7.5 or 8 (in the case of a New Hampshire almandite). The specific gravity ranges from slightly above 3.5 (pyrope) to 4.3 (almandite). For a nearly pure end member, the lowest refractive index has been measured for grossularite (1.735) and the greatest for andradite (above 1.88). Depending upon the titanium content, the refractive index may be appreciably higher. A schorlomite variety from Kuusamo, Fin., has a refractive index above 2. Although the refractive index of pyrope has been calculated to be 1.705, specimens containing more than 60% of this end member are extremely rare.

Garnets of some compositions, particularly grossularite, andradite, spessartite and uvarovite, are not strictly isotropic at ordinary temperatures, but are composed of anisotropic sectors. On heating the anisotropism is said to disappear, suggesting that passage through an inversion temperature has brought the crystal to a truly cubic condition which is not stable at lower temperatures. Many observations on the anisotropism indicate that the individual sectors commonly have orthorhombic or lower symmetry. An anisotropic garnet from Nevada displays spectacular iridescence.

The thermal behaviour and synthesis of garnets have been studied extensively. Most garnets melt incongruently, *i.e.*, decompose on or before melting and form pyroxenes, anorthite, spinels and other minerals on solidification. Grossularite, spessartite and almandite fuse at far lower temperatures than uvarovite. Utilizing high pressures and water vapour, garnets of various compositions can be synthesized, but only uvarovite, spessartite and possibly melanite have been produced at atmospheric pressure and possibly only the first two from a dry melt. On fusion most garnets form melts having appreciably lower specific gravities. Ferriferous varieties yield a magnetic material on cooling.

Varieties.—*Almandite* or so-called precious garnet is usually deep red and slightly purple in colour. It occurs typically in schistose rocks formed by regional or dynamic metamorphism of argillaceous sediments, in gneisses and in granulites. Its presence is used as a criterion to indicate the grade of metamorphism by dynamic processes. Well-known localities include Gore mountain, N.Y.; Salida, Colo.; Minas Gerais, Braz.; Fort Wrangell, Alaska; Nordland, Nor.; southern Greenland; Ceylon and India. Gem quality garnet is produced mostly in Brazil, Ceylon and India. Almandite may display asterism in the form of a four-rayed cross but this phenomenon is nearly always less spectacular than that of the star ruby or sapphire.

Pyrope also is frequently deep red, owing its colour to the presence of the almandite end member with which it occurs isomorphously combined, but there is reason to believe that pure pyrope would be very nearly colourless. A rose red variety found at Macon county, N.C., is called rhodolite. The common garnet of the jewelry trade, variously called Cape ruby or Bohemian garnet, contains appreciable quantities of pyrope. Pyrope of gem quality occurs in alluvial deposits near Prague. The characteristic occurrences of pyrope are basic igneous rock, such as peridotites, and the serpentinites derived from their alteration.

Grossularite, called the gooseberry garnet because its rounded shape and greenish colour may produce a close resemblance to the fruit, when pure is completely colourless, or white because of numerous internal fractures. White, dodecahedral crystals from Mexico are well known, as is a pink variety called rosolite. Reddish-brown varieties include so-called cinnamon stone and hessonite (or essonite) that are occasionally seen in jewelry. A massive variety is called South African or Transvaal jade from the locality and its jadelike colour. Grossularite occurs typically in impure limestones that have been thermally metamorphosed in proximity to an intrusive igneous rock. A typical mineralogical assemblage in addition to grossularite would include several or all of these: coarsely crystalline calcite, wollastonite, idocrase, diopside and scapolite. Many such contact metamorphic zones are known throughout the world so that grossularite is a common garnet, particularly when isomorphously combined with andradite.

Andradite is similar in its occurrence to grossularite, except that availability of ferric iron is essential, and related thermally metamorphosed rocks are more likely to contain ore deposits. Andradite also occurs in igneous rocks that have assimilated other rock fragments during emplacement. Titaniferous varieties may be black by reflected light but appear dark brown by light transmitted through thin slices. Schorlomite, a highly titaniferous variety, is found in nephelite-syenite at Magnet Cove, Ark. Melanites, so called because of their dark colour, are varieties containing titanium that likewise occur in association with alkaline igneous rocks, particularly in Norway, the Kola peninsula, U.S.S.R., Tasmania and the Kaiserstuhl, Ger.

The crystal chemistry of the titanium-bearing garnets has not been thoroughly investigated, but it has been supposed that schorlomite contains Ti_2O_3 in addition to the TiO_2 contained in the melanites. Green gem varieties of andradite are called demantoid because of the high index of refraction and dispersion. The deceptive name Uralian emerald has sometimes been applied to such gems inasmuch as this material occurs in the Ural mountains, as well as Saxony and Hungary. Pure andradite is probably yellow, but the colour is influenced by the presence of other isomorphous constituents. Topazolite, resembling topaz in colour, is a variety from the Piedmont region of Italy.

Spessartite, the manganese-aluminum garnet, is yellow when pure but red or orange when combined with almandite. It occurs in granites, their associated pegmatite veins, in acidic lavas and in thermal metamorphic rocks if manganese is available. Garnet predominantly of spessartite composition is found in association with metamorphic manganese ores in central India. It is found in cavities in rhyolite with topaz at Silver Cliff, Colo., and near Nathrop, Utah. In the Spessart district of Bavaria, whence the name, it occurs in granite. Other noteworthy localities include the Piedmont of Italy, Alba, It., and Madagascar.

Uvarovite, the chromium-containing garnet, is comparatively rare. It is emerald green in colour and typically occurs as small, brilliant, euhedral crystals in veins in chromite. Also it is reported from metamorphosed limestones in Tasmania and from serpentinites. First reported from the northern Urals, it is found also in California, Canada, Finland and Silesia.

See also references under "Garnet" in the Index volume.

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GARNETT, HENRY (1555–1606), English Jesuit implicated in the Gunpowder plot (*q.v.*), was born in Derbyshire, the son of a schoolmaster. He was educated at Winchester and later studied law in London. His early religious training was in the Anglican faith, but by the time he was 20 he had been converted to Roman Catholicism. His great religious zeal prompted him to leave England in 1575, travel to Italy and there join the Society of Jesus. He studied at the Roman college, showed much proficiency in his studies and later was added to the faculty as professor of Hebrew. Garnett returned to England as a Catholic missionary in 1586, and he was appointed superior of the Jesuits in the English province in 1587. Until his arrest in 1606 he ad-

ministered the province with much industry and courage and greatly promoted Catholicism in England.

Garnett's downfall was caused by his becoming involved in the Gunpowder plot in 1605. The full extent of his complicity is still in dispute; certainly he was not one of the active conspirators, but at the same time he knew of the plot and took no decisive action to prevent its execution. In various statements made after his arrest he freely admitted having seen the plotters on a number of occasions. He also stated that when the leader of the plot, Robert Catesby, asked him whether an undertaking which was designed to promote Catholicism, but would involve the destruction of the innocent together with the guilty, was lawful, he replied in the affirmative. However he claimed that he did not understand the application of the question. A short time later Garnett learned the details of the plot, but since this information was obtained in the confessional he could not reveal it. His activities in the period before the date set for the plot were somewhat suspicious. In Sept. 1605 he went on a pilgrimage with some of the conspirators in the course of which he was reported to have asked for prayers "for some good success for the Catholic cause at the beginning of parliament." When Garnett returned he went to Coughton, where the plotters had agreed to assemble after the destruction of the parliament building. On hearing that the plot had been discovered and the conspirators seized, he wrote a letter to the government protesting his innocence. He then went into hiding, but in Jan. 1606, after one of the conspirators implicated him in the plot, he surrendered to a search party and was taken to London.

Garnett continued to disclaim any prior knowledge of the plot, but in March he finally confessed his connection with it. Tried on March 28, he was found guilty, and was executed on May 3, 1606. Although he admitted that he had known of the plot, he claimed in his defense that he had never given his approval to it.
(R. C. Jo.)

GARNETT, RICHARD (1835–1906), English librarian and man of letters, eminent for his work for the British Museum library, was born at Lichfield on Feb. 27, 1835, the son of the learned philologist the Rev. Richard Garnett (1789–1850), priest-vicar of Lichfield cathedral and afterward keeper of printed books at the British museum. Garnett was educated at home and at a private school, and in 1851, just after his father's death, entered the British museum as an assistant in the library. In 1875 he rose to be superintendent of the reading room, and from 1890 to 1899, when he retired, he was keeper of the printed books. He died in London on April 13, 1906. In the history of the British Museum library his place is second only to that of Sir Anthony Panizzi (*q.v.*). Besides introducing the "sliding press" (a movable bookcase) in 1887 he was responsible for reviving the publication of the general catalogue, the printing of which, interrupted in 1841, was resumed under him in 1880 and gradually completed. In 1863 he married Olivia Narney Singleton (d. 1903), an Irishwoman. The family literary tradition was carried on by his son Edward (1868–1937), the critic and well-known publisher's reader, whose wife, Constance (1861–1946), translated the great Russian authors, and by his grandson, David Garnett (1892–), the novelist.

Garnett's works include several volumes of original and translated verse, brief biographies of Milton, Carlyle, Emerson, Edward Gibbon Wakefield and Coleridge, literary histories and a volume of fables in the style of Lucian, *The Twilight of the Gods* (1888).

See Carolyn G. Heilbrun, *The Garnett Family* (1961).

GARNIER, (JEAN LOUIS) CHARLES (1825–1898), French architect, creator of the Paris opera house, was born in Paris on Nov. 6, 1825, and died there on Aug. 3, 1898. The son of a wheelwright, he studied at the Petite École de Dessin and entered the atelier of L. H. Lebas in preparation for the École des Beaux Arts. Admitted in 1842, he won the Grand Prix de Rome in 1848 and went to the Villa Medici. He entered and won the competition for the new Opéra de Paris in 1860. One of the most famous buildings of the century, the opera house followed an eclectic style with lavish ornamentation which was intended as a foil to the pageantry of a glittering court and a suitable palace of the arts of the second empire. Started in 1861, this vast undertaking, interrupted by the war of 1870, was completed in 1875. Garnier's other works included the small theatre for the casino of Monte Carlo, the casino and baths at Vittel, the observatory at Nice, an apartment house and the Hôtel du Cercle de la Librairie in Paris, as well as villas in Bordighera. For the Paris exposition of 1889 he conceived the Exposition des Habitations Humaines, which became the subject of his book *L'Habitation Humaine* (with A. Ammann, 1892). He also published, in 1871, *Le Théâtre* and, in 1878–81, *Le Nouvel Opéra de Paris*, a monumental description and defense of the work with which his name is irrevocably linked.
(Jn. P. C.)

GARNIER, FRANCIS (Marie Joseph François Garnier) (1839–1873), French naval officer and explorer in the far east, was born at St. Étienne on July 25, 1839. After campaigning in Cochin China he was appointed an administrator at Saigon in 1862. In 1866, at his suggestion, the minister of the navy sent a mission under Capt. E. M. L. Doudart de Lagrée, with Garnier as second in command, to explore the upper Mekong. He undertook a dangerous mission to Sultan Suleiman II (Tu Wên-hsiu) in Yünnan and, on Lagrée's death, led the expedition safely to the coast. Garnier served in the defense of Paris in 1870–71, and in 1872 was back in China where he explored the upper Yangtze river. Returning to Indochina he was killed in action on Dec. 21, 1873, shortly after taking Hanoi. His chief fame rests on the important part he took in exploring the Mekong, recorded in his best-known work, *Voyage d'exploration en Indo-Chine, 1866–68* (1873).

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(R. L. Hl.)

GARNIER, ROBERT (*c.* 1545–1590), the outstanding French tragic dramatist of his time, was born at Ferté Bernard, near Le Mans. While a law student at Toulouse, he won two prizes in the *jeux floraux* for two *Chant royal en allegorie* (1564 and 1566), and published his first work, a collection of lyrical pieces now lost, *Plaintes amoureuses de Robert Garnier* (1565). After practice at the Parisian bar, he became *conseiller du roi* in his native district, and later *lieutenant-général criminel*. He died at Le Mans on Sept. 20, 1590.

In his early plays Garnier was a follower of the Senecan school. His pieces in this style are *Porcie* (1568), *Hippolyte* (1573) and *Cornélie* (1574; Eng. trans. by Thomas Kyd, 1594). His next group of tragedies—*Marc-Antoine* (1578; Eng. trans. by the countess of Pembroke, 1590), *La Troade* (1579), *Antigone* (1580)—shows an advance on the plays of Étienne Jodelle and Jacques Grévin (*qq.v.*) and on his own early plays, since the rhetoric is accompanied by some action.

In 1582 and 1583 he produced his two masterpieces, *Bradamante* and *Les Juives*. In *Bradamante*, the first important French tragi-comedy, which alone of his plays has no chorus, he turned from Senecan models and sought his subject in Ariosto. The romantic story becomes a real drama in Garnier's hands: although the lovers, Bradamante and Roger, never meet on the stage, the conflict in the mind of Roger supplies a genuine dramatic interest. *Les Juives* has for its theme the story of the barbarous vengeance of Nebuchadrezzar on King Zedekiah and his children. This tragedy, although almost entirely elegiac in conception, is given unity by the personality of the prophet. Garnier was a Catholic and a patriot: he used his tragedies to convey moral and religious arguments to his contemporaries, who were then suffering in the wars of religion. His fine verse betrays the influence of his friend Pierre de Ronsard (*q.v.*). His plays, which contain many affecting emotional scenes, were being performed at the end of the 16th century.

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(Ra. L.)

GARNIER, TONY (1869–1948), a precursor, with August Perret, of 20th-century French architecture, was born at Lyon in 1869. Both Garnier and Perret explored the means of expression inherent in the new material, reinforced concrete. Most of the

works of Garnier were executed in Lyon, under the aegis of the mayor, Édouard Herriot. The large complex of the stockyards (1909), the stadium (1915), the Granges-Blanches hospital with its 22 pavilions (started in 1915), as well as his planned housing schemes (*see* T. Garnier, *Grands travaux de la ville de Lyon,* 1919), developed out of the farsighted planning of his *Cité Industrielle* ("industrial city"), which secured Garnier's place in the history of architecture. On his Grand Prix de Rome grant he developed (beginning in 1898, exhibited in 1904 and published in 1917) plans for an entire city, embracing new concepts of city planning far more advanced than the garden city idea: long narrow lots running east-west, buildings separated by wide open spaces, separate levels provided for pedestrians and houses with roof gardens. The detailed ground plans for the houses were decades in advance of their time. The plasticity and strength of Garnier's chief material, concrete reinforced with steel, was employed to reach unexpected solutions for his schools, railway stations and sanatoriums. (S. GN.)

GARNIER-PAGÈS, LOUIS ANTOINE (1803–1878), French republican leader, prominent in the formation of the second and third republics, was born at Marseilles on Feb. 16, 1803. Together with his half-brother Étienne, he actively supported the revolution of 1830 which resulted from Charles X's ultraroyalist attitude. Étienne was leader of the republican opposition in the chamber of deputies from 1831 until his death in 1841, whereupon Louis Antoine abandoned his business career and entered politics, being elected a deputy for Eure in July 1842. A member, after the revolution of Feb. 1848, of the provisional government which proclaimed the second republic, he became mayor of Paris and on March 5 was appointed minister of finance. To deal with the financial crisis he introduced an additional tax of 45 centimes per franc on direct contributions, thereby incurring unpopularity which harmed his career. He sat in the constituent assembly in 1848 but was not elected to the legislative assembly. Under the second empire (1852–70) Garnier-Pagès was a leader of republican opposition in the *corps législatif* after his election in 1864 and opposed the war with Prussia. In Sept. 1870, after the fall of the empire, he sat in the provisional government of national defense but failed to get elected to the new national assembly in 1871. He died in Paris on Oct. 31, 1878.

Garnier-Pagès' writings include *Histoire de la Révolution de 1848,* ten volumes (1861–72), and *L'Opposition et l'Empire,* two volumes (1872).

GAROFALO, BENVENUTO DA (Benvenuto Tisi or Tisio) (1481–1559), Italian painter, was the most prolific 16th-century painter of the Ferrarese school. Modern knowledge of his early life and training is due entirely to Giorgio Vasari, who records Garofalo's apprenticeship with Domenico Panetti, his association with the Cremonese Boccaccio Boccaccino and his two visits to Rome in the first and second decades of the century. The style of his early works confirms Vasari's account but shows in addition the strong influence of Dosso Dossi, especially in the treatment of landscape backgrounds. This is clearest in several pictures of the Nativity painted before 1520; it is also apparent in the fine "Sacrifice to Ceres" (1526) in the National gallery, London. North Italian influences, particularly from Andrea Mantegna's "Camera degli Sposi," also dominate the ceiling paintings in the Seminario at Ferrara (1519).

The influence of Raphael and Michelangelo made itself increasingly felt from about 1520 onward, however, and Garofalo, though he seems never to have left Ferrara at this time, kept pace with the developments of Michelangelesque mannerism in Florence and Rome, for example, in the "Baptist Taking Leave of His Father" (1542) in S. Salvatore, Bologna. Garofalo died in his native Ferrara on Sept. 6, 1559. The history of his development well illustrates the derivative status of the Ferrarese school after its great period in the second half of the 15th century.

See E. G. Gardner, *The Painters of the School of Ferrara* (1911). (M: W. L. K.)

GARO HILLS, a district in Assam, India, takes its name from the Garo peoples by whom it is almost entirely inhabited. Area 3,119 sq.mi.; pop. (1961) 307,228. The district headquarters are at Tura which has road connections with Gauhati and Goalpara. The district corresponds approximately with the geographical region of the Garo hills which form the westernmost part of the Shillong plateau. The plateau is distinct from both the young folded mountains of the Himalayan foothills on the north and the Assam-Burma ranges on the east, as it forms an outlying block of the extremely ancient stable formations of peninsular India, which include chiefly Archean quartzites and schists with granite intrusions. The plateau forms a barrier which has caused the Brahmaputra to flow directly westward for several hundred miles before resuming its southerly course to the Bay of Bengal. The plateau rises to a height of more than 5,000 ft., and drops steeply to the Brahmaputra valley on the north and west, and to the plains on the south. The district, like the rest of Assam, has an extremely high rainfall and is covered in thick forest. Coal and limestone occur in large quantities and petroleum has also been found. (X.)

The People.—The Garos are an Assam tribe of the Bodo group which seems to have migrated from the direction of Bhutan, but probably absorbed some pre-existing local stock (wavy and even curly hair is frequent); the existing culture suggests Indonesian affinities. A Tibeto-Burman language is spoken; the tribe is related to the Rabhas, Kacharis and Tipperas.

Villages are built on river banks, the houses raised on piles; land is communal and cultivation shifting, rice and cotton being grown. Garos are good fishermen but indifferent hunters. Distention of the ear is practised. There are a dozen subtribes with varying customs and dialects, but all are divided into matrilineal clans. Marriage is exogamous and polygamous and the proposal comes from the woman, who, if accepted, lives for a time in the bridegroom's house on probation, but this system is subject to compulsory cross-cousin marriage coupled with a rule by which a man must marry his wife's father's widow, who is in such cases the husband's father's sister, actual or classificatory. Such a wife takes precedence of her daughter married before her. A man's sister's son, called his *nokrom,* stands therefore in intimate relationship to him, as the husband of one of the daughters and ultimately of his widow and the vehicle through which his family's interest in the property of his wife is secured for the next generation, for no male can inherit property.

The dead are buried, followed by various forms of secondary disposal including urn burial, burial by water and sometimes by special treatment of the frontal bone. Head-hunting used to be practised, enemy skulls being kept in the latrines, and there are faint traces of cannibalism and human sacrifice in the past. A considerable portion of the population is now Christian, converted by the American Baptist mission, but in the case of the unconverted Garos, religion is generally animistic but provides a benevolent creator and a sort of vague ancestor worship with soul figures of wood or stone, probably phallic, and a fertility cult which involves the sacrifice of an imitation horse. They believe in the reincarnation of the soul. *See* also Head-Hunting; Metempsychosis.

See A. Playfair, *The Garos* (1909). (J. H. H.)

GARONNE (Lat. Garumna), the great river of southwestern France and an important part of the French inland waterway system, rises 30 mi. beyond the frontier in the Maladetta group of the central Pyrenees in Spain, and flows for 360 mi. in a wide arc through the lowland basin of Aquitaine to enter the Bay of Biscay by the Gironde estuary. The Spanish headstreams enter the high mountain Valle de Arán from which the Garonne crosses the frontier through the narrow defile of the Pont du Roi at a height of 1,870 ft. Before it crosses the outer ridge of the Petites Pyrénées to emerge into the plain, the Garonne skirts the gravel plateau of Lannemezan, flowing with its left-bank tributary the Neste in a west-east longitudinal valley past St. Gaudens. In its northeasterly course from the Pyrenean foothills toward Toulouse, the Garonne is joined by another large Pyrenean river, the Ariège. Approach is made by the Ariège valley past Foix to the chief crossing in the central Pyrenees, but since World War II road tunnels have pierced the Maladetta massif and made the upper Garonne valley accessible to Lérida and Saragossa in Spain.

From Toulouse the Garonne flows in a general northwesterly direction to Bordeaux and its estuary.

Sudden floods are common, and the river has been known to rise more than 40 ft. at Castets. The wide flat-floored trench of its valley is entered by the great valleys of its right-bank tributaries the Tarn and Lot, and by numerous left-bank tributaries from the hills of Armagnac, chief among them the Save, Gers, and Baise. At Toulouse the Canal du Midi, connecting with the Mediterranean sea, reaches the Garonne by the Hers valley from the Col de Naurouze and the gate of Carcassonne. Since 1856 the Garonne Lateral canal has improved navigation between Toulouse and Castets, 34 mi. above Bordeaux. It follows the right bank as far as Agen and there crosses by an aqueduct to the left bank. The fall of 420 ft. that takes place over its 120-mi. length is negotiated by 50 locks. Beyond Castets the channel of the Garonne widens considerably and at Bordeaux, the great commercial port, the river is 600 yd. broad. Sixteen miles farther north it unites with the Dordogne to form the vast estuary known as the Gironde which extends from the Bec d'Ambès to the Pointe de Grave. The peninsula between the converging rivers, known as Entre-deux-Mers, is clothed with vineyards, which are also widespread throughout the lowland part of the Garonne basin. The river flows from the Pyrenees through a rich agricultural area. Minerals were unimportant until the discovery in 1939 of natural gas in the upper basin at St. Marcet. From the early 1960s the considerable hydroelectric power resources of the upper Garonne and its Pyrenean tributaries were also being actively developed, and the tourist industry was becoming increasingly important, bringing new prosperity to old spa towns in the Pyrenean valleys.

(Ar. E. S.)

GARRETT, JOÃO BAPTISTA DA SILVA LEITÃO DE ALMEIDA, Visconde de Almeida Garrett (1799–1854), one of Portugal's finest prose writers, the most important playwright since Gil Vicente and chief of the romantic poets. He was born on Feb. 4, 1799, in Oporto, but the French invasion of Portugal drove the family to the Azores where he lived for a time. In 1816 he went to the University of Coimbra where he soon earned notoriety by the precocity of his talents and his fervent liberalism. His tragedy *Lucrécia* was played at Coimbra in Feb. 1819, and there also he wrote *Mérope* and a great part of *Catão*. All these plays, which are of little merit, belong to the so-called classical school. After taking a degree in law, he went to Lisbon, and on Nov. 11, 1822, married Dona Luisa Midosi, but the marriage proved unhappy, and a formal separation was granted in 1839.

The reactionary movement against the liberal revolution of 1820 reached its height in 1823, and Garrett, forced to leave Portugal by order of the absolutist ministry, went to England where he read and was impressed by the work of the English romantics. Imbued with the spirit of patriotism, he published in 1825 the poem, *Camões*, which, together with his *Dona Branca* of 1826, undermined the influence of the worn-out classical and Arcadian poets. He was permitted to return to Portugal in 1826, and thereupon devoted himself to journalism. His defense of liberal principles led to three months' imprisonment and when Dom Miguel was proclaimed king on May 3, 1828, Garrett again had to leave the country. He spent the next three years in and about Birmingham, Warwick and London. Returning in Feb. 1832, he disembarked at the island of Terceira, whence he proceeded to São Miguel, then the seat of the liberal government. There he co-operated with the statesman Mousinho da Silveira, assisting him in drafting the laws which were to revolutionize the framework of Portuguese society. In his spare time he wrote some of the lyrics later collected in *Flores sem Fruto* (1845). He took part in the expedition that landed on the Portuguese mainland at Mindelo on July 8, 1832, and in the subsequent occupation of Oporto by the liberal forces. In Oporto, influenced by the works of Walter Scott, he sketched out his historical romance *O Arco de Sant'Ana*, the first part of which was published much later, in 1845.

During 1834–35 Garrett served as consul general and chargé d'affaires in Brussels. Entering parliament in 1837, he soon made his mark as an orator, and was asked by the government to draw up proposals for the formation of a national theatre. Thus a school of actors and playwrights arose under his influence. To give them models he wrote a series of prose dramas, choosing his subjects from Portuguese history. He began in 1838 with the *Auto de Gil Vicente* and followed this with *Dona Filipa de Vilhena* (1840), *O Alfageme de Santarém* (1841) and *Frei Luís de Sousa* (1843), one of the greatest of 19th-century Portuguese plays.

An excursion to Santarém in July 1843 resulted in a prose masterpiece describing his journey, *Viagens na minha terra* (1846). He took no part in the intermittent civil war which raged in Portugal about this time. He spent much of 1850 in completing his *Romanceiro*, a collection of traditional poems; he was the first to perceive the value of this type of poetry. In June 1851 he was created a viscount, and in 1852 was for a short time minister of foreign affairs. In 1853 he brought out *Folhas Caídas*, a collection of short love poems exquisite in form—the best Portuguese lyric poems of the romantic period. He died in Lisbon on Dec. 9, 1854. Poet, dramatist, novelist, journalist and orator, he deserves the comment of Rebelo da Silva: "Garrett was not a man of letters only but an entire literature in himself."

Garrett was endowed with a deep sensibility, a creative imagination and a fine control of language. He was first and always an artist. His artistic temperament is revealed in his many-sided activity, his expansive kindliness, his seductive charm, especially for women, his ardent patriotism, his aristocratic pretensions, his vanity and dandyism and the ingenuousness that made forgivable the many faults of his irregular life. His sincere, sensual and melancholy lyrics, his eloquence, the truth of his comedy and the elegance of his lighter compositions are all expressions of his richly endowed personality.

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(E. P.; A. B.; N. J. L.)

GARRICK, DAVID (1717–1779), perhaps the greatest English actor and theatrical manager, was of French Huguenot descent. His grandparents, probably surnamed Garrigues, escaped to England from Bordeaux on the revocation of the Edict of Nantes, anglicized their name and, in due course, purchased a commission in the English army for their elder son, Peter. After Peter had married Arabella Clough, the daughter of a lay singer of Lichfield cathedral, he made Lichfield his home, bringing up a large family on modest means. His famous second son was born, however, at Hereford on Feb. 19, 1717, during a recruiting campaign. David, like Samuel Johnson before him, was educated at Lichfield grammar school under that stern disciplinarian John Hunter. In 1731 Captain Garrick, after some years on half pay, rejoined his regiment at Gibraltar, relying on "Davy" as the eldest son at home to send him regular reports on the doings at Lichfield during his absence. On his return in 1736 he sent David to be coached at Samuel Johnson's newly opened academy at Edial. But the seminary closed down six months later, and master and pupil decided to seek their fortunes in London. On March 2, 1737, Johnson, aged 27, and Garrick, aged 20, left Lichfield together on horseback for London—Johnson, as he later recalled, "with two-pence halfpenny in his pocket" and Garrick "with three-halfpence in his." Intended by his father for the bar, David dutifully betook himself to Rochester to read law under the tutelage of John Colson, but Captain Garrick's death and a legacy of £1,000 from an uncle released him from studies profoundly uncongenial to him. In 1738 he and his elder brother, Peter, who had abandoned his career in the navy, set up in partnership as vintners in Lichfield and London, David managing the London branch.

Garrick had been stagestruck since childhood and, on the pretext of seeking custom, frequented the coffee houses of Covent Garden, where he made many theatrical friends, including Charles Macklin, whose theories on the reform of acting he assimilated, and Charles Fleetwood, manager of Drury Lane. Henceforth Garrick haunted the theatres, studying every branch of the art from tragedy to

pantomime. On April 15, 1740, Fleetwood presented Garrick's first comic sketch, *Lethe,* which entered on a long period of popularity. In March 1741 Garrick appeared incognito as Harlequin in Henry Giffard's small unlicensed theatre at Goodman's Fields. In the summer Giffard's company opened at Ipswich, and there, under the name of Lyddal, Garrick made his first appearance as an actor as Aboan in T. Southerne's tragedy, *Oroonoko.* On Oct. 19, 1741, he appeared anonymously as Richard III at Goodman's Fields with resounding success. His daringly naturalistic style discredited forever the singsong elocution and formalized movements of the older tragedians—a style introduced into England from France after the Restoration. Among those who applauded him was Macklin, whose novel interpretation of Shylock earlier that year had prepared the way for Garrick's greater break with tradition. Londoners flocked to Goodman's Fields. Alexander Pope saw him three times and declared "that young man never had his equal and he never will have a rival." Having made his name as a tragedian, Garrick turned to comedy and after the hunchback king came a coxcomb, an aged madman, a tragic young lover, a foolish old husband and many more in a dazzling display of versatility, until it became an open question whether he excelled in comedy or tragedy. On Dec. 2, 1741, he used his own name for the first time as Lothario in N. Rowe's *The Fair Penitent.* Within the first seven months of his career he acted 18 characters.

Garrick's decision to go on the stage deeply offended his family, and they were slow to forgive him. On the day after his initial triumph in 1741, he wrote to Peter proposing to break their partnership. He had, he said, already lost £400 of his capital, whereas as an actor his future was assured. Neither his arguments nor the success of his farce, *The Lying Valet,* mollified his brother. Nevertheless, Garrick's fortune was indeed made, and Fleetwood engaged him for Drury Lane for the nine-month season opening in Sept. 1742 at the record salary of 500 guineas. In preparation for his debut, Garrick acted at Drury Lane on three benefit nights in May. In June he went to Dublin and played opposite the fascinating Irish actress Peg Woffington at Smock Alley theatre. Their liaison, which lasted three years, began that summer. From Sept. 1742 to April 1745 he played at Drury Lane. After this he went again to Dublin and, jointly with Thomas Sheridan, managed Smock Alley theatre for the whole of the ensuing winter season. On his return in 1747 he accepted a short engagement with John Rich at Covent Garden and gave his last performances under a management not his own. At the close of the 1746–47 season, Fleetwood's patent for the management of Drury Lane expired, and Garrick, in partnership with James Lacy, purchased its renewal. Garrick contributed two-thirds of the money; *i.e.,* £8,000. The partners agreed to draw £500 a year each as managers, and Garrick, in addition, his actor's salary of 500 guineas with a clear benefit. On April 8, 1747, the agreement was signed, and in the autumn Garrick began his career as a manager.

The theatre reopened on Sept. 15, 1747, with Macklin's Shylock. Johnson's famous prologue was spoken by Garrick, whose policy as a manager it may be taken to express, while the latter's epilogue was spoken by Mrs. Woffington. The company included, besides Garrick himself, Mrs. Cibber, Mrs. Pritchard, Mrs. Clive, Mrs. Woffington, Spranger Barry, Macklin, Richard Yates and Edward Shuter. Henry Woodward joined them a year later. Fulfilling most of the functions of a modern producer, Garrick brought discipline to a slipshod stage and with judicious casting and strict rehearsing achieved a unity of style and an all-round excellence of performance new to its history. His own acting continued to astonish and delight. He chose his parts wisely, preferring those with energetic action and rapid changes of mood to suit his flamboyant style. Although his short stature made failure in such parts as Othello and Hotspur inevitable, his supremacy was never challenged. In tragedy, Barry most nearly approached him; in comedy, Woodward.

As a manager, Garrick's aim was to restore Shakespeare to favour and to discredit the Restoration plays, whose obscenity and false sentiment had, he thought, vitiated taste. Every season he presented at least ten plays popularly accepted as Shakespeare's, although most of them were in fact adaptations. He gave Nahum Tate's *King Lear,* without the Fool and with a happy ending; Colley Cibber's *Richard III,* in which only half the lines were Shakespeare's; and John Dryden's *The Tempest,* in which Miranda has a sister and the love interest is doubled. Among his own versions are *Catherine and Petruchio, Florizel and Perdita* and *Cymbeline.* No copy of his ridiculed *Hamlet,* omitting the gravediggers and with a sentimentalized ending, survives, and the manuscript is said to have been buried with him. Like his audiences, he valued Shakespeare's dramatic situations rather than his poetry, but by popularizing certain roles he aroused fresh interest in Shakespeare's then unfamiliar text.

In considering new plays Garrick was ready to encourage talent and during his 29 years' management presented 75 new plays, exclusive of afterpieces. Nevertheless, disappointed authors accused him of malice and self-interest and involved him in many paper wars. Even Johnson, whose turgid play, *Irene,* he presented in 1749 with painstaking care, showed little gratitude. Among his few sins of omission are his refusals of R. Dodsley's *Cleone* and J. Home's *Douglas.* More reprehensibly, he failed to recognize Oliver Goldsmith's dramatic gifts and missed the opportunity of presenting *She Stoops to Conquer.* He did little to bring greater historical accuracy to stage costume, excelling rather in spectacle, thus preparing the way for melodrama. In Philippe de Loutherbourg, he discovered a stage designer of genius.

Garrick had married in 1749 Eva Maria Veigel, a Viennese dancer professionally known as Mlle Violette, the ward of Lord and Lady Burlington. Little is known of her prior to her arrival in England in 1746, and her adoption by the Burlingtons has inspired many legends as to her parentage. The Garricks' marriage, though childless, was ideally happy. When in London they lived in Southampton street until 1772, when they removed to Adelphi terrace. Their real home was, however, by the Thames at Hampton, where in 1754 Garrick bought a villa. In 1763 fatigue suggested the need for a holiday. Leaving his younger brother, George, in charge of his personal interests, he and Mrs. Garrick went abroad for 18 months. In Naples they basked in the flattering attentions of the English aristocracy; elsewhere in Italy they were also cordially received. In Munich, Garrick suffered a serious abdominal illness, which left him with a weakness he never wholly overcame. In Paris, where they broke their outward and homeward journeys, Garrick made many friends among the actors and among the Philosophes, to whom as Shakespeare's champion he was especially interesting. His private performances of Shakespearean scenes in dumb show started a vogue for naturalism in the English manner, and Denis Diderot's *Paradoxe sur le comédien* was the outcome of their meeting.

In Nov. 1765 Garrick reappeared at Drury Lane as Benedick in *Much Ado About Nothing.* Henceforth he acted less frequently and never again in a new role. His refusal to play Lord Ogleby in his own and G. Colman's *The Clandestine Marriage* led to a quarrel between them, but Thomas King's brilliant rendering of the part contributed to the comedy's success in Feb. 1766. In 1769 Garrick organized the Shakespeare jubilee at Stratford-upon-Avon, thus bringing that town into prominence as the poet's birthplace. In 1773 he was elected to the Literary club and, as a member of the Johnson circle, makes many appearances in the pages of James Boswell's *Life of Johnson.* In 1776 he sold his share of the Drury Lane patent for £35,000 and gave a series of last performances in his favourite roles. They included Hamlet, Lear, Richard III and Benedick, Lusignan in A. Hill's *Zara,* Drugger in Ben Jonson's *The Alchemist,* Sir John Brute in Sir John Vanbrugh's *The Provoked Wife,* Archer in Thomas Farquhar's *The Beaux' Stratagem,* Leon in John Fletcher's *Rule a Wife and Have a Wife* and Ranger in John Hoadly's *The Suspicious Husband.* Finally, on June 10, he bade farewell to the stage as the youthful Don Felix in Mrs. Centlivre's *The Wonder!* In the course of his career he had played 96 roles. He died in London on Jan. 20, 1779, and was buried in the Poets' corner of Westminster abbey. He left a fortune of over £100,000. Mrs. Garrick survived him until 1822.

Garrick was under medium height and in later years inclined to stoutness. His large, well-marked features and compelling black eyes served him as an actor in a theatre lit by candlelight better

than conventional good looks. The extraordinary mobility of his whole person, which enabled him to transform himself, as it were, at will, are attested by many anecdotes. His charm and culture gained him many friends among the aristocracy, but his vanity, touchiness and snobbishness alienated his fellow actors. His reputation for meanness was ill-deserved. According to Johnson, Garrick had given away more money than any man in England. Goldsmith's poem *Retaliation* is a portrait of penetrating truth. Garrick's own work has proved ephemeral. "A fellow-feeling makes one wond'rous kind" is one of the few lines remembered from his 80 prologues and epilogues. Of his songs, the best-known is "Heart of Oak."

Portraits and engravings of Garrick are numerous. Sir Joshua Reynolds painted him many times. Hogarth, Zoffany and Sir Nathaniel Dance-Holland depicted him in character. Mrs. Garrick's favourite likeness of him by Gainsborough perished in the fire at Stratford in 1946. L. Roubillac's statue of Shakespeare, for which Garrick sat, is in the British museum.

See also references under "Garrick, David" in the Index volume.

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